Improving public health through housing: critical reflections on current housing delivery approaches in England

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Abstract

Housing may be the most powerful and underused tool at our disposal to improve population health. Despite substantial evidence showing which features of housing are beneficial or detrimental to health, too often people are living in homes which have a negative health impact. Therefore, there is a pressing need to understand how to move from theoretical principles to delivering healthy housing in practice, especially in England where the medical costs associated with inadequate housing are highest compared to all European Union member states.

Through the submission of seven academic works, alongside a critical commentary which triangulates data, theory and methodologies, this thesis seeks to meet requirements for the Doctor of Philosophy by Publication award. It establishes health impacts of current approaches to market housing delivery in England and possible changes to produce healthier housing. Framed with social science levels of analysis, it is complexity informed to a greater degree than is often explored within the field.

Novel contributions include: considerations when selecting a framework to demonstrate how housing impacts on health, the most comprehensive healthy housing framework known to date, depth of understanding regarding challenges and opportunities to healthy housing delivery and a matrix representation of the power relations between relevant stakeholders. Overall, it highlights concern that some mainstream current approaches to housing delivery (crowding, reducing regulatory requirements and increasing use of privately rented housing) without the necessary checks and safeguards, seem to be delivering variable and often poor-quality, insecure housing with detrimental health implications. Whereas one of the emerging approaches (Community-Led Housing) may support good health.

Given that England has some of the oldest housing stock in Europe, and the dominant stakeholders with power over housing are from non-health and often private sectors, five key recommendations are put forward to improve public health through future research and practice.

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Director of Studies: Dr Isabelle Bray
Second Supervisor: Prof Elena Marco

Declaration of authorship and training

I confirm that all of the work presented in this doctoral thesis, including the selected works and accompanying commentary (except where stated), is the original work of the author.

I confirm that none of the published body of work included within this doctoral thesis has been submitted for another academic award in this or any other institution.

I confirm that the necessary training requirements have been met (60 credits of at least M-level). The following training has been completed as part of this DPhil (Accredited Learning):

- Epidemiology on Non-Communicable Disease (UZVSMR) - 15 M-level credits
- Dissertation (UZVSMT) - 45 M-level credits

Rachael McClatchey, 2024

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Abbreviations

CLH	Community-Led Housing
COVID-19	Coronavirus Diseases of 2019
DEFRA	Department for Environment, Food and Rural Affairs
DHSC	Department for Health and Social Care
DLUHC	Department for Levelling Up, Housing and Communities
DPhil	Doctor of Philosophy by Publication
GP	General Practice
HHSRS	Housing Health and Safety Rating System
NHS	National Health Service
OHID	Office for Health Improvement and Disparities
PDR	Permitted Development Rights
PRS	Private Rented Sector
UK	United Kingdom
UWE	University of the West of England
WHO	World Health Organisation

Definitions

Community-Led Housing: An umbrella term encompassing several non-profit models of housing delivery, which meets the following criteria:

1. Meaningful community engagement and consent occurs throughout the process. The community does not necessarily have to initiate and manage the development process, or build the homes themselves, though some may do.
2. The local community group or organisation owns, manages or stewards the homes and in a manner of their choosing.
3. The benefits to the local area or specified community must be clearly defined and legally protected in perpetuity (Co-operative Councils Innovation Network, 2018).

Conceptual framework: Setting of bounds around a research problem and the specification of which constructs and relationships are fundamental to consider in understanding the problem and obtaining answers to related scientific questions (Merriam & Simpson, 2000; Diez Roux, 2020).

Crowding: This thesis refers to crowding within households, rather than housing density. Crowding can be measured, and overcrowding defined in several different ways. There are simple measures, e.g. floor area, or the number of people per bedroom, to more complex measures with underlying normative expectations of social standards, e.g. nationally described space standard (Howden-Chapman, 2004; Marsh *et al.* 2019b).

Diagram: a simplified drawing showing the appearance, structure, or workings of something; a schematic representation (Oxford English Dictionary, 2022).

Framework: A set of rules, ideas or beliefs that is used as the basis for making judgements and decisions (Oxford English Dictionary, 2022). They serve five functions: to build a foundation, demonstrate how a study advances knowledge, conceptualise the study, assess research design and instrumentation, and provide a reference point for interpretation of findings (Merriam & Simpson, 2000). In this thesis a framework refers to a diagram, tool, conceptual framework, or theoretical framework.

Health inequalities: Differences in health status or in the distribution of health determinants between different population groups (OHID, 2022).

Housing intervention: Housing can be a setting for a public health intervention, and improvements to housing can be an intervention in themselves (Mansour *et al.* 2022). This encompasses specific policies, programmes and services which directly or indirectly impact housing conditions, as well as whole-housing interventions (Howden-Chapman *et al.* 2023).

Inclusion health groups: Vulnerable groups of society, for example, migrants; Gypsy, Roma and Travellers, people experiencing homelessness and sex workers (OHID, 2022).

Theoretical framework: The broad scaffolding of a study developed from one or more theories (Merriam & Simpson, 2000; Diez Roux, 2020).

Tool: a collection of summary measures with a utility or intention to support policy and decision-making (Pineo *et al.* 2018a)**.**

Chapter 1: Introduction

This chapter presents the requirements of a Doctor of Philosophy by Publication (DPhil) award at the University of the West of England (UWE) Bristol, the list of works submitted, and the aim, objectives and research questions addressed by this thesis to meet those requirements. It also includes a summary of the authors background, academic interests and development to date.

1.1 Requirements of the DPhil award

The qualification descriptors for the DPhil award at UWE Bristol are aligned with guidelines set out by the Quality Assurance Agency for Higher Education (QAA, 2015). UWE Bristol Academic Regulations stipulate that students working towards any doctoral-level award are required to demonstrate that they:

1. Have conducted enquiry leading to the creation and interpretation of new knowledge through original research or other advanced scholarship, shown by satisfying scholarly review by accomplished and recognised scholars in the field.
2. Can demonstrate a critical understanding of the current state of knowledge in that field of theory and/or practice.
3. Show the ability to conceptualise, design and implement a project for the generation of new knowledge at the forefront of the discipline or field of practice including the capacity to adjust the project design in the light of emergent issues and understandings.
4. Can demonstrate a critical understanding of the methodology of enquiry.
5. Have developed independent judgement of issues and ideas in the field of research and/ or practice and are able to communicate and justify that judgement to appropriate audiences.
6. Can critically reflect on their work and evaluate its strengths and weaknesses including understanding validation procedures.

1.2 Access to submitted works

This DPhil is based on seven academic works, produced between 2019 and the time of writing. These include six peer-reviewed journal publications and a further under review by a journal. These works share a common concern with the intersections between housing delivery, health and inequalities. The submitted works are listed in Table 1, summarised in Table 3 and available in full in Appendix D. The presentation of published works represents only one aspect of the DPhil submission process. A critical commentary is also provided to present additional insight into the importance of the research undertaken and its contribution to existing knowledge; to explore the methodological approaches utilised; to demonstrate the candidate’s intellectual

contribution to submitted works; and, to chart the candidate's development as a researcher.

Table 1: Title and full reference for each submitted work

NO	TITLE	FULL REFERENCE
#1	Permitted Development Rights	**Marsh, R**., Chang, M., and Wood, J. (2020) The relationship between housing created through Permitted Development Rights and health: a systematic review. *Cities & Health*, 6(4), pp.833-852.
#2	Household Crowding	**Marsh, R**., Salika, T., Crozier, S., Robinson, S., Cooper, C., Godfrey, K., et al. (2019) The Association of Crowding within Households and Behavioural Problems in Children. *Paediatr Perinat Epidemiol*, 33(3), pp.195-203.
#3	Community-Led Housing	**McClatchey, R**., McClymount, K., Griffin, E., and Carmichael, L. (2023) Community led housing, health and wellbeing: a comprehensive literature review. *Int J Hous Policy*.
#4	Private Rented Sector Housing	**McClatchey, R**., Ferraro, C., Turner, E., and Harris, J. (2023) Local government approaches to improving the health and wellbeing of tenants in private rented housing: developing initial program theory to inform evaluation in the United Kingdom. *BMC Public Health* (submitted, under review). Available as additional file on the UWE repository.
#5	Building Policy	Carmichael, L., Prestwood, E., **Marsh, R**., Ige, J., Williams, B., Pilkington, P., et al. (2020) Healthy buildings for a healthy city: Is the public health evidence base informing current building policies? *Sci Total Environ*, 719(1), pp.137-146.
#6	Workforce Development Evaluation	**Marsh, R**., Pilkington, P., Marco, E., and Rice, L. (2020) Evaluating a workforce development programme: bringing public health into architecture education in England. *Cities & Health*, 6(2), pp.326-338.
#7	Architecture Profession	**Marsh, R**., Pilkington, P., and Rice, L. (2019) A guide to architecture for the public health workforce. *Public Health*, 30(178), pp.120-123.

1.3 Aim, objectives, and research questions

Aim

Drawing upon a body of published academic works, this DPhil aims to evidence a significant contribution to knowledge in public health and housing, set in the context of current approaches in market housing delivery in England.

Objectives

To achieve this aim, the following objectives are proposed:

- Collate evidence from a body of seven published academic works, including their contribution to each of UWE's doctoral requirements.
- Synthesise the evidence through a written critical commentary, framed with complex systems thinking across micro, meso and macro levels, and a focus on moving understanding from theory to delivering healthy housing in practice.
- Critically examine the methodological considerations associated with these works and wider research in this field, to make recommendations for future research and practice.

Research questions

The two main research questions are:

1. What are the health impacts of current approaches to market housing delivery in England?
2. What changes to housing delivery in England can be made to produce more healthy housing?

To facilitate answering these, further sub-questions have been designed:

1. What considerations should be given when selecting a framework to demonstrate how housing impacts on health?
2. How are four current housing delivery approaches in England impacting on health inequalities?
3. How might relevant stakeholders influence healthy housing delivery?
4. What are the challenges and opportunities in England to delivering healthy housing in practice?

1.4 Definition of healthy housing

Many definitions of 'healthy housing' exist. For the purpose of this thesis healthy housing is understood as the definition set out by the World Health Organisation (WHO, 2018); "*shelter that supports a state of complete physical, mental and social well-being*". This

conceptualisation applies to the housing's physical structure, as well as its social and economic characteristics (Mansour *et al.* 2022; WHO, 2018).

There is now an understanding that not just physical features of housing (e.g. sanitation, ventilation, insulation, or materials), but also psychosocial features (e.g. affordability, or feelings of belonging, privacy and safety) can have an impact on health. In addition to features at the building level, whether housing is healthy also depends on aspects outside its walls. It depends on the local community and the immediate environment surrounding the house. Features at the neighbourhood level can include access to local services, greenspaces, social interactions, active and public transport options, and protection from pollutions or disasters (Prochorskaite, *et al.* 2016; WHO, 2018; Pineo *et al.* 2018b; Ige *et al.* 2020; Turcu *et al.* 2021).

1.5 Scope

Geoffrey Rose transformed our conception of public health prevention by introducing the notion of a universal strategy of prevention, which targets a whole population regardless of variation in individuals' risk status for disease (Rose, 1985). Housing can be viewed as both a 'population-level' or 'universal' intervention by using it as environment that affects every individual in a population, or as a 'high risk' or 'targeted' intervention by selecting types of housing where the occupants' are likely to be particularly vulnerable and have greater health needs (e.g. temporary accommodation or social housing) (Ellaway *et al.* 2016). Whilst both approaches have advantages and disadvantages, Rose argued that intervening for the entire population improves risk distribution for all, resulting in the most effective improvement in public health overall. From the spectrum of housing (see chapter 2.2 'Housing as part of a complex system' for further details), only market housing (privately rented, and housing owned outright by individuals or groups), which houses the majority (83%) of the population in England is in scope for this thesis (DLUHC, 2022a), thereby approaching a universal approach. Homelessness, temporary accommodation, supported housing and social housing are all out of scope as they are fundamentally different from market housing and too disparate to be included. Housing can be at any lifecycle stage but must be in England. In addition, behaviours which take place within the housing environment (e.g. smoking, domestic violence) but are not a consequence of the housing itself, are beyond the scope of this thesis so may be mentioned but not explored in detail.

1.6 Author background

The author is a Public Health physician with a long-standing interest in healthy environments. They have over nine years' experience, having worked in local, regional

and national government, acute NHS trusts, and academic institutions.

Health challenges faced in the 21st century; including the rise of non-communicable diseases, rapid urbanisation, and the climate emergency, drew the author to specialise in public health and work in particular on environmental determinants of health for much of their career. Given the complexity of these challenges and necessity of disciplines that would not usually be considered within the public health field (Academy of Medical Sciences, 2022), they have developed expertise in bridging academia and practice, and in transdisciplinary working.

Internationally there are few leaders in the overlap between health and housing, especially from medical backgrounds. Working initially as a clinician and now as a qualified consultant in Public Health, gives the author strong scientific and evidence-based skills, and a detailed understanding of the health impacts from environmental exposures. They are a practitioner-researcher, always spanning policy, practice and academia. In their current split role in the Office for Health Improvement and Disparities (OHID) South West, and as Visiting Fellow at UWE, they use their practitioner role to determine research priorities and maximise its' impact, and their academic role to ensure policy and programmes are evidence informed.

Their interdisciplinary expertise, working with professionals from housing, planning, transport, natural environments, air quality and sustainability, enables them to develop new approaches, inspire others, and build consensus to improve peoples' health and reduce health inequalities. As directorate lead for wider determinants of health they are well connected with public health and environment professionals both in academia and with influential national and local policymakers. This enables them to have significant influence in the field of healthy housing.

Chapter 2: Background

This chapter set out the important points relevant to the thesis objectives and research questions regarding the existing evidence base and housing delivery context in England.

2.1 Housing as a public health opportunity

"*Housing may be at once the most powerful and underused tool at our disposal to improve population health.*" (Leifheit *et al.* 2022)

There is extensive evidence demonstrating the importance of housing as a wider determinant of health (Dahlgren & Whitehead, 1992; WHO, 2018; Morris *et al.* 2019). In terms of duration of exposure, people typically spend more time at home compared with their exposure to any other kind of environment (Farrow *et al.* 1997; Sharpe *et al.* 2018). The impact of housing on health has been widely reported for numerous outcomes including cardiorespiratory diseases, infectious diseases, injuries, allergies, and mental health conditions (Gibson *et al.* 2011; Bird *et al.* 2017; WHO, 2018; Ige *et al.* 2020; Leifheit *et al.* 2020; Garret *et al.* 2021).

Moreover, the unequal distribution of poor-quality homes across the population correlates with other forms of social and economic inequality and contributes to health inequalities (Gibson *et al.* 2011). The elderly, those with pre-existing health conditions, and the very young, often spend an even greater proportion of their time inside and are especially vulnerable to impacts from the housing environment (WHO, 2018). The Coronavirus Diseases of 2019 (COVID-19) pandemic and the Cost-of-Living Crisis (the fall in 'real' disposable incomes, adjusted for inflation and after taxes and benefits) have exacerbated health issues associated with poor housing, through multiple lockdowns requiring people to stay at home and increasing financial difficulties in running costs and maintenance (Kings Fund, 2023; ONS, 2022).

Despite a substantial evidence base showing which features of housing are beneficial or detrimental to health, too often people are living in homes which have a negative impact on their health, evidenced by;

- The United Kingdom (UK) has the oldest stock and the highest medical costs associated with inadequate housing compared to all 27 European Union member states (Nicol *et al.* 2016; Kings Fund, 2023); with 14% of all homes failing to meet the Decent Homes Standard (free from the most serious health and safety hazards) (DLUHC, 2021a; DLUHC, 2022a).

- In England 7.5 million households (one in three) experience at least one housing problem (unaffordability, poor quality or overcrowding) and around one million households (13%) experience more than one of these housing problems (Kings Fund, 2023).
- Of new homes delivered in England 20% are of such poor quality that they should not have been given planning permission (Place Alliance, 2020), and less than 13% are within walking distance of public transport (Carmichael *et al.* 2019).

Not only does this have significant implications on the occupants' lives but for wider health and social care systems too. In the UK, the National Health Service (NHS) spends more than £1 billion per year to treat people who are affected by poor housing (e.g. General Practice (GP) visits, prescriptions, and hospital treatment) (Garrett *et al.* 2023). If wider societal costs are included, such as those relating to care, £136 billion could be saved over 30 years (Garrett *et al.* 2023). These costs rival those of other significant societal health hazards such as smoking. Improving the non-decent homes up to the required standard is anticipated to pay for itself in savings to the NHS in nine years (Garrett *et al.* 2023).

There is therefore a pressing need to understand how to move from theory (i.e. the evidence base and principles of healthy housing) to delivering healthy housing in practice (Academy of Medical Sciences, 2022; Pineo & More, 2022).

2.2 Housing as part of a complex system

Although knowledge about the pathways through which wider determinants influence health has accumulated and is growing, the complexity that is involved with studying and understanding these determinants, the exact pathways through which they operate, and how they affect population health outcomes continue to pose real challenges for advancing the field, and for developing coherent, practical interventions (Mahamoud *et al.* 2013). In the past 20 years, there has been rapidly growing interest in the applicability of complex systems theory to public health (Carey *et al.* 2015).

Complex systems theory is based on an understanding that properties within a system are dynamic, interdependent and interact over time. Among factors that compound the complexity are multiple levels of determinants, multiple pathways linking each determinant to outcomes, the intersection of these levels and the potential feedback relationships between all of these factors. Essential to note regarding public health, are also intergenerational influences and the accumulation of risk and social disadvantage across the life span, further adding to the intricacies associated with public health research, particularly, on intervention research or real-world change (Mahamoud *et al.*

2013; Rutter *et al.* 2017). Applying complex systems theory is therefore relevant to the aim of this thesis as it supports understanding of how and why decisions on healthy housing are made and what actions may be required for positive change.

The housing sector is acknowledged as part of a complex system (Gibb & Marsh, 2019; Morris *et al.* 2019; WHO, 2021). Housing ranges across a spectrum, including homelessness (e.g. rough sleeping, sofa surfing), temporary accommodation (e.g. emergency shelters, transitional), supported housing (e.g. for disabled people, older people, or people who have experienced domestic abuse), affordable housing (e.g. socially rented, shared ownership), and market housing (private rented, owned outright). There are multiple lifecycle stages of housing to consider, from the construction and design of new homes, to maintenance and renewal, through to demolition. In addition, differential health impacts may emerge for the same housing dependent on the occupants individual sociodemographic, health and care needs, the household composition, and the use of and behaviour within the house (e.g. time spent in housing, cleanliness, use of utilities, etc).

The pathways through which housing can impact on health are numerous and interlinking (Gibson *et al.* 2011; Mahamoud *et al.* 2013). A single housing feature can lead to multiple health impacts. Unaffordable rent or mortgage costs, lead to stress and feelings of insecurity from risk of eviction, affecting mental health. It might also have physical health impacts by altering occupants' behaviour, e.g. using less heating to reduce utility costs, contributing to a cold indoor environment and damp and mould development, with subsequent respiratory impacts. Another pathway would be through overcrowding, in attempts to spread housing costs, multiple people might share a single home. This could have both mental and physical health impacts, through lack of privacy, and greater risk of infectious disease transmission. This example would be more significant for certain vulnerable groups, such as those with pre-existing respiratory disease, or older people (Ige *et al.* 2020; Mansour *et al.* 2022).

Housing is interdependent with other major systems such as planning, transport, environment, education, and social security. Whilst we can attempt to understand the mechanisms through which housing may generate health outcomes, it is neither possible nor practically useful to separate elements of this complex system. The need to improve research on housing and health by taking a holistic, whole systems approach is increasingly highlighted by researchers (Gibson *et al.* 2011; Rutter *et al.* 2017; Sharpe *et al.* 2018; Munro *et al.* 2022; Leifheit *et al.* 2022). Ignoring the interdependencies between factors can have unintended harmful consequences, e.g. draft proofing to

reduce ventilation improves energy efficiency and reduces carbon emissions but can worsen air quality (Ige *et al.* 2020).

As the underlying factors that drive public health are complex and fragmented, especially in urban settings, addressing this calls for the active confrontation of substantial policy challenges (Mahamoud *et al.* 2013). Achievement of meaningful impacts on a complex problem like healthy housing, requires more than isolated interventions. Shifts within multiple elements across the many systems that influence housing are required, some of which might only have small effects on individuals but can drive large changes when aggregated at population level (Rutter *et al.* 2017). The development of healthy housing is therefore likely to be most effective if the complexity is acknowledged and policy objectives are not considered in isolation (Mahamoud *et al.* 2013; Fink & Keyes, 2017; WHO, 2021).

2.3 Current housing delivery context in England

Housing delivery governance mechanisms

In England, there are extremely complex governance mechanisms regarding healthy housing, spread across legislation (laws passed by legislative bodies), regulation (requirements usually mandated by governments to implement legislation), and industry, voluntary or independent initiatives. Table 2 shows a summary of the main current governance mechanisms relevant to healthy housing in England.

Table 2: Summary of the main governance mechanisms relevant to healthy housing in England, as of March 2024

	LEGISLATION (INCLUDING PROPOSALS)	GUIDANCE & REGULATION	INDUSTRY, VOLUNTARY OR INDEPENDENT INITIATIVES
NATIONAL	Renters (Reform) Bill (2024)	National Planning Policy Framework (updated 2023)	NHS Healthy New Towns principles (2022)
	Healthy Homes Bill (House of Lords, 2023)	Future Homes and Buildings Standard (updated 2023)	WELL Building Standard v2 (2018) - charity
	Social Housing (Regulation) Act (2023)	Decent Homes Standard (under review)	Building for a Healthy Life (previously Building for Life 12) (updated 2018) - industry
	Coronavirus Act (2020)	National Model Design Code (updated 2021, recent consultation)	Building with Nature 2.0 (2015) – charity
	Homes (Fitness for Human Habitation) Act (2018)	Planning Practice Guidance, inc. National Design Guide (2019)	Fitwel v3 (2015, updated 2023) – US government, increasing use in UK
	Homelessness Reduction Act (2017)	Homes England Strategic Plan (–2023-2028)	Building Research Establishment Environmental Assessment Method (1990) inc. Home Quality Mark (2015) - independent
	The Town and Country Planning General Permitted Development Orders (various)	The Licensing of Houses of Multiple Occupation (Mandatory Conditions of Licences) (England) Regulations (2018)	Lifetime Homes (updated 2010) – charity developed, endorsed by government
	Housing and Planning Act (2016)	Homes England Housing Quality Indicators (2007)	One Planet Living (2003) - charity
	Energy Efficient standards e.g. European Parliament Energy Efficient Directive	Housing Health and Safety Rating System (2006)	
	Housing Act (2004)	Building Regulations (various)	
	Environmental Protection Act (1990)	Chartered Institute of Building Services Engineers Guides (various)	
	Town and Country Planning Act (1990)		
	Landlord and Tenant Act (1985)		
REGIONAL		Combined Authority Housing Delivery Strategy	
LOCAL		Local Plan	
		Housing Strategy	
		Private Rented Sector Strategy	
		Homelessness and Rough Sleeping Strategy	

Governance mechanisms span national, regional and local levels, and different governance mechanisms apply depending on the location, type and funding of the housing (Turcu *et al.* 2021). Whilst some apply across all housing types and lifecycle stages (e.g. Healthy Homes Bill (TCPA, 2023)), others are specific to a sub-set of housing (e.g. Future Buildings Standard to new builds only (DLUHC, 2021b), or the Renters (Reform) Bill (2024) to privately rented housing only).

In England, quality for all housing is evaluated using the Housing Health and Safety Rating System (HHSRS), a risk-assessment tool that does not set out a prescribed minimum standard but can be used to judge hazards based on the likelihood and severity of potential harm (Houses of Parliament, 2018; DLUHC, 2022a). Generally, energy efficiency and building safety/ health hazards are prominent, but housing features which promote health and wellbeing, particularly mental health, are less common (Houses of Parliament, 2018; Parallel Parliament, 2023). The governance mechanisms are often owned and administered by different government departments with limited understanding of how they impact on one another, or which need to be complied with (CABE, 2010; Houses of Parliament, 2018), consequently there are calls for a more holistic approach to simplify the governance and accountability around healthy housing (Parallel Parliament, 2023).

In addition to governance mechanisms there are also programmes, services and financial systems which influence healthy housing delivery (CABE, 2010; WHO, 2021). These vary in purpose, from creating new housing (e.g. construction programmes or land tax), to maintaining existing housing (e.g. refurbishment programmes, or grants for individuals to adapt their homes), to improving access to healthy homes (e.g. rehousing programmes or utility subsidies) (WHO, 2021).

Overall, whilst there a significant body of regulation to guide healthy housing, it is extremely complex and there can be overlap, gaps and potentially conflicting priorities within it.

Market housing delivery trends

Approaches to housing delivery in England have changed drastically over time. From a focus on sanitary improvements in the 19th century to the rise of social housing delivery following World War II through to the second half of the 20th century. Some main current trends in market housing delivery include:

<u>Tenure: proportion of privately rented housing is increasing</u>

The Private Rented Sector (PRS) has experienced significant growth, doubling over 20 years, from approximately 10% of British households in 2000, to approximately 19% in 2021/22 (DLUHC, 2022a). Although there are indications that this may be beginning to decline (Propertymark, 2022). PRS housing is generally the worst quality of housing stock across tenures. In England, 14% of all homes are classified as non-decent; and this figure rises to 23% of homes in the private rented sector (DLUHC, 2022a).

Regulation: level of regulation is reducing

Since 2010, the planning system has been gradually deregulated. Permitted Development Rights (PDR) (which enable the change of a buildings use to take place, bypassing the standard planning process) have been significantly expanded (Marsh *et al.* 2020). In 2018/19, in some areas, over half of the housing delivered was through PDR (Marsh *et al.* 2020).

Size: within homes the space is decreasing, and the density is increasing

New homes in the UK have long been the smallest in Western Europe (Williams, 2009), and there is an increasing trend towards small or 'micro' home. The overall rate of people living in overcrowded conditions in England is currently 3% (over 730,000 households, or 3.7 million people) and this has been increasing in recent years, particularly in rented accommodation (National Housing Federation, 2021; DLUHC, 2022a). There is a risk that this is likely to worsen with an increasing population size, continued urbanisation, and ongoing concerns about housing shortages.

Producers: community involvement is gaining attention

In England, most homes are delivered by private developers. Whereas, in 2000, many small firms were responsible for the majority of houses built in the UK, now only eight house builders are responsible for over half of new homes (House of Commons, 2017). Over a similar period, community involvement in housing delivery has been gaining attention, and whilst Community-Led Housing (CLH) (an umbrella term encompassing several non-profit models of housing delivery with community involvement) still comprises a relatively small portion of housing delivery, it has greatly increased (Ruiu, 2016).

2.4 Evolution in the evidence base

There is less research on housing than other aspects of environmental determinants of health. In an umbrella review of the impacts of the built environment on health, just 21 (12%) of the 178 studies that met the inclusion criteria were focussed on housing compared with 25% on neighbourhood design and 35% on natural and sustainable environments (Bird *et al.* 2017). Similarly, an umbrella review by Turcu *et al.* (2021)

mapped health evidence with a specific focus on urban housing across the spatial scales of the built environment (building; neighbourhood; and wider system) and found most evidence reports on health determinants at the neighbourhood level. Recently, Callway *et al.* (2023) found healthy housing was one of the least reported themes in an analysis of seven Local Plans.

Whilst there is still a large amount of research on housing and health, most is on understanding the impact of housing on human health, and on what healthy housing is (i.e. which features of housing have an impact on health outcomes), but relatively little is understood about how health can be factored in at key governance tipping points further 'upstream' (Black *et al.* 2021). Understanding the mechanisms which determine whether and how healthy housing is delivered is less researched and extremely complex due to the many interdependent elements. There is therefore a pressing need to understand the how to move from theory (i.e. the evidence base and principles of healthy housing) to delivering healthy housing in practice (Academy of Medical Sciences, 2022; Pineo & More, 2022), and to better integrate research into the policy context (WHO, 2020).

Leifheit *et al.* (2022) performed a critical reflection to guide the future direction for research on housing and health. They recommend that researchers should now pursue research questions with the potential to meaningfully alter social, economic and policy landscapes. This is further reinforced by a recent evidence review on housing and health inequalities, which concluded that there is an urgent need for research to explore mechanisms to enabling effective interventions (Munro *et al.* 2022).

Gaps in the current evidence base are further expanded in the chapter 3 ('Research approach') and chapter 4 for each research sub-question.

Chapter 3: Research approach

This chapter documents the research paradigm and methods used, both within the individual submitted works and the critical commentary. Importantly, it specifies the authors own individual contribution, which is critical to meeting the DPhil requirements.

3.1 Research paradigm and theory

Pragmatism

Pragmatism is often referred to as a philosophy for identifying "what works", as opposed to a search for objective "truth" or "reality" (Weaver, 2018; Allemang *et al.* 2022). The philosophical movement emerged in the 1870's and it asserts that the nature of reality (ontology), the nature of knowledge (epistemology), and the approaches for research inquiry (methodology) are not fixed. Concepts are only relevant when they are supporting action. As pragmatic research seeks to identify "what works" in a real-world context, it draws upon quantitative, qualitative and mixed methods approaches that are best suited to answer the research question under investigation (Weaver, 2018; Allemang *et al.* 2022).

In undertaking the research presented within this thesis, which sought to identify evidence to improve health and reduce health inequalities through housing, the application of a pragmatic research approach, which attempts to move from theory to making a difference in practice, using methods most appropriate to answer the research questions of each submitted work, was particularly apt. Also, given that diverse forms of disciplinary and experiential knowledge are required to understand challenges around healthy housing delivery and develop workable solutions, this thesis has been produced from transdisciplinary research. Differing epistemological positions is a known challenge of transdisciplinary working (Allemang *et al.* 2022), so pragmatic housing research presents an opportunity to generate evidence that is of value to stakeholders and decision-makers working in real-world multidisciplinary settings, such as housing officers, planners, and public health professionals.

Socio-ecological theory and social science levels of analysis

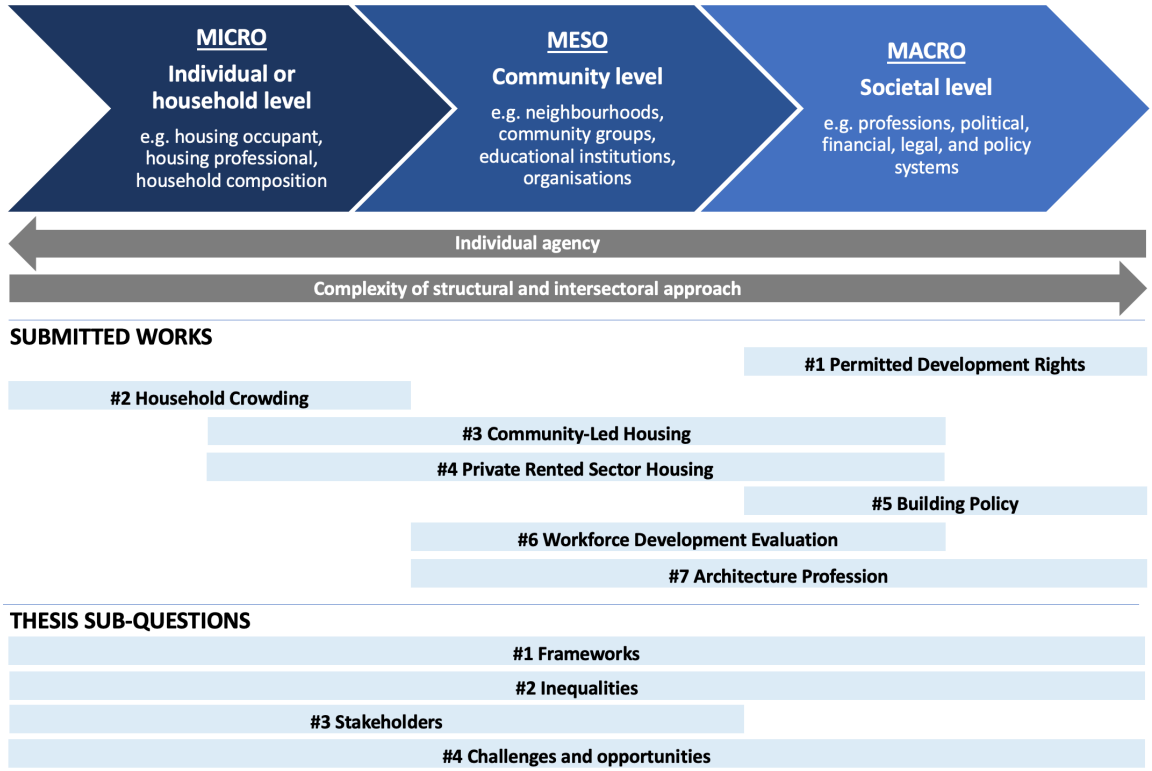
Socio-ecological theory was first introduced for understanding human development by psychologist Urie Bronfenbrenner in the 1970s. The initial theory was illustrated by five nesting circles surrounding the individual in the centre each representing various systems (Bronfenbrenner, 1977). A notable construct of health that is broadly conceptualised on this socio-ecological theory is Dahlgren and Whitehead's (1992) socio-ecological model of health. This places individuals at the centre, surrounded by community and organisational factors, further encircled by socio-economic, cultural and

environmental factors, all of which are hypothesised to influence health. Socio-ecological theory states that health is affected by the interaction between the characteristics of the individual, the community, and the environment, which includes physical, social, economic and political components (Bronfenbrenner, 1977).

Similarly, there is are‘levels’ of social analysis, which have been used to frame understanding of behaviour since the establishment of social sciences (Wiley, 1988). This is well aligned with the socio-ecological model of health (Dahlgren & Whitehead, 1992; Allemang *et al.* 2022) in which the importance and complexity of the social, political and environmental context is acknowledged. It is also well aligned with complex systems theory which supports understanding of how the system works and actions that may be required for positive change. Housing interventions may be implemented at one or multiple levels, and each level involves different stakeholders and types of governance. Hence, understanding the confluence of different levels of housing in which an intervention acts is necessary to improve knowledge and to implement healthy housing initiatives more effectively (Bronfenbrenner, 1977; Morris *et al.* 2019; Turcu *et al.* 2021). Therefore, to frame this thesis the levels of social analysis has been used.

Figure ***1*** maps elements which influence healthy housing delivery against the three levels of social analysis, along with alignment of the issues being studied within each submitted work, and by each research sub-question. This Figure is an adaptation of previous efforts to map one aspect of healthy housing to the levels of social analysis; Leifheit *et al.* (2022) on housing security and Lawler *et al.* (2022) on fuel poverty. It shows, moving from left to right involves more complexity in structural and intersectoral approaches, while, conversely, the level of householders' individual agency to tackle issues decreases (Lawler *et al.* 2022). As well as demonstrating that between them, the submitted works span all of the levels of social analysis, with the majority on meso or macro level factors, it shows that each research sub-question has used the levels of social analysis to structure the analysis.

Figure 1: Theoretical framework showing how housing affects health across the levels of social analysis and alignment of submitted works



3.2 Submitted works

The seven works submitted with this DPhil share a common concern with the intersections between housing delivery, health and inequalities. For each submitted publication, the methodological approach applied was deemed the most appropriate methodology for answering the original research question(s). Submitted works include evidence synthesis methodologies (Publications 1, 2, 3, 5), quantitative inquiry (Publications 2, 4, 6), qualitative inquiry (Publications 3, 4, 5, 6), and a descriptive commentary (Publication 7). A list of the submitted works, along with the authors intellectual contribution is presented (Table 3 and Appendix A). Data collection methods across the submitted works include a total of four systematic reviews, 51 interviews, one focus group, six surveys and three document reviews (of which the author carried out or directly supervised three systematic reviews, 19 interviews, two surveys and one document review). Data analysis methods have included basic descriptive analysis, multiple linear regression, thematic analysis, and realist evaluation.

3.3 Intellectual contributions

Table 3 clearly documents the authors contributions to each publication submitted; as lead author for six of the seven papers, the author was involved at each stage, from study conceptualisation through to publication. In the paper where the author was third,

they joined the research team after the initial research question had been proposed and led on one aspect of the methodology (a policy review).

In the interest of openness and transparency, co-authors of each publication were invited to provide a signed statement confirming the contribution (Appendix A). In total, 16 co-authors were consulted.Four co-authors (Sarah Crozier, Sian Robinson, Keith Godfrey, and Cyrus Cooper) for Publication 2 and two co-authors (Eleanor Eaton and Aleksandra Michalec) for Publication 5 were not contacted due to their relatively small involvement in co-authorship.

Table 3: Summary of submitted works' research validation, citations, impact factor, methods and intellectual contribution

NO.	SUBMITTED WORK	RESEARCH VALIDATION	CITATIONS & IMACT FACTOR[+]	METHODS	INTELLECTUAL CONTRIBUTION[++]
#1	Permitted Development Rights	Published Double-blind peer-reviewed	Citations: 9 Impact Factor: 2.2 (CiteScore)	• Evidence synthesis/ systematic literature review	• Lead author • Collaboratively identified and developed the topic • Led the overall concept and design of the project • Conducted systematic literature review of heterogenous sources (database searches performed by knowledge and evidence specialist) • Collaboratively drew conclusions and corresponding implications • Led all drafts of the work, including revisions • Disseminated the findings
#2	Household Crowding	Published Double-blind peer-reviewed Open Access	Citations: 22 Impact Factor: 3.98	• Evidence synthesis/ systematic literature review • Birth cohort study, multi-point survey • Quantitative - Secondary data analysis of two survey time-points, including multivariable linear regression (Stata)	• Lead author • Identified and developed the topic • Led the overall concept and design of the project • Conducted a systematic literature review • Conducted quantitative data analysis (multivariable linear regression) • Collaboratively drew conclusions and corresponding implications • Led all drafts of the work, including revisions • Contributed to dissemination of the findings • A statistician performed the multiple imputation
#3	Community-Led Housing	Published Double-blind peer-reviewed	Citations: 0 Impact Factor: 3.92	• Evidence synthesis/ systematic literature review	• Lead author • Collaboratively identified and developed the topic

		Open Access		• Community engagement/ participatory methods	• Collaboratively led the overall concept and design of the project • Conducted systematic literature review of heterogenous sources • 4th author on initial report, worked jointly with a Research Associate from a built environment background and performed the quality appraisal • 1st author on peer-reviewed publication when independently re-conducted the review to make it contemporary • Presented at community engagement event • Collaboratively drew conclusions and corresponding implications • Led all drafts of the work, including revisions • Disseminated the findings
#4	Private Rented Sector Housing	Pre-publication, submitted Double-blind peer-reviewed	Citations: N/A Impact Factor: N/A	• Evaluation • Primary data collection • Mixed methods • Qualitative data collection (documents and 10 interviews) and analysis (NVivo) • Quantitative data collection and analysis (1 survey)	• Lead author • Identified and developed the topic • Created the research team • Led the overall concept and design of the project • Conducted ethics approval process • Supervised a registrar to collect quantitative and qualitative data • Supervised a registrar to conduct quantitative and qualitative analysis • Collaboratively drew conclusions and corresponding implications • Collaboratively drafted the first manuscript, and led on revisions

					• Collaboratively disseminated the findings
#5	Building Policy	Published Double-blind peer-reviewed	Citations: 35 Impact Factor: 10.75	• Policy review and analysis • Evidence synthesis especially grey literature • Qualitative data collection (28 interviews)	• 3rd author • Conducted a policy search, data extraction and synthesis • Collaboratively drew conclusions and corresponding implications • Led drafts of sections of the work, including revisions
#6	Workforce Development Evaluation	Published Double-blind peer-reviewed	Citations: 5 Impact Factor: 2.2 (CiteScore)	• Evaluation • Before-and after study • Mixed methods • Primary data collection • Qualitative data collection (12 interviews, 1 focus group, documents) and analysis (NVivo) • Quantitative data analysis (3 surveys)	• Lead author • Identified and developed the topic • Led the overall concept and design of the project • Conducted ethics approval process • Collected quantitative and qualitative data • Conducted quantitative and qualitative analysis • Collaboratively drew conclusions and corresponding implications • Led all drafts of the work, including revisions • Disseminated the findings
#7	Architecture Profession	Published Double-blind peer-reviewed	Citations: 16 Impact Factor: 4.98	• Short communication/ thematic descriptive approach mapping profession to public health models	• Lead author • Identified and developed the topic • Led the overall concept and design of the project • Led all drafts of the work, including revisions • Disseminated the findings

[+]*Citations according to Google Scholar, up to 04/01/2024; Journal esteem according to Impact Factor or equivalent, taken form the Journal metrics as of 01/06/2023*

[++]*mapped to International Committee of Medical Journal Editors Vancouver Protocol on authorship (ICMJE, 2009)*

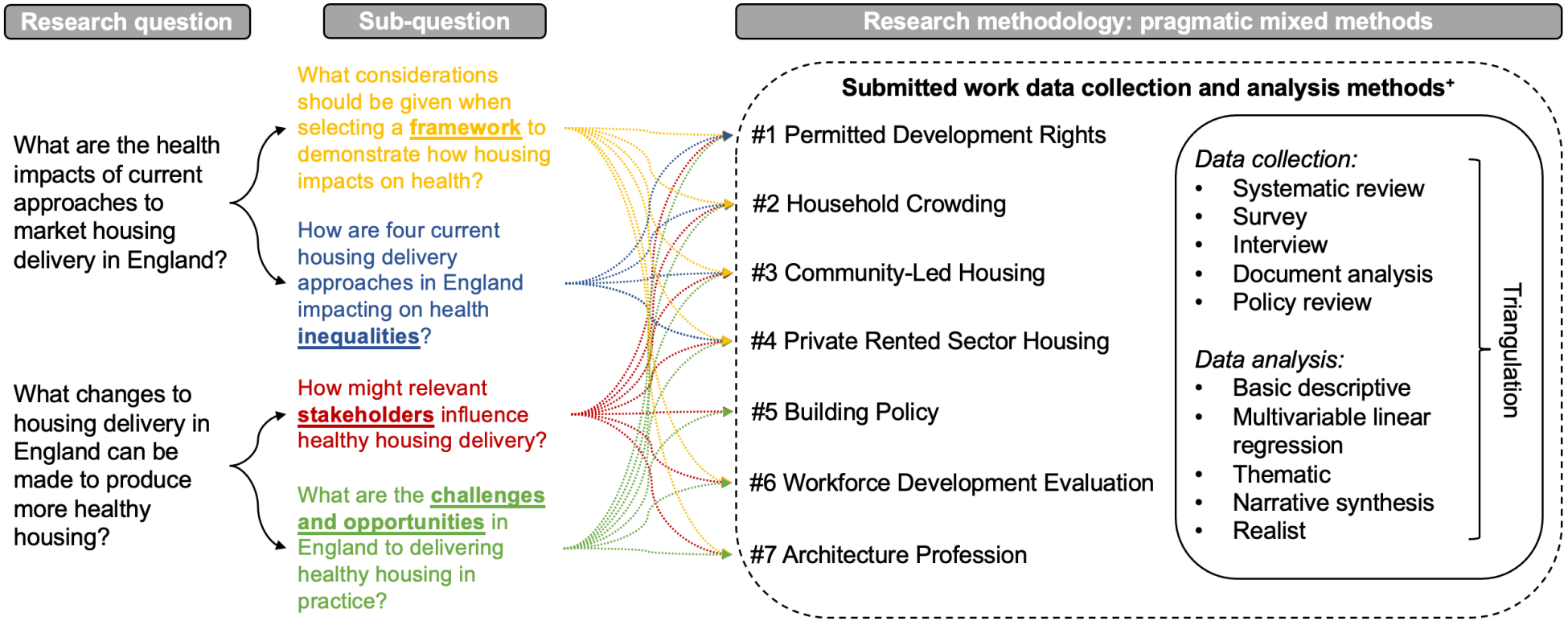
3.4 Critical commentary methods

To synthesise the submitted works into a single body, which evidences complex systems thinking across micro, meso and macro levels, a critical commentary has been provided. To facilitate this commentary, four research sub-questions have been designed, and Figure 2 shows how these questions link to the submitted works.

For each sub-question a rapid evidence review was conducted to inform the analysis and discussion. The critical commentary utilises three types of triangulation (data, methodological and theory) across the relevant submitted works. Triangulation refers to the application and combination of several datasets, methods, theories and/or investigators in the study of the same phenomenon. It is used in research to gain insights into the research problem from multiple perspectives and levels, to capture the complexity of real-world phenomena, and for a more holistic perspective on a specific research question (Rothbauer, 2008; Noble & Heale, 2019). Triangulation was deemed appropriate as the method of analysis in this DPhil because of the complex, multi-factorial and transdisciplinary nature of healthy housing, because qualitative and mixed methods were used in the majority of the submitted works, and because it can accommodate a wide range of research questions (Rothbauer, 2008).

Chapter 6 evidences the first and second objectives, by individually cross-referencing each submitted work with UWE's doctoral requirements, and summarising how collectively with the critical commentary they evidence knowledge, methodological capabilities and understanding of theory in relation to housing delivery approaches and health. The third objective is evidenced in chapter 5 through the discussion of the methodological strengths, limitations and future research and practice recommendations.

Figure 2: Research questions and methods addressed by each submitted work



+*Table 3 provides more detail on which data collection and analysis methods were used by each submitted work*

3.5 Ethical considerations

Publications 1, 3 and 5 utilised evidence synthesis methods. Publications 1 and 3 are systematic reviews, and Publication 5 is a policy review. Evidence synthesis is a form of secondary research that draws upon publicly available data, and as such, formal ethical approval was not required. However, in undertaking the reviews, guidance was consulted on the ethical issues associated with evidence synthesis preparation and reporting, such as avoiding plagiarism, transparency and ensuring accuracy (Wager & Wiffen, 2011).

Publication 2 is secondary data analysis which includes a systematic review. The author familiarised themself with the original full ethical approval granted for the cohort study from the Southampton and Southwest Hampshire Local Research Ethics Committee. As the participants were children, all their mothers had given written informed consent.

Publications 4 and 6 utilised mixed methods which involved the collection and analysis of primary data, requiring careful consideration of ethical issues and potential risks. Ethical approval was granted by the Health and Applied Science Research Ethics Committee at UWE Bristol. All data collected from these research projects were held and used in accordance with the Data Protection Act (2018). All participants provided informed consent, after being provided information on how their data would be used, stored, and how to withdraw. Neither study included participants who were vulnerable, and no names, dates of birth or other individual identifiers were recorded (participants were provided with anonymous identification numbers). However, since information regarding job role and organisation was recorded, in combination these variables could compromise confidentiality and therefore in publications data was not attributed to a named organisation.

Lastly, Publication 7 was a short communication paper, taking a thematic descriptive approach, and as such ethical approval was not required.

Chapter 4: Critical commentary

This chapter meets the second objective by synthesising the submitted works into a single commentary, which evidences complex systems thinking across micro, meso and macro levels. The first question considers how the entirety of health impacts from housing can be understood to facilitate the rest of the thesis. The second question shifts the focus from theory to how to deliver healthy housing in practice.

The same structure is used to answer each of the four research sub-questions in turn. First the current evidence base is presented including any gaps or suggested research. Next the exact method used is expanded on. Lastly, the results and a brief discussion are presented. A fuller and integrated discussion is provided in chapter 5.

4.1 What are the health impacts of current approaches to market housing delivery in England?

This first question focusses on how the entirety of health impacts from housing can be understood, through a critique of the application of frameworks, a review of health inequality impacts from four current approaches to market housing delivery in England and summated with the development of a comprehensive healthy housing framework.

4.1.1 What considerations should be given when selecting a framework to demonstrate how housing impacts on health?

To examine the health impact of current approaches to housing delivery, it is necessary to understand the complexity of relationship between housing and health. This sub-question is designed to explore how the entirety of health impacts can be understood and illustrated. Whilst each submitted work contains its own approach to presenting the complex relationship, this section provides an opportunity to synthesise them collectively, examining their characteristics and considering their appropriateness for selection, including their ability to represent considerations across levels of social analysis.

Evidence base

The complexity of the relationship between housing and health can be represented through diagrams, tools, conceptual frameworks and theoretical frameworks. Whilst they are not the same, they can all structure, simplify and represent the ways in which complex issues, such as environments can impact on health (Pineo *et al.* 2018b; Morris *et al.* 2019; Merriam & Simpson, 2000; WHO, 2020; Pineo, 2022). This kind of framing can be particularly relevant for topics covering diverse sectors but working towards a

common goal, such is the nature in healthy housing, and for ensuring that no unintended effects are being overlooked (Merriam & Simpson, 2020; Diez Roux, 2020).

Several concepts were explored in the housing and health literature to develop a definition for 'healthy housing framework' for this analysis. The individual definition for 'healthy housing' can be found in chapter 1 'Introduction' and for 'diagram', 'tool', and 'conceptual' and 'theoretical' frameworks in the Definitions section. This DPhil defines a 'healthy housing framework' as 'a set of ideas and principles about housings' contribution to human physical, mental and social well-being, that provides a structure for illustrating current knowledge, identifying a problem, making decisions or understanding findings', and therefore includes any representation from diagrams, tools, and theoretical and conceptual frameworks.

There are two recent, comprehensive systematic reviews of healthy urban environment frameworks. Pineo (2022) identified 15 frameworks all of which included housing to a degree. As this included literature published between 1999 and 2019, some more recent frameworks are not included, such as Ige *et al.* (2020), Rolfe *et al.* (2020), and Rice (2021). Further, Pineo *et al.* (2018a) reviewed 145 urban health indicator tools, which collectively collated 8,006 indicators, of which 496 were on housing. These tools span multiple levels of social analysis, including country, city and neighbourhood frameworks, with an increasing proportion seen in those at meso levels over time (Pineo *et al.* 2018a). Both the tool and framework reviews (Pineo *et al.* 2018a; Pineo, 2022) only included literature which incorporated more than one environmental factor, therefore some frameworks relevant to healthy housing alone are not included, e.g. Shaw (2004), CIEH (2008) and Sharpe *et al.* (2018). Whilst all of the frameworks included housing to a degree, it was only the major focus in one (Pineo, 2022). Five presented some detail on how housing impacts health, seven mentioned housing only as a word or line, and two did not include housing in the framework itself but had been referred to within the narrative. Although built environment frameworks may include housing, they are not granular and can miss many nuances of how housing can impact on health.

The reviews found that whilst there is a plethora of options, researchers have tended to focus on the development and validation of frameworks, often duplicating previous research efforts, rather than investigating how they are used by researchers and decision-makers (Pineo *et al.* 2018a). Also, the authors concluded that the use of tools in policy and decision-making appears to be limited, thus raising questions about their continued development. There remains a lack of information on how to apply tools, helping to structure research and the planning of housing interventions (Pineo *et al.* 2018a; WHO, 2020). Therefore, to strengthen the evidence base, this sub-question

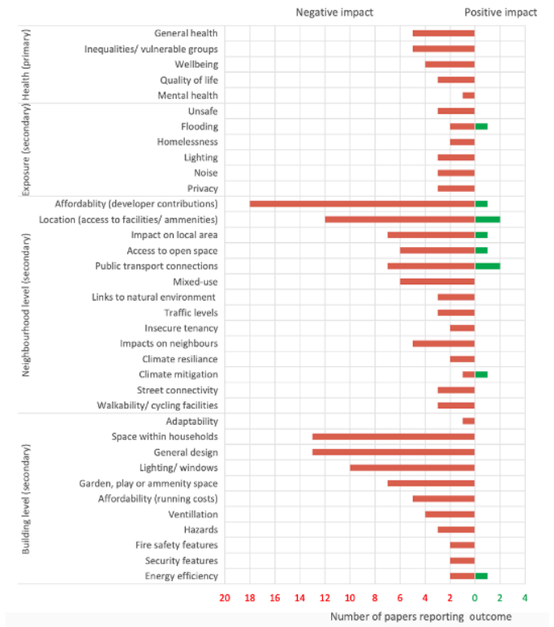
focuses on the application of frameworks and the considerations in selecting as well as producing one.

Method

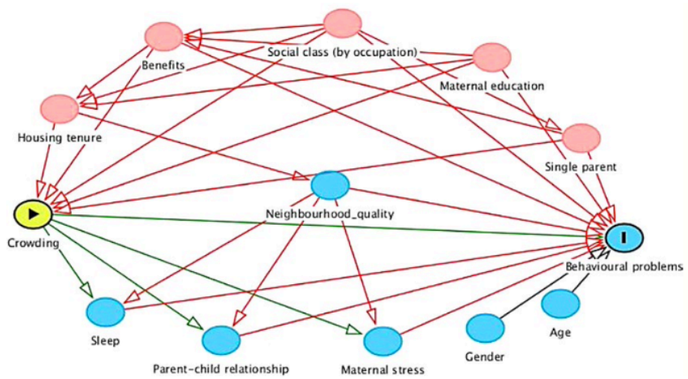
Six of the submitted works utilised a framework which demonstrates how housing impacts on health. The frameworks were extracted (Figure 3) and then to enable triangulation and facilitate a systematic analysis, a data extraction form was created. The form was iteratively developed using information on frameworks (Morris *et al.* 2019; Merriam & Simpson, 2020) and previous taxonomies of urban health tools and frameworks (Pineo *et al.* 2018a; Diez Roux, 2020). The characteristic categories and prompts developed to extract data can be seen in Table 4. This enabled the characteristics of each framework to be identified, compared and considered in terms of appropriateness to the individual publications' aims (Table 4). The analysis was then used to develop considerations that should be given when selecting and applying a healthy housing framework in research or practice (Table 4). Lastly, to illustrate what a comprehensive framework might look like and to facilitate the subsequent analyses in this thesis, a prototype comprehensive healthy housing framework is presented.

Figure 3: Images of healthy housing frameworks used in the submitted works

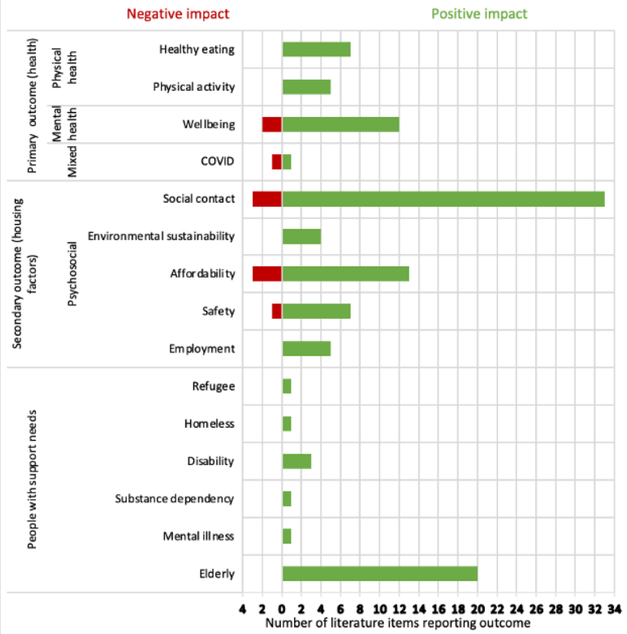
Publication #1
Permitted Development Rights



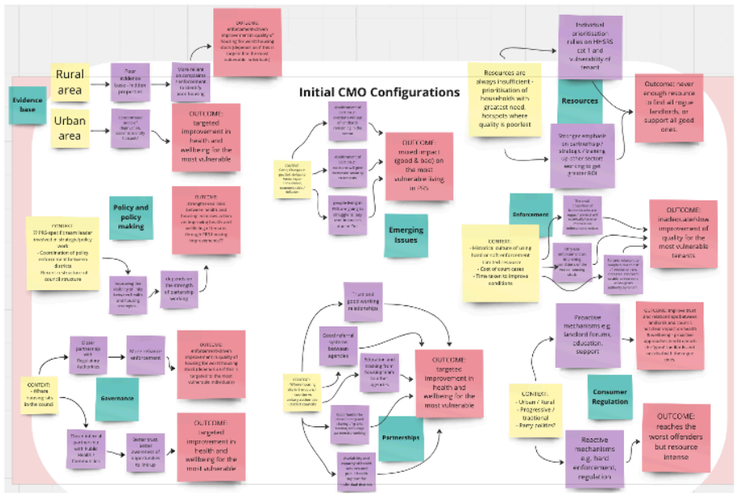
Publication #2
Household Crowding



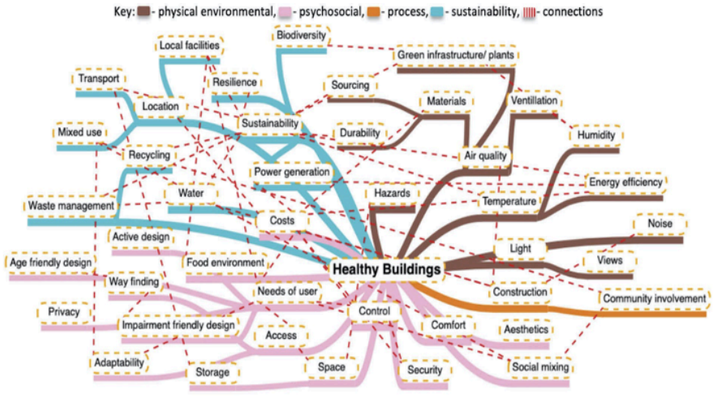
Publication #3
Community-Led Housing



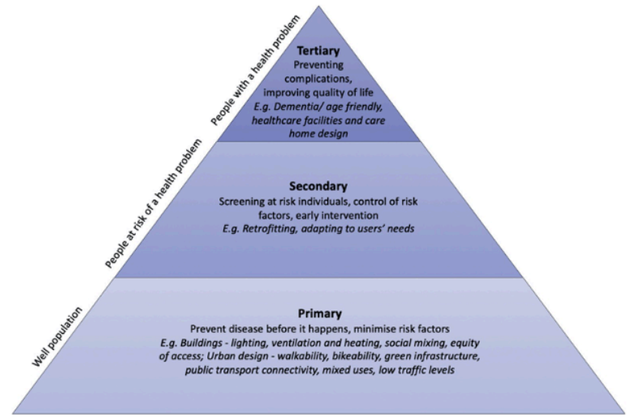
Publication #4⁺
Private Rented Sector Housing



Publication #6
Workforce Development Evaluation



Publication #7
Architecture Profession



⁺*The image for Publication 4 is taken from the data analysis process rather than the final manuscript to better illustrate the framework used*

Results and discussion

Table 4 brings together information from six studies related to housing delivery approaches in England, meeting the need of investigating how healthy housing frameworks are used in research (Pineo *et al.* 2018a; WHO, 2020). It shows us how the frameworks have been applied to facilitate the studies and that there are differences and similarities between the characteristics of each chosen framework, noted across seven categories. These characteristics have then been used to identify twelve essential considerations for selecting a healthy housing framework that is fit for purpose, and can accommodate the complexity of the relationship between housing and health, including the interplay between the occupants characteristics and needs as well as housing features.

Some of the frameworks were bespoke to the publication (Publications 2 and 6), some adapted from pre-existing theories or methodologies, such as the realist approach, RE-AIM evaluation and Prevention Pyramid (Publications 4, 6 and 7 respectively), and some directly adapted from a pre-existing healthy housing framework (Publications 1 and 3) (Pineo *et al.* 2018b; Carmona, 2019; Ige *et al.* 2020). The frameworks were used to either structure the method (Publications 2), present the results (Publications 1, 3, 6 and 7) or both (Publication 4). Although between them the frameworks considered a wide range of housing features with impacts on health, not all features were consistently represented in each individual frameworks.

Most of the considerations can be seen as universal and good practice to guide the selection of a healthy housing framework in any situation. However, two of the considerations suggest that different frameworks can be appropriate for different scenarios. These were:

- Purpose - Where there is a more developmental aim such as exploring how to understand knowledge on an aspect of healthy housing, e.g. role of a relevant profession, a framework which is more theoretical in nature would be beneficial. This is because it can support idea generation and articulate the underpinning theoretical assumptions of a study. Whereas if the purpose is to refine a hypothesis (e.g. assessing the health impact of a housing related policy, testing the impact of a discrete housing programme on health outcomes), a more conceptual framework would be beneficial. These frameworks can enable researchers and policymakers to not only identify health impacts in a structured way, but also research gaps where no impacts have yet been documented by the exposure or intervention, but potential impacts are known from the existing evidence base.

- Format - If informing a scientific audience, a detailed or tabulated format would be appropriate to convey more technical information. Whereas for a lay audience a more simplified and visual format may be beneficial, ideally one which can be interactive and allow participants to focus-in on features most relevant to their interest.

Whilst there is not a one size fits all framework, for the scenarios described where a more conceptual framework would be beneficial there is scope for a single more fully comprehensive framework to be adopted. To illustrate what this might look like, a prototype healthy housing framework which meets most of the twelve considerations, has been developed (Figure 4). Given the clear parallels with inequality considerations, this is presented after the next analysis on health inequalities.

Table 4: Data extraction form for characteristics of six healthy housing frameworks used in the submitted works and related considerations for selecting a framework

CHARACTERISTIC	PROMPTS	CHARACTERISTICS OF FRAMEWORKS IN SUBMITTED WORKS	CONSIDERATIONS
PURPOSE	How was the framework originally referred to? What is the stated purpose? Was the choice of the framework justified?	None of the papers explicitly named their chosen form of framework, or gave a strong justification for their use of the chosen framework over others, however some papers did give points of justification for their general approach taken, e.g. Publication 6 as an evaluation. All frameworks were used to structure research, either in terms of methods and/or results. The majority (Publications 1, 3, and 6) were diagrams, being used to illustrate the known empirical research and/or knowledge gaps relevant to the study' purpose. Two frameworks (Publications 4 and 7) were more theoretical, and were adapted from pre-existing theories, a realist framework and the Prevention Pyramid respectively. Lastly, Publication 3 utilised a Directed Acyclic graph, which is a tool used for building consensus on a proposed conceptual framework.	1. The choice of framework form is justified in the context of the research or practice question or purpose.
EVIDENCE	Does the framework refer to evidence which was used to develop it? Is the framework able to demonstrate the strength of the evidence for various housing features?	One framework applied findings from a literature review to a Directed Acyclic Graph (Publication 2), one framework did not use any pre-existing structure but grouped findings as they emerged (Publication 6), and two frameworks adapted pre-existing healthy housing frameworks (Pineo *et al.* 2018b; Carmona, 2019; Ige *et al.* 2020) (Publications 1 and 3). Two frameworks showed the strength of evidence in terms of study numbers within a systematic review (Publications 1 and 3). None of the frameworks showed the degree of the impact or strength of the evidence base in terms of study type or quality.	2. The framework is evidence based, either from a pre-existing validated framework, or by clearly refencing peer-reviewed scientific evidence on the health impacts of housing features. 3. The framework clearly illustrates the strength of the evidence for the impact of a housing feature on health.
SCALE	At what scales was the framework applied (i.e. micro, meso, macro)?	All of the frameworks were being applied to an exposure or intervention at a single social level of analysis, with one at the micro (Publication 2), two at the meso (Publications 3 and 6), and three at the macro level (Publications 1, 4 and 7). In contrast, most of the frameworks were applied to health outcomes across multiple levels of analysis, with two frameworks including all levels (Publications 4 and 6), three frameworks including micro and meso levels (Publications 1, 3 and 7), and a single framework including a micro level health outcome only (Publication 2). Only one framework made it clear that the process/ outputs are of interest, rather than health outcomes (Publication 4).	4. The framework demonstrates the potential range of health impacts considering micro (individual and household), meso (community) and macro (societal) levels. This includes the occupants sociodemographic, health and care needs, and use of/ behaviour within the house.
SCOPE	What aspects of housing are analysed (e.g. types, temporal perspective/ lifecycle, demographics, population groups and differential impacts)?	Most frameworks included all types of housing, with one framework including market housing only (Publication 4), and another including affordable and market (Publication 1). Only two frameworks included all lifecycle stages of housing (Publications 4 and 6). A further three frameworks included the creation and use of homes (Publications 1, 3 and 7), and one framework considered the use of housing only (Publication 2). All frameworks were able to illustrate the differential health impacts across population subgroups, however two frameworks had a limited breakdown (Publications 1 and 6). All frameworks considered the prevention of ill health although this was sometimes only clear from the narrative.	5. The framework sites the research or practice question within the spectrum of housing types and acknowledges factors specific to each where relevant. 6. The framework acknowledges the health impacts of different lifecycle stages of housing where relevant. 7. The differential health impacts on sub-populations are considered within the framework. 8. The prevention of ill health is recognised in the framework.
COMPLEXITY	Does the methodology refer to complexity and, if so, in what context? E.g. multiple exposures, multiple outcomes, pathways, interconnections, subjective vs objective measures.	All of the frameworks were able to capture multiple outcomes, except for Publication 2. Three frameworks clearly visualised pathways including interconnections, but only one was between housing features and health outcomes (Publication 2), with the other two being between various exposures (Publications 4 and 6). Distinction between physical, psychological and/or social outcomes was clear in 3 frameworks (Publications 1, 3 and 6). Health behaviour was a sub-classification in only one framework (Publication 3). Two frameworks included subjective and objective measures (Publications 1 and 2).	9. The framework acknowledges the complexity of the relationship between housing and health by illustrating how housing exposures are directly and indirectly connected to each other and to health outcomes. 10. The framework demonstrates the potential range of health impacts, including physical, psychological, and social outcomes, and risk factors from direct exposures and/ or behaviours.
DIRECTION	Is there distinction between positive and negative impacts?	Three of the frameworks illustrated whether health impacts were positive or negative (Publications 1, 3 and 4).	11. The framework clearly illustrates the direction of the housing features' impacts on health (beneficial or detrimental).
FORMAT	What was the presentation? E.g. graphical, tabulated.	Two frameworks were tabulated (Publications 1 and 3), with the remainder being image based. There were no interactive frameworks.	12. The presentation of the framework is tailored to the intended audience.

4.1.2 How are four current housing delivery approaches in England impacting on health inequalities?

This sub-question still relates to health impacts from housing delivery approaches but is distinguished from the previous in that it specifically focusses on differences in impact between sub-populations.

Housing is a major pathway through which health inequalities emerge, are sustained over time, and can be ameliorated (Gibson *et al.* 2011; Ige *et al.* 2020; Leifheit *et al.* 2022). For example, avoiding the harmful effects of lead paint, which was banned in 1978, requires tenants to have either the power to advocate for remediation or the finances and housing options to move out. Thus, low-income households continue to be exposed over 40 years later (Leifheit *et al.* 2022). Therefore, it is important to evaluate housing delivery approaches not only based on population-wide health impacts but also by considering impacts on sub-populations and health inequalities.

Whilst several of the submitted works included consideration of inequalities, this section provides an opportunity to synthesise them against the levels of social analysis, and to provide a collective narrative comparing current housing delivery approaches in England.

Evidence base

General frameworks exist, which illustrate how health inequalities can be considered across a range of dimensions. One of the most widely used is by OHID (2022), which proposes four intersectional domains of inequality largely regarding a person's characteristics; socioeconomic status (e.g. people living in deprived circumstances will experience their housing differently to affluent circumstances), nine protected characteristics in the Equality Act (2010) (e.g. people of different ages, genders and cultures will have different needs from their homes), inclusion health groups (e.g. Gypsy, Roma and Travellers require different expectations from their accommodation) and geographical (e.g. people living in rural areas will experience their housing differently to urban areas, and regional inequalities are seen with households in London being more likely to experience at least one housing problem then other regions in England (Kings Fund, 2023). In addition, there is growing research that specifically links housing to health inequalities, by identifying how housing features linked to poor health are not equally distributed across populations, (Gibson *et al.* 2011; Swope & Hernández, 2019; Ige *et al.* 2020; Leifheit *et al.* 2022; Howden-Chapman *et al.* 2023). For example, people living in privately rented or socially rented homes are more likely to be unemployed than those in hoes owned outright (DLUHC, 2022b). The relationship is challenging to comprehensively elucidate and understanding of it is still being refined.

One of the clearest inequality frameworks to date is by Swope & Hernández (2019), which is able to capture differential effects on sub-populations, and is summarised with four pillars:

1) **Cost (housing affordability)** - Residents can pay the cost of the housing (including the purchase, mortgage or rent, maintenance, and utilities) without burden (i.e. draining finances that could otherwise be used for health services, prescriptions or health-related expenses such as food, or without comprising on living arrangements, such as doubling up with friends of family, or living in overcrowded conditions). Also, residents should be able to acquire capital gains and provide the intergenerational transfer of wealth.
2) **Conditions (housing quality)** - There is adequate physical hardware and environmental conditions within the building, e.g. warm, ventilated, and free from damp, pests or hazards.
3) **Consistency (residential stability)** - Residents have the right to remain in their home for as long as they desire. Going beyond a dichotomy of housed or unhoused, residential stability considers a spectrum of temporary or insecure housing arrangements, including forced displacement from homes and communities (e.g., eviction), and frequent moves which are not through choice. This includes being affected by rents rising out of line with income (e.g. gentrification), natural disasters (e.g. flooding), or government policies. The housing meets the needs of its' residents over their life course, e.g. a disabled or older person with extra care needs. Residents have a sense of safety and security including for those in precarious living circumstances e.g. people experiencing homelessness, or refugees and asylum seekers (including for those living in temporary accommodation).
4) **Context (neighbourhood opportunity)** - Whether urban or rural, the housing has a health promoting surrounding environment, e.g. non-contaminated land, easy access to public transport, local facilities (well-performing schools, healthy food, healthcare), greenspaces and mixed communities and social capital (e.g. contacts for social support or employment opportunities, low risk of violence).

These domains and pillars can lead to cumulative burden by interacting with one another and with other structurally rooted inequalities to produce and rectify health disparities (Swope & Hernández, 2019; Kings Fund, 2023). The pillars represent considerations across the levels of social analysis, having been informed by macro factors (e.g. historical policies), and enabling a structured way to assess a housing delivery approach or intervention against meso factors (e.g. neighbourhood opportunity)

and micro factors (e.g. meeting residents needs over their life course) making it well suited to the research approach chosen for this thesis.

Methods

Four submitted works were selected for the analysis (Publications 1-4), because they each consider a current housing delivery approach in England. The entire publications were reviewed for the direction of impact on health inequalities from the housing delivery approach in question, including triangulation across their underpinning theories, methods, and data.

Mapping to both the general inequality domains (OHID, 2022), and the healthy housing specific inequality pillars (Swope & Hernández, 2019), provided a novel analysis by allowing a comparison between the frameworks (Table 5), and added rigor by checking for consistent results regarding each housing delivery approach. Also, as the framework by Swope & Hernández (2019) was originally developed based on historical policies and practices in the United States, this was the first application of their framework to more current housing delivery approaches and to England.

Results and discussion

Table 5 and Table 6 bring together information on four current housing delivery approaches in England enabling a holistic understanding and comparison of their impact on health inequalities based on the submitted works. They show that three of the mainstream current approaches to market housing delivery in England, namely crowding, reducing regulatory requirements and increasing the use of PRS housing, are delivering variable and often poor-quality and insecure housing with detrimental health inequality implications. Whereas one of the emerging approaches, CLH, appears beneficial for reducing health inequalities, especially for populations with support needs. These are important findings in terms of the selection of current policies, and possible checks or safeguards that could be incorporated so that they do not further entrench inequalities. For example, moving specific requirements into building regulations (e.g. dwelling size or amenity space), requiring application of local standards as part of the PDR process, or introducing requirements for health practitioners to assessing and refer people living in crowded conditions to support services (e.g. childcare) (Marsh *et al.* 2019b; Marsh *et al.* 2020a).

The implications from affordability appeared mixed in the submitted works and may need further research to understand. Similarly, current opportunities to access CLH may not be equal for people from disadvantaged backgrounds. The findings on crowding were consistent with the majority of earlier, small-scale studies. However a strong link

between tenure and crowding was noted, thus it is possible to argue that the health impacts lie with housing tenure rather than crowding (Marsh *et al.* 2019b). Lastly, children and young people were less well-represented in submitted works, a challenge shared with the wider evidence base (Marsh *et al.* 2019b; McClatchey *et al.* 2023b; Munro *et al.* 2022).

The findings are consistent regardless of whether the general inequalities framework (OHID, 2022), or healthy housing specific inequalities framework (Swope & Hernández, 2019) was used to analyse the submitted works. This suggests that there is consistency between the frameworks, enhances rigor in the method and adds confidence in the results regarding the housing delivery approaches.

Table 5: Comparison of two inequality frameworks showing health inequality impacts from four housing delivery approaches in England

		HOUSING DELIVERY APPROACH (SUBMITTED WORK)			
		#1 Permitted Development Rights	#2 Household Crowding	#3 Community-Led Housing	#4 Private Rented Sector Housing
GENERAL INEQUALITY DOMAINS (OHID, 2022)	Socio-economic	↓	↓	↓	↓
	Protected characteristics	↓	↓	u	↓
	Inclusion Health	→	↑	↑	u
	Geography	↓	↓	↓	u
	OVERALL	↓	↓	↑	↓
HEALTHY HOUSING INEQUALITY PILLARS (SWOPE & HERNANDEZ, 2019)	Cost (Affordability)	↓	→	→	↓
	Conditions (Quality)	↓	u	↑	↓
	Consistency (Stability)	↓	↓	↑	↓
	Context (Opportunity)	→	↓	↑	u
	OVERALL	↓	↓	↑	↓

Key - *Evidence from submitted works points towards: ↓ = negative impact/ increases inequality, ↑ = positive impact/ reduces inequality, → = both positive and negative impacts, u = unknown impact from submitted works alone*.

Table 6: Detailed impacts on health inequalities from four housing delivery approaches in England across four pillars of housing inequalities (Swope & Hernandez, 2019)

SUBMITTED WORK	COST (AFFORDABILITY)	CONDITIONS (QUALITY)	CONSISTENCY (STABILITY)	CONTEXT (OPPORTUNITY)	OVERALL
#1 PERMITTED DEVELOPMENT RIGHTS	Loss of developer contributions, sometimes higher running costs as less energy efficient.	Poor ventilation, lack of light, noisy, hazards, poor fire safety and security features.	Used by vulnerable groups unlikely to have means to live elsewhere, e.g. sex workers, people with substance dependency. Can be difficult to adapt homes to meet residents' needs. Linked to areas of flood risk and therefore risk of needing to move, although this should be considered in Prior Approval conditions.	Can be on industrial estates, surrounded by busy roads, and far from public transport, services and facilities. Often do not enable mixed communities, so risks of neighbourhood conflict. No outdoor play space, with reports of children playing in car parks.	Populations from disadvantaged backgrounds are overrepresented in the poorer quality housing delivered through PDR so more likely to experience the negative health consequences of this.
#2 HOUSEHOLD CROWDING	Consequence of low affordability, however smaller homes are likely to be more affordable than larger homes, or sharing homes can bring down costs (e.g. HMOs).	Not reported.	Crowding and tenure were strongly linked, with the greatest crowding seen in social housing, followed by privately rented. The positive association between crowding and behavioural difficulties in children was partly mediated by stress and parent-child conflict.	Poor neighbourhood quality partly explained the positive association between crowding and behavioural difficulties in children.	Populations from disadvantaged backgrounds are overrepresented in crowded accommodation so more likely to experience the negative health consequences of this.
#3 COMMUNITY-LED HOUSING	Self-help housing may reduce the costs of external builders and contractors, whilst co-operative or Community Land Trusts may cross-subsidise, acquire grants, or partner with housing associations or local authorities. Many CLH projects reported to have good energy efficiency, hence low running costs. Community Land Trusts may limit wealth accumulation through capital gains for those populations most in need of acquiring wealth: those with low incomes, from ethnic minority backgrounds, and female-headed households.	Limited evidence on building level features.	Promotes inclusion and independence for vulnerable populations, including refugees, homeless, people with drug or alcohol dependency, with a disability or older people. Peer to peer support enabled ageing in place and mitigated the need for people to move into care homes. Often environmentally sustainable, with reduced food purchases, shared travel, sustainable technologies, and energy efficiency design, construction methods and materials.	Good access to education, employment opportunities and social connections. Gave participants new skills and work experience, which in turn led to greater employment prospects. Generally, residents felt safe (other than one report from a Tenant Management Organisation)	CLH can provide positive health effects for populations with support needs and from disadvantaged backgrounds, however opportunities to access this form of housing delivery may not currently be equal.
#4 PRIVATE RENTED SECTOR HOUSING	On average, PRS tenants spend 32% of their income on housing, more than those living in their own properties (18%) or social housing (27%). It is increasingly challenging to meet rent rises given the Cost-of-Living Crisis.	In England, 14% of all homes are classified as non-decent compared to 23% PRS homes.	Vulnerable tenants are also less likely to make complaints due to fear of eviction, including 'no fault', (Section 21), or understanding of rights.	Not reported.	Populations from disadvantaged backgrounds are overrepresented in the PRS so more likely to experience the negative health consequences of this.
OVERALL	Populations from disadvantaged backgrounds will have less income to spend on housing costs, so are more likely to have to adjust, such as living in smaller or crowded conditions, spending less on utilities, or accepting poorer quality conditions.	Populations from disadvantaged backgrounds are more likely to have to live in poor quality accommodation.	Populations from disadvantaged backgrounds are more likely have the risk of, or actual frequent moves.	Populations from disadvantaged backgrounds are less likely to have opportunities in the neighbourhood surrounding their housing.	

It is important to remember that this analysis is drawing conclusions from a limited selection of the evidence base (submitted works only). Whilst some of these were comprehensive evidence synthesis' (Publication 1 on one form of deregulation and Publication 3 on CLH), much of the underlying evidence base was grey literature, case studies or interviews. Similarly, other submitted works were single studies (Publication 2 on crowding, and Publication 4 on PRS housing), therefore the conclusions can only point towards a positive or negative impact, rather than draw firm conclusions. The evidence base is continually growing and the policy landscape rapidly developing, so the direction of impact may change. For example, the Renters (Reform) Bill (2024) introduces increased regulatory expectations and powers for local government so the health inequality impacts for stability and quality may become positive in the future.

4.1.3 Summary

There are synergies between this analysis of inequality considerations and the prior analysis of healthy housing frameworks. Together they have been used to design a prototype, comprehensive healthy housing framework (Figure 4). This draws on learning from socio-ecological theory (Bronfenbrenner, 1977), the considerations identified in sub-question one (Table 4) and other examples of healthy housing frameworks.

In the wider evidence base there are many pre-existing frameworks, however they are not fully comprehensive. Figure 4 is most closely based on the framework structure used by Pineo *et al.* (2018b), in terms of pathways and health outcome groupings. However, it adds detail through a consideration of occupants' characteristics and behaviours, the macro features/ drivers, the lifecycle stages, and health inequality pathways. Similarly, Shaw (2004) helpfully conceptualised the physical or 'hard', psychosocial or 'soft', micro or 'direct' (individual/ household) and meso or 'indirect' (neighbourhood) features of housing but did not include occupant characteristics, housing lifecycle stage or pathways between features. Figure 4 meets most of the twelve considerations (Table 4), with the exception of being able to clearly illustrate the strength of the evidence. It is a more fully comprehensive framework and better able to represent the complexity of healthy housing than many others in the existing evidence base for several reasons:

- Is person-centred by capturing characteristics and behaviours of the occupants as well as features of the housing, and can recognise differential health impacts on sub-populations as per sub-question two. This aligns the framework with socio-ecological theory, in that it represents how health is affected by the interaction between the characteristics of the individual and the housing environment (Bronfenbrenner, 1977), which is important given the interactions and resulting variation in impact on health. For example, the risk of transmission of infectious diseases in crowded households can be affected by cleaning

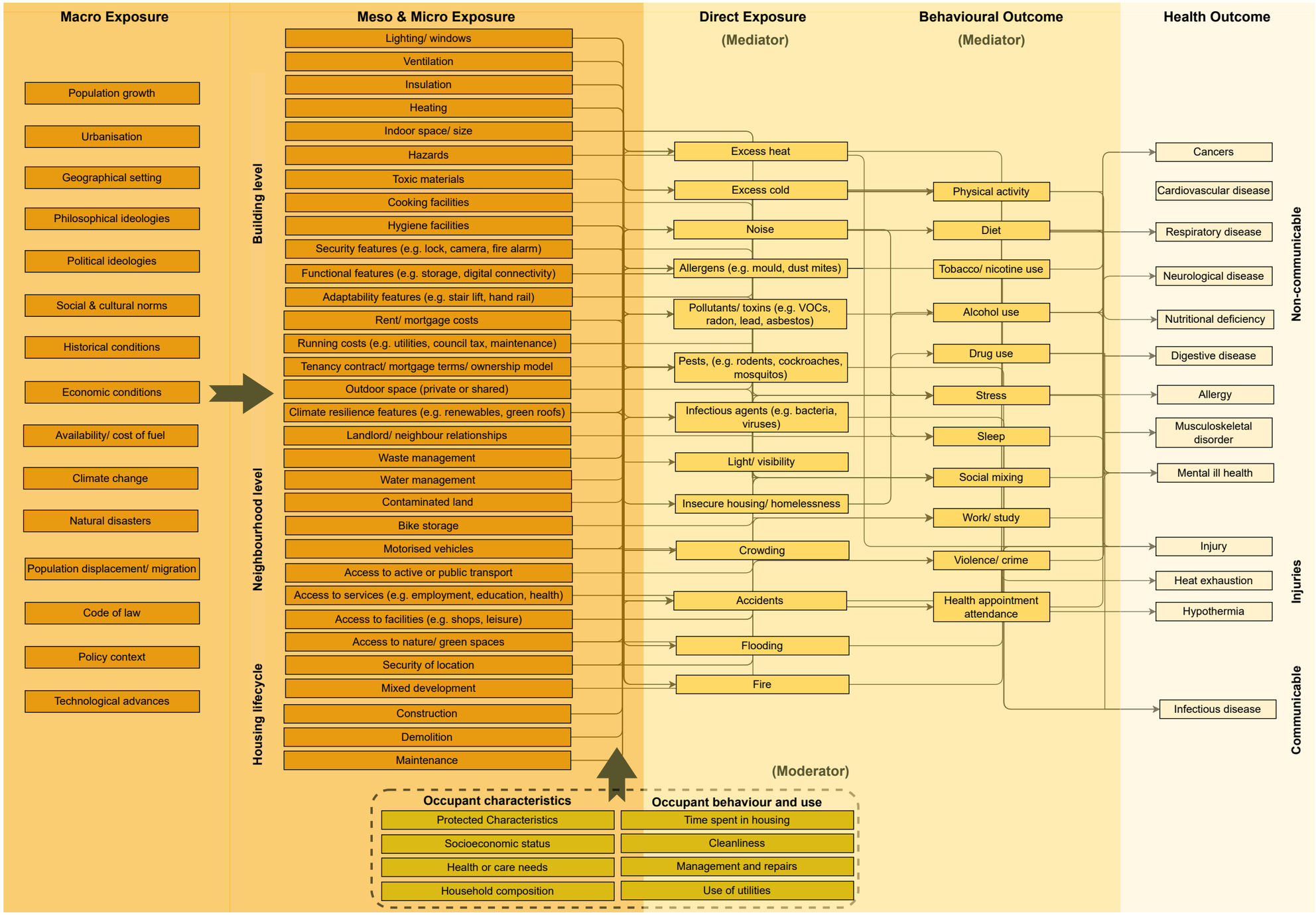
regimes and would be more significant for older people or those with pre-existing respiratory disease (Ige *et al.* 2020; Mansour *et al.* 2022). Whether housing is culturally appropriate (Mansour *et al.* 2022) depends on occupant characteristics such as religion, and housing features such as indoor space. Previous frameworks appear to be either strong at eliciting the pathways between housing features and health outcomes (CIEH, 2008; Pineo *et al.* 2018b) or taking a holistic view which recognises the importance of occupants' characteristics and health needs as well as the housing features (Rolfe *et al.* 2020; Rice, 2021) but not both.

- Inclusion of features of different types of housing (e.g. tenancy contract) and lifecycle stages of housing, especially regarding the use and maintenance. In existing frameworks many do not account for this lifecycle stage of housing, with none clearly including the construction or demolition/ decommissioning of housing.
- By collating the housing features reported to impact on health from across all the submitted works and reviewed literature for this thesis, it provides the most comprehensive collation to date spanning 15 macro features, 29 meso and micro features, 13 direct exposures, eleven behavioural outcomes and 13 health outcomes. Commonly missing features include climate resilience features (such as low carbon heating, flood risk considerations, harvesting rain or grey water, composting toilets, green roofs), waste and water management, and contaminated land (Shaw, 2004; CIEH, 2008; Sharpe *et al.* 2018; Swope & Hernández, 2019; Ige *et al.* 2020; Rolfe *et al.* 2020) and indoor and/or outdoor space (Shaw, 2004; CIEH, 2008; Ige *et al.* 2020; Rolfe *et al.* 2020; Rice, 2021) or drivers (Shaw, 2004; Ige *et al.* 2020; Rolfe *et al.* 2020). Again, this aligns the framework with socio-ecological theory, in that it represents how health is affected by physical, social, economic and political components (Bronfenbrenner, 1977).
- This is in a diagram format and could be further developed to create an interactive online version that can be tailored to different audiences.

By critiquing the application of six healthy housing frameworks which were used to structure research on current housing delivery approaches, this analysis contributes to the evidence gap identified by other researchers (Pineo *et al.* 2018a; WHO, 2020). Together the twelve considerations for selecting a framework, and critique of four current approaches, have enabled the production of a prototype, more comprehensive, conceptual healthy housing framework (Figure 4) and the above discussion demonstrates how this makes a novel contribution to research.

As this was conducted as a retrospective analysis of submitted works, it has not been underpinned by a systematic literature review, so it is possible other healthy housing frameworks do exist. The considerations regarding framework selection have been based on a broad definition of a framework, which has been helpful for collectively synthesising evidence across diverse submitted works, but there may be value in being more specific or analysing each type of framework (diagram, tool, conceptual and theoretical) in turn for future more in-depth analyses. Similarly, to better understand the requirements of housing policy and decision-makers, public health professionals, local communities and other relevant stakeholders regarding the form and use of frameworks which support their varied objectives refinements would be needed, which are discussed under the ’Recommendations for future research and practice’ section.

Figure 4: Prototype comprehensive conceptual healthy housing framework



4.2 What changes to housing delivery in England can be made to produce more healthy housing?

The next two sub-questions shift the focus from theory to how to deliver healthy housing in practice. By grounding the theoretical principles of healthy housing within the policy, political and economic situation in England, practical suggestions leading to change are proposed.

4.2.1 How might relevant stakeholders influence healthy housing delivery?

Stakeholders are key to delivery, hence the exploration within this sub-question of which stakeholders, and how, are involved in healthy housing. The majority of the submitted works included consideration of stakeholders, and this section provides an opportunity to synthesise explicitly their influence over healthy housing features and delivery across the levels of social analysis.

Evidence base

The Royal Society for Public Health identified through stakeholder workshops that 'environment' professionals (such as architects, town planners, surveyors and ecologists) were the largest employment group of the wider public health workforce (13%), the most interested (20%) but one of the least involved with the public health agenda (1%) (CfWI & RSPH, 2015).

An umbrella review by Turcu *et al.* (2021) found that many studies note implications for housing stakeholders on delivering healthy housing, but that discussion is rather general. This may be explained by the fact that much research which takes a health perspective is undertaken by health researchers, hence roles outside health in implementing or changing exposure risks in housing are not fully considered. The WHO (2020), states that to ensure all relevant stakeholders are involved in discussions about healthy housing interventions, a comprehensive overview of actors, their interests, power and relations to other stakeholders is required, and suggests that a stakeholder mapping tool on healthy housing would be useful.

Complex systems theory encourages a rethinking of real-world issues, including how actors behave in relation to them (Carey *et al*. 2015). The governance of healthy housing involves professionals responsible for housing- or health-related policy, regulation, and actions, such as architects, planners, developers, funders, landowners, construction staff/ engineers, environmental health officers, landlords, housing officers, as well as social care, healthcare, and public health professionals. It can also extend to community groups and political members and should consider the views of end users.

Combined, these stakeholders determine whether housing is built, maintained, renovated, used and demolished in ways that support health.

There are widely used general stakeholder tools, such as the power-interest matrix (Ackermann & Eden, 2011), and previous attempts have been made to illustrate which stakeholders have influence over urban environments (McGlynn, 1993). The latter has been relatively recently revised (Lukovich, 2017), but again focussed on urban design rather than housing. A framework which is focussed on housing, and in particular healthy housing, does not yet exist and so this analysis aims to produce a provisional matrix which represents the complex nature of stakeholders involved in healthy housing delivery in a format which is user-friendly for professionals in both academia and practice.

Method

All the submitted works refer to different stakeholders involved in healthy housing delivery. To triangulate, first all of the stakeholders identified across the submitted works were listed, then the extent to which they might have the interest and/or power to influence certain housing features (at micro and meso levels as identified through the healthy housing frameworks described earlier in this DPhil and listed in Figure 4) was mapped, building on a previous stakeholder matrix for urban environments (McGlynn, 1993). Macro level factors were not included due to the limited power to control the majority of them (e.g. historical conditions and natural disasters) across stakeholder groups. Where it was not possible to draw a conclusion from the submitted works alone, this was supplemented with a rapid review of other literature, including job descriptions, statutory consultees on planning applications for residential developments, and the target audience for relevant regulations (Table 2). The analysis was also informed by the authors' professional experience which introduces an element of subjectivity, but continues to draw on the aforementioned literature and its' application in practice.

On the vertical axis of the matrix are listed the range of housing features (at buildings and neighbourhood level). On the horizontal axis are the major stakeholders in healthy housing, categorised into the 'suppliers' of the basic commodities of housing delivery such as land and capital; the 'producers' from developers through to local government, the 'consumers', that is everyone who uses the housing; and lastly the health sector. The diagram distinguishes between stakeholders who have power (to initiate or control through legal or contractual responsibilities), and stakeholders who have an interest but limited power, and who therefore can only be effective through advocacy, alliance or participation.

In line with the DPhil scope, each stakeholder group is considered regarding their power over market housing. Housing providers (e.g. housing associations) have been included as although their main function is to provide social housing, they can also be involved in providing market housing. Several other stakeholders would be relevant to this analysis, however if they were not identified in the original submitted works they have not been included, e.g. building control.

Results and discussion

The matrix in Table 7 attempts for the first time to compress into a single diagram a representation, albeit crude, of the power relations between stakeholders in healthy housing delivery. The graphical presentation is unique and provides a good way of comprehending information for diverse audiences as is required in healthy housing delivery. The matrix illustrates the uneven distribution of power in the current housing delivery system in England. Most notable is that there is not necessarily alignment between stakeholders who have power and stakeholders who have the most interest and motivation for ensuring housing is healthy. There is the huge potential to disadvantage the health of the 'consumer' group within the housing delivery process, especially for tenants, who have even less power than owners.

73% of cells were populated based on the submitted works and authors' professional experience, with 27% requiring a rapid review of literature. 34% were based on the authors' professional experience alone and this subjective classification risks introducing bias, which may either overestimate or underestimate the degree of power assigned to different stakeholders.

Taking the top row as an example, power over lighting/ windows has been identified for national government (through setting legislative, regulatory and policy requirements), all producers and regulators (e.g. developers through their designs in planning applications; architects through their design and construction documents; planners through setting Local Plan requirements; environmental health and housing officers through inspections including the consideration of lighting in the HHSRS), and owners (through installation and maintenance of windows and artificial lighting). Interest over lighting/ windows has been identified for tenants and local residents (who could request installation or maintenance but do not have the legal rights to carry this out without owning the property) and health stakeholders (who, as an example, can advocate for adequate lighting to reduce falls in an older persons' home but again have no legal standing to enforce this). Lastly, no obvious power or interest was identified from landowners or financiers.

Table 7: Matrix showing influence and interest of stakeholders on housing features known to impact health, in England 2023 (adapted from McGlynn, 1993)

		Suppliers		Producers/ regulators							Consumers			Health	
Housing feature	**National government[1]**	**Land owner**	**Funder[2]**	**Developer**	**Planner**	**Architect**	**Construction staff[3]**	**Environmental health officer**	**Registered Provider[4]**	**Landlord/ housing officer (private)**	**Owner**	**Tenant**	**Community group/ local resident**	**Public Health professional**	**Health & social care professional[5]**
Building (micro) level															
Lighting/ windows	●	-	-	●	●	●	●	●	●	●	●	o	o	o	●
Ventilation	●	-	-	●	o	●	●	●	●	●	●	o	o	o	o
Insulation	●	-	-	●	o	●	●	●	●	●	●	o	o	o	o
Heating	●	-	-	●	o	●	●	●	●	●	●	o	o	o	o
Indoor space/ size	●	-	o	●	●	●	-	●	●	●	●	o	o	o	o
Hazards	●	-	-	●	o	●	●	●	●	●	●	o	o	o	●
Toxic materials	●	-	-	●	o	●	●	●	●	●	●	o	o	o	o
Cooking facilities	●	-	-	●	o	●	-	●	●	●	●	o	o	o	●
Hygiene facilities	●	-	-	●	o	●	-	●	●	●	●	o	o	o	o
Safety features	●	-	-	●	o	●	●	●	●	●	●	o	o	o	●
Functional features	●	-	-	●	●	●	-	o	o	●	●	o	o	o	o
Adaptability features	●	-	-	●	●	o	-	-	●	●	●	o	o	o	●
Rent/ mortgage costs	●	o	●	●	●	-	-	-	●	●	o	o	o	o	o
Running costs	●	-	-	●	o	●	●	●	●	●	●	●	o	o	o
Tenancy/ mortgage terms	●	-	-	-	o	-	-	-	●	●	●	o	o	o	o
Outdoor space	●	●	-	●	●	●	-	-	-	-	o	o	o	o	o
Climate resilience features	●	-	-	●	●	●	●	-	●	●	●	o	o	o	o
Landlord/ neighbour relationships	-	-	-	-	-	-	-	o	●	●	●	●	o	o	o
Neighbourhood (meso) level															
Waste management	●	●	-	●	●	●	●	●	●	●	o	o	o	o	o
Water management	●	●	-	●	●	●	●	●	●	●	o	o	o	o	o
Polluted land, air or water	●	●	o	●	●	o	-	●	-	-	o	o	o	o	o
Bike storage	●	-	-	●	●	●	-	-	-	-	●	o	o	o	o
Motorised vehicles	●	●	-	●	●	-	-	●	-	-	o	o	o	o	o
Access to active or public transport	●	●	o	●	●	-	-	-	-	-	o	o	o	o	o
Access to services	●	●	●	●	●	-	-	-	●	-	o	o	o	o	o
Access to facilities	●	●	o	●	●	-	-	-	●	-	o	o	o	o	o
Access to nature/ green spaces	●	●	o	●	●	-	-	-	-	-	o	o	o	o	o
Security of location	●	o	o	o	o	-	-	-	o	o	o	o	o	o	o
Mixed development	●	●	●	●	●	o	-	-	●	-	o	o	o	o	o
Lifecycle															
Construction	●	●	●	●	●	●	●	●	o	o	o	o	o	o	o
Demolition	●	●	●	●	●	-	●	●	o	o	o	o	o	o	o
Maintenance	●	-	-	-	-	-	●	●	●	●	●	o	o	o	o

Key: ● = power (to initiate or control through legal or contractual responsibilities); o = interest but limited power (e.g. through advocacy, alliance or participation only); - = no obvious power or interest

[1] National government includes all departments, and both elected officials and civil servants

[2] In this analysis funders include banks and private investors (e.g. pension funds, Real Estate Investment Trusts, and private equity firms)

[3] Construction staff includes plumbers, electricians, plasterers, painters and decorators, scaffolders, steel erectors and labourers, foreman and chargehands

[4] Registered Providers are organisations registered with the Regulator of Social Housing, and in this analysis include private registered providers (not-for-profit housing associations and for-profit organisations)

[5] Health and social care professionals includes commissioners and providers

The real power lies with the left side of the matrix, with the landowners, funders, developers, and planners having the most notable power over neighbourhood (meso) level factors. In England, most of these stakeholders generally operate in the private sector, which has significant implications for stakeholder engagement regarding healthy housing delivery. However, it is difficult to draw firm conclusions, as many of these stakeholders can have roles in the private and public sector, e.g. landowners, financers, and architects. Local government, particularly planning departments, also have power over neighbourhood level factors. Building level (micro) factors again are controlled by developers and planners, as well as architects, construction staff/ engineers, environmental health officers, and housing officers. This is broadly in-line with findings from Turcu *et al.* (2021).

There is a similar divide in terms of the house lifecycle. Construction of new homes is largely controlled by the suppliers and producers/regulators, whereas the maintenance power mainly lies with producers/regulators and consumers. Given that the UK has the oldest housing stock in Europe and possibly globally, with new builds making up only a small proportion of housing stock (Nicol *et al.* 2016). This highlights the importance of focusing efforts on improving our existing housing, and therefore the roles of producers/regulators and consumers.

The health sector has widespread interest across all of the housing factors, however power to directly influence almost none of them, except for occupational therapy assessments (e.g. adjustments to add handrails, lighting or remove trip hazards). Examples of interest or indirect influence, but not direct power, include; social prescribing for heating bills, health and social care teams writing referrals for patients' priority needs of better housing conditions (NHSE, 2016), the NHS Healthy New Towns programme including work with housing developers, associations and government to produce healthy demonstrator sites (NHSE, 2022), and some newly established Integrated Care Boards which are identifying housing as a health priority. However, these stakeholders are in a weaker position than the professionals who have a formal responsibility which guarantees their representation in the process, e.g. by being formally invited to comment on development applications. One further exception might be with NHS estates, as one of the largest landowners in England there is potential to re-use and develop quality, affordable housing. However, this is only applicable to certain population groups, namely key workers, and as supported living for vulnerable individuals (NHSE, 2023).

Whilst presenting a very complex situation regarding stakeholders' power over healthy housing delivery in a format which is user-friendly can be helpful, it also risks losing the

diversity of individuals' knowledge, attitudes and behaviours under broad groups. For example, some developers and funders may be very motivated to deliver housing which supports health and wellbeing and seek mechanisms to enable this, whereas others may be more motivated by economic outcomes, but in this matrix all are graded the same. Similarly, groupings and binary power grading further risks mis-representing information.

For example, national government can be seen to have power over all aspects of healthy housing, through their role in legislation, regulation and policy. However, this is a crude classification and different departments will have power over only some aspects, for example, the Department for Environment, Food and Rural Affairs (DEFRA) for waste management, the Department for Levelling Up, Housing and Communities (DLUHC) for access to services and facilities, and Homes England for affordability. Also, the actions of government are influenced themselves by many other factors, including economic conditions, science and technological change, and particularly public opinion. Whilst there is an All Party Parliamentary Group (APPG) on Healthy Homes and Buildings, which has made recommendations on a cross-departmental committee for health and buildings and housing renewal focus, these groups have no official status within Parliament (Parallel Parliament, 2023). Potential refinements and next steps for developing this prototype stakeholder matrix into a more robust form are discussed in Chapter 5 on 'Discussion'.

4.2.2 What are the challenges and opportunities in England to delivering healthy housing in practice?

The final sub-question considers challenges and opportunities within the current context in England to propose practical changes. All the submitted works include consideration of challenges and/or opportunities, which this section amalgamates and maps against the levels of social analysis.

Evidence base

An international review of health-promoting housing legislation, regulation and policies, spanning national, regional and local levels, found that there are well-recognised challenges and opportunities to both policy development and implementation (WHO, 2021). These vary depending on the country (Pineo & More, 2022), and there is also a significant UK specific evidence base on the challenges and opportunities of healthy placemaking, which includes housing (Design Council, 2018; Black *et al.* 2021). Between them these reports already identify over 100 challenges and opportunities, mainly on macro level factors and, to a degree, meso and micro factors.

The WHO continues to seek concrete practice examples to provide insights into context-specific challenges and opportunities in the effective design and realisation of healthy housing (WHO, 2020). This analysis therefore considers whether any new challenges or opportunities to delivering healthy housing have been identified through the submitted works.

Method

All of the submitted works take note of challenges and opportunities to delivering healthy housing in practice. To triangulate, these were extracted from the introduction, results and discussion sections of the submitted works, and grouped in-line with the three levels of social analysis (Wiley, 1988). A comparison was then made to the existing global (WHO, 2021; Pineo & Moore, 2021) and national (Design Council, 2018; Black *et al.* 2021) evidence base, to highlight which of the challenges and opportunities identified in the submitted works were already known, and which, if any, are new considerations to the evidence base.

Results and discussion

Table 8 shows 26 challenges and/or opportunities which were identified in the submitted works and brings these together through a new approach by categorising across the levels of social science. This has enabled a more holistic perspective, as well as identification of future areas of work.

Table 8: Summary of challenges and opportunities to delivering healthy housing in England identified from submitted works, graded against the extent this was known from the existing evidence base

SOCIAL SCIENCE LEVEL	CHALLENGE	OPPORTUNITY	SUBMITTED WORK NO.	EXISTING EVIDENCE BASE				
				Design Council, 2018	Black *et al.* 2021	WHO, 2021	Pineo & Moore, 2021	Overall
		Later career stage	6					
		Interest and depth of understanding regarding healthy housing	4, 6					
		Project brief and constraints, e.g. on larger sites, with fewer site constraints	6					
	Limited budgets and time	Working in larger firms with greater resource	6					
	Culture and a reluctance to try new things in older firms	Working in new firms	6					
		Community involvement in housing delivery and/ or management	3					
MICRO	Insufficient funding for housing teams in local government e.g. salaries, training, temporary contracts, or consultants so staff spend time seeking external funding/ future employment	Integrated funding e.g. Integrated Care Boards with housing as a priority	4					
	Competing priorities across local government departments	Meaningful partnership working e.g. education and engagement activities across local department, reduced complexity within unitary authority	4					
	Lack of a systems approaches especially with sustainability	Able to use sustainability as a hook for health objectives	3, 5, 6					
		Local strategies, guidance, and protocols; e.g. referral protocols between health, social care and housing, Health Impact Assessments of housing policies/ strategies or related strategies, e.g. housing investments plans	2, 3, 4					
	Information governance and data quality issues, hidden more dispersed properties in rural areas, difficult to demonstrate impact/ outcomes without access to high quality data	Data sharing within organisations to identify unhealthy housing and people vulnerable to impacts of unhealthy housing	4					
		Tools e.g. 3D modelling, acoustic studies, profiling surveys, virtual reality headsets, Health Impact Assessments, health incorporated into Environmental Impact Assessments, Post Occupancy Evaluations	6					
		Evidence and guidance presented in format accessible to audience	6					
MESO		Public awareness e.g. consultation methods, community engagement activities	3, 4, 6					
		Charity advocacy e.g. Healthy Homes Bill and campaign	7					
	Limited education requirements regarding healthy housing in curriculum and CPD	Health in built environment curricula and professional accreditation specifications and vice versa	3, 4, 5, 6, 7					
	Language/ various definitions e.g. for crowding, often more simple measures used in research and more complex definitions in policy	Workforce development initiatives e.g. multidisciplinary conferences, courses, multidisciplinary think tanks, site tours, online forums, networks, profession codes of conduct, Memorandum of Understanding, public health accreditation/ branding/ credentialing/ new regulated profession	5, 6, 7					
	Complex legislation and regulations evolve slowly and do not always reflect up-to-date health evidence	Legislation and regulation e.g. moving specific requirements from local planning to buildings regulations (dwelling size, amenity space) or applying them to multiple types of housing	1, 2, 4, 5, 6					
	Standards can be complex, disjointed and risk being tick-box exercises	Voluntary standards e.g. Fitwel, WELL, landlord registration or star-ratings, and health in environmental standards	1, 4, 5, 6					
	Political leadership for housing in local and national governments		4					
	Uncertain attitudes of lenders, complex funding pathways		3					
MACRO	Landowner behaviours e.g. land banking, ransom strips		6					
	Limited research bodies/ funding opportunities for grants		7					
	Cost of Living Crisis, refugee resettlement, disasters		4					
		Continued evidence generation on the health effects of housing and multi-component interventions to promote healthy housing	1, 3, 5, 6, 7					
	Focus on economic principles of housing delivery, healthy housing is perceived to be costly, loss of developer contributions, viability assessments, valuation mechanisms are open to misuse	Clear evidence of links between housing and health including the costs of wider societal impacts	1, 4, 5					

Already known in evidence base; Adds detail to evidence base; Was not yet known or in evidence base

Examples at the micro level included a professionals' career stage or level of interest in healthy housing, and a housing developments' budget, site size and constraints. At the meso level, an organisations funding streams and culture were of note. Lastly, at the macro level, the degree of political interest and leadership, the complexity of funding pathways, and the societal demands on housing supply were all significant.

There is little control over some of the macro level challenges, such as disasters and the Cost-of-Living crisis, however the response to them can act as an opportunity. For example, it is unclear whether the COVID-19 pandemic could shift the political acceptability of legal requirements for healthy development (Pineo & Moore, 2021). Change is particularly likely to come about when multiple opportunities are spanned at once. For example, in a recent landmark case of a child death where housing conditions were held directly responsible for the cause of death (Kearsley, 2022) multiple factors were present. Evidence on the condition of the property from inspection reports, public awareness due to the harrowing nature of the event and subsequent advocacy efforts all acted as drivers of policy development. This has resulted in Awaab's Law and changes to damp and mould legislation in social housing (DLUHC, 2023).

Many of these findings are consistent with the existing evidence base and were already known. A current and significant lack of resource and capacity within the system is a well-reported issue, especially within the public sector (i.e. capital budgets, number of staff, level of expertise) (Houses of Parliament, 2018; Black *et al.* 2021). Low public awareness about the impact of buildings on health, and subsequent lack of advocacy to increase political or market pressures to deliver healthy housing is known (Pineo & Moore, 2021). Similarly, enforcement and accountability are well discussed. Legislation is often seen as an opportunity to bring about healthy housing, and there are perceptions that some developers will not deliver healthy housing unless it is a legal requirement (Pineo & Moore, 2021). There are also concerns that it can be overly complex and slow to evolve (Marsh *et al.* 2020b). Current building regulations tend to emphasise safety but not health promotion and are particularly limited for aspects that do not concern the fabric of buildings, such as connectivity and access to green space. Planning policy and guidance, meanwhile, is often too weak, or too easily misapplied (TCPA, 2023).

The findings added additional detail to some of the known challenges and opportunities. Although the importance of data to target and evaluate the impact of housing interventions on health is known (Design Council, 2018; Pineo & Moore, 2021), the submitted works highlighted the importance of overcoming information governance and data quality issues, as well as actions to enable data sharing within and across

organisations to identify unhealthy housing and people vulnerable to impacts of unhealthy housing. Similarly, the challenge posed by workplace cultures not being supportive towards healthy placemaking (Design Council, 2018; WHO, 2021, Black *et al.* 2021) was expanded with findings on working in older firms, which may have set ways and a reluctance to try new things.

Two of the challenges and one of the opportunities appear to be new findings based on the systematic reviews that have been used as a comparison. The limited health educational requirements in university curricula and Continuing Professional Development for some of the relevant healthy housing stakeholders, such as architects (Marsh *et al.* 2019a) appears to be a newly identified barrier. However, there is more general commentary on public health and built environment practitioners and an evolving transdisciplinary workforce (Chang *et al.* 2022). This prompts consideration over reviewing other relevant professions such as construction staff and environmental health officers. Collaboration between accreditation bodies and co-developed educational content would therefore be important. The reduction in funding to research bodies and therefore grant opportunities regarding healthy housing also seemed an unacknowledged barrier. For example, the Building Research Establishment became a charitable trust in 1997, but again medical and public health funders are now increasing emphasis on wider determinants of health (NIHR, 2023a). The influence of government and relevant corporations who fund research is therefore important. Lastly, the development and use of novel tools, such as 3D modelling, acoustic studies, profiling surveys, and virtual reality headsets provide a promising opportunity. Visual and striking methods to demonstrate the impact of housing on health to professionals and users may result in increased health considerations in decision-making and advocacy efforts.

The implications of the opportunities and challenges identified (sub-question four), in the context of the findings from the stakeholder influence analysis (sub-question three) are discussed next.

4.2.3 Summary

Given that England has some of the oldest housing stock in Europe (Nicol *et al.* 2016; Kings Fund, 2023), and the dominant stakeholders with power over housing are from non-health sectors, this analysis suggests that to deliver healthy housing within the current system it would be valuable to;

- Incentivise stakeholder groups with power to become more interested in health (i.e. suppliers and producers, such as developers), for example through private-public partnerships, or regulatory or financial means.

- Shift power to, or improve the understanding of where power lies, for those who already have high interest in health (health and consumer stakeholder groups).
- Place emphasis on stakeholder groups with power over renewal and the maintenance of existing homes (i.e. regulators such as Environmental Health Officers, housing officers and consumers).

Practical suggestions to work towards these shifts in the current system are presented in the next chapter under the ‘Recommendations for future research and practice’ section.

Chapter 5: Discussion

This chapter evidences the third objective by critically examining the methodological considerations associated with the submitted works, and the wider body of evidence on healthy housing. It is divided into four areas; methodological approaches, disciplinary perspectives, generalisability and theory. It uses the results and discussion from all the submitted works and the four thesis sub-questions, to make five main recommendations for future research and practice. It showcases the impact of the thesis research in academia and practice, and lastly, it presents the authors personal future academic development goals.

5.1 Methodological considerations

Methodological approach best suited to answering a research question

A key strength of the publications submitted is their utilisation of a range of methodological approaches best suited to answering a research question (Weaver, 2018): evidence synthesis (Publications 1, 2, 3, 5), a prospective birth cohort study (Publication 2), mixed methods evaluations using a realist approach (Publication 4) or the RE-AIM framework (Publication 6), and a descriptive commentary (Publication 7). This included well-accepted approaches, such as the RE-AIM framework, and more novel approaches such as application of the public health prevention model to the architecture profession.

Within the field of public health, evidence synthesis is highly regarded for its ability to identify and summarise evidence related to a specific topic. It is less commonly utilised by built environment disciplines and therefore adds significant value to the field, as one of many types of evidence policymakers may consider (Bates *et al.* 2023). The utilisation of evidence synthesis methods for Publications 1, 2, 3 and 5 allowed for conclusions to be drawn about the breadth and quality of the existing evidence base, the identification of gaps in the evidence base, and for future directions for research to be highlighted. It was an indicated methodology because it was the first time a systematic review had been done on PDR, on all types of CLH and any health outcomes, and to analyse the extent to which health evidence informs building policy. However, it is recognised that searching for primary studies of complex social interventions, including those in the field of housing, is particularly challenging (Gibson *et al.* 2011). In the reviews submitted with this DPhil, most included literature were grey, and of the academic papers most were reliant on findings from case studies or interviews. These research methods cannot prove causality. Grey literature and non-experimental studies are also at greater risk of bias. Many of the grey literature items did not have a clearly stated aim or parameters to define their content coverage, so may have reported only on the most extreme findings.

Similarly, those from third sector organisations may be at risk bias through promoting a certain agenda.

Whilst some randomised-controlled trials do exist on aspect of healthy housing, such as fuel poverty interventions (Gibson *et al.* 2011), the submitted works also sought to address important criticisms of the majority of the existing evidence base on housing and health, namely the non-randomised nature, use of subjective outcome measures and not adequately incorporating follow-up of study participants (Marsh *et al.* 2020). This shows that the common limitations of research on healthy housing are understood and have been overcome within the constraints of each individual study:

- Non-randomised and confounding: It is often not feasible to randomise participants in studies on housing and health (Ige *et al.* 2018), therefore, observational studies are frequently used, and within these cohort studies are highest in the evidence hierarchy (Bates *et al.* 2023). Publication 2 was a cohort study design and controlled for an extensive range of confounding factors. Similarly, Publication 6 used a before-and-after study on a single educational cohort of architecture students, which minimised confounding from variations in staffing and delivery of the programme. However, as there was no control group, it is possible that participants would have become more health aware anyway, given the identified trend of increasing awareness about mental health and wellbeing among the architecture profession. The changes seen may not, therefore, be due to the educational programme alone. There will always remain a degree of residual confounding in non-randomised studies.
- Follow-up of study participants: Studies on housing and health infrequently include adequate follow-up, for example only three studies out of 48 literature items in the systematic review for Publication 3 were longitudinal. Determining whether housing features lead to poor health, or people with poor health are more likely to live in poor housing conditions, is therefore challenging. Publication 2 and 6 were both longitudinal in nature, collecting data over three and eight years respectively. This enabled account to be taken of temporality. Missing data did not seem to be a major problem for Publication 2 as analyses of multiply imputed data sets gave very similar results to the complete-case analysis, however in Publication 6 roughly half of participants were lost to follow-up possibly resulting in selection bias, with those who completed the survey or accepted an interview being those who most enjoyed or felt the greatest impact from the educational programme, potentially overestimating the impact.
- Subjective outcome measures: Publication 2 used validated measurement tools, and the level of crowding was recorded by a researcher at the participants' house, making this as objective as possible. However, the outcome and

covariates were all reported by the participants' mothers, which introduces the potential for response bias. The interviewers and participants were blinded to the research hypothesis, which minimised reporting bias. The mixed methods studies used dual coders to confirm accuracy and interpretation of the data during the coding process and at theme development, findings were discussed and agreed between authors and reported in line with relevant guidelines, e.g. Publication 6's Supplementary File 1.

Whilst triangulating findings from across the submitted works ultimately provides a rich approach and is well suited to the complex subject area of healthy housing (Weaver, 2018; Allemang *et al.* 2022) it also presents limitations. The submitted works are heterogenous, involving different collaborators from varied disciplines, and spread over a period of more than five years making the triangulation process complicated, for example framework terminology was not available within individual submitted works. The critical commentary analyses four sub-questions which were not the original research questions of the submitted works, therefore the methods have not been designed accordingly. Although four sub-questions enable a good breadth of connections to be made across the submitted works, it limits the depth of analysis that was possible for each one. Therefore, all sub-question findings would benefit from further refinement and testing, with suggestions set out throughout this thesis.

Disciplinary perspectives

This thesis is grounded in inter-disciplinary research, with its supervision and each of the publications submitted being co-developed, with individuals from the disciplines of medicine, psychology, epidemiology, environmental health, architecture, town planning, to name but a few, employed in academic- and practice-based roles in the UK (e.g. UWE Bristol; University of Bristol; MRC Lifecourse Epidemiology Unit, University of Southampton; OHID; and the Tenancy Deposit Scheme) which brings an added dimension to the findings. The traditional hierarchy of evidence in Public Health only speaks to a limited selection of relevant academics and policymakers. Whereas some of the research methods used in the submitted works including interviews, focus groups, public engagement workshop, and from the systematic review case studies, hold significant weight in housing and planning policy (Bates *et al.* 2023). Importantly, working with such diverse disciplines also enabled invaluable opportunities; for sharing and developing understanding of real-world challenges, creating ideas and the production of findings which have implications for stakeholders working in multi-disciplinary settings. This is essential given within national and local government in England there is no single discipline which influences housing. It spans government

departments, and consequently levers to influence housing delivery rely on cross-government and discipline working.

Complex systems theory argues that by replicating the real world, simplifying where possible while retaining the critical aspects relevant to the problem under study, we can better understand the structural complexity of real-world problems that results from the interaction of specific phenomena and their environments (Carey *et al.* 2015). This is the intention of this research, in terms of moving from theoretical principles to creating change to housing delivery in practice. However, this brings a degree of compromise there are limits of reductionism and condensing complex systems into simplified processes can lead to problems. For example, over-simplification can lead to the implementation of ineffective or harmful interventions (Atkinson *et al.* 2015; Fink & Keyes, 2017), and synthesising large amounts of information into something which is simple, user friendly and useful in practice means that there is a risk of mis-representing information. This has been most evident in the stakeholder matrix production (Table 7).

Working with other disciplines also presented challenges, for example, differing perspectives on how “evidence” is defined and how it can and should be generated through research. It can be argued that overall, this submission is still bound under the umbrella of ‘public health’, given the authors positivist background and later recommendations for use of objective data and statistical techniques. Ideally future research would move further towards transdisciplinary research, as the most integrative form of multi-disciplinary research (Lawrence, 2006). This could be through greater flexibility in methods (e.g. ethnography, community meetings) and approaches to implementation and dissemination of findings (Bates *et al.* 2023). Future research teams could be expanded to include other relevant disciplines such as law, political science and social science, to further accommodate the complexity of the relationship between housing and health.

Generalisability

For all of the primary research submitted within this DPhil, recruitment was limited to an organisation, locality or region within England. This enabled creation of evidence that is contextually relevant but replicability, scalability and the generalisability of findings to the rest of England, and more widely, is important to consider. Publication 6 was conducted in a single educational institution, where there were already several very health-engaged tutors. This may not be the case in other educational institutions, where baseline knowledge and support are lower, making the generalisability of this study uncertain. The cohort in Publication 2 has been well characterised, with a study population which is slightly more affluent than the general population in the UK, as commonly results from

selection bias in studies. Publication 4, whilst only conducted in a single region, employed a realist approach, which aims to overcome the issue of generalisability by understanding the contextual factors that explain what works, for whom, and under what circumstances (Pawson & Tilley, 1997). Lastly, the evidence synthesis in Publications 1 and 3 were limited to OECD countries only, due to differences in housing governance mechanisms, general economic circumstances and levels of informal housing, which may act as confounders (Shrestha *et al.* 2021). It is possible that evidence from other contexts, including developing countries where CLH is also increasingly being used as a form of housing delivery (CAHF, 2022), may offer alternative insights and could be an avenue to explore in future research.

Whilst the scope of this thesis justified the focus on market housing, there is value in considering the extent that its' findings can be applied to other types of housing. The occupants of the types of housing which were out of scope (i.e. temporary accommodation, supported housing and social housing) are more likely to be vulnerable and to report ill-health than occupants of market housing (Ellaway *et al.* 2016). Social housing has also had significant focus in recent policy in England following the Grenfell Tower fire and death of a child from damp and mould in social housing (DLUHC, 2022; Kearsley, 2022). The considerations for framework selection, method of analysing health inequality impacts from a housing delivery approach, and collated opportunities and barriers are of relevance to any housing type. Similarly, the stakeholder power analysis could be relatively easily expanded to explicitly include social housing with additional funders of social housing (e.g. national, regional or local government, philanthropic foundations and non-profit organisations), and the full range of Registered Providers (i.e. local authority landlords as well as housing associations).

Socio-ecological and complexity theory

Although the application of methodological reductionism has been useful for answering certain causal questions about 'downstream' exposures, methods underpinned by complex systems theory are required for wider determinants of health such as housing (Fink & Keyes, 2017). In this thesis application of both the socio-ecological theory and complex systems theory can be seen in each research sub-question and all reinforce the importance of taking a holistic and complexity informed approach in research on healthy housing (Bronfenbrenner, 1977; Gibson *et al.* 2011; Atkinson *et al.* 2015; Rutter *et al.* 2017; Sharpe *et al.* 2018; Munro *et al.* 2022; Leifheit *et al.* 2022). This includes the complex relationship between housing and health including interactions between individual characteristics, household and neighbourhood features, and broader driving forces illustrated by frameworks (sub-question one), the intersectionalities between inequality domains (sub-question two), the difficulties in grading stakeholder power (sub-

question three), and the multiple, interlinked levels at which challenges and opportunities arise to make change happen in the current system in England (sub-question four). In the evidence syntheses, particularly for Publications 1 and 3, by collating and assessing the quality of existing evidence against frameworks that include building and neighbourhood features as well as primary health outcomes, knowledge as well as research gaps on the complex links between housing and health were identified. In more recent work the author has utilised complexity informed methodologies, particularly evidenced in Publication 4 through the realist evaluation. This is becoming an increasingly popular way to synthesise complex public health issues as it allows a far greater theoretical understanding of the intervention process, rather than simply deducing whether an intervention is effective or not (Rolfe *et al.* 2020).

In summary this section shows that the common limitations of healthy housing research are understood and have been overcome where feasible. A key strength is the mixed methods and interdisciplinary approach which adds richness and includes a level of complexity not often explored to this degree within the field.

5.2 Recommendations for future research and practice

This seminal submission advances the body of evidence on healthy housing and recommends that future research and practice continues to be complexity informed through its approach (e.g. levels of social analysis), and methodology (e.g. realist). Five options for future research and practice on healthy housing are discussed below.

More effective use of data and observational studies

Objective measures, particularly of health outcomes, at low geographical area or individual level, were often found to be lacking in availability or use by professionals relevant to healthy housing (McClatchey *et al.* 2023a). Objective data can reduce the risk of bias in studies and decisions, so it is recommended that existing objective data sources regarding both housing (e.g. EPC and council tax data, inspection reports, property stock modelling) and health (e.g. GP or hospital records) are more widely used (McClatchey *et al.* 2023b). Exploring barriers to data linkage between these existing datasets would be invaluable for future research, enabling observational studies and techniques such as Structural Equation Modelling (SEM) to be utilised. SEM is a multivariate statistical analysis which can produce more accurate models with direct and indirect pathways than standard regression techniques (Gunzler *et al.* 2021), so would be apt for the complex causal pathways between housing and health. In addition, national housing surveys and cohort studies can significantly contribute to evidence generation (WHO, 2020). In England, there is the English Housing Survey (a continuous national survey which collects information and inspects a changing sample of properties)

(Houses of Parliament, 2018; DLUHC, 2022), and numerous cohort studies many of which have some data on housing features (UKRI, 2023), which could be used for further objective research.

In practice, objective data would enable better assessment of need, evaluations of impact, and targeting of resources and interventions to individuals who live in poor housing and experience poor health. Wider uses of housing data in health strategies and assessments (e.g. Joint Strategic Needs Assessments, Public Health Outcomes Framework data dashboard) and of health data in housing assessments and strategies (e.g. housing and related strategies, calculations used to determine local housing need, design codes) would be beneficial.

In particular, children and young people justify future focus in observational studies, as they were recognised as population sub-groups less prominent in the current evidence base (Marsh *et al.* 2019b; McClatchey *et al.* 2023b; Munro *et al.* 2022). Research has shown that young children, who spend much time at home particularly before starting school, are especially vulnerable to the health impacts of housing, making it ever more important as a future focus (WHO, 2018).

Evaluations

It is often not feasible to randomise participants in studies on housing and health (Ige *et al.* 2018), especially when considering macro level influences or policies. However, natural experimental methods, particularly at opportunistic times, can be invaluable. Evaluations of large-scale government projects and policies would significantly contribute to evidence generation (WHO, 2020). Housing interventions are often implemented at the local authority or combined authority level in England (housing responsibility sits with upper tier or district in two-tier authorities), presenting opportunities for quasi-experimental study designs. As well as retrospective evaluations, prospective impact assessments and monitoring to anticipate health impacts are crucial. Methods such as Health Impact Assessments, incorporating health into Environmental Impact Assessments or Post Occupancy Evaluations (POE), could be valuable. Despite the known benefits of POE, the culture of evaluating the performance of a building, after it has been built and occupied by users for a while, has not yet been successfully embedded in the design and procurement process or routinely carried out in England (Durosaiye *et al.* 2019).

Examples of forthcoming opportunities include;

- The National Planning Policy Framework consultation proposals; process and calculations used to determine local housing need, building on brownfield sites,

strengthening socially rented housing, increasing housing for older people, and of particular relevance to this thesis supporting CLH (DLUHC, 2022a).

- The Renters (Reform) Bill (2024) introduces increased powers for local governments to protect tenants' rights and may put social and private rented housing on the same level in terms of regulatory expectations. However, new regulations remove the requirement for accommodation for asylum-seekers provided on behalf of the Home Office to have an HMO license (The Houses in Multiple Occupation (Asylum-Seeker Accommodation) (England) Regulations, 2023).
- Health services are increasingly being reshaped with reference to addressing wider determinants of health, with social prescribing a prominent example (Lawler, 2023). Health and social care teams referring priority patients with health needs for better housing conditions is therefore an important intervention to continue to evaluate in the future (Baraniuk, 2023).
- Housing delivery approaches which have been outside the scope of this thesis, such as Exempt housing, a form of supported housing which has seen a significant increase in use over recent years (Wilson, 2022).

Transdisciplinary working and stakeholder matrix development

The new stakeholder matrix (Table 7) could advance work in the field with significant value in both academia and practice. A researcher could use it to guide their participant selection depending on which aspects of healthy housing their research question is addressing. Similarly, for practitioners the matrix could be used as a tool for examining the role and potential effectiveness of engaging certain groups of stakeholders to achieve healthy housing in practice, and guiding stakeholder engagement plans and partnership working. It is anticipated most users would identify the need to strengthen public-private partnerships and collaboration with landowners, financiers, and developers given their power, and Environmental Health Officers, housing officers and consumers given their critical role in housing maintenance. Findings could be easily extrapolated to the widely used power-interest matrix by Ackermann & Eden (2011), i.e. 'power' so keep satisfied or manage closely, 'interest but limited influence' so keep informed, 'no obvious interest or influence' so monitor. Considering this, dissemination methods in addition to an academic paper would be valuable, for example sharing through community events, social media, and through organisations such as Public Practice, Chartered Institute of Environmental Health, and the Chartered Institute of Housing.

There are all sorts of qualifications and refinements which could be made to this type of diagram, such as inclusion of some stakeholders and the exclusion of others (e.g. could

add building control, estate agents/ valuers, utility companies and hostels/ refuges). The rationale for categories used could change, as one could split apart national government (by department or civil servant from politician), health and social care (by commissioner and provider), planner (by planning policy and development management) and funders (as different types of funders may have specific legal restrictions). The classification of power is binary in this analysis but there could be benefit from grading power in a subsequent iteration. For example, planners have been categorised as having power regarding adaptability and affordability as they are able to stipulate requirements in their Local Plan, such as Lifetime Homes. However, there are concerns that the extent to which such requirements are met through the development process is questionable, with affordable homes frequently cited as being lost through viability assessments (Marsh *et al.* 2020a). In this respect the power held by planners could be downgraded so that more power is visible with the developer. This would require stakeholder insights to refine, as this type of data would likely not be able to be elicited from existing literature, regulations and job descriptions. There would likely be diverse views, as seen in an earlier attempt to quantify the interest of four stakeholder groups on a limited selection of housing features (Prochorskaite, *et al.* 2016), and so a method such as extended peer review or a Delphi study could be helpful in building consensus.

In a similar vein, the limited health educational requirements noted in architecture university curricula and Continuing Professional Development programmes prompt a review of other relevant professions such as construction staff, environmental health officers, developers and councillors. Co-development of educational content and accreditation specifications are important for the continued growth of knowledge and skills across relevant professionals. The development and use of novel tools, which provide visual and striking methods to demonstrate the impact of housing on health to professionals, may result in increased health considerations in decision-making.

Public engagement and understanding

The stakeholder matrix, and opportunities and challenges sections, highlighted the need to empower the public more, as they have interest in all aspects of healthy housing, a key role in housing maintenance, and can play an important role in advocating for change in political and economic landscapes. Improving the low public awareness about the impact of housing on health, and corresponding lack of advocacy, could increase political and market pressures to deliver healthy housing. This could provide further support to promising political discussions similar to those regarding a Healthy Homes Manifesto (Parallel Parliament, 2023).

Research methodologies such as case studies, ethnography, and community meetings could be particularly helpful for engaging the public and producing emotive examples aligned with the evidence base, to add weight to housing and planning policy discussions (Bates *et al.* 2023).

A valuable practice example is the TCPAs campaign on Healthy Homes, which recently includes the These are Homes photobook, and uses a very visual and striking approach, accessible to all audiences, to demonstrate the negative impact housing can have on health. Also, the FrameWorks Institute has recently developed a toolkit designed to overcome subconscious obstacles, including framing the narrative about housing around health and not wealth, and to include solutions and explanations when speaking with the public (FrameWorks UK, 2023). Tools which can demonstrate the impact of housing on health through visual and striking methods could further help public understanding of the complex and important links. Examples include 3D modelling, virtual reality headsets and tailoring the healthy housing framework (Figure 4) to the public, through an online, interactive version.

Healthy Housing Framework and holistic governance

Figure 4 provides the most comprehensive attempt to date at illustrating the entirety and complexity of the relationship between housing and health. There is value in adopting a holistic framework of this nature to advance work across research and practice with a consistent approach when assessing the health and inequality impacts of housing. Testing the considerations for selecting a framework with other researchers and practitioners through a systematic approach such as a Delphi study and possibly developing an online interactive version of the prototype comprehensive framework (Figure 4) which could be adapted for audiences, would be valuable next steps in refinement. There may be value in conducting a systematic literature review of healthy housing specific frameworks, including grey literature (to capture frameworks developed by the voluntary sector and industry). Extracting the characteristics and developing a scoring system against the considerations for selecting a framework developed in this DPhil could strengthen the identification and adoption of a single framework.

Given governance mechanisms' role in incentivising stakeholders with power (e.g. suppliers and developers), ensuring they are comprehensive, holistic and that they reflect the evidence base on healthy housing is crucial. Given the emphasis on energy efficiency and building safety/ health hazards in governance mechanisms, increasing prominence of housing features which promote health and wellbeing, particularly mental health, are needed (Parallel Parliament, 2023). The healthy housing framework could enable this critique, reviewing the extent that each housing feature known to impact

health is specified in current mechanisms available to govern healthy housing (Table 2), such as Building for a Healthy Life which is adopted by Homes England (Homes England, 2020). This would build on earlier endeavours regarding a national review of three health hazards in building policy (Carmichael *et al.* 2019) and international review of health in built environment standards (Callway *et al.* 2020). It could support rationalisation of governance mechanisms and recognition of resource levels, especially within the public sector, to be able to enforce or implement the mechanisms (Houses of Parliament, 2018).

Lastly, research to understand the interplay between climate and health agendas has emerged as a priority. Consideration of health outcomes associated with energy efficiency interventions, such as increased insulation and reduced ventilation promoted during the Cost-of-Living Crisis, is particularly urgent in the context of the national commitment to be carbon net zero by 2030 and the need to adapt to hotter summers (Carmichael *et al.* 2020; Munro *et al.* 2022). Similarly, opportunities should be taken to decarbonise homes while building healthier buildings and places.

5.3 Impact of the submitted works

The impact of the submitted works, both for academia and practice, is presented throughout this thesis. In summary, each of the works have been published in reputable peer-reviewed journals from a range of disciplines, including public health, medical and environmental, and each journal has a high Impact Factor for its field. Since 2018, I have presented the research submitted here at regional, national and international conferences. To date, the combined works submitted have been cited by academic journals or policy over 85 times (Table 3) despite only two being open access. The most cited publications are Publication 7, 5, and 1 (which also received an award for Wiley's 'Top downloaded paper' and has been cited in multiple books). These have been cited internationally including New Zealand, US, Canada, Nigeria, Russia, Italy, Belgium, Uruguay, and the Netherlands. Interestingly, most of these were by environmental disciplines, such as architecture and civil engineering, even for Publication 7 aimed at the public health workforce.

The findings of the submitted works have been disseminated through a range of methods (Appendix B). The author has presented at over ten conferences from local to international level. Most recently the Local Government Association national conference, and European Public Health and Healthy City Design International conference. The author also has several publications in other formats, e.g. a contribution to a book chapter, blog, commissioned report and briefings.

A strength of the submitted works impact is the extent that they have been disseminated through routes to reach practitioners and be used in practice. This impact beyond academia is recognised as particularly important by the Research Excellence Framework (REF, 2021). Examples include:

- Publication 1 was picked up by a news outlet and led to a proposal at the NIHR Public Health Research Prioritisation Committee in 2021 to fund research on the gaps identified in my publication. Subsequently over £2 million has been awarded to a university for research, including on the gaps identified by the author (NIHR, 2023b).
- Publication 2 was used in South Gloucestershire council to make the case for greater space requirements in their Local Plan than the nationally described space standard demand and received positive feedback from the Royal College of Paediatricians and Child Health.
- Publications were shared with the South West Healthy Places regional network and OHID national housing lead thereby influencing business planning objectives, e.g. deep dive into data sharing challenges on healthy housing and focussed regional sessions on healthy housing.
- Thesis findings were shared with South West localities, contributing to consideration of housing as an Academic Health Science Network priority and the establishment of Devon Housing Commission (a group including a member of the House of Lords and chief executives who makes funding decisions regarding health and housing delivery).

The author's contribution to public health research extends beyond the works submitted here, as evidenced by their nine co-authored peer-reviewed publications (Appendix B).

5.4 Future personal academic development

In the short term, the author has plans for further publications based on the critical commentary, aligned with the research sub-questions (particularly the first and third). They are hopeful for further collaborative research and joint publications, with their supervisors and the academic contacts made through the process.

The author has recently been appointed to a Senior Research Associate position at the University of Bristol to work on an urban health consortium (TRUUD, 2024). They would like to secure further arrangements for a split academic and service role when this fixed-term position comes to an end. They will explore the possibility of a formal joint post being established across their current organisations, applying for funding to enable part-time hours, or securing a further part-time research associate or post-doctoral fellowship post. Secondments and joint appointments are recommended by the Academy of

Medical Science (2022) for improving relationships and coordination between organisations.

Through the DPhil process, particularly by mapping my skills to the Researcher Development Framework (Vitae, 2010) to inform the Accredited Learning application, the author has identified potential academic development needs. By cross-referencing these with examples of relevant job descriptions, areas which would benefit from strengthening have been identified:

- **Funding generation and management** – Whilst the author has a supportive assurance role for some funding streams within OHID and have to a degree influenced funding policy through OHID and attendance at Applied Research Collaboratives, they do not have any successful applications or management experience for grants. Applying to open competition funding (initially an external, small grant) is a top priority to enable the author to develop skills in budget management and compliance with financial processes and advance their reputation in the field.
- **Global citizenship** – Whilst the author has presented at conferences internationally and published in journals with international readership, they have limited international research contacts. Re-starting as a peer reviewer for an international journal on environmental determinants of health would facilitate familiarity with leading academics in the field. They have explored networks to facilitate this including the Healthier Housing Partnership (HHP, 2023), Health through Housing Coalition (Archive Global, 2023), and the International Conference on Urban Health by the International Society for Urban Health, in the hope of being part of an international research collaboration in the future.
- **Enterprise** – The author has presented at conferences which have industry attendance, however stronger relationships with the commercial sector, e.g. developers, and real estate companies, could strengthen the impact of healthy housing research. Options include industry participants in future research, application of research to industry standards, and exploring becoming an accredited professional with pre-existing industry standards to improve reputation in the field, e.g. WELL Building Standard version 2 (IWBI, 2018), which enables networking with other registered professionals.
- **Teaching** – As an accredited public health educational supervisor, specialty tutor, and examiner, the author has experience of line management and supervision, including a public health apprentice, registrar and research associate. They aim to continue to supervise at research associate level and start to support postgraduate research training and degree supervision. They are

particularly interested in the development of curriculum or courses for the wider public health workforce or the general public relevant to healthy environments.

Chapter 6: Contribution of submitted works to doctoral descriptors

A summary of how the UWE doctoral descriptors have been addressed by the analysis in this thesis and a collective body of research is summarised in this chapter. In addition, Table 9 shows how each submitted work individually evidences that the doctoral descriptors have been addressed.

1) Has conducted enquiry leading to the creation and interpretation of new knowledge through original research or other advanced scholarship, shown by satisfying scholarly review by accomplished and recognised scholars in the field
As the lead author of all but one of the seven publications submitted, and through all works being published in double-blind peer-reviewed journals (except one in pre-publication format), this demonstrates knowledge creation and interpretation by accomplished and recognised scholars in the field. The works respond to gaps in the healthy housing evidence base and span a range of settings, populations, housing types and lifecycle stages. All works are published in reputable journals from a range of disciplines, including public health and built environment journals, and each journal has a high Impact Factor for its field.

Submitted works provide two of the first overviews of health and health inequality impacts from current trends in market housing delivery in England (PDR and CLH) and added deeper understanding to two other current approaches (PRS housing and crowding).

Through critiquing the application of six healthy housing frameworks, the creation of new considerations that should be given when selecting, appraising and applying healthy housing frameworks, and the production of a prototype comprehensive framework (which more fully illustrates the complexity of the relationship between housing and health) this analysis has contributed to the evidence gap identified by other researchers (Pineo *et al.* 2018a; WHO, 2020), thereby evidencing new knowledge generation and interpretation.

This thesis contains the first comparison of a general (OHID, 2022) and a housing specific inequality framework (Swope & Hernández, 2019), and the first application of the latter to England and to four current market housing delivery approaches. This has produced important findings in terms of the design of policies and programmes that do not further entrench inequalities and can use housing to promote health equity.

The creation of a stakeholder matrix, which attempts to compress into a single diagram a representation of the power relations between stakeholders in healthy housing delivery, and to what extent they might have interest and influence over different housing factors known to impact on health, demonstrates the creation and interpretation of new knowledge. This is because previously a matrix had been produced on urban design but not specifically housing, and no known matrix yet includes health considerations.

Lastly, this thesis has taken a new approach by collating challenges and opportunities against levels of social science, enabling a holistic perspective. Several of the challenges (e.g. limited education requirements and reduced funding to research bodies or for grant opportunities) and opportunities (e.g. development and use of tools) identified from the submitted works have added detail and depth of understanding to the evidence base.

2) Can demonstrate a critical understanding of the current state of knowledge in that field of theory and/or practice

This research, grounded in socio-ecological theory (Bronfenbrenner , 1977), responds to gaps in the healthy housing evidence base, by moving understanding from theory to the generation of new knowledge regarding delivering healthy housing in practice, as is called for in the evidence base (Academy of Medical Sciences, 2022; Pineo & More, 2022). For many of the submitted works (Publications 1, 2, 3, 5), a systematic literature review was undertaken to examine existing knowledge, policy or theory related to each individual research question. In addition, rapid literature searches were carried out to inform each of the four research sub-questions in this thesis.

The research has evolved in terms of its use of pre-existing literature and theories. The earliest submitted work (Publication 2) was not based on a pre-existing healthy housing framework, whereas later publications were either adapted from pre-existing theories or methodologies, such as the Prevention Pyramid, RE-AIM evaluation and realist framework (Publications 4, 6 and 7), or directly adapted a pre-existing healthy housing framework (Pineo *et al.* 2018b; Carmona, 2019; Ige *et al.* 2020) (Publications 1 and 3).

As submitted works cover a range of disciplinary perspectives, including public health, medicine, geography, epidemiology, environmental health, architecture, and town planning, a rich breadth of perspectives, and in-depth exploration and constructive critique of the relative contributions to healthy housing knowledge, methodologies and theory has been possible. This enables findings and recommendations to be considered in terms of their value to stakeholders and decision-makers working in real-world

multidisciplinary settings, such as housing officers, planners, and public health professionals.

3) Show the ability to conceptualise, design and implement a project for the generation of new knowledge at the forefront of the discipline or field of practice including the capacity to adjust the project design in the light of emergent issues and understandings

The author initiated and led the overall concept and design of six of the submitted works (Publications 1, 2, 3, 4, 6, and 7) and collaborated with colleagues on the design of the seventh (Publication 5) (Table 3). For the six that were led, the author also project managed and oversaw implementation, which required skills in developing the research questions, establishing research teams and delegation of roles, data collection and analysis, time management and disseminated project outputs to academic and lay audiences. This was done without the support of dedicated funding, apart from Publication 3.

Project designs and methods employed, which led to each of the submitted works, have been adjusted in the light of a range of emergent issues and understandings. For example, the research that led to Publication 3 was preceded by an earlier discrete project initially commissioned by an independent trust, Power to Change, and was not peer reviewed (McClymount *et al.* 2019). Building upon feedback from readers and academic best practice, the review was updated and improved in rigour (e.g. adding in a quality assessment of studies).

The focus on four current market housing delivery approaches produced findings of high importance to the current system in England with potential health safeguards needed for crowding, reducing regulatory requirements and increasing the use of PRS housing, and support indicated for CLH as an approach. This places the new knowledge generated at the forefront of the field of healthy housing.

4) Can demonstrate a critical understanding of the methodology of enquiry

Framed with social science levels of analysis, the research presented is complexity informed to a greater degree than is often explored within the field. A range of robust methodological approaches and research methods were utilised, including, but not limited to; evidence synthesis, regression analysis of a birth cohort study data, thematic analysis of qualitative data, and realist evaluation. As per the pragmatic research paradigm (Weaver, 2018; Murphy, 1990), for each work submitted the methodological approach utilised was deemed to be the best suited to the research aims and questions under investigation.

Through the submitted works expertise in evidence synthesis and evaluation methodologies have been developed, as well as a strong critical understanding of quantitative and qualitative methodologies. The thesis submission demonstrates knowledge and an ability to apply a range of pragmatic methods to examine public health issues. Chapter 5 critically examines the methodological considerations associated with research on healthy housing and recommendations for more effective use of data and cohort studies, opportunistic evaluations both retro- and prospectively, and public/ community engagement show awareness of future beneficial methods of enquiry.

Whilst interdisciplinary working underpins the research, with all but one submitted work (Publication 2) utilising a research team comprising mixed disciplines, it still predominantly represents a certain type of knowledge and a certain view. The authors medical and public health background, and its rooting in a western research context means that other disciplines and other cultures or parts of the world may have different research philosophies and approaches.

5) Has developed independent judgement of issues and ideas in the field of research and/ or practice and are able to communicate and justify that judgement to appropriate audiences

The author has have moved from being supervised in the earliest study (Publication 2), to working in independent, leadership roles for later publications. In the later studies they have also supervised others, including informally a Research Associate for Publication 3, and as an Educational Supervisor for a public health registrar and apprentice for Publication 4.

This thesis demonstrates independent judgement of issues associated with the delivery of healthy housing. A key strength of the submission is the mixed methods and interdisciplinary approach which adds richness and includes a level of complexity not often explored to this degree within the field of healthy housing. Works submitted have been developed through independent thought, collaboration with colleagues, and engagement with a range of stakeholders (including local and national governments and the voluntary sector). Dissemination of these works has not only been through academic publications, but the research findings have also been tailored and presented to a range of audiences, including academics, stakeholders, and lay audiences (Table 3 & Appendix B). In addition, the thesis specifically considers how the findings can be presented flexibly to be better tailored to varied audiences. For example, the stakeholder matrix could be used by researchers to guide their participant selection, or practitioners

to guide stakeholder engagement plans. Similarly, consideration has been given to an online version of the prototype healthy housing framework so that it can be interactive and relevant sections highlighted for different audiences. The need for greater focus on public engagement is also presented.

6) Can critically reflect on their work and evaluate its strengths and weaknesses including understanding validation procedures

Each work submitted includes a reflection on its strengths and weaknesses. These publications have each been through peer-review, demonstrating an ability to critically reflect upon, and respond to, the limitations of the research. Consideration of research validation is apparent in each of the submitted works. For example, the critical appraisal of empirical research included in Publications 1, 2, 3 and 5, the critical reflections on research instrument validity in Publication 1, and dual coders in Publications 4 and 6.

The critical commentary also shows rigor, through a comparison of; two inequality frameworks, multiple sources of evidence to determine stakeholder influence, and challenges and opportunities mapped against four evidence reviews. The research has evolved and improved over time, with earlier studies being more simplistic in nature (i.e. analysing a single micro level exposure and single micro level outcome), and later studies progressing in complexity (i.e. macro level exposure and range of health outcomes spanning all levels of social analysis). Later submitted works; develop frameworks meeting more of the considerations for selecting a comprehensive framework, consider a greater range of inequalities, and identify more opportunities and challenges. Generally, the consideration of socioeconomic and protected characteristics was strong, whilst inclusion health groups and geographical perspectives were weaker (Table 5 & Table 6).

In addition, Chapter 5 discusses the methodological considerations associated with the wider body of evidence on healthy housing including methodological approaches, disciplinary perspectives, generalisability, and theory. The common limitations of healthy housing research (non-randomised, subjective outcomes measures and follow-up) and have been overcome where feasible.

Table 9: Summary of how each individual submitted work evidences that the UWE doctoral descriptors have been met

SUBMITTED WORK	UWE DOCTORAL DESCRIPTORS		
	Knowledge **(Doctoral descriptors 1, 2)**	**Methodology** **(Doctoral descriptors 3, 4, 6)**	**Theory** **(Doctoral descriptors 2, 3, 5)**
#1 PERMITTED DEVELOPMENT RIGHTS	First overview of the health and wellbeing impacts of housing created through PDR and an indication of the impacts of deregulating a planning system without explicitly considering health and wellbeing.	The extensive inclusion of grey literature and the approach of collating and assessing the quality of existing evidence against building and neighbourhood features as well as primary health outcomes enabled the identification of knowledge and research gaps on the complex link between PDR and health.	Directly adapted a pre-existing healthy housing framework to develop a bespoke conceptual framework about PDR and all relevant health outcomes.
#2 HOUSEHOLD CROWDING	Added to prior evidence on crowding impacts on health. Confirmed that living in a more crowded home is associated with a greater risk of behavioural problems in children, and that crowding occurs more commonly in social housing. Identified that this relationship was independent of confounding factors (gender, age, single-parent family, maternal education, receipt of benefits and social class and neighbourhood quality) and was mediated in-part by maternal stress, less sleep, and strained parent-child interactions.	Used established multivariable linear regression but on the only birth cohort study in Europe in which the mothers were recruited before conception of the child.	Developed a bespoke conceptual framework about household crowding and children's behaviour.
#3 COMMUNITY-LED HOUSING	First overview of the health impacts of all forms of CLH and all relevant health outcomes.	The use of community participatory methods and the approach of collating and assessing the quality of existing evidence against building and neighbourhood features as well as primary health outcomes enabled the identification of knowledge and research gaps on the complex link between CLH and health.	Directly adapted a pre-existing healthy housing framework to develop a bespoke conceptual framework about CLH and all relevant health outcomes.
#4 PRIVATE RENTED SECTOR HOUSING	Identified that the use of mechanisms is dependent on local context, and that limited objective health outcomes are being used to understand impact.	The first realist evaluation conducted on mechanisms available to improve PRS housing quality and tenants' health and wellbeing.	Adapted the pre-existing realist methodology to develop the first realist Initial Programme Theories about the complex link between PRS housing and health to further test.
#5 BUILDING POLICY	Identified that building policy in England focuses on climate mitigation rather than public health and uses public health evidence in a patchy way.	The comparison between a building policy review and a systematic literature review enabled the identification of practice and research gaps on the complex link between housing and health.	No notable contribution to theory.
#6 WORKFORCE DEVELOPMENT EVALUATION	The innovative Public Health Practitioner in Residence programme (PHPiR) is one of the few programmes in the world to conduct research into the expansion of the public health workforce into the design professions, and one of the first to evaluate the impact this has in practice. The study reveals for the first time, the effectiveness of the integration of public health input to an architecture undergraduate course.	The application of an established evaluation framework, and relatively long-term follow-up, enabled consideration of a complex intervention including identifying the barriers and facilitators to real-world implementation.	Developed a bespoke conceptual framework about the complex link between housing and health, as understood by architects trained through the PHPiR.
#7 ARCHITECTURE PROFESSION	Finds that despite the architecture profession having the potential to improve the health and wellbeing of the population through healthier buildings and places, there has been relatively little engagement between public health and this profession to date and much more attention has been on integrating the planning sector. Identifies ways to improve engagement with the architecture profession.	Novel mapping of the remit, skills and influence of the architecture profession to well-accepted public health models; the prevention pyramid and themes identified by the Royal Society for Public Health.	Adapted the pre-existing Prevention Pyramid theory to develop a bespoke theoretical framework about how the architecture profession can contribute to the prevention of ill-health.

Chapter 7: Conclusions

Improved housing conditions can prevent disease, increase quality of life and even save lives. The home environment is increasingly important to health given continued urbanisation, homeworking, concerns about housing shortages and the climate emergency. This research makes a critical contribution to the evidence base on how to harness one of the most powerful yet underused tools at our disposal to improve population health, presenting approaches to deliver the theoretical principles of healthy housing in practice.

Whilst the submitted works have had impact in their own right at local, regional and national levels, the triangulation and critical commentary has added a deeper layer of analysis and stimulated new ideas for future research and practice. By grounding the research with socio-ecological theory within the policy, political and economic context regarding market housing in England, this thesis meets the pressing need to understand why this country has higher medical costs associated with inadequate housing than all European Union member states, and to describe practical steps that can change this. In addition, synthesising the contributions to new knowledge, methodology, and theory collectively, provides further evidence of achievement of UWE's doctoral requirements than each of the submitted works in isolation.

One of the most concerning findings is that three of the current mainstream approaches to market housing delivery in England (crowding, reducing regulatory requirements and increasing use of privately rented housing) seem to be delivering variable and often poor-quality, insecure housing with detrimental health implications. This requires urgent attention regarding the selection of future housing policies, and the checks or safeguards that could be incorporated so that current approaches do not further entrench inequalities.

A second pertinent result is the misalignment between stakeholders who have power and stakeholders who are motivated to deliver healthy housing. Most notably, the health sector does not have power to directly influence almost any of the housing features known to impact on health. This analysis demonstrates that cross-sector collaboration is critical, especially given no single discipline influences housing. It suggests that to deliver healthy housing within the current system it would be valuable to improve cross-departmental working within government, incentivise suppliers and producers (e.g. through private-public partnerships, regulatory or financial means) and to improve public awareness and subsequent advocacy efforts.

By recognising the complexity of healthy housing to a greater degree than is often explored within the field, this thesis has been able to produce novel analyses with practical applications in both research and practice. The Healthy Housing Framework (Figure 4), which provides the most comprehensive list of housing features known to impact health to date, including the characteristics, needs and behaviours of the occupants, can enable holistic assessments (e.g. the extent to which governance mechanisms may overlook health promotion and wellbeing). The twelve considerations for selecting a framework (Table 4) contributes to the evidence gap on how such tools are applied, supporting researchers and decision-makers to identify frameworks most fit for their purpose, be that the design, implementation, or evaluation of healthy housing interventions. Lastly, the stakeholder matrix (Table 7) if validated could be used by both researchers (to guide participant selection depending on which aspects of healthy housing are being studied) and practitioners (to guide stakeholder engagement plans and partnership working).

The submission shows an understanding of the common limitations of healthy housing research (non-randomised, subjective outcome measures and follow-up) overcoming them where feasible, with a key strength being the pragmatic and interdisciplinary approach, which adds richness and a deeper understanding of the complexity of healthy housing. This thesis recommends five key areas for future policy, practice and research; 1) more effective use of data and observational studies, 2) opportunistic evaluations both retro- and prospectively, 3) use of the seminal stakeholder matrix to support effective transdisciplinary working, 4) greater focus on public engagement, and 5) refinement of healthy housing framework considerations to guide holistic governance.

This DPhil has been pursued to obtain academic recognition of research skills to a doctoral level and for expertise on healthy housing. This body of work charts the authors development as a researcher, showing increasing independence, understanding of complexity and leadership in this field over time. Finally, it has facilitated the authors' successful appointment as a research fellow on an urban health research consortium, enabling them to put the findings and recommendations into practice, and to better utilise housing as a tool to improve population health in the future.

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Appendices

Appendix A: Signed statements of intellectual contributions to works submitted

This appendix has been removed as it contains personal information

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+ Statements of Rachael McClatchey's contributions are in Table 3

Appendix B: Bibliography of published works and presentations (chronological)

Full peer reviewed publication list

1. **McClatchey, R**., Ferraro, C., Turner, E., and Harris, J. (2023) Local government approaches to improving the health and wellbeing of tenants in private rented housing: developing initial program theory to inform evaluation in the United Kingdom. *BMC Public Health* (submitted, under review).
2. **McClatchey, R**., McClymount, K., Griffin, E., and Carmichael, L. (2023) Community led housing, health and wellbeing: a comprehensive literature review. *Int J Hous Policy*. DOI: 10.1080/19491247.2023.2232200
3. Fouad, ATZ., Sinnett, D., Bray, I., **McClatchey, R.**, Reece, R. (2023) Measures of greenspace exposure and their association to health-related outcomes for the periods before and during 2020's Lockdown: A cross-sectional study in the West of England. *Land,* 12(4), pp.728.
4. **Marsh, R**., Chang, M., and Wood, J. (2020) The relationship between housing created through Permitted Development Rights and health: a systematic review. *Cities & Health*, 6(4), pp.833-852.
5. **Marsh, R**., Pilkington, P., Marco, E., and Rice, L. (2020) Evaluating a workforce development programme: bringing public health into architecture education in England. *Cities & Health*, 6(2), pp.326-338.
6. Carmichael, L., Prestwood, E., **Marsh, R**., Ige, J., Williams, B., Pilkington, P., et al. (2020) Healthy buildings for a healthy city: Is the public health evidence base informing current building policies? *Sci Total Environ*, 719(1), pp.137-146.
7. **Marsh, R**., Pilkington, P., and Rice, L. (2019) A guide to architecture for the public health workforce. *Public Health*, 30(178), pp.120-123.
8. **Marsh, R**., Salika, T., Crozier, S., Robinson, S., Cooper, C., Godfrey, K., et al. (2019) The Association of Crowding within Households and Behavioural Problems in Children. *Paediatr Perinat Epidemiol*, 33(3), pp.195-203.
9. Bola, S., **Marsh, R.**, Braggins, S., Potter, C., and Hickey, S. (2016) Does the continuation of warfarin change management outcomes in epistaxis patients? Torbay Hospital, South Devon Healthcare Trust. J *Laryngol Otol,* 130(3), pp. 256-60.

Non peer reviewed publications relevant to DPhil

1. Invited book review: **McClatchey, R**. (2023) Ren, C. & McGregor, G. (2021) Urban Climate Science for Planning Healthy Cities. *Cities & Health*, pp.1.
2. **Marsh, R**., and Sharpe, C. (2022) '*Insider story 9.2: Public health practitioners' viewpoint on planning for health work placement experience'* in Chang, M., Green, L., and Petrokofsky, C. (ed.) Public Health Spatial Planning in Practice. Bristol University Press: Bristol**,** pp176-179.

3. Chang, M., and **Marsh, R**. (2020) Can a deregulated planning system deliver healthy homes? UK Collaborative Centre for Housing Evidence. CaCHE blog. Available at: https://housingevidence.ac.uk/can-a-deregulated-planning-system-deliver-healthy-homes/ (Accessed 02 March 2023)
4. McClymount, K., Griffin, E., Carmichael, L., and **Marsh, R**. (2019) Community-led housing and health: a comprehensive literature review. Power to Change: Bristol.

Presentations relevant to DPhil

International:

- Oral presentation, **Marsh, R**. (presenting author), Pilkington, P., Marco, E., and Rice, L. (2019) Engaging a wider public health workforce: bringing public health into architecture education. European Public Health Conference (Marseille, France).
- Poster, **Marsh, R**. (presenting author), Pilkington, P., Marco, E., and Rice, L. (2019) Engaging a wider public health workforce: bringing public health into architecture education. Healthy City Design International Conference (London, UK).
- Oral presentation, **Marsh, R**. (presenting author), Salika, T., Crozier, S., Robinson, S., Cooper, C., Godfrey, K., *et al.* (2018) The effect of Crowding within Households on Behavioural Problems in Children. Amps Health (Bristol, UK).

National:

- Oral presentation, **McClatchey, R.** (presenting author), Ferraro, C., Harries, J., Turner, E., and Davies, L. (2023) Local government mechanisms to improve the health and wellbeing of tenants in private rented housing: a realist evaluation in the South West. LGA annual conference 2023. (Bournemouth, UK).
- Oral presentation, Ferraro, C. (presenting author), **McClatchey, R**., Harries, J., Turner, L., and Davies, L. (2023) Local government mechanisms to improve the health of tenants in private rented housing: an evaluation in the South West. RHE Global: A Safe, Decent, Stable Home: Is That Beyond Our Reach in 2023? (virtual).
- Poster presentation, **Marsh, R.** (presenting author). (2018) Crowding in the Household and Behavioural Problems in Children: Quantitative, Prospective Cohort study. Public Health England Conference (Warwick, UK).
- Oral presentation, **Marsh, R.,** Inskip, H., and Baird, J. (presenting author). (2018) The effect of Crowding within Households on Behavioural Problems in Children: A Quantitative, Prospective Cohort study in Southampton. Society for Social Medicine (Glasgow, UK).

Regional:

- Oral presentation, 2023, South West Scientific Conference (Bristol, UK). Ferraro, C. (presenting author), **McClatchey, R**. Local government mechanisms to improve

the health and wellbeing of tenants in private rented housing: a realist evaluation in the South West

- Poster, **McClatchey, R.** (presenting author)**.** (2021) Engaging a wider public health workforce: bringing public health into architecture education. South West Scientific Conference (Bristol, UK).

- Oral presentation, **Marsh, R. (**presenting author), Inskip, H., and Baird, J. (2018) The effect of Crowding within Households on Behavioural Problems in Children: A Quantitative, Prospective Cohort study in Southampton. Wessex Public Health Conference, (Southampton, UK).

Appendix C: Copyright approvals

Copyright approval for 'Figure 1: Theoretical framework showing how housing affects health across the levels of social science analysis and alignment of submitted works'

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#1 Permitted Development Rights

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The relationship between housing created through Permitted Development Rights and health: a systematic review

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ABSTRACT

Permitted Development Rights are a regulatory mechanism in the English planning system where the use of a building can be changed bypassing the standard planning process. Other countries have similar arrangements. In England, no assessment of the health impacts has been completed. This systematic review provides the first overview of the health and wellbeing impacts of housing created through Permitted Development Rights. 1,999 literature items were identified from a structured search of 14 databases and manual searching for grey literature. Literature published between January 2013 and July 2020, in England, were eligible. Eight academic and 13 grey literature items were included. The review identifies both a greater number of literature and greater number of ways permitted development conversions have negative compared to positive health impacts, and may contribute towards widening health inequalities. There is a lack of research directly with the occupants of housing created through Permitted Development Rights. These findings provide an indication of the impacts of deregulating a planning system without explicitly considering health and wellbeing. They warrant further assessment of how to enable the change of a buildings use to take place whilst also ensuring the homes created are supportive of good health.

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Permitted development; spatial planning; change of use; housing; health; wellbeing

Introduction

Background

There is extensive evidence demonstrating the importance of housing as a wider determinant of health (Barton and Grant 2006, Bird *et al.* 2018). The design and quality of homes on the health of occupants has been widely reported for numerous outcomes including cardiorespiratory diseases, infectious diseases, injuries, allergies and mental health conditions (Bird *et al.* 2018, Rodgers *et al.* 2018). Understanding the mechanism for this is complex as there are many interdependent elements (eg. type, tenure, size, location, cost, household composition, etc), as well as links with other major systems such as transport, education and social security (Rutter *et al.* 2017). Casual pathways have shown how housing can impact on health. These pathways can be used to infer how risk factors at the building level (such as ventilation and space), the neighbourhood level (such as affordability, proximity to green space, local facilities and public and active transport options) and through direct exposures (such as mould or air pollutants) (Bird *et al.* 2018, Pineo *et al.* 2018, Carmona 2019), can have longer-term health impacts (Rodgers *et al.* 2018). These casual pathways underpin the methods of this paper.

Despite this, producing housing of good quality (for new and existing ones), which is supportive of health and wellbeing, is a challenge faced by many countries. In Europe, 1 in 6 homes, are of poor quality (Ecofys, Fraunhofer IBP, Copenhagen Economics 2017). Not only does this have significant implications on the occupants lives but for wider health and social care systems too. In the United Kingdom (UK) for instance, the Building Research Establishment estimated that the National Health Service spends about £2.5 billion per annum on housing and health-related conditions (Nicol *et al.* 2015). The effects of this have been exacerbated with the COVID-19 pandemic and subsequent lockdowns, forcing people to spend significantly more time in their homes and the immediate surrounding areas.

The factors which determine the quality of housing created are extremely complex, one of which is the level of regulation in the planning system. In England, since 2010, the planning system has been gradually deregulated, of which Permitted Development Rights (PDRs) are one example. PDRs enable the change of a buildings use to take place, and aim to reduce vacant buildings and help increase the supply of housing. Using PDRs, changes to a building can bypass the standard planning process. Traditionally, PDRs have only covered a limited set of circumstances, such as

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minor extensions to existing homes, which given their minor scale, would not require the level of scrutiny the planning process provides. However, since 2013 the government has expanded the role of PDRs dramatically. Significant aspects of this have been the decisions allowing; commercial buildings to be converted to residential use, and in August 2020 to allow building upwards on existing buildings (up to two storeys for residential), and demolishing vacant commercial, industrial and residential buildings to be replaced with new residential units (The Town and Country Planning (Use Classes) (Amendment) (England) Regulations 2020, Town and Country Planning Association (TCPA) 2020) (see Figure 1 for timeline).

Governments are under pressure to stimulate the economy following COVID-19. Deregulation such as PDRs is already forming part of this recovery. For example, the UK Government announced significant expansions and reforms to PDRs as part of their COVID-19 economic renewal package (PM 2020).

Permitted Development Rights explained

PDRs are a regulatory mechanism in the English planning system which provides automatic permissions for development subject to meeting prerequisite rules. This mechanism is not unique to England, other systems, such as Australia, New Zealand, the United States, Canada and Germany also have such arrangements (Royal Town Planning Institute (RTPI) 2020). Although PDRs are the focus of this paper, the findings may be of interest to researchers or policymakers from any country where deregulation which prevents health forming part of the decision-making process is being implemented or considered.

In England, PDRs legislation at the national level sets out which changes of land/building use are permitted (The Town and Country Planning (Use Classes) (Amendment) (England) Regulations 2020). Planning applications are not required. But developers do still need to seek a lighter-touch form of planning permission or 'Prior Approval' from a local planning authority if they intend to create housing through this route. Only specific aspects can be considered by the planning authority, and such 'conditions' are set out in legislation governing each individual PDR. For example for PDRs of office to residential conversions, these conditions are: transport and highways impacts, contamination or flooding risks on the site, impacts of noise from commercial premises on the intended occupiers (introduced in 2016) and the provision of adequate natural light in all habitable rooms of the dwellinghouses (only introduced in June 2020) (The Town and Country Planning (Use Classes) (Amendment) (England) Regulations 2020). Building regulations still apply; however these do not necessarily consider the full evidence base linking building features and health impacts and, as minimum standards, often do not consider how building design could promote better health and improved wellbeing (Carmichael *et al.* 2020). Wider policy requirements normally set out in a local plan, such as dwelling size, green space, play and amenity provision, or levels of air pollution cannot form part of the decision-making process.

Regulatory tools allow for local authorities to suspend national PDRs in their local area, in the form of an Article 4 direction. Change of use can still take place but would then have to do so through a standard planning application. However, Article 4 directions can be time consuming relative to the scale of potential PDRs in the area, can involve costly compensation payments and can be modified or overturned by central government (Clifford *et al.* 2018). Therefore only few Article 4 directions have been adopted by local authorities since 2013 and those which have are nearly all in London (Nedin 2018).

The scale of the problem

The scale of PDRs is measurable by the number of new homes created. In the United Kingdom, data on those which have been created through PDRs have only been collected since 2015–16, since then there have been an estimated 60,399 homes created through these routes (Ministry of Housing, Communities & Local Government 2019). If you assume the UK household size average of 2.3 persons, then PDRs conversions would have housed around 138,779 people (Office

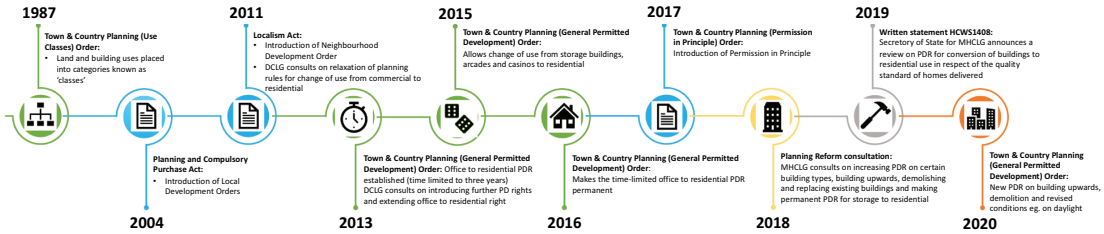


Figure 1. Timeline showing key legislative changes affecting Permitted Development Rights change of use to residential, in England.

for National Statistics 2013). In some areas, over half the housing delivered was through PDRs (51% in Harlow borough in 2018/19) (Mercer 2020).

Health and wellbeing impacts were not identified, considered and accounted for in the Government's initial regulatory impact assessment of PDRs (Department for Communities and Local Government 2013). Since then, whilst there have been assessments into the extent of policy uptake, there have been few into the impact, especially on health and wellbeing (Bibby *et al.* 2018). This paper aims to systematically review what is known on the health and wellbeing impacts of housing created through PDRs. Whilst this mechanism is specific to England, which is used as a case study area, it gives an indication of the potential impacts of deregulating a planning system without explicitly considering health and wellbeing.

Method

Search strategy

A list of potentially relevant databases and organisations was compiled from existing systematic reviews across similar topics (Bird *et al.* 2018) and in consultation with experts in the field (see Acknowledgements). Fourteen electronic databases (MEDLINE, PsycINFO, Cochrane, SocINDEX, EconLit, Allied and Complementary Medicine (AMED), Scopus, Web of Science, Bielefeld Academic Search Engine (BASE), Business Source Complete, CORE, Embase, Global Health, Health Management Information Consortium, Social Policy and Practice (SPP) were searched by heading, keyword or free text to identify relevant publications from January 2013 to May 2020.

The search terms were categorised into two-word groups relating to permitted development and health outcomes (Appendix 1). Following an initial draft of search terms, subject area experts were contacted to verify and refine the terms. A pilot search was performed by a knowledge and evidence specialist (JW) in one database (MEDLINE) to test the search strategy and refine the search terms before the full search was undertaken by the same researcher. Additional searches were conducted by RM on Google, Google Scholar and relevant organisation websites to locate additional potentially eligible literature. All authors were involved in identifying relevant grey literature. This was combined with manual searching of referenced articles by RM.

Two reviewers independently screened all titles identified by the searches (RM and JW). Subsequently, two reviewers (RM and MC) independently assessed the quality of selected literature and extracted relevant data. When reviewers' conclusions differed, the literature was reviewed jointly by three reviewers. The reporting of this review conforms to recommendations from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Swartz 2011).

Eligibility

Articles were screened in three phases; title, abstract, and full-text. To be selected for inclusion, literature items were required to meet the following inclusion criteria:

(1) Be published in English language (literature not in English language were excluded due to limited capacity to translate within the research team)
(2) Be published between 1 January 2013 and 22 July 2020 (the limit on year of publication is in order to reflect the timeframe within which permitted development rights have been expanded).
(3) Be conducted in England (literature from countries outside England were excluded from this review due to differences in planning systems and regulations which may act as confounders).
(4) No restriction of study design. The following types of grey literature are eligible: reports, dissertations, policies, conference abstracts, presentations, expert opinion, video and text accessible from nationally recognised stakeholder websites.
(5) Reports on associations between;
    a. Population: people of any age or sex, who occupy the building or local area of housing created through PDRs
    b. Exposure: housing created through PDRs
    c. Outcome: health and wellbeing (primary) or risk factors with evidence of impact on health at the building level, neighbourhood level and direct exposures (secondary) (Bird *et al.* 2018, Pineo *et al.* 2018, Carmona 2019).

Results were exported to EndNote, and duplicates were removed. The reference lists of included articles were screened to identify additional relevant publications.

As the scoping search identified mainly grey literature, the quality assessment AACODS checklist was used to rate the quality of included literature, in line with previous systematic reviews containing grey literature (Tyndall 2010). This tool was selected for its ability to assess a range of literature, and as it is recommended by the National Institute for Health and Care Excellence (National Institute for Health and Care Excellence

(NICE) 2014). The tool has been recommended for rating the methodological quality of literature based on construct validity and acceptable content. The tool consists of six quality assessment domains: (i) Authority; (ii) Accuracy; (iii) Coverage; (iv) Objectivity; (v) Date; and (vi) Significance.

Results

In total, 4,226 literature items were identified from a structured search of 14 databases combined with manual searching for grey literature. A total of 2,068 duplicates were removed prior to screening. A total of 21 literature items met the eligibility criteria and were included in the review (see Figure 2). Of these, eight were academic studies (four mixed methods, three qualitative research, one quantitative research) and the remaining 13 were grey literature (6 expert opinion, 6 reports, 1 documentary).

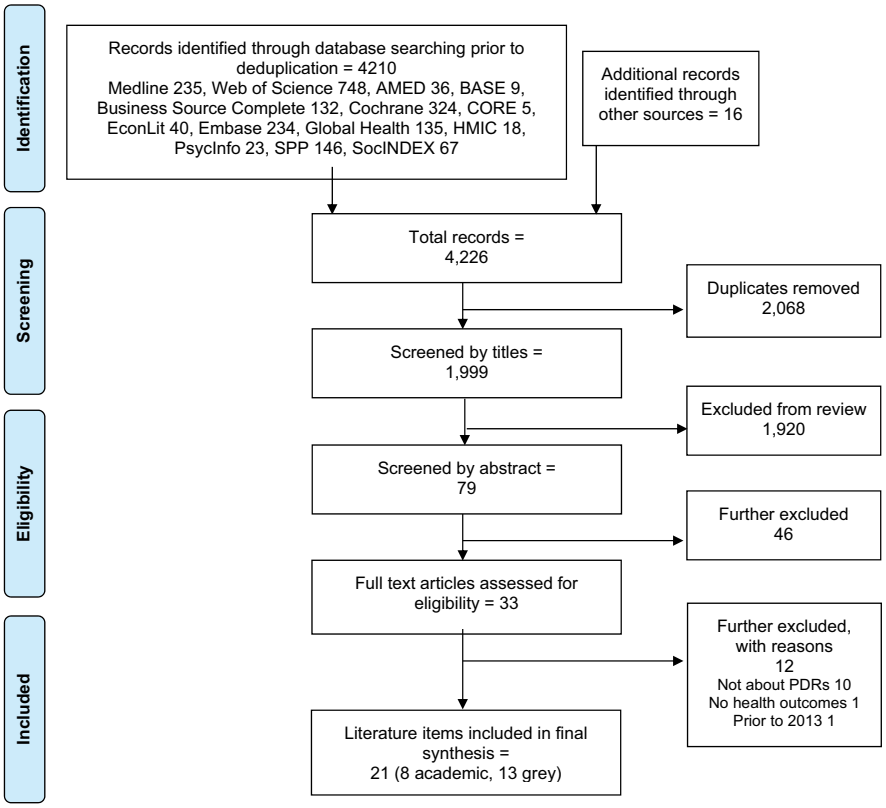
The only research that has been conducted with residents of PDRs conversions is a small survey conducted by Clifford *et al.* (Clifford *et al.* 2018) and two follow-up interviews. The rest of the academic research has been conducted through desk-based reviews, case studies, surveys, or roundtables and interviews with experts.

The literature included in the synthesis comprised of 11 items of high quality (ACCODS score of 5 or 6), eight items of moderate quality (ACCODS score of 3 or 4) and two items of low quality (ACCODS score of 2 or less). Due to the anticipated nature of built environment exposures including the complex mechanisms which link housing to health, as well as the relatively recent introduction of PDRs, we did not exclude literature on the basis of quality.

Findings consistently show that housing created through PDRs is likely to have a negative impact on health and wellbeing (see Figure 3 and Appendix 2).

Primary outcomes

Very few literature items report on direct health outcomes, with only five items describing who the occupants of dwellings created through PDRs were. This lack of data means it was not possible to break findings down by population subgroups. PDRs conversions were being used as temporary accommodation by local authorities, for people with substance dependence or as student accommodation (Grimwood and Barton 2019, Association for Public Service Excellence (APSE), Town and Country Planning Association (TCPA) 2019, Mercer 2020, Clifford *et al.* 2020, Town and Country Planning Association (TCPA) 2020). A survey with residents of PDR conversions reported a brothel had been established in one of the blocks (Clifford *et al.* 2018). These are vulnerable



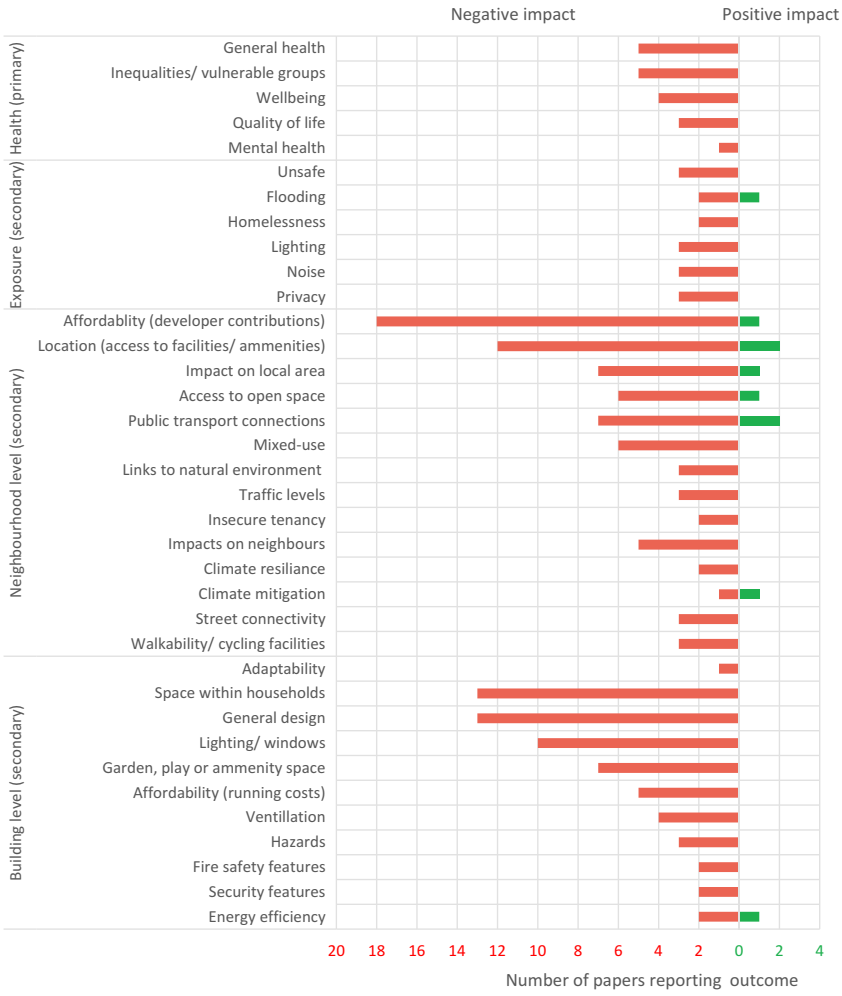


Figure 3. Primary and secondary health outcomes of dwellings created through Permitted Development Rights found in included literature.

groups of people who are unlikely to have the means to live elsewhere, despite risk factors at building and neighbourhood level for their physical and mental health.

Clifford *et al.* noted uptake of PDRs seems to be driven by uplift in value from one use to residential use, with significantly greater update in London, the South East and the South West of England where it is more profitable (Clifford *et al.* 2018). This reduces affordable housing in areas which are already the least affordable, thus potentially widening spatial inequalities.

Clifford *et al.* considered a number of socioeconomic factors (including average house prices, office rental prices and vacancy rates, unemployment and index of multiple deprivation) and found that the more deprived a locality, or the lower its average house prices, the smaller the average space standards and the lower the quality of housing created through PDRs. This relationship was not seen for dwellings created under the full planning permission process (Clifford *et al.* 2020). People from deprived backgrounds are more likely to have pre-existing health conditions, which may make them more vulnerable to the effects of poor quality housing (Barton and Grant 2006). Thus PDRs have the potential to exacerbate health inequalities already existing within communities.

Secondary outcomes

The majority of literature report on secondary outcomes, at the building and neighbourhood level, rather than on direct exposures. Therefore the following results are broken down in such terms, with the known health impacts refenced throughout.

Building level

Internal and amenity space. At the building level the greatest reference was to the small sizes of units

created, referenced by 13 included literature items. In an audit by Clifford *et al.*, of 2,140 residential units created through PDRs, just 13.6% would comply with the nationally described space standards (Clifford *et al.* 2019a). Studio flats of just 15 m^2 (just larger than a standard parking space) each were not uncommon. Whilst moderate density can be beneficial in achieving compact neighbourhoods which can be health promoting, (Carmona 2019) such small dwellings are likely to result in households living in crowded conditions, which can interfere with privacy, strained family relationships, reduced storage, lack of space to play, study or work and difficulties sleeping. Evidence shows crowding within households is linked to a range of physical and mental health problems, and in children lowered educational attainment and behavioural difficulties (Marsh *et al.* 2019).

These small dwellings were often compounded by a lack of private or communal amenity space, such as a balcony or garden. Severn literature items referred to lack of a garden or amenity space (Town and Country Planning Association (TCPA) 2020, Clifford *et al.* 2018, Mercer 2020, Clifford *et al.* 2020, Association for Public Service Excellence (APSE), Town and Country Planning Association (TCPA) 2019, Clifford *et al.* 2019a, Ministry of Housing, Communities & Local Government 2020a). Just 0.7% of the 2,140 residential units reviewed had access to any private amenity space, and 9 out of the 30 schemes reviewed (30%) had access to communal amenity space (Clifford *et al.* 2019a). There were reports of children having to resort to playing in carparks (Clifford *et al.* 2018). The Developer found that in Leeds, only 1% of new homes created under PDR had access to private or communal amenity space, and in Leicester there were none (Mercer 2020). Amenity space, particularly private outdoor space, is one of the housing features COVID-19 has caused the most notable leap in demand (Royal Institution of Chartered Surveyors (RICS) 2020). Amenity space can contribute to a better quality of life of residents of all ages, particularly in higher density schemes. Outdoor space provides access to daylight, fresh air, a place to dry washing, socialise, play in, enjoy wildlife and to grow plants/vegetables. Compared to no garden access, access to a private garden or balcony was associated with better wellbeing, and being more likely to meet physical activity guidelines (de Bell *et al.* 2020).

General building design. 13 literature items described generally poor design of homes created through PDRs, with none describing good design (Butter 2013, Muldoon-Smith and Greenhalgh 2016, Grimwood and Barton 2019). Some expanded on specific elements, such as windows (Town and Country Planning Association (TCPA) 2020, Ministry of Housing, Communities & Local Government 2020a, Clifford and Canelas 2018), ventilation (Remøy and Street 2018), or hazards (East Sussex County Council 2020), and some referenced direct exposures that impact on health including privacy, noise and lighting (Clifford *et al.* 2018, 2019a, 2020, Association for Public Service Excellence (APSE), Town and Country Planning Association (TCPA) 2019, Mercer 2020).

Ten papers described problems with windows, either in terms of not providing adequate lighting, being single-aspect, or having a high degree of overlooking and not being able to provide enough privacy (Town and Country Planning Association (TCPA) 2020, Clifford *et al.* 2018, Mercer 2020, Clifford *et al.* 2020, Association for Public Service Excellence (APSE), Town and Country Planning Association (TCPA) 2019, Clifford *et al.* 2019a, Ministry of Housing, Communities & Local Government 2020a, Clifford and Canelas 2018, Remøy and Street 2018, Smith 2019). Clifford *et al.* found 85.3% of units reviewed were single aspect only (Clifford *et al.* 2019a). In the UK, if northerly facing this can cause problems with low lighting levels and cold homes in the winter, or if southerly facing potential overheating in the summer. High quality windows and doors, which fully function and are double glazed are associated with reduced hospital admissions (Rodgers *et al.* 2018). This was sometimes compounded by unusual layouts in some schemes, for example a dwelling whose only window faces an internal atrium area, dwellings with office style tinted windows still present, or some dwellings with no windows at all (Town and Country Planning Association (TCPA) 2020, Clifford *et al.* 2020). In some cases, office style windows are still present (Clifford *et al.* 2019a). There is evidence linking increased daylight exposure to improved mental and physical health outcomes (Bird *et al.* 2018).

A survey by Clifford *et al.* found only around half of residents were happy with their housing, with some giving very negative accounts. They mentioned problems such as a large number of children living in blocks with lack of play space, and a lack of noise insulation and a brothel in the block (Clifford *et al.* 2018).

Neighbourhood level

Loss of developer contributions and affordability. At the neighbourhood level the problem most frequently described was to the loss of developer contributions, with 18 literature items expressing concerns about it. Developer contributions is a mechanism to require developers to provide monetary or non-monetary mitigation measures to negative impacts such as the provision of green spaces, play areas or funding towards local facilities like schools and health facilities. In 2018–19, in one year, around £7 billion was secured through this mechanism (Ministry of Housing,

Communities & Local Government 2020b). Bibby *et al*. found the law relating to developer contributions complex and there were conflicting interpretations that have resulted in some local authorities exempting PDRs from developer contributions (Bibby *et al*. 2018). They estimated that the direct financial impact of the extension of PDR is a net loss of around £50 m (between 2010 and 2017), mainly through lost planning fees and affordable housing contributions (Bibby *et al*. 2018). The Developer expressed this as equivalent to over 13,500 affordable homes lost over 4 years (Mercer 2020). Affordable housing has been linked to better health through engagement with health services, more income being available to support health and wellbeing and improved quality of life (Bird *et al*. 2018). With small units in PDRs conversions contributing to rising population sizes, additional pressure may be placed on health, social care and other local services.

Location and green space. Clifford *et al*. found little difference in access to services, transport connections and green space between homes created through PDRs and full planning permission (Smith 2019). Clifford *et al*. described some PDRs conversions in potentially desirable locations, close to public transport and services (Clifford *et al*. 2019a); however the same paper and 11 others referenced conversions in problematic locations, for example, close to factories, a waste transfer station, or on industrial estates. These papers also described difficulties accessing local facilities such as schools, healthcare, public transport, and supermarkets, which evidence shows is linked to reduced physical activity, and in older people reduce social participation and mobility (Bird *et al*. 2018). Four papers describe conversions in areas of very high traffic, such as between two busy dual carriageways (Ministry of Housing, Communities & Local Government 2020b).

There were limited references to access to green space, but three literature items did express concerns about poor links the natural environment (Smith 2019, Clifford *et al*. 2019a, Mercer 2020). In the audit by Clifford *et al*., 15 of the 30 schemes reviewed were within 250 m of some public green or open space, and 25 were within 500 m^{39}. However, with small units and little amenity space common in PDR conversions, additional pressure is likely to be put on such green infrastructure. There is evidence that access to green space and engagement with the natural environment is beneficial for health particularly in terms of physical activity, social cohesion and mental health (World Health Organisation (WHO) 2017).

Impact on local area. Seven literature items found PDRs conversions to residential use had a negative impact on the local area, mainly via reducing local employment opportunities. One paper suggested the policy enables regeneration of empty, unproductive office space, (Grimwood and Barton 2019) whilst others highlighted nowhere in the regulation was there any provision to distinguish between redundant and economically viable office space, and that 25% of early applications were being made for buildings already in use (Holman *et al*. 2018). Small to medium enterprises were noted as most likely to be displaced (Clifford *et al*. 2018).

Five literature items considered the impact on neighbours and community cohesion, describing concerns about PDR conversions causing neighbourhood tensions and conflict (Butter 2013, Baker and Parker 2018, Clifford *et al*. 2019a, Mercer 2020, Ministry of Housing, Communities & Local Government 2020a). Consultation is one of the many features of the planning system bypassed with PDR so neighbours have no control over changes in the local area which take place via this route. Community cohesion and environments which are supportive of this can promote residents wellbeing (Bird *et al*. 2018).

Housing provision and need. Three literature items found a positive aspect of PDRs conversions was that they contribute towards meeting housing need (Grimwood and Barton 2019, Mercer 2020, Clifford *et al*. 2020). However, it is unclear whether these homes would have been created anyway, but via the standard planning process had PDRs not been an option. Six literature items found the type and mix of housing was poor, often dominated by studio and one-bedroom flats (Clifford and Canelas 2018, Bibby *et al*. 2018, Holman *et al*. 2018, Baker and Parker 2018, Clifford *et al*. 2019a, 2020). Clifford *et al*. found 91.7% of units reviewed were studios or one beds, which can lead to overcrowding, particularly in the case of families with children in need of accommodation, exacerbated by the small spaces often seen (Clifford *et al*. 2019a). Evidence suggests mixed housing can increase social cohesion and perceptions of safety among more deprived areas (Bird *et al*. 2018).

Discussion

To our knowledge, this literature review provides the first overview of the evidence for associations between dwellings created through PDR and health.

We find that the building and neighbourhood features prominent in housing created through PDRs are linked to a range of negative health impacts, including risk of cardiorespiratory diseases, type 2 diabetes, obesity, excess winter deaths, musculoskeletal conditions, cancer, mental health problems, low wellbeing and premature death (Nicol *et al*. 2015, Bird *et al*. 2018, Rodgers *et al*. 2018). The review identifies both

a greater number of papers and a greater number of ways that PDRs conversions have negative compared to positive impacts on health. Categories for 29 ways dwellings created through PDRs negatively impact on health are found (five primary health outcomes, six direct exposures, 11 building level features and 14 neighbourhood level features), compared to just eight ways positive impacts are realised. It is difficult to draw conclusions about the impact on inequalities due to the small number of papers which consider it, but the findings suggest homes created through PDRs may contribute to widening health inequalities. Poorer quality housing, such as very small internal spaces, is being created in more deprived areas, and less affordable housing is being created in the areas which already have high housing costs.

Although the majority of evidence included in this review is grey literature, it highlights some concerning findings on the range of negative impacts on health, wellbeing and quality of life that housing created through PDRs might have, which warrants further assessment by researchers and policy makers as set out below.

Strengths and limitations

A key strength of this study is the robustness and rigour of the review methods applied. Our systematic approach of collating and assessing the quality of existing evidence against building and neighbourhood features as well as primary health outcomes has enabled the identification of knowledge and research gaps on the complex link between PDRs and health.

Public health evidence for impacts from built environment exposures, such as housing, is often weak because study designs tend to be opportunistic, non-randomised, use subjective outcome measures and do not incorporate follow-up of study participants. In this review the majority of included literature were grey, and of the academic papers most reliant on findings from case studies or interviews. These research methods cannot prove causality, nevertheless our findings highlight a range of ways that housing created through PDRs has a mainly negative impact on health and the importance of policies and actions to mitigate this. Grey literature and non-experimental studies are also are at greater risk of bias. Many of the grey literature items did not have a clearly stated aim or parameters which define their content coverage, so may report only on the most extreme findings. Publication bias may be present if literature about PDRs that did show positive results are less likely to have been submitted or accepted for publication. This traditional hierarchy of evidence only speaks to a limited selection of relevant policy concerns. Some of the research methods used by the included studies, such as interviews and surveys do hold weight in housing and planning policy areas (Nieuwenhuijsen and Khries 2019). However, caution is advised on using the review findings to draw conclusions about the impact of PDRs conversions on health and wellbeing.

The majority of the identified literature did not report on a specific type of change of use (15 items). This means it is not known if the buildings converted to housing were previously used as offices, or for agricultural, storage, industrial or other purposes, which may have implications on the findings and suitability for conversion to homes. The rest of literature items were focused on office to residential (3), agricultural to residential (1) or office and agricultural to residential (1). This is consistent with national data which shows that office to residential change of use accounts for the vast majority of PDRs uptake, with 54,162 units produced from 2015/16 to 2018/19 (Ministry of Housing, Communities & Local Government 2019). Although in recent years there has been an increase in the change of use from agricultural to residential (Ministry of Housing, Communities & Local Government 2019).

Implications for researchers

This review reveals many research gaps, where outcomes from PDRs conversions are not known, including:

- Direct exposures, such as damp and mould, air pollutants, pests, and temperature.
- Health outcomes, particularly respiratory disease, cardiovascular disease, diabetes, allergies, injuries, excess winter deaths, infectious diseases and mental health conditions.
- Additional building and neighbourhood features; materials and toxicity, adaptability and use by groups with specific needs (e.g. elderly, or disabled), opportunities for physical activity (e.g. bike facilities and cycle infrastructure) and further climate adaption and mitigation measures.

The reasons for limited literature, particularly of academic studies may be because PDRs are a relatively new mechanism in the English planning system, a cross disciplinary approach is needed to explore the research question, and because of the challenges researching complex exposure as described in the introduction (Rutter *et al.* 2017). Tracking objective impacts resulting from specific PDRs regulatory changes on population health and wellbeing is needed. Although it is unlikely to be possible or appropriate to undertake an experimental approach, such as a randomised controlled trial, natural experiments or longitudinal studies would be plausible. Future academic research linking

directly to exposure and health outcomes rather than just building and neighbourhood level features would strengthen the evidence base.

In particular, we report a significant gap in research with the occupants of housing created through PDRs. A descriptive or qualitative study would help evaluate the impact of PDR on users' health, wellbeing and contribute to understanding on the impact on inequalities.

Implications for policymakers

The findings from our review would be relevant to policymakers from any country where there is an ideological and practical focus on harnessing the opportunities of planning deregulation and promotion of brownfield redevelopment. Such an approach may be more attractive post-COVID-19 particularly for those counties struggling to recover from slowing economies and housebuilding activity, making this paper particularly timely.

PDRs have the potential to be beneficial in a number of ways. First, by making the planning system less onerous for developers and more efficient, thereby making administrative savings. Second, reusing buildings and wider brownfield redevelopment is likely to have a lower carbon footprint and in more sustainable and accessible locations in urban centres or close to transit hubs, which is beneficial given the climate emergency and increasing understanding of burdens of disease linked to the environment. However, in practice this form of deregulation, without the necessary checks and balances, seems to be delivering variable and often poor-quality housing with detrimental health and wellbeing implications.

There are potential solutions which would continue to enable the change of use of buildings to take place with a more efficient planning process, whilst also ensuring the homes created are supportive of good health. As stated earlier it is not known whether without PDRs, these developments would not have taken place or whether they would have been developed through full planning process anyway with the normal protections and contributions. Ideas include (Ministry of Housing, Communities & Local Government 2020a);

(1) Moving specific requirements into building regulations, such as dwelling size or amenity space – This would help mitigate the negative health impacts from small spaces and pressure on local facilities and amenities, but not the numerous others negative impacts found in this review. Additionally, size does not always relate to quality and this may be an over simplistic mechanism to reduce risks from housing created through PDRs on the occupant's heath.

(2) Applying voluntary design guidance or a certification processes to Prior Approval applications – Similar voluntary schemes already exist, such as Fitwel (Fitwel 2020) and the international WELL building standard (International WELL Building Institute 2020), which provide a global certification process and overview of best practices in design and construction to support health and wellbeing through buildings. This option could help act as an incentive to developers to produce higher quality housing through PDRs than the minimum required, as well as improve monitoring by providing data on the quality of developments. However, as a voluntary process it its likely many PDRs conversions would continue to have features detrimental to health. For example, WELL was launched in 2014 but as of June 2020 only 4,290 projects across 62 countries have used it (International WELL Building Institute 2020). Also, voluntary schemes can have shorter longevity, such as the Code for Sustainable Homes. A voluntary standard for the sustainable design and construction of new homes in the United Kingdom. Introduced in 2006, and often cited as a mandatory requirement by planners and commissioners of social housing, was dropped in 2014 (Ministry of Housing, Communities & Local Government 2014).

(3) Requiring application of local standards as part of the PDRs process – This would enable both the theoretical benefits of re-using buildings, with the accountability, scrutiny and safeguard the planning process provides. It would also help mitigate a much wider range of ways that PDRs conversion negatively impact on health. However, the more prescribed PDRs become the more we can question the value of the approach compared to a full planning application. For example in other parts of the UK nations such as Wales and Scotland, devolved planning responsibilities allow the respective governments to set out planning rules for PDRs.

With people spending significantly more time in their homes and the surrounding areas due to the COVID-19 pandemic, the differential effects from good and poor quality homes, such as those produced through PDRs are likely to be exacerbated. However, the recovery period from COVID-19 also provides opportunities. For example in the United Kingdom, alongside legislative changes further expanding PDRs, (Town and Country Planning Association (TCPA) 2020) further changes require PDRs to have access to natural daylight, and the Planning for the Future White Paper for England proposes a greater

focus on design and placemaking which can help ensure decision-makers consider wellbeing through good design (Ministry of Housing, Communities & Local Government 2020b).

Conclusion

This literature synthesis provides the first overview of the evidence for associations between housing created through PDRs and health. The review identifies both a greater number of papers and a greater number of ways that PDRs conversions have negative compared to positive health impacts. This includes producing housing which is small, has little amenity space, is of poor design and is not mixed or necessarily aligned with housing need. PDR conversions can be in inappropriate locations with poor connections to facilitates and the natural environment, loose developer contributions which would usually be used to improve the local area and risk causing neighbourhood tensions and conflict. Evidence links these building and neighbourhood features to a range of negative health impacts, including risk of cardiovascular disease, type 2 diabetes, obesity, respiratory disease, excess winter deaths, musculoskeletal conditions, cancer, mental health problems, lower wellbeing and premature death.

The paper also sets out several ways that PDRs conversions may contribute to widening health inequalities, through poorer quality PDR conversions taking place in deprived area, greater uptake amongst vulnerable groups and reducing affordable housing in areas which already have high housing costs. The implications for planning practice to consider these health impacts could be promoting the greater use of tools such as health impact assessments, if undertaking such an assessment does not detract from the purpose of PDR which is to streamline and expedite decision-making on certain developments.

The review reveals a significant research gap, with very little research with the occupants of housing created through PDRs and therefore limited evidence on primary health outcomes. The findings provide an indication of the impacts of deregulating a planning system without explicitly considering health and wellbeing, and warrant further assessment by researchers and policy makers of how to enable the change of a buildings use to residential to take place. whilst ensuring that the homes created are supportive of good health.

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Appendices

Appendix A: *Example search protocol for Medline*

#	Searches	Results
1	exp 'Quality of Life'/	191,942
2	quality of life.tw.	272,256
3	QoL.tw.	37,469
4	health impact*.tw.	12,519
5	health effect*.tw.	28,336
6	well being.tw.	74,051
7	wellbeing.tw.	15,265
8	health equi*.tw.	2839
9	exp Health Impact Assessment/	664
10	health impact assessment*.tw.	822
11	exp Accidents, Home/or exp Accidents/	188,187
12	accident*.tw.	111,269
13	exp Hypersensitivity/	342,039
14	hypersensitiv*.tw.	73,076
15	allerg*.tw.	184,308
16	exp Asthma/	127,017
17	asthma.tw.	144,155
18	exp Blood Pressure/	288,736
19	blood pressure.tw.	290,613
20	exp Hypertension/	252,568
21	hypertension.tw.	374,964
22	exp Body Mass Index/	125,225
23	body mass index.tw.	179,777
24	BMI.tw.	140,717
25	exp Neoplasms/	3,317,282
26	neoplasm*.tw.	134,105
27	cancer*.tw.	1,744,717
28	exp Cardiovascular Diseases/	2,364,063
29	cardiovascular disease*.tw.	166,079
30	CVD.tw.	34,920
31	exp Lung Diseases/	877,276
32	exp Pulmonary Disease, Chronic Obstructive/	55,061
33	lung disease*.tw.	51,105
34	chronic obstructive pulmonary disease*.tw.	47,337
35	COPD.tw.	44,676
36	exp Death/	147,550
37	death*.tw.	802,669
38	dying.tw.	34,156
39	exp Dehydration/	13,221
40	dehydration.tw.	30,214
41	dehydrat*.tw.	42,397
42	exp Depression/	117,214
43	depressi*.tw.	379,659
44	exp Diabetes Mellitus/	421,262
45	diabet*.tw.	620,004
46	exp Diet/	277,469
47	diet*.tw.	554,788
48	exp Disabled Persons/	64,717
49	disabilit*.tw.	182,847
50	exp Disease/	182,972
51	diseas*.tw.	3,685,066
52	disorder*.tw.	1,103,934
53	emot* health*.tw.	2220
54	exp Accidental Falls/	23,894
55	fall*.tw.	205,924
56	exp Fires/	9773
57	fire*.tw.	45,592
58	illness*.tw.	257,788

(*Continued*)

(Continued).

#	Searches	Results
59	exp Accident Prevention/	85,885
60	accident prevent*.tw.	976
61	injury prevent*.tw.	7220
62	exp Social Isolation/	17,264
63	social isolat*.tw.	6828
64	exp Mental Health/	37,509
65	mental health*.tw.	140,153
66	exp Musculoskeletal Diseases/or exp Musculoskeletal Pain/	1,076,289
67	musculoskeletal*.tw.	49,093
68	MSK.tw.	1133
69	exp Obesity/	210,124
70	obes*.tw.	294,109
71	exp Exercise/	192,578
72	exercise*.tw.	286,140
73	physical activit*.tw.	109,172
74	exp Respiratory Tract Infections/	356,453
75	exp Respiratory Tract Diseases/	1,331,660
76	respiratory.tw.	423,072
77	exp Safety/	79,195
78	safety.tw.	494,364
79	exp Sedentary Behavior/	9095
80	sedentar*.tw.	31,162
81	exp Sleep Wake Disorders/	88,447
82	sleep wake disorder*.tw.	290
83	sleep disturb*.tw.	15,042
84	exp Drug Misuse/	13,258
85	drug misus*.tw.	1593
86	drug abus*.tw.	19,922
87	substance misus*.tw.	2451
88	substance abus*.tw.	25,390
89	exp Suicide/	62,306
90	exp Self-Injurious Behavior/	70,042
91	suicid*.tw.	76,257
92	self injur*.tw.	4580
93	self harm*.tw.	5588
94	exp Violence/or exp Domestic Violence/or exp Intimate Partner Violence/	94,006
95	violen*.tw.	58,252
96	or/1-95	13,566,388
97	exp United Kingdom/	362,763
98	exp England/	105,873
99	united kingdom.tw.	36,906
100	great britain.tw.	7607
101	england.tw.	49,310
102	or/97-101	403,649
103	'change of use'.tw.	931
104	exp Housing/	32,549
105	housing.tw.	28,210
106	planning permi*.tw.	21
107	building conver*.tw.	11
108	high rise.tw.	539
109	hous* qualit*.tw.	405
110	permitted develop*.tw.	88
111	PDR.tw.	4351
112	or/103-111	57,740
113	96 and 102 and 112	1261
114	limit 113 to (english language and humans and yr = '2013–2021')	276

Database(s): **Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R)** 1946 to 14 May 2020
Search Strategy:

Appendix B: Summary of included literature and their findings

						Quality Appraisal (AACODS)							Primary outcome	Secondary outcome		
Literature item	Grey or academic literature	Type of literature	Details	Country	Type of change of use	A	A	C	O	D	S	Total	Health or wellbeing	Building	Neighbourhood	Exposure
Butter 2013	Grey	Expert opinion	RTPI	England	Not specific	Y	N	N	Y	Y	Y	4		Poor quality	Neighbourhood conflict	
Shaw and Blackie 2013	Grey	Expert opinion	Mixed experts	England	Not specific	Y	N	N	N	Y	N	2			Isolated developments, economic costs where employment sites are converted, social costs if shops, etc are converted, cannot control if there is appropriate public transport and social infrastructure, detrimental to high streets	
Ferm and Jones 2016	Grey	Expert opinion	Academic	England	Not specific	Y	N	N	N	Y	N	2			Loss of affordable homes	
Muldoon-Smith and Greenhalgh 2016	Academic	Qualitative – Interviews, literature review	Semi structured interviews, literature review	England	Office to residential	Y	Y	N	Y	Y	Y	5		Poor quality	Unable to get contributions, compounds inflated rents, lack of appropriate infrastructure	
Holman *et al.* 2018	Academic	Qualitative – Document analysis, interviews, field observations, expert opinion	Expert roundtables, document analysis, interviews field observations	England	Office to residential	Y	Y	Y	Y	Y	Y	6			Loss of employment land, loss of developer contributions, no support for local public transport or schools, less affordable housing	
Baker and Parker 2018	Grey	Expert opinion	TCPA	England	Agricultural to residential	Y	N	Y	N	Y	Y	4			Loss of fees/developer contributions, affordability	

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Literature item	Grey or academic literature	Type of literature	Details	Country	Type of change of use	Quality Appraisal (AACODS)							Primary outcome	Secondary outcome		
						A	A	C	O	D	S	Total	Health or wellbeing	Building	Neighbourhood	Exposure
Bibby *et al.* 2018	Academic	Qualitative – Cost benefit analysis	Cost benefit analysis	England	Not specific	Y	Y	Y	Y	Y	Y	6			Loss of CIL, S106, planning application fees depending on type of PDRs. Less mixed uses (decline of business property stock). Some include renewable energy schemes and installation of charging points for electric vehicles	
Remøy and Street 2018	Grey	Report	Policy comparison	England, Netherlands	Office to residential	Y	Y	Y	Y	Y	Y	6		Poor quality, low light, space and ventilation	Unaffordability, far from facilities like schools, healthcare, transport, supermarkets, mix of residential and commercial is difficult	
Clifford and Canelas 2018	Academic	Mixed methods – Case studies, interviews, cost benefit analysis	Combines Bibby et al. 2018 and Clifford et al. 2018, with an overarching synthesis	England (comparison to Scotland and Netherlands)	Not specific	Y	Y	Y	Y	Y	Y	6	Quality of life	Overall quality, no amenity space, no space standards	Loss of financial contributions, no supporting infrastructure, poor mix of accommodation, mainly goes to students, rural residential developments not sustainable and add to road traffic	

(*Continued*)

(Continued).

Literature item	Grey or academic literature	Type of literature	Details	Country	Type of change of use	Quality Appraisal (AACODS)							Primary outcome	Secondary outcome		
						A	A	C	O	D	S	Total	Health or wellbeing	Building	Neighbourhood	Exposure
Clifford *et al.* 2018	Academic	Quantitative – Case studies, interviews	Qualitative, 5 case study areas, 2 comparison areas, 568 site visits, 30 stakeholder interviews including 2 residents)	England (Scotland and Netherlands comparison)	Not specific	Y	Y	Y	Y	Y	Y	6		Quality, crowded, unsafe, noisy, poor sound insulation, few windows, not affordable, no garden, had to cover shop windows with boxes	No outdoor space, children playing in carpark, loss of developer contributions, loss of local employment risks high street, many SMEs and arts businesses get displaced, brothel in building	Noise, poorly maintained, no privacy
APSE and TCPA, 2019 (Association for Public Service Excellence (APSE), Town and Country Planning Association (TCPA) 2019)	Academic	Mixed methods – Policy review, case studies, survey, expert opinion	Desk based policy review, five case studies, online survey, expert roundtable	UK	Not specific	Y	Y	N	Y	Y	Y	5	Reduced general health and wellbeing, quality of life, vulnerable people are likely to be disproportionately negatively affected	Poor design and quality of development, lack of space or garden, poor storage, poor energy performance so higher running costs, poor lighting and ventilation, not many fire safety features, difficult to adapt	Poor location of housing, low street connectivity, not compact, uninviting to walk, traffic, poor public transport connections, lack of climate resilience measures, quote about outdoor space, low rents and access to amenities and less affordable housing, negative impact on local economy	Poor light, noisy, risk of homelessness, need flood resilience, low safety
RIBA, 2019 (Royal Institute of British Architects 2019)	Grey	Expert opinion	President RIBA	England	Not specific	Y	N	N	Y	Y	Y	4		Little space		
Smith 2019	Grey	Expert opinion	TCPA policy manager	England	Not specific	Y	N	N	N	Y	Y	3	General health	Poor quality, small, no windows	Low affordable homes, impacts economy, less developer contributions, isolated industrial estates no access to services, open space, green space, public transport	

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Literature item	Grey or academic literature	Type of literature	Details	Country	Type of change of use	Quality Appraisal (AACODS)							Primary outcome	Secondary outcome		
						A	A	C	O	D	S	Total	Health or wellbeing	Building	Neighbourhood	Exposure
Shelter 2019	Grey	Report	Briefing	England	Not specific	Y	N	N	Y	Y	Y	5	Health and safety problems	Small, low quality, not many fire safety features, hazards, high running costs	No social or affordable homes, lack of diversity in tenancy, doesn't provide for specific groups, poor street connectivity, inappropriate locations, risks neighbourhood conflict	Homelessness, in areas of flooding risk, low safety
Clifford *et al.* 2019b	Academic	Mixed methods – Case studies	30 case studies (desktop, and site visits)	England	Office to residential and 1 light industrial to residential	Y	Y	Y	Y	Y	Y	6	Mental health, wellbeing	Compliance with national space standards, provision of amenity space, access to daylight, often no garden private or shared, high degree of overlooking, poor security features	Mixture of unit types, location in relation to green or open space (often not within 250 m), near waste or industrial units, no residential areas within 10 min walk, poor street connectivity, some near busy highways, minimal surrounding greenery. Some well-located to access the shops, services and public transport available in the area, risks neighbourhood conflict	Little light or privacy
Grimwood and Barton 2019	Grey	Report	Briefing – house of commons	England	Not specific	Y	N	Y	Y	Y	Y	5	Used for most vulnerable families	Poor quality of schemes, possibly cramped	Loss of office space, lack of developer contributions for affordable housing or local amenities. Helps regenerate area by using empty spaces	
East Sussex County Council 2020	Grey	Report	JSNA, East Sussex	England	Not specific	N	Y	N	Y	Y	N	4			Loss of CIL, S106	

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Literature item	Grey or academic literature	Type of literature	Details	Country	Type of change of use	Quality Appraisal (AACODS) A	A	C	O	D	S	Total	Primary outcome Health or wellbeing	Secondary outcome Building	Neighbourhood	Exposure
TCPA, 2020 (Town and Country Planning Association (TCPA) 2020)	Grey	Report	Briefing	England	Not specific	Y	Y	N	N	Y	Y	4	Housing most vulnerable in substandard conditions, damages health and life chances, oppressive to health and wellbeing	Poor design, recreation and play space cannot be considered, windowless, unsafe, tiny	Unsuitable locations, excludes possibility of developer contributions	
MHCLG, 2020 (Ministry of Housing, Communities & Local Government 2020a)	Grey	Report	Planning review – Building Better, Building Beautiful commission	England	Not specific	Y	N	N	Y	Y	N	3		No space standards, low quality slums, lack of private of communal space, no windows	Loss of affordable housing and developer contributions, not near public transport, possible impacts on neighbours	
Mercer 2020	Grey	Documentary	Interviews including with a resident, statistics, case studies	England	Not specific	Y	N	N	Y	Y	Y	4	Houses vulnerable families, some residents have addiction problems, many fights	No space, 13 $m^{2,}$ flats, whole flats without a window, sub-standard housing, very few have outdoor space, often sited in car parks, do not have adequate light or ventilation, no play facilities, drug gangs operating from conversions, noise complaints, many single aspect so problems with overheating, communal areas not clean, old buildings so often low energy efficiency and more expensive to run, have used double glazing	Interrupts walking and cycling routes, good facilities close by, access to country side, no developer contributions eg. to schools, bus services, or GPs, moves vulnerable people so can increase pressure on local authorities, dislocates communities and stops democratic process, no consultation or engagement with community, can help to provide social housing	Residents feel unsafe, can account for flooding risk through prior approval, no privacy, noisy

(*Continued*)

(Continued).

						Quality Appraisal (AACODS)							Primary outcome	Secondary outcome		
Literature item	Grey or academic literature	Type of literature	Details	Country	Type of change of use	A	A	C	O	D	S	Total	Health or wellbeing	Building	Neighbourhood	Exposure
Clifford *et al.* 2020	Academic	Mixed methods – Case studies, interviews	639 building visits over 11 local planning authorities, 11 interviews with development professionals	England	Not specific	Y	Y	Y	Y	Y	Y	6	PDRs conversions create worse quality residential environments than planning permission conversions in relation to a number of factors widely linked to health, wellbeing and quality of life of future occupiers. Often used as temporary accommodation, may house vulnerable people	concerning quality, small space standards, can lead to overcrowding, poor layouts, lots with single aspect windows, poor access to daylight, lack of amenity space, concerns over insulation and energy performance, does not correspond to housing need, e.g. lots of studio flats	loss of employment space, problematic locations such as industrial estates, examples of development in positioned in an island formed by A roads and feeling very cut off, poor amenity access, do not create mixed communities, frequent concerns about loss of S106	Poor light

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ORIGINAL ARTICLE

Paediatric and Perinatal Epidemiology WILEY

The association between crowding within households and behavioural problems in children: Longitudinal data from the Southampton Women's Survey

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Abstract

Background: In England, nearly one child in ten lives in overcrowded housing. Crowding is likely to worsen with increasing population size, urbanisation, and the ongoing concerns about housing shortages. Children with behavioural difficulties are at increased risk of mental and physical health problems and poorer employment prospects.

Objective: To test the association between the level of crowding in the home and behavioural problems in children, and to explore what factors might explain the relationship.

Methods: Mothers of 2576 children from the Southampton Women's Survey population-based mother-offspring cohort were interviewed. Crowding was measured at age 2 years by people per room (PPR) and behavioural problems assessed at age 3 years with the Strengths and Difficulties Questionnaire (SDQ). Both were analysed as continuous measures, and multivariable linear regression models were fitted, adjusting for confounding factors: gender, age, single-parent family, maternal education, receipt of benefits, and social class. Potential mediators were assessed with formal mediation analysis.

Results: The characteristics of the sample were broadly representative of the population in England. Median (IQR) SDQ score was 9 (6-12) and PPR was 0.75 (0.6-1). In households that were more crowded, children tended to have more behavioural problems (by 0.20 SDQ points (95% CI 0.08, 0.32) per additional 0.2 PPR, adjusting for confounding factors). This relationship was partially mediated by greater maternal stress, less sleep, and strained parent-child interactions.

Conclusions: Living in a more crowded home was associated with a greater risk of behavioural problems, independent of confounding factors. The findings suggest

Drs. Inskip and Baird are joint last authors.

Social media quote: Living in a more crowded home is associated with a greater risk of behavioural problems in children, independent of confounding factors. Crowding occurs more commonly in social housing.

that improved housing might reduce childhood behavioural problems and that families living in crowded circumstances might benefit from greater support.

KEYWORDS
behaviour, cohort study, crowding, housing tenure, parent-child interactions, strengths and difficulties score

1 | INTRODUCTION

Behavioural problems lead to a range of negative outcomes including mental and physical health problems,[1] increased violence and risk of a criminal conviction,[2] and poorer educational attainment and employment prospects.[1] Studies have shown that behavioural problems affect one in ten children in the United Kingdom (UK).[1,3] This results in a serious burden for the individual, their families, and the wider community and economy.

Housing quality is now widely recognised as one of the social determinants of health.[4] Determining which elements of housing quality can be detrimental to behavioural problems in children could enable policies to be more effectively targeted at addressing this inequity. One such important and timely element is crowding. Crowding is worsening in the current housing crisis,[5] and new homes in the UK are the smallest in Western Europe.[6]

There are various ways both to measure the level of crowding in a household and to define the point at which a household is classed as overcrowded (see Figure 1 for definitions). People per room (PPR) is the most useful measure of crowding as it is continuous and is the most commonly used metric in research.[7] The bedroom standard is widely used as a definition for classifying a household as overcrowded.[8] Using the bedroom standard, nearly one million children, or one child in every ten, live in overcrowded conditions in England.[8-10] This problem is more common among families of lower socio-economic status, in rented accommodation, and in cities, with nearly one child in every three living in an overcrowded home in London's social housing.[5,10]

Most research on the effects of crowding is based on adults.[11] Yet children are particularly influenced by their home environment.[12] Studies have shown crowding in the home has a negative impact on children's education and a range of physical health outcomes,[13] but, as highlighted by other researchers, despite the strong theoretical links to adverse psychological processes, almost no research on children has focused on associations between crowding and behavioural outcomes.[14]

The majority of studies on crowding in the home and behavioural problems in children originate from America, are from the 1970s or earlier, were based on very small samples, and used cross-sectional designs.[13-16] Notably, there has not been a study in the UK for over 25 years.[14,15] In most of the studies, children living in crowded households had more behavioural problems than children in less crowded households.[14-18] Crowding may impact on children's behaviour through a lack of privacy or space to play,[19,20] increased reliance on childcare,[1] interrupted sleep,[17] or impacts on parent-child interactions including conflict, reduced monitoring, and less parental responsiveness.[1,16,21] Despite the numerous theoretical explanations for the relationship between crowding and child behaviour, very little research has included potential confounding or mediating factors.

Synopsis

Study question
Is there an association between the level of crowding in the home and behavioural problems in children, and if so, what factors might explain the relationship?

What's already known
Early, small scale studies indicate that living in a more crowded home is associated with a greater risk of behavioural problems in children.

What this study adds
This UK-based cohort study confirms that living in a more crowded home is associated with a greater risk of behavioural problems in children, independent of confounding factors (gender, age, single-parent family, maternal education, receipt of benefits and social class and neighbourhood quality). The relationship was mediated in-part by maternal stress, less sleep, and strained parent-child interactions. Crowding occurs more commonly in social housing.

The aim of this study was to assess whether the level of crowding in the home is associated with more behavioural problems in a UK cohort of children, and to explore what factors might explain the relationship.

2 | METHODS

2.1 | Participants

The Southampton Women's Survey (SWS) is a prospective cohort study of 12 583 women aged 20-34 years recruited, when not pregnant, from the general population resident in Southampton.[22] A total of 3,158 women who subsequently became pregnant were

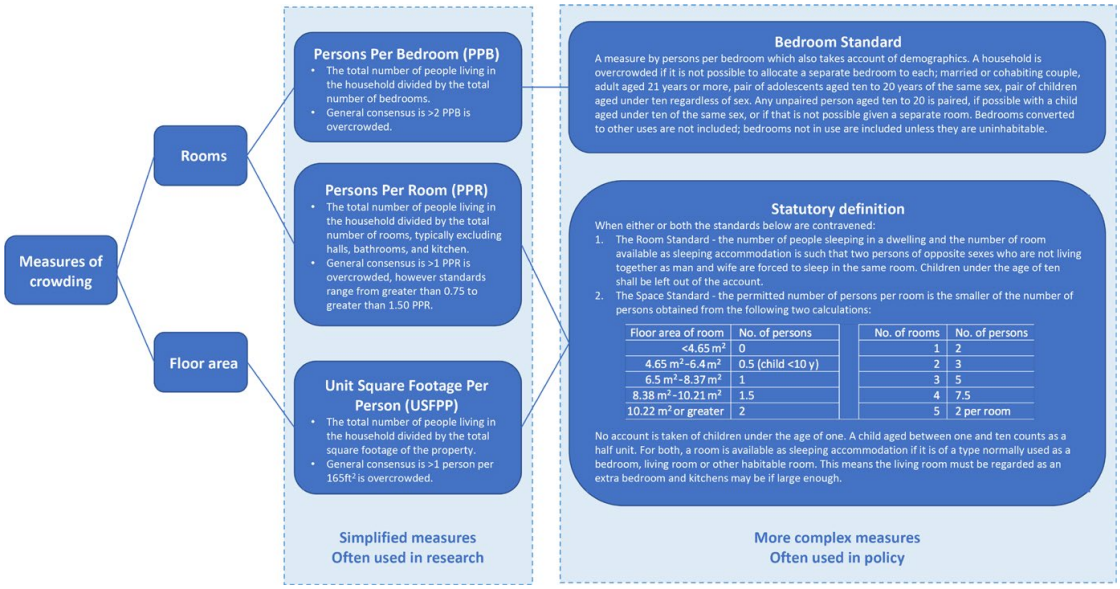

FIGURE 1 Summary of measures of crowding and definitions of overcrowding, the association between crowding within households and behavioural problems in children, Southampton, 2019[7,35]

followed through their pregnancy, and their children were then followed up at intervals during childhood. Those who had information collected on behavioural problems at age 3 years were included in the study. The final sample consisted of 2576 children (see Figure 2). Information relating to the children in this study was collected from 2001 to 2010. The study had full approval from the Southampton and Southwest Hampshire Local Research Ethics Committee, and all participants' mothers gave written informed consent.

The level of crowding in the household at age 2 years was captured as PPR. Information on the numerator (sum of the number of

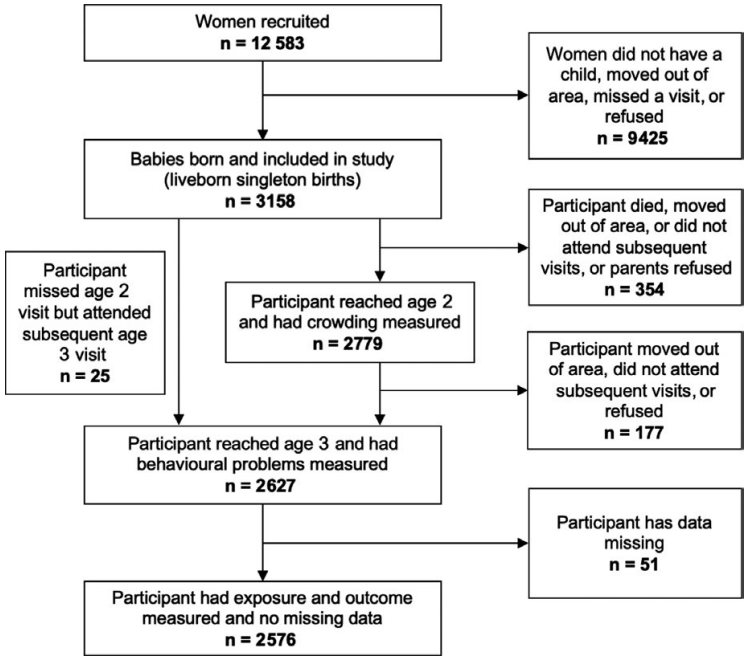

FIGURE 2 Participant flow diagram and dropout at various stages of the Southampton Women's Survey, the association between crowding within households and behavioural problems in children, Southampton, 2019

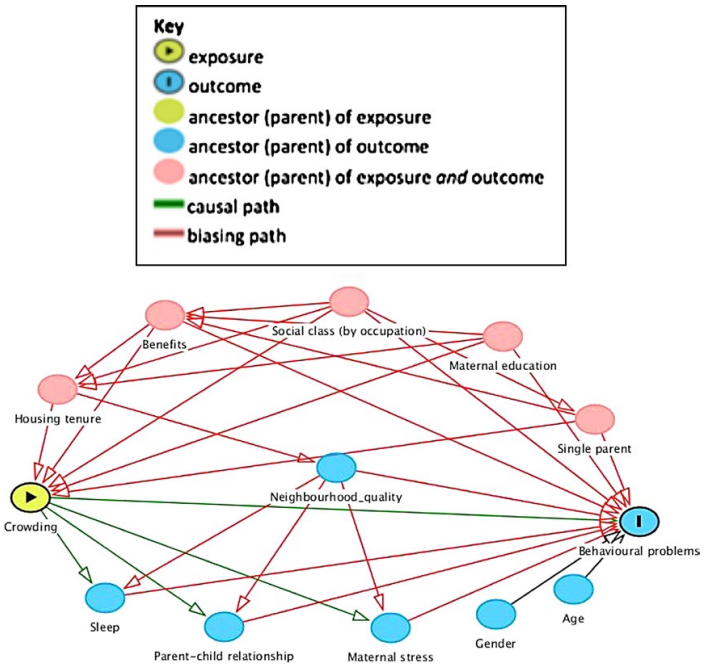

FIGURE 3 DAG model created to show covariates included in the analyses, the association between crowding within households and behavioural problems in children, Southampton, 2019

people living in the household) and the denominator (total number of rooms, excluding halls and bathrooms, minus one to represent the kitchen) was collected during face-to-face interviews with the participants' mothers at their homes. A further question assessed whether the household composition had changed since pregnancy. Behavioural problems were assessed at age 3 years using the preschool, parent-only version of the Strengths and Difficulties Questionnaire (SDQ). Mothers were questioned regarding their children in four areas: emotional, conduct, hyperactivity/inattention, and peer problems; and the scores from each of these were summed to create a total difficulties score.[23] This score can range from 0 to 40 and was treated as a continuous variable. A higher score indicates greater behavioural problems (a score under 13 is "close to average," 13-15 "slightly raised," 16-18 "high," and 19 and above "very high").[24]

Potential confounding factors were identified a priori from existing literature and included in a directed acyclic graph (DAG) (see Figure 3). This indicated two different minimal sufficient adjustment sets. The first included level of maternal educational attainment, highest level of parental social class (by occupation), single-parent household, whether the household received benefits (support/job seekers allowance, working tax credit, or housing benefits), and housing tenure. The second included the same factors with the exception of housing tenure which was replaced with neighbourhood quality. Additionally, adjustments for age and gender of the child were included in all analyses to improve the precision of the outcome variable. We separately examined the relationship between housing tenure and crowding to try to identify the types of housing in which most crowding occurs. Housing tenure was classified as owner occupied (homes owned outright and mortgaged); privately rented; socially rented (housing rented from local authorities and housing associations); or other (families who live with a relative, in a hostel, halls of residence, or bed and breakfast).

The following variables, shown in the DAG, were considered as possible mediators: sleep duration (time spent asleep per night); maternal stress (stress experienced in daily living in the last 4 weeks ranked on a 5-point scale); and two variables for parent-child interactions (conflict and closeness) which were measured using the Child-Parent Relationship Scale (CPRS). CPRS is a self-report instrument, completed by mothers, that assesses their perceptions of their relationship with their child. It is widely used and has been validated for use at this age.[25] It produces conflict and closeness scores which run from 0 to 60, with higher scores representing negative and positive interactions, respectively.

Information on all the confounding and mediating variables and housing tenure was collected in the same interview with the mothers of the participants when the children were aged 2 years, with the exception of parent-child interactions and sleep, which were measured in the interview at age 3 years.

2.2 | Statistical analysis

Using Stata 15.0,[26] standard summary statistics including median, interquartile range (IQR), or number (n) and percentage were produced for the variables in the analysis. Spearman's correlation and linear regression methods were used to explore the relationship between crowding and behavioural problems. In all the models, crowding was

entered in units of 0.2 PPR which equates to an additional person in an average-sized five-room household. The first model simply adjusted for child's gender and age. Models 2 and 3 were based on the two options for minimal sufficient adjustment indicated by the DAG. In Model 2, single parent, maternal education, receipt of benefits, social class, and housing tenure were included. In Model 3, neighbourhood quality replaced housing tenure while the other variables remained the same.

Mediation analysis, using formal mediation techniques, for the association between crowding and SDQ score was implemented.[27,28] We used Model 3 to consider the mediators. Bias-corrected confidence intervals were estimated from 500 Monte Carlo draws for nonparametric bootstrap. Direct and indirect effects were averaged across all individuals.

Data on behavioural problems were slightly skewed to the right so a sensitivity analysis was conducted using the square-root transformation. We tested for nonlinearity of the relationship between child's behaviour and crowding by including a quadratic term for crowding in our models. Further, we conducted an analysis restricted only to those living in owner-occupied houses.

In our data set, 78% of individuals had fully observed data. The proportion of missing data for each variable ranged from 0.2% (gender) to 19% (conflict score); we did not identify important missing data patterns in our data set. We used multiple imputation of missing data to minimise selection bias and increase the power of our analysis. For each imputation model, we included all the variables identified from the DAG as potential confounders or mediators, as well as our outcome. We generated 100 imputed data sets and combined the coefficient estimates using Rubin's rule.[29,30] We based our imputations on the assumption that missingness in the data is explained by the observed variables included in the imputation model (ie data are missing at random).[31] More details are in Table S1.

3 | RESULTS

The characteristics of the 2576 children are given in Table 1. The median age was 3 years at the time of assessment of behavioural problems. The study sample characteristics were almost identical to the wider SWS cohort and broadly in line with England figures.[1,5,23]

In households, the number of rooms ranged from 2 to 12 with a mean of 6.0. The number of individuals in households ranged from 2 to 11, and level of crowding ranged from 0.3 to 4 PPR. There was relatively little change in the level of crowding from the child's birth to age 2 years, with 1951 (76%) households having no change to the number of individuals in them. Of households that did see a change, the majority were due to the addition of a single child. The total difficulties behavioural score ranged from 0 to 31, with 248 (9.6%) of children having "high" or "very high" scores (SDQ score ≥ 16).

Table 2, Model 1 shows the positive association between crowding and behavioural problems adjusted for age and gender. In Model 2, which also includes additional adjustment for the confounding variables (single-parent households, maternal education,

TABLE 1 Baseline characteristics of the study population, the association between crowding within households and behavioural problems in children, Southampton, 2019

Participant characteristics	Study sample n = 2576 Median (IQR) or *n (%)*
Crowding (PPR)	0.75 (0.60, 1.00)
Behavioural problems (SDQ score)	9 (6, 12)
Boys	1338 (52)
Age (years)	3.04 (3.01, 3.09)
Single-parent household	231 (9)
Maternal White ethnicity	2478 (96)
Maternal education[a]	
No qualifications	66 (3)
GCSE only	939 (37)
A-levels or equivalent	825 (32)
Degree or higher	740 (29)
In receipt of benefits	871 (34)
Housing tenure[b]	
Owner occupier	2046 (79)
Privately rented	125 (5)
Socially rented	326 (13)
Other	78 (3)
Social class	
Professional (I)	303 (12)
Management and technical (II)	1258 (49)
Skilled nonmanual (IIIN)	662 (26)
Skilled manual (IIIM)	240 (9)
Partly skilled (IV)	96 (4)
Unskilled (V)	14 (1)
Parent-child interaction[c]	
Conflict	25 (20, 30)
Closeness	45 (43, 47)
Sleep duration (hours per night)	11.0 (10.5, 11.5)
Mothers level of stress[d]	
None	331 (13)
Mild	1715 (66)
Moderate to severe	525 (20)

Percentage totals may not add to 100 due to rounding. Only data on behavioural problems were slightly skewed, but medians (IQRs) are presented for consistency.

[a]ISCED level equivalents are as follows: No qualifications is ISCED-0, 1, and 2; GCSE only is ISCED-3 A-levels or equivalent ISCED-3 and 4; and Degree or diploma is ISCED-4, 5, and 6.

[b]Owner occupied (homes owned outright and mortgaged), socially rented (housing rented from local authorities and housing associations), and other (family lives with a relative, in a hostel, halls of residence, or bed and breakfast).

[c]Child-Parent Relationship Scale produces conflict and closeness scores which run from 0 to 60, with higher scores representing negative and positive interactions between parent and child, respectively.

[d]Mothers ranked the stress or pressure they experience in daily living in a 4-week period on a 5-point scale: none, just a little, a good bit, quite a lot, or a great deal. Responses were grouped so that "just a little" and "a good bit" represent mild stress and "quite a lot" and "a great deal" represent moderate-to-severe stress.

TABLE 2 Multivariable regression assessing the relationship between crowding in the household and behavioural problems in children, the association between crowding within households and behavioural problems in children in the multiply imputed data set, Southampton, 2019

	Model 1 (n = 2,576)	Model 2 (n = 2,566)	Model 3 (n = 2,563)
Variable	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
Crowding (0.2 PPR)	0.45 (0.34, 0.56)	0.13 (−0.003, 0.26)	0.20 (0.08, 0.32)
Girls (vs boys)	−1.03 (−1.37, −0.68)	−1.06 (−1.40, −0.72)	−1.04 (−1.38, −0.70)
Childs age (years)	−0.70 (−2.64, 1.19)	−1.53 (−3.44, 0.37)	−1.49 (−3.38, 0.41)
Single parent		−0.33 (−0.99, 0.33)	−0.69 (−1.32, −0.07)
Maternal education		−0.33 (−0.47, −0.18)	−0.36 (−0.50, −0.21)
On benefits		0.28 (−0.11, 0.68)	0.32 (−0.07, 0.72)
Social class (by occupation)[a]		0.24 (0.04, 0.44)	0.26 (0.07, 0.46)
Housing tenure			
Owner occupier		0.00 (Reference)	
Privately rented		0.11 (−0.73, 0.94)	
Socially rented		1.54 (0.88, 2.19)	
Other		1.73 (0.71, 2.74)	
Neighbourhood quality[b]			0.21 (0.14, 0.28)
Constant	11.12	15.68	15.43

Model 1 is adjusted for child's gender and age

Model 2 is adjusted for confounders in model 1 plus additional DAG-identified confounders including single parent, maternal education, receipt of benefits, social class, and housing tenure

Model 3 is adjusted for confounders in model 2, plus neighbourhood quality but excludes housing tenure.

[a]Ordered categorical variables included in the model as continuous variables to account for the trend.

[b]Summed ratings for eight categories: vandalism, litter, small, muggings, burglaries, disturbances, traffic, and noise. Possible score ran from 0 to 16 with a higher score indicating more problems.

income, social class, and housing tenure), the association between behavioural problems and crowding was markedly attenuated. In Model 3, in which housing tenure was replaced by neighbourhood quality, there was less attenuation from Model 1 than was seen in Model 2. In households that were more crowded by 0.2 PPR (equating to an additional person in an average-sized five-room household), the children tended to have more behavioural problems by 0.20 SDQ points (95% CI 0.08, 0.32, $P < 0.001$), after adjustment for confounding factors. Furthermore, children with SDQ scores ≥ 16 ("high" or "very high" total difficulties score) lived in houses that had, on average, 0.2 more PPR than children with SDQ scores < 13 ("close to average" score). Examining the subscales of the SDQ score indicated that the association was dominated by the relationship with conduct problems and peer problems rather than with the other subscales of hyperactivity and emotional symptoms (Table S2).

The analysis of the multiply imputed data sets to take account of missing data found very similar results to those in Table 2. The results are given in Table S3.

The four mediators examined (conflict and closeness in the parent-child relationship, maternal stress, and child sleep duration per night) explained 15% of the effect of crowding on behaviour. In the fully adjusted model, including all variables in Model 3 and all of the mediators, the coefficient for crowding (using the 0.2 PPR values) reduced to 0.16 (95% CI 0.04, 0.28) (see Table 3). This indicates that all of these factors could, in part, explain the positive association between crowding and behavioural problems, but that after adjustment, the relationship between crowding and behavioural problems remained.

A sensitivity analysis using a square-root transformation of the data on behavioural problems produced the same Spearman's correlation coefficient and significance for the correlation between crowding and behavioural problems. All the same factors remained statistically significant in the regression analyses in Models 1 and 2. We found no evidence of nonlinearity in the relationships.

The association between crowding and housing tenure was found to be strong, with children living in socially rented housing being more likely to experience crowding (see eFigure 1). Some 25% of the variability in crowding was explained by housing tenure. Restricting the analysis to those living in owner-occupied homes showed that even in such homes, there was an association between crowding and child's behaviour with the coefficient for crowding being 0.15 (95% CI −0.0006, 0.30).

TABLE 3 Regression analyses of potential mediators and associated factors in the relationship between crowding in the household and behavioural problems in children, the association between crowding within households and behavioural problems in children, Southampton, 2019

Covariate	Coefficient for crowding adjusted for confounders as in Model 3, further adjusted for each mediator	Coefficient for crowding adjusted for confounders as in Model 3, further adjusted for all mediators
Increasing stress[a]	0.19 (95% CI 0.06, 0.32)	0.16 (95% CI 0.04, 0.28)
Reduced sleep duration[b]	0.19 (95% CI 0.05, 0.33)	
Parent-child interaction[c]		
Increasing conflict	0.19 (95% CI 0.07, 0.31)	
Increasing closeness	0.16 (95% CI 0.04, 0.28)	

Numbers rounded to two decimal places.
[a]Mothers ranked the stress or pressure they experience in daily living in a 4-week period on a 5-point scale: none, just a little, a good bit, quite a lot, or a great deal.
[b]Hours spent asleep per night.
[c]Child-Parent Relationship Scale produces conflict and closeness scores which run from 0 to 60, with higher scores representing negative and positive interactions between parent and child, respectively.

4 | COMMENT

4.1 | Principal findings

This UK-based study confirms the associations shown in studies in other countries that children living in crowded households had more behavioural problems than children in less crowded households and this was independent of age, gender, single-parent households, and maternal education, receipt of benefits, and social class. It adds to the evidence base by showing that maternal stress, less sleep per night, and strained parent-child interactions might all, in part, be mediating factors. Furthermore, we identified that children living in social housing tended to live in more crowded homes, but that even in owner-occupied homes, crowding and behavioural problems are associated.

The findings of this study are consistent with the majority of earlier, small-scale studies on crowding and behavioural problems and offer resolution to a number of common limitations, not least study design.[14-18] It has a large sample size, strong, prospective cohort design, and relatively robust control for potential confounding factors. The findings agree with the only other longitudinal study to date by Solari et al,[12] which also found that children from more crowded households had more behavioural problems than children from less crowded households, irrespective of socio-economic status and demographic factors.

4.2 | Strengths of the study

Possible reasons why the findings of this study differ from the few studies that did not find an association between crowding and behaviour, such as Li et al,[20] are because of the differing methods of measuring crowding. Li et al used unit square footage per person; however, capturing crowding through PPR is preferred because it is has been reported as the most consistent crowding metric with human consequences,[7] and because of inconsistencies in how people define bedrooms.[12,16] There is no known threshold for any detrimental effect from crowding on a child's behaviour, so the continuous measure is justified and more sensitive than arbitrary categorical intervals.[12]

A further strength of this study was its prospective cohort design. The longitudinal nature of the data enabled account to be taken of temporality. The SWS cohort has been well characterised, thus allowing consideration of important confounding factors, albeit that there is likely to be residual confounding. The characteristics of the sample were almost identical to the wider SWS cohort, but the SWS cohort is slightly more affluent than the general population in the UK, as commonly results from selection bias in studies.[23] Interviewers and participants were blinded to the research hypothesis, which minimised reporting bias. Missing data did not seem to be a major problem as analyses of our multiply imputed data sets gave very similar results to the complete-case analysis. The SDQ is not a clinical assessment, but it is a validated tool to measure behavioural problems in the sample age group.[32] The age of 3 years was an appropriate time to measure the outcome as child behaviour shows increasing stability from around this point onwards.[1]

4.3 | Limitations of the data

Several covariates could have been more refined; for example, receipt of benefits is a crude measure of income, and there is some evidence to suggest that the SDQ might be a more sensitive measure of behavioural problems after age 4 years.[32] The exposure, outcome, and covariates were all reported by the participants' mothers, which introduces the potential for response bias. For example, if some mothers in overcrowded households gave information that led to an underestimation of the PPR, then this might have led to an exaggerated effect size. However, the interviews were conducted in the participants' homes, so interviewers could, to an extent, verify the validity of participants' answers. Data were not available on some factors that may also be involved, such as intrafamilial violence or a lack of privacy. Also, the child-parent relationship variables and sleep

were measured at the same time as the behaviour outcome and it is possible that an element of reverse causation might explain the relationship between them and behaviour. The study did not have statistical power to analyse either changes in the level of crowding or household demographics over time. Lastly, in the SWS, the recruitment of pregnancies was necessarily over a prolonged period and the study was unable to account for potential temporal changes in housing and socio-economic conditions between 2001 and 2010.

Our approach to causal inference using the DAG led to two different minimal sufficient adjustments sets, and we have shown analyses using both sets. Housing tenure and crowding are strongly linked and adjustment for housing tenure attenuated but did not completely remove the relationship between crowding and behavioural problems, whereas in the model adjusting for neighbourhood quality, the relationship was stronger. It is thus possible to argue that the problem lies with housing tenure rather than crowding, but we believe that our various analyses indicate that an association between crowding and behavioural problems is apparent.

4.4 | Interpretation

The National Institute for Health and Care Excellence (NICE) recommends that vulnerable children under 5 years at risk of developing behavioural problems are identified as early as possible so that increased visits and free childcare services can be provided.[33] This study provides support for categorising children in crowded households as "at risk" and taking action, such as referring those families to existing local support services. As maternal stress, less sleep, and strained parent-child interactions all in part mediated the positive association between crowding and behavioural problems, intervening to influence any one of them may reduce the impact of crowding on behavioural problems. In fact, Bywater et al[34] have already demonstrated that parenting interventions which improve parent-child relationships can reduce behavioural problems.

In the UK, the statutory definition of overcrowding has not been updated since 1935 and it sanctions extremely overcrowded conditions.[7,9,35] Problems with the statutory definition include the following: children under 1 year are not counted; people of the same gender are not entitled to their own room; living rooms and large kitchens are counted as acceptable places to sleep; and it looks at how sleeping arrangements within the premises could be organised, rather than how they are actually organised (see Figure 1 for definition).[9,18] The UK is also one of the few European nations to have no nationally agreed minimum space standards for housing.[7] Although the effect of crowding on child behaviour is relatively modest, it does provide some support for creating space standards.[35]

Children in social housing tended to have the highest levels of crowding, so improvements in such housing to reduce crowding should be encouraged. Evaluating housing interventions that are already in place would offer tremendous research opportunities. For example, a large-scale longitudinal study that compared two groups of households—one group where overcrowding had been alleviated compared with a group where overcrowding remained and which took into account confounding variables—would enable analysis of how crowding improvements can change behavioural trajectories.

5 | CONCLUSIONS

Living in a more crowded home was associated with a greater risk of behavioural problems, independent of confounding factors (gender, age, single-parent family, maternal education, receipt of benefits, social class and neighbourhood quality). The relationship was mediated in-part by maternal stress, less sleep, and strained parent-child interactions. Therefore, families living in crowded circumstances might benefit from greater support, or intervening on any one of the mediators may reduce the impact of crowding on behavioural problems. Crowding occurs more commonly in social housing, so increasing space in social housing would ideally be a long-term aim.

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CONFLICT OF INTEREST

Janis Baird received research funding from Nutricia Early Life Nutrition for a specific research study which aims to improve the nutrition and vitamin D status of pregnant women and is collaborating with Iceland Foods Ltd to evaluate the impact of fruit and vegetable availability on diet. Keith Godfrey has received reimbursement for speaking at conferences sponsored by companies selling nutritional products and is part of academic research programmes that have received research funding from Abbott Nutrition, Nestec, and Danone.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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Community led housing, health and wellbeing: a comprehensive literature review

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ABSTRACT

Community Led Housing (CLH) is an umbrella term encompassing several non-profit models of housing delivery, which is used internationally. There has been little comprehensive assessment of the health impacts of housing arrangements where people intentionally live or work together in a community. This systematic review provides the first overview of the health, wellbeing and heath inequality impacts of all forms of CLH. 4,091 literature items were identified from a structured search of eight databases and manual searching for grey literature. Literature published between January 2009 and June 2022, in OECD countries, were eligible. 34 academic and 11 grey literature items were included. The review identifies far more literature reporting that CLH has positive rather than negative impacts, on primary health outcomes and on neighbourhood level factors which impact on health (social contact, employment, safety, environmental sustainability, and affordability). There is a lack of research on CLH impacts on the health of children and young people, and on health inequalities. These findings provide an indication of largely positive impacts of CLH arrangements on health and wellbeing. They indicate the importance of further longitudinal, objective research, and of policies and actions to support this form of housing delivery.

KEYWORDS: Community led; housing; inequalities; health; wellbeing

Introduction

There is extensive evidence demonstrating the importance of housing as a wider determinant of health, and of health inequalities (Ige et al., 2019; WHO, 2018). However, currently, 1.6 billion people, or 20% of the world's population, live in inadequate, crowded and unsafe housing (Woetzel et al., 2014). In high-income countries, around 70% of people's time is spent inside

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their home, and in some places, including where unemployment levels are higher and where more people are employed in home-based industries, this percentage is even higher (WHO, 2018). Not only does this have significant implications on the occupants' lives but for wider health and social care systems too (Garrett et al., 2021).The impact of the design and quality of homes on the health of occupants has been widely reported for numerous outcomes including cardiorespiratory diseases, infectious diseases, injuries, allergies and mental health conditions (Ige et al., 2019; WHO, 2018). Causal pathways have shown how housing can impact on health. These pathways can be used to infer how risk factors at the building level (e.g., ventilation and space), the neighbourhood level (e.g., proximity to green space, local facilities and public and active transport options) and through direct exposures (e.g., cold or air pollutants) (Bird et al., 2018; Pineo et al., 2018), can have health impacts. As well as physical environments, psychosocial environments (e.g., affordability, safety, environmental sustainability, and social contact) play a role in health outcomes (Bird et al., 2018; Ige et al., 2019; WHO, 2018). These causal pathways underpin the methods of this paper.To date, there has been little comprehensive assessment of the health impacts of housing arrangements where people intentionally live or work together in a community (Lubik & Kosatsky, 2019).

Community Led Housing definition

Community Led Housing (CLH) is an umbrella term encompassing several non-profit models of housing delivery. While the CLH movement is diverse, for the purpose of this review we have used the following definition: CLH is housing development which meets the following three criteria (Co-operative Councils Innovation Network, 2018):

1. A requirement that meaningful community engagement and consent occurs throughout the process. The community does not necessarily have to initiate and manage the development process, or build the homes themselves, though some may do.
2. The local community group or organisation owns, manages or stewards the homes in a manner of their choosing.
3. A requirement that the benefits to the local area or specified community must be clearly defined and legally protected in perpetuity.

Within this definition of CLH, there are a range of ownership, management and occupancy models, which may have very different funding or governance structures. These include (Co-operative Councils Innovation Network, 2018):

- Housing co-operative: groups of people who provide and collectively manage, on a democratic membership basis, homes for themselves as tenants or shared owners.

- Cohousing: groups of like-minded people who come together to provide self-contained, private homes for themselves, but manage their scheme together and share activities, often in a communal space. Cohousing can be developer-led, so it is important to examine whether cases meet the broad definition of CLH given above, rather than simply use of the term cohousing as a marketing device.
- Community Land Trust (CLT): not-for-profit corporation that holds land as a community asset and acts as the long-term steward, which can provide housing through rent or shared-ownership.
- Community self-build: groups of local people in housing need building homes for themselves with external support and managing the process collectively. Individual self-build is not regarded as CLH.
- Self-help housing: small, community-based organisations bringing empty properties back into use, often without mainstream funding and with a strong emphasis on construction skills training and support.
- Tenant-Managed Organisations (TMO): provide social housing tenants with collective responsibility for managing and maintaining the homes through an agreement with their council or housing association landlord. This category, similar to (developer-led) cohousing, is contested and needs specific case by case consideration to deem tenant management a meaningful form of community control.

These models are not necessarily mutually exclusive, a cohousing group could form a CLT or a co-operative, as could a TMO. Further, any of the types listed above could be self-built. Some forms of CLH may also be 'intentional communities', a group of people who have chosen to live together with a common purpose, working co-operatively to create a lifestyle that reflects their shared core values, often involving shared resources and responsibilities, but equally, intentional communities may not engage with CLH. The sector is complex, evolving and differs between contexts and countries. These definitions aim to illustrate what is in the scope of CLH, and how it is different from market-driven or standard (welfare-oriented) social housing, rather than provide a set of discrete categories into which each CLH development could be exclusively placed.

Historical and policy context

CLH has a long history, with roots in the co-operative movement of the nineteenth century, where housing co-operatives were at the core of Ebenezer Howard's Garden City Movement, which had influence globally (Goulding et al., 2018). This was followed by the CLT movement in the United States (US) in the 1960s, which was intertwined with struggles for land-based racial justice (Bates, 2022). The bulk of the current stock of CLH is attributable to housing co-operatives formed

in the 1970s and 1980s (Goulding et al., 2018), largely in Denmark, Sweden, Germany and the Netherlands. Subsequently there was a small wave of CLH in other western countries (Ruiu, 2016). Whereas in those early years most projects were isolated events, since 2000 a trend has emerged and CLH now exists worldwide, including in developing countries (CAHF, 2022).

CLH has experienced increased attention in recent years (Jarvis, 2015; Moore & McKee, 2012; Mullins, 2018; Tummers, 2016), which has been attributed to a couple of key factors. The first relates to a shortage in affordable housing and precarious rental conditions (Moore & McKee, 2012; Mullins, 2018), which is widely cited as a 'housing crisis'. The second factor relates to a more ideological position. Literature refers to a growing desire for a sense of belonging, a need to feel connected to a community, and an increasing rejection of dominant models of consumption (Jarvis, 2015).

Previous reviews have considered a single aspect of CLH, such as cohousing (Carrere et al., 2020), or a single health outcome, such as social networks (Warner et al., 2020). These found that the majority of studies found CLH to be health promoting. To our knowledge, no systematic review has yet been undertaken analysing the entirety of links between CLH and health and wellbeing. Therefore, the aim of this review was to gather and synthesise all of the evidence, from an international context, on the relationships between all forms of CLH and any health and wellbeing outcomes, including health inequalities.

Methods

Search strategy

A list of potentially relevant databases and organisations was compiled from existing systematic reviews across similar topics (Ige et al., 2019). Eight electronic databases related to a variety of fields, including health, architecture, ageing and social sciences, were used to conduct the search; Taylor and Francis, Social Policy and Practice, Wiley Online, ScienceDirect, Springer, MEDLINE (OVID), The Allied and Complementary Medicine Database (AMED), and Applied Social Sciences Index & Abstracts (ASSIA), were searched. To ensure we obtained evidence from a broad range of sources the search strategy included grey literature as well as academic databases. We searched 14 grey literature sources (see Table 1). Additional searches were conducted by Rachael McClatchey on Google, Google Scholar and relevant organisation websites to locate additional potentially eligible literature. All authors were involved in identifying relevant grey literature. To ensure we did not miss key papers we also used a snowballing technique, which involves scanning the reference list of included papers to check for any relevant sources that may have been overlooked.

Table 1. Example search protocols for academic databases and for grey literature. Search run in August 2019, and again in June 2022

Source	Search terms	Results
Social Policy and Practice		
S1	("community housing" or "communal housing" or "collaborative housing" or "collective housing" or "co-housing" or "community land trust" or "community-land trust" or "community led housing" or "community-led housing" or "community involved housing" or "housing collective*" or "collective housing" or "communal housing" or "eco-communit*" or "eco communit*" or "community-driven housing" or "participatory housing" or "community engaged housing" or "intentional communit*" or "people led housing" or "people-led housing").af.	304
S2	(health or "physical health" or "mental health" or environment* or "quality of life" or QoL or wellbeing or well-being or welfare or "purpose in life" or flourish* or sautogen* or "health equit*" or "socially inclusive").af.	148376
S3	(improv* or chang* or effect or impact or increas* or decreas* or equity or inequality or benefit* or help* or assist* or evidence or value or performance or efficien* or outcome* or performance).af.	211090
S4	1 and 2 and 3	72
S5	limit 4 to yr="2009 -Current"	35
Department of Health and Social Care	Community housing	2
Power to Change	Browse of publications	2
New Economics Foundation	Browse of publications on search community led housing	7
Department of Levelling Up, Housing and Communities	Community housing	1
Parliament UK	Community housing	2
Royal Town and Country Planning Institute	Community housing	0
Shelter	Community housing	0
World Habitat	Community housing	3
National Housing Federation	Community housing	4
The Health Foundation	Community housing, and search by topics (social determinants)	0
The King's Fund	Community housing	2
Joseph Rowntree Foundation	Community, Refined by topic: housing	8
Community Land Trust Network	Browse of publications	0
Community Led Homes	Browse of publications	0

Community led housing, health and wellbeing: a Comprehensive literature review, 2023.

Preliminary searches were used to gain depth of understanding, as to whether our initial search process needed further refining. The authors considered including a range of additional search terms on secondary outcomes, such as physical and psychosocial housing factors with evidence of impact on health, and on population sub-groups (Ige et al.,

2019; WHO, 2018). As the preliminary searches identified a limited number of sources relating to the primary outcome of health, the authors decided not to apply this secondary level of search terms (see Table 1 for search terms). To ensure the authors gathered the most relevant possible range of results, US and United Kingdom (UK) spelling terms, truncations, wildcards, and Boolean terms were used. A pilot search was performed by Emma Griffin in one database (Taylor and Francis) to test the search strategy and refine the search terms before the full search was undertaken by the same researcher.

Eligibility criteria

Articles were screened in three phases: title, abstract, and full-text. To be selected for inclusion, literature items were required to meet the following inclusion criteria:

1. Be published in English language (literature not in English language were excluded due to limited capacity to translate within the research team).
2. Be published between 1st January 2009 to 30th June 2022 (as CLH grew in momentum from 2000 on, the authors did not anticipate much literature published prior to this date).
3. Be conducted in OECD countries (literature from countries outside OECD were excluded from this review due to differences in planning systems and regulations, general economic circumstances and levels of informal housing, which may act as confounders) (Shrestha et al., 2021).
4. No restriction of study design. Evidence reviews were excluded but checked for additional eligible literature. The following types of grey literature are eligible: reports, dissertations, policies, conference abstracts, presentations, expert opinion, video and text accessible from nationally recognised stakeholder websites.
5. Reports on associations between:

    - Population: people of any age or sex involved in or affected by CLH, including residents, prospective residents, visitors, those involved in the construction process, board members and/or the local community. Literature on informally settled or travelling communities was not included.
    - Exposure: CLH; the authors adopted the definition as agreed by the CLH sector (see introduction for definition). Intentional communities were only included if they also fulfilled a definition of CLH, so intentional communities such as residential treatment facilities were excluded.

- Outcome: the primary outcomes of interest were health and wellbeing impacts, secondary outcomes were risk factors with evidence of impact on health at building or neighbourhood level (including the physical or psychosocial environment).

Search results

Results were exported to referencing software Zotero, and duplicates were removed. Emma Griffin independently screened all titles and abstracts identified by the searches, removing literature which did not meet the eligibility criteria. A selection of the literature was then independently assessed by a second reviewer to ensure consistency and accuracy in the selection process (McClatchey).

In total, 4,091 literature items were identified from a structured search of eight databases combined with manual searching for grey literature. 714 duplicates were removed prior to screening. A total of 45 literature items met the eligibility criteria and were included in the review (see Figure 1, and Tables 2 and 3). Of these, 34 were academic studies (13 mixed methods, 18 qualitative, and three quantitative) and the remaining 11 were grey literature (one briefing, one commentary, one book chapter, two policy reviews, four reports, one workshop reflection, and one blog).

Data extraction

Two reviewers (McClatchey and Griffin) extracted relevant data on: author, publication date, location, type of CLH, funding, study design, methods, participants including sub-populations, and negative and positive impacts on health (primary outcome) and physical and psychosocial housing factors with evidence of impact on health (secondary outcome). Data and themes were reviewed jointly with Katie McClymont. The reporting of this review conforms to recommendations from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020).

Quality appraisal

As the search identified quantitative, qualitative and mixed method studies, the quality assessment Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018) was used to rate the quality of included literature. This tool was selected for its ability to assess a range of study designs. The tool consists of screening questions followed by five quality assessment domains depending on the study methodology. The tool is recommended for rating the methodological quality of literature, and its reliability (Souto et al., 2015) and content validity (Hong et al., 2019) has been corroborated.

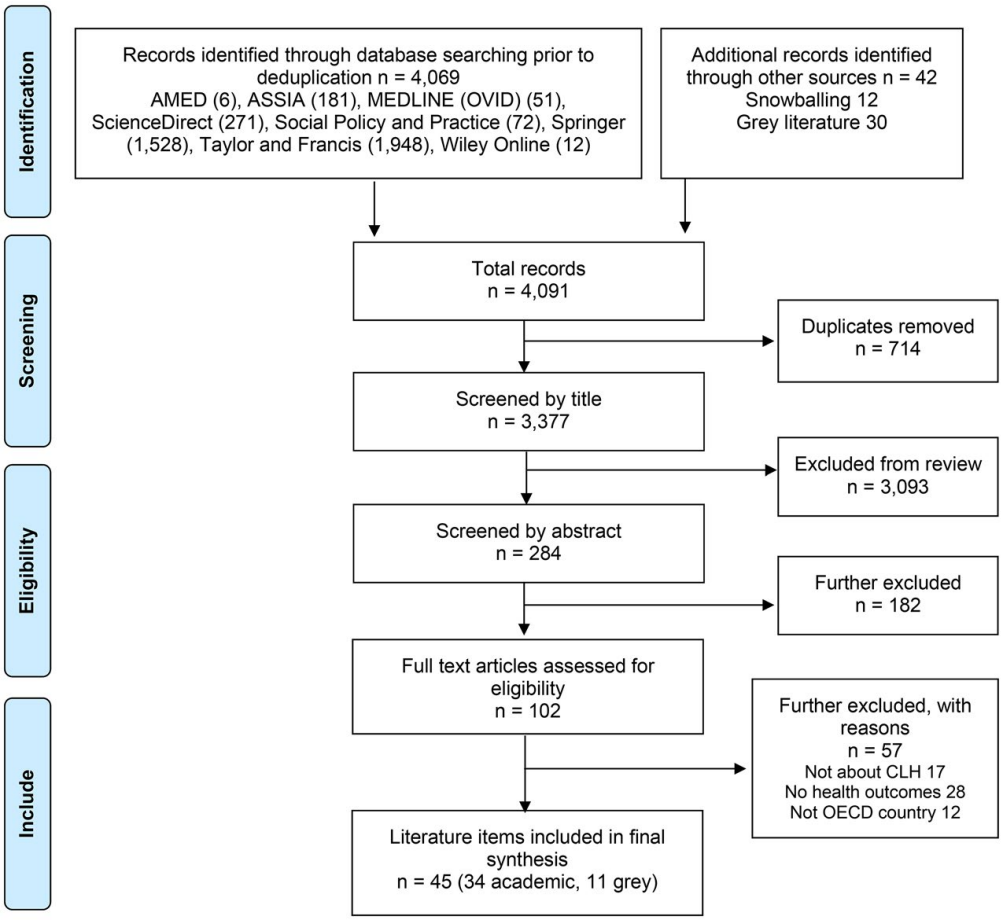

Figure 1. Flow diagram showing search results, and literature selection process. Community Led housing, health and wellbeing: a Comprehensive literature review, 2023.

As the search also included grey literature, the quality assessment AACODS checklist was used to rate the quality of these literature items, in line with previous systematic reviews containing grey literature (Tyndall, 2010). This tool was selected for its ability to assess a range of literature types, and as it is recommended by the National Institute for Health and Care Excellence (NICE, 2014). The tool has been recommended for rating the methodological quality of literature based on construct validity and acceptable content. The tool consists of six quality assessment domains: Authority; Accuracy; Coverage; Objectivity; Date; and Significance.

The quality of included literature was assessed by McClatchey, with 10% (selected using a random number generator) of the literature independently assessed by McClymont to check for consistency. The authors did not exclude literature on the basis of quality, and we provide a commentary on the type and quality of the literature included in this review in the Discussion section.

Table 2. Characteristics and findings of included academic literature (n = 34).

Reference	Model of CLH	Location	Funding model	Type of study	Case study no.	Methods
Bresson & Labit (2019)	Community led housing	France	Various	Qualitative	10	Semi-structured interviews, focus groups, site visits
Clever Elephant (2019)	Community led housing	UK	Unclear	Qualitative	22	Semi-structured interviews and survey
Coele (2014)	Cohousing	UK	Resident funded	Qualitative	1	Autoethnography
CSBA & UWE (2016)	Self-build	UK	Housing association	Qualitative	1	Interviews
Czischke & Huisman (2018)	Community led housing	Netherlands	Government funded	Qualitative	1	Semi-structured interviews, observations, document review (project website, policy documents, newspaper articles, and audio-visual material)
Dang & Seemann (2020)	Community led housing	Germany	Unclear	Mixed methods Quantitative (cross-sectional), Qualitative	1	Document review, interviews, and survey

(*Continued*)

Table 2. (Continued).

Reference	Model of CLH	Location	Funding model	Type of study	Case study no.	Methods
Garciano (2011)	Cohousing	USA	Private cohousing architect firm and private non-profit developer rental units	Qualitative	1	Interviews
Glass (2009)	Cohousing	USA	Various	Mixed method Quantitative (cross-sectional, longitudinal 3 years) Qualitative	1	In-depth interviews, survey
Glass (2012)	Cohousing	USA	Private; Part government funded	Mixed methods Quantitative (cross-sectional, longitudinal 2 years,) Qualitative	3	In-depth interviews
Glass (2013)	Cohousing	USA	Privately owned and subsidised rented units	Mixed methods Quantitative (cross-sectional, longitudinal 3 years) Qualitative	1	Interviews, survey and participant observation
Glass (2016)	Cohousing	USA	Rented units	Quantitative (cross-sectional)	3	Survey

Reference	Participants	N and target population	Negative impacts	Positive impacts
Bresson & Labit (2019)	Residents, prospective residents, developers, housing associations, local authorities, architects	33	Unclear impacts on most vulnerable residents	Social inclusion
Clever Elephant (2019)	Residents, prospective residents, providers	53 residents or prospective residents, 14 staff from providers	N/A	Improved skills; improved mental well-being; increased confidence; better physical health; affordability; less loneliness; greater community feeling
Coele (2014)	Resident	1 (older person with a disability)	Can be hard to have privacy	Benefits for older people and people with a disability; ability to maintain independence

CSBA & UWE (2016)	Resident self-builders	10 (ex-Service Personnel who have encountered alcohol or drug dependency)	N/A	Improved diet during self-build process; physical activity from labour of process; social integration with other self-builders; sense of learning and achievement; supports vulnerable parts of population (ex-service personnel)
Czischke & Huisman (2018)	Residents and members of housing co-operation	Refugee	N/A	Refugee residents experience social integration and support
Dang & Seemann (2020)	Residents or 'experts' (interviews), general population (survey)	6 interviews, 524 survey responses	N/A	Sense of community; environmental sustainability and energy efficiency; affordability, especially for disadvantaged groups; inclusion and diversity
Garciano (2011)	Prospective residents, developers and architects	Unclear	Limited diversity, including socio-economic background, ethnicity, and language	Improved relationship to food and healthy eating, e.g. organic garden, healthy eating initiatives, common meals; improved connections to wider community, e.g. cultural events
Glass (2009)	Residents	33 (elderly)	N/A	Inclusion of communal facilities, such as a common house where meals can be shared. Neighbours for help with household and care; sense of community
Glass (2012)	Residents	58 survey responses, 25 interviews (elderly)	N/A	Majority had good physical and mental health and it remained the same a year later living in the cohousing
Glass (2013)	Residents	43 (elderly)	Lack of privacy	Improved social connections and support; maintained independence and reduced need for external development and satisfaction of a sense of community; increase in physical activity as a result of residents mutually encouraging each other to exercise
Glass (2016)	Residents	59 (elderly)	N/A	Self-reported high levels of physical and mental health; high reported levels of social cohesion and support

(Continued)

Table 2. (Continued).

Reference	Model of CLH	Location	Funding model	Type of study	Case study no.	Methods
Glass and Vander Plaats (2013)	Cohousing	USA	N/A	Mixed methods Quantitative (cross-sectional) in 2012, Qualitative in 2009	1	In-depth interviews, survey
Hackett et al. (2018)	Community land trust	USA	Privately and publicly funded	Mixed methods Quantitative (cross-sectional), Qualitative	1	Datasets from time of purchase and property stock, and survey (at two time points)
Jarvis (2015)	Cohousing	UK, USA, Australia	Unclear	Qualitative	15	Interviews, oral histories, observations, archival data
Kehl and Then (2013)	Cohousing	Germany	Privately and publicly funded	Mixed methods Quantitative (cross-sectional with control), Qualitative	5	Interviews and survey
Labit (2015)	Cohousing	Germany, Sweden and UK	Germany, Sweden: co-operative and municipal England: privately owner or rented	Qualitative	5	Semi-structured interviews, participants observation and photographic record
Labit and Dubost (2016)	Cohousing	France and Germany	Private	Qualitative	2	Semi-structured interviews
Lang and Novy (2014)	Co-operative	Austria	Public, private, co-operatively funded	Mixed methods Quantitative (cross-sectional with control), Qualitative	8	Interviews and survey

Markle et al. (2015)	Cohousing	USA	Shared ownership	Mixed methods - Quantitative (cross-sectional with control) Qualitative	1	Semi-structured interview and survey
Martin et al. (2019)	Community land trust	USA	Co-operatively funded	Qualitative	4	Interviews
Izuhara et al. (2021)	Community led housing	UK	Co-operatively funded	Mixed methods Quantitative (cross-sectional), Qualitative	18	In-depth interviews and survey
Pedersen (2015)	Cohousing	Denmark	Various	Mixed method Quantitative (cross-sectional) Qualitative	26	In-depth interviews, and survey

Reference	Participants	N and target population	Negative impacts	Positive impacts
Glass and Vander Plaats (2013)	Residents	26 interviews, 31 survey responses (elderly)	N/A	Increased social support; reduced isolation; sense of security
Hackett et al. (2018)	CLT homeowners	Data on 204 individuals, and 91 unique survey responses	N/A	Improved affordability, especially for low- to moderate-income households; secure; social and shared values; sustainable housing
Jarvis (2015)	Residents	38 digitally recorded interviews (with individuals, couples and small groups)	N/A	Empowerment and increased engagement in governance of home; social cohesion and support; sustainability and low carbon lifestyles
Kehl and Then (2013)	Residents	313 program group; 428 control group	N/A	Reduced need for outside care; improved social connections
Labit (2015)	Residents	30	N/A	Strong sense of solidarity; self-reported healthy ageing

(*Continued*)

Table 2. (Continued).

Reference	Participants	N and target population	Negative impacts	Positive impacts
Labit and Dubost (2016)	Residents	10 Cologne; 8 Berlin	N/A	Older people received care and felt more secure in their homes; younger residents had access to affordable housing
Lang and Novy (2014)	Residents, housing managers	547 interviews	N/A	Professional co-operative structures give residents a voice and improve social cohesion
Markle et al. (2015)	Residents and people registered as interested in cohousing	60 living in cohousing; 65 not living in cohousing survey responses 10 interviews	N/A	Cohousing residents received more social support than non-residents; better relationships with neighbours; greater sense of security
Martin et al. (2019)	CLT staff, other non-profit and funding agency staff, public officials, and residents of land trusts	124 interviews	N/A	Improved affordability, and reduced financial stress, particularly for low income residents; stability and sense of security
Izuhara et al. (2021)	Residents	18 survey responses, 10 interviews	Negotiated the use of shared spaces; many restricted themselves to individual household use of communal space on a pre-arranged basis, to avoid interaction	Improved relationship to food and healthy eating; improved social interactions and sense of community, emotional support; shared social care for elderly or unwell
Pedersen (2015)	Residents	643 survey responses, 19 interviews (elderly)	N/A	Increased social support; increased sense of security; physical exercise in common areas; common meals

Table 2. (Continued).

Reference	Model of CLH	Location	Funding model	Type of study	Case study no.	Methods
Rosenberg (2012)	Tenant management organisation	UK	Community owned housing association	Qualitative	1	In-depth interviews
Ruiu (2015)	Cohousing	UK	Private and housing association	Qualitative	1	Semi-structured interviews and cognitive maps
Ruiu (2016)	Cohousing	UK	Various	Qualitative	1	Interviews, observation and cognitive maps
Sanguinetti (2014)	Cohousing	USA	Various	Mixed methods Quantitative (cross-sectional), Qualitative	127	Survey
Scanlon and Arrigoitia (2015)	Cohousing	UK	Housing association, shared equity	Qualitative	1	Semi-structured interviews, and observation (3 years)
Scanlon et al. (2021)	Community led housing	UK	Various	Mixed methods Quantitative (cross-sectional with control), Qualitative	5 case studies, compared to general population control survey	Survey, interviews, focus group, site visits. Control group from the annual Community Life Survey
Schneider (2022)	Community land trust	USA	Publicly funded, shared equity	Quantitative (cross-sectional with control)	2	Survey and administrative data

(Continued)

Table 2. (Continued).

Reference	Participants	N and target population	Negative impacts	Positive impacts		
Theriaut et al. (2010)	Co-operative	Canada	Part government funded	Mixed methods Quantitative (cross-sectional), Qualitative	2	Semi-structured interviews and survey
Van den Berg et al. (2021)	Self-build	Netherlands	Unclear	Quantitative (retrospective case control)	25	Survey
Wang et al. (2021)	Cohousing	UK	Unclear	Qualitative	8	Semi-structured interviews
Warner et al. (2022)	Cohousing	Australia	Unclear	Qualitative	1	Semi-structured interviews and focus groups
Weeks et al. (2019)	Cohousing	Canada	Various	Qualitative	7	Semi-structured interviews

Reference	Participants	N and target population	Negative impacts	Positive impacts
Rosenberg (2012)	Residents	156	More likely to feel unsafe in the dark and show a lesser degree of trust in their neighbours	Residents reported higher levels of social connectedness than reported in comparative area; resident control improved collective wellbeing
Ruiu (2015)	Residents	18	N/A	High levels of affordable housing; greater social support; greater sense of security; self-build process built strong sense of belonging

Reference	Participants	N and target population	Negative impacts	Positive impacts
Ruiu (2016)	Residents	23 interviews	N/A	Sense of belonging; improved social connections; common dinners; building social capital
Sanguinetti (2014)	Residents	477 survey responses	Did not seem to have much effect on connection to nature	Cohousing residents reported higher levels of social connectedness and connection to community
Scanlon and Arrigoitia (2015)	Residents, housing association staff	Unclear (elderly)	Greater risk and uncertainty in build process; new cohousing not necessarily cheaper than conventional new-build (longer to construct)	Encourages active and preventive ageing
Scanlon et al. (2021)	Residents	221 survey responses, 1 focus group (expert roundtable)	N/A	Reduced loneliness and provided social networks; volunteering and neighbourhood connections
Schneider (2022)	CLT owners, and market homeowners for 3 control groups	494	Limits wealth accumulation for populations most in need: those with low incomes, people of colour, and female-headed households	Improved financial well-being; increased housing stability and security; increased autonomy and quality of life

(*Continued*)

Table 2. (Continued).

Reference	Participants	N and target population	Negative impacts	Positive impacts
Theriault et al. (2010)	Residents	43	N/A	Improved relationship to food and healthy eating; improved financial stability; increased self-confidence; able to live in better neighbourhood
Van den Berg et al. (2021)	Resident self-builders, residents of conventionally built homes (19 control areas)	326 (elderly)	N/A	Directly related to neighbourhood social cohesion and lower feelings of social loneliness; indirect effect on social satisfaction; these positive relationships hold while controlling for personal and household characteristics
Wang et al. (2021)	Cohousing group members, architects	24	N/A	Social contact; reduced loneliness; better mental health and well-being; older people had support from others when physical decline means they are less able to look after their own property; safe environment and sense of security; sustainable living, reduced food purchase, joint travel, sustainable technologies, energy efficiency, design standards, and construction methods and materials; affordability, especially for low income populations
Warner et al. (2022)	Potential residents, community group	2 focus groups (each of 5 participants), 6 interviews (elderly)	N/A	Sense of security; affordability; meets diverse needs; supportive community with shared values and interests; access to amenities in the immediate environment; benefits, particularly for low-income residents
Weeks et al. (2019)	Knowledgeable of completed, or in-development cohousing	7	Not seen as affordable	Older people received care and felt more secure in their homes; improved social connections, reduced loneliness, enhances friendships and mutual support

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Table 3. Characteristics and findings of included grey literature (n = 11).

Reference	Model of CLH	Location	Funding model	Type of grey literature	Case study no.	Methods
Archer (2009)	Self-help	UK	N/A	Briefing paper	N/A	N/A
Devlin et al. (2015)	Cohousing	UK	Resident funded	Report	1	Architects report and comments from residents
Fernandez et al. (2018)	Cohousing	UK	N/A	Workshop and research reflections	N/A	Learning day with members cohousing communities
Heslop (2017)	Self-build	UK	Charity and local government	Book chapter	1	Interviews and participatory research approach
Joseph Rowntree Foundation (2013)	Cohousing	Germany, Denmark and the Netherlands	N/A	Report	N/A	2 events, lessons learned
Lubik and Kosatsky (2019)	Community led housing	Canada	N/A	Commentary	N/A	N/A
Moore and McKee (2012)	Community land trust	UK and USA	Housing association, publicly funded, shared equity	Policy review	N/A	N/A
Mullins (2018)	Self-help	UK	N/A	Policy review	N/A	N/A
New Economics Foundation (2018)	Community led housing	UK	N/A	Blog	3	N/A
Prasad (2019)	Cohousing	Denmark	N/A	Report (fellowship)	1	Case study and site visit
Stevens (2016)	Community led housing	UK	N/A	Report	8	Case studies

(*Continued*)

Table 3. (Continued).

Reference	Model of CLH	Location	Funding model	Type of grey literature	Case study no.	Methods				
				Quality Appraisal (AACODS)						
Reference	Target population	Negative health links	Positive health links	A	A	C	O	D	S	Overall
Archer (2009)	N/A	N/A	Increased confidence and skills; healthy food, e.g. food co-operatives; filling gaps in public services e.g. informal care provided by neighbours to older people, or peer support sessions for those suffering a certain health condition; atmosphere of safety and neighbourliness	**N**	**Y**	**Y**	**N**	**Y**	**Y**	**4**
Devlin et al. (2015)	Architects, residents, housing association staff	N/A	Beneficial for older people	Y	Y	Y	Y	Y	Y	6
Fernandez et al. (2018)	Residents	N/A	Physical and mental wellbeing of older people; increased social connections and mutual support; increased sense of agency	Y	N	Y	Y	Y	Y	5
Heslop (2017)	Self-builders and key support staff, for people who have or are at risk of experiencing homelessness	N/A	Participant empowerment and confidence building; improved social connections	Y	N	N	Y	Y	Y	4

Reference	Model of CLH	Location	Funding model	Type of grey literature	Case study no.	Methods				
Joseph Rowntree Foundation (2013)	Unclear	N/A	Improved physical and mental health for older people; ability to maintain independence	Y	Y	Y	N	Y	Y	5
Lubik and Kosatsky (2019)	N/A	May not benefit everyone, it takes time to form social bonds and a few studies have demonstrated that some residents opt out of communal living in less than a year, citing either too much or not enough social planning/ interaction	Social inclusion; higher perceived levels of wellbeing; supportive environment for older people to age in place, with neighbours' help allowing residents to remain in their homes longer; greater affordability	Y	Y	Y	Y	Y	Y	6
Moore and McKee (2012)	N/A	Those with the time and affluence to engage in civic action benefit, while marginalised populations remain on the fringes	Scope to empower and build community resilience; affordable housing	Y	Y	Y	Y	Y	Y	6

(*Continued*)

Reference	Model of CLH	Location	Funding model	Type of grey literature	Case study no.	Methods				
Mullins (2018)	N/A	N/A	Improved skills and work experience which led to better employment opportunities; improved mental health	Y	Y	Y	Y	Y	Y	6
New Economics Foundation (2018)	N/A	N/A	Delivers affordable homes	Y	N	Y	Y	Y	Y	5
Prasad (2019)	Residents	N/A	Improved social connections and reduced loneliness for older people	N	N	Y	N	Y	Y	3
Stevens (2016)	Older people, Learning Disabilities	N/A	Mutual care and support for many older people; control and retaining their independence and feeling secure; enhanced well-being; combining voluntary help and assistance with care, e.g.. for those with Learning Disabilities	Y	N	Y	Y	Y	N	4

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Figure 2. Number of literature items reporting associations between community Led housing and positive and negative impacts on primary health outcomes, secondary housing factor outcomes, and health inequalities. Community Led housing, health and wellbeing: a Comprehensive literature review, 2023.

Data synthesis

Given the heterogeneity in the study design, study populations, measurements, and outcomes, the authors developed a narrative synthesis of the results. For each piece of literature, the authors summarised the study characteristics and described the positive and negative associations observed between CLH and health (see Tables 2 and 3). Key topics were identified in each paper (see Figure 2), and these were then refined to clusters, which are presented and discussed below. The authors then organised the findings under the original primary and secondary outcome headings, with an additional cluster emerging on health inequalities.

Results

Study characteristics

The rate of publication of literature ranged throughout the included period, with the majority (53%) being published between 2015 and

2019. The UK (40%), followed by the US (25%) were the most common geographical locations of studies. Australia, Austria, Canada, Denmark, France, Germany, the Netherlands and Sweden also had literature identified.

The majority of literature focussed on a single form of CLH, with only nine (20%) of studies including all or multiple forms of CLH. Cohousing was the most commonly studied type of CLH, accounting for 24 (53%) of included studies. The number of CLH cases within a study ranged from one to 127, with most literature items (61%) including multiple case studies. Across all included literature, there was a total of 284 CLH cases examined.

All of the literature included residents or prospective residents of CLH as study participants. In addition, some studies included developers, architects, housing association staff, local authorities, and community groups. There were at least 5,240 participants across all included literature, with a further two studies where the total sample size was unclear.

Key themes

Findings consistently showed positive associations between all forms of CLH and a range of health impacts, with a very small number reporting negative health impacts (see Figure 2 and Tables 2 and 3). This applied to primary outcomes (health and wellbeing) and secondary outcomes (risk factors at building and neighbourhood level), largely regardless of country or CLH housing type.

Primary outcomes: health and wellbeing

Physical health.

There were a number of studies that referenced a positive relationship between CLH and physical health, and no studies which identified physical health harms. The relationship between CLH and physical health was expressed through increased physical activity ($n = 4$), and healthy eating behaviours ($n = 8$).

Glass (2013) reported an increase in physical activity as a result of residents encouraging each other to exercise. Additionally, in the CSBA and UWE's (2016) study of a community self-help project, the residents reported increased levels of physical fitness as a result of the labour involved in constructing their homes.

Glass (2009), Theriault et al. (2010), Ruiu (2016), CSBA and UWE (2016), and Izuhara et al. (2021), all suggested that living in a CLH project contributed towards improved relationships to food and healthier eating habits. The participants reported that their involvement in the project

led to them collectively cooking and eating more nutritious meals. Garciano (2011) also identified that opportunities for organic gardening, joining healthy eating initiatives, and regular common meals all contributed.

Mental health and wellbeing

Housing and mental health are closely linked, with evidence linking a range of housing factors to stress, anxiety and depression, sleep disorders, and relationship difficulties (Ige et al., 2019; WHO, 2018). The majority of included literature reporting on mental health outcomes identified positive impacts ($n = 12$). All of these reported on wellbeing as the outcome, with one study also suggesting that CLH led to feelings of increased confidence (Dang & Seemann, 2020). Conversely a small number of studies did identify negative impacts on wellbeing ($n = 2$), reporting that residents found it hard to have privacy (Coele, 2014; Glass, 2013). None of the studies have identified links to diagnosed mental health conditions.

COVID-19

One study (Izuhara et al., 2021) specifically considered the health impacts of CLH through the COVID-19 pandemic. They found that there were ambiguous definitions of 'households' associated with CLH communities when interpreting the lockdown rules to provide mutual aid and support, and that many communities restricted themselves to individual household use of communal space on a pre-arranged basis, to avoid interaction. Others found significant evidence of mutual support among CLH members both in practical terms but also in terms of social contact (Scanlon et al., 2021).

Secondary outcomes: risk factors at building and neighbourhood level

Five risk factors at the neighbourhood level through which CLH impacts on health were identified, all of which were psychosocial factors. No risk factors at the building level (such as ventilation and space), or through direct exposures (such as cold or air pollutants) were identified.

Social contact

By far the greatest impact identified in the literature was on social contact, with 33 literature items reporting positive impacts. Evidence shows social contact and environments which are supportive of this has short and long-term effects on health, including health behaviours, and mental and physical health outcomes (Bird et al., 2018; Umberson & Montez,

2010; WHO, 2018). Studies suggested that CLH led to increased feelings of belonging, inclusion, and less loneliness, and that these positive findings remained whilst controlling for personal and household characteristics (Clever Elephant, 2019; Dang & Seemann, 2020; Ruiu, 2016; Van den Berg et al., 2021). Participants of CLH felt a strong sense of community, for example through new social networks, enhanced relationships with neighbours, volunteering, or cultural events (Garciano, 2011; Glass, 2009; Sanguinetti, 2014; Scanlon et al., 2021). Support with day-to-day tasks such as cooking, informal childcare and gardening, provided increased social capital (Garciano, 2011). The sharing of responsibilities and resources in cohousing contributed to what Jarvis (2015) identified as group solidarity. Lang and Novy (2014) found that professional co-operative structures give residents a voice, and improve social cohesion and residents' sense of autonomy.

Conversely a small number of studies did identify negative impacts on social inclusion ($n = 3$). Garciano (2011) found limited diversity of the cohousing resident population, in terms of socioeconomic background, ethnicity, and language. For example, even when interested in participating, low-income residents, who often need to work in multiple jobs, had little time and energy to invest in the wider community. Similarly Lubik and Kosatsky (2019) found a few studies have demonstrated that some residents opt out of communal living in less than a year, citing either too much or not enough social interaction.

Affordability

Affordable housing has been linked to better health, especially for vulnerable groups (including adults with intellectual disability or chronic conditions, substance users, and people experiencing homelessness) through engagement with health services, reduced stress, reduced overcrowding, and more income being available to support health and well-being through spending on healthy food, utilities, and healthcare, therefore, leading to improved mental and physical health (Bird et al., 2018; WHO, 2018).

There is an assumption in policy discourse that CLH is an affordable model of housing. However, as CLH does not follow a single funding or governance structure; the extent to which this is true varies across the type of CLH, the context within which they exist, and whether the initial build or ongoing lifecycle of the housing is being considered. 13 literature items found that CLH could produce affordable housing, with four of these discussing all forms of CLH, four specifically referencing CLTs, and a further four on cohousing. This was compared to three literature items which found the contrary, two of which questioned the affordability of cohousing, and one on CLTs.

Self-help housing may reduce the costs of external builders and contractors, and co-operatives or CLTs may cross-subsidise, acquire grants, or partner with housing associations or local authorities making the initial build process affordable. (Clever Elephant, 2019; Dang & Seemann, 2020; Hackett et al., 2018; Martin et al., 2019). Cohousing may enable resident households to benefit from substantial increases in housing equity (Labit & Dubost, 2016; Ruiu, 2015; Wang et al., 2021), whilst co-operatives, and CLTs can explicitly limit such accumulation in order to preserve ongoing affordability (Schneider, 2022). Scanlon and Arrigoitia (2015) reported greater risk and uncertainty in the build process, and often lengthier construction times, meaning new cohousing was not necessarily cheaper than conventional new builds. Similarly, Weeks et al. (2019) found that due to the shared costs of common areas, the overall cost per owner is not reduced compared to conventional builds, and that residents were not able to identify any funding to support the costs of development, building or the ongoing operation of cohousing.

Employment

Four studies found that being involved in CLH led to greater employment prospects, which in turn brings beneficial health impacts, especially for vulnerable groups such as people experiencing homelessness, and leads to improved mental and physical health outcomes (Bird et al., 2018; WHO, 2018). Mullins (2018) found self-help communities gave participants new skills and work experience, which in turn led to greater employment prospects.

Safety

Seven studies found CLH created an environment which felt safe and gave residents a sense of security. Perception of safety has been linked to better health, especially for low-income groups, in part through physical activity, leading to improved mental and physical health outcomes (Bird et al., 2018). However, Rosenberg (2012) found residents of a TMO were more likely to feel unsafe being out after dark and showed a lesser degree of trust in their neighbours than those in non-community housing.

Environmental sustainability

Lastly, studies found CLH supported environmentally sustainable living ($n=4$). Climate change is inextricably linked with health outcomes (WHO, 2018), for example, energy efficient homes have been linked to better health, leading to improved mental and physical health outcomes, especially reduced asthma (Bird et al., 2018). Wang et al. (2021) specified mechanisms, including reduced food purchase, joint travel, sustainable technologies, and energy efficiency design, construction methods and materials.

Health inequalities

32 literature items included consideration of the impact of CLH on health inequalities, which ranged across protected characteristics, vulnerable population groups and socioeconomic considerations.

14 literature items focussed on a particular population sub-group, with elderly (aged 50 years or older) people accounting for 11 of these. A further 10 literature items, which did not target a specific sub-population, also acknowledged positive impacts on the health of older people. Cohousing has been suggested to maintain independence and support ageing in place, delaying or mitigating the need for people to move into care homes (Kehl & Then, 2013; Lubik & Kosatsky, 2019). Glass (2009) found that in cohousing residents were able to support older people in the community with social care, rather than being dependent on family members, and that this took place outside traditional working hours. Social care generally referred to support with shopping, cooking, and companionship, and did not extend to personal care tasks such as bathing, dressing and toileting (Izuhara et al., 2021). However, it was noted that cohousing provided an opportunity to house overnight assistants, or to exchange accommodation for personal care from trained professionals (Coele, 2014). Labit and Dubost (2016) found that intergenerational community housing projects in France and Germany reduced health and social care costs both to individuals and the state. Additionally, a small body of literature discussed the wider benefits of designing communities with older people in mind, such as adapting physical design features to ensure they are accessible to residents throughout the ageing process (Glass, 2013, 2016).

Other sub-groups included people who have a disability (Coele, 2014; Stevens, 2016), have experienced homelessness (Heslop, 2017), drug or alcohol dependency (CSBA & UWE, 2016), and refugees (Czischke & Huisman, 2018). The main themes in these studies was that CLH can promote inclusion and independence for vulnerable sub-populations. For example, studies suggested that less hierarchical structures of care giving and receiving contributed to improved quality of life for people living within the community with a learning disability (Stevens, 2016) or physical disability (Coele, 2014). Homeless veterans who had encountered alcohol or drug dependency reported that the self-build gave them a sense of achievement, increased confidence and a sense of trust (CSBA & UWE, 2016). Lastly, Czischke and Huisman (2018) studied a single CLH project, which provided homes for 565 refugee and Dutch people between the ages of 18 and 27. Living in the CLH community provided residents with access to education, employment opportunities and social connections. The findings suggest that the housing project is successful in supporting the integration of refugees into Dutch society.

Many studies discussed here have found CLH benefited socioeconomically deprived groups (Dang & Seemann, 2020; Wang et al., 2021; Warner et al., 2022), however given the heterogeneity in funding and governance structures of CLH it is difficult to draw conclusions. Some studies have observed

unequal access to CLH and limited diversity within the resident populations, with people from disadvantaged backgrounds appearing to have fewer opportunities to access CLH and thus less chance to benefit from potential positive health effects (Garciano, 2011; Lubik & Kosatsky, 2019; Moore & McKee, 2012; Schneider, 2022). Therefore, there is a possibility that CLH could have the undesirable effect of leading to increased health inequalities if consideration is not given to access of this form of housing.

Schneider (2022) conducted a large cross-sectional study which found that CLTs were associated with improved financial wellbeing and increased housing stability. However, the study also proposed that CLTs may limit wealth accumulation for those populations most in need of acquiring wealth: those with low incomes, people from Black, Asian and minority ethnic backgrounds, and female-headed households.

Discussion

In this review the majority of included literature was academic, consisting of observational studies using mainly qualitative or mixed method. These research methods cannot prove causality, nevertheless our findings demonstrate an emerging picture of largely positive links between both the primary outcome (health), and the secondary outcomes (psychosocial housing factors). CLH may be particularly beneficial for people with support needs. The findings warrant further assessment by researchers as set out below.

Evaluating CLH more rigorously could establish stronger links between CLH and health, thereby encouraging public and private investors, policymakers, as well as potentially interested residents worldwide, to consider this model of housing as a means of improving public health.

Strengths and limitations

A key strength of this review is the robustness and rigour of the methods applied. Our systematic approach to collating and assessing the quality of existing evidence against building and neighbourhood features as well as primary health outcomes has enabled the identification of knowledge and research gaps, from an emergent evidence base, on the complex link between CLH and health.

Grey literature and non-experimental studies are at greater risk of bias. The grey literature included in the synthesis comprised seven items of high quality (ACCODS score of 5 or 6), four items of moderate quality (ACCODS score of 3 or 4) and no items of low quality (ACCODS score of 2 or less). Generally items scored lower for being from potentially biased sources, such as third sector organisations promoting CLH, or for having unclear aims or parameters which define their content coverage, so may report only on the most extreme findings. It is not recommended to report scores

with the quality assessment MMAT, so the most noteworthy limitations of included academic literature are described below (Hong et al., 2018).

Many studies in this review either did not adequately report recruitment methods, or encountered challenges with recruitment. For example, Theriault et al. (2010) attempted random recruitment but a low acceptance rate meant they had to widen their approach. Glass (2016) use a convenience sample at a CLH dinner hall, where not everyone participated. It is possible that those most supportive of CLH were more likely to participate. Thus selection bias may have occurred. Some studies provided little information regarding who carried out the research, and few studies have quantitatively assessed health outcomes, with the majority that did using small scale surveys. The majority of studies rely on self-reported data to measure behaviours and practices among CLH residents. Therefore, studies may be affected by social desirability bias or inaccurate recall by participants. The exceptions are Hackett et al. (2018) who linked datasets from time of purchase and property stock with a survey, and Schneider (2022) who included administrative data. Thus response bias may have occurred. Publication bias may be present if literature about CLH that showed neutral or negative results were less likely to have been submitted or accepted for publication.

We found six studies that drew comparisons between CLH and non-community housing (Kehl & Then, 2013; Lang & Novy, 2014; Markle et al., 2015; Scanlon et al., 2021; Schneider, 2022; Van den Berg et al., 2021). All but one (i.e., Schneider, 2022), identified only positive health impacts, which remained when controlling for confounders. These generally included age, sex, marital status, education level, language, and ethnicity, with Van den Berg et al. (2021) additionally including household composition, income, car ownership, employment status, home-ownership, club or organisation memberships, participation in voluntary work and neighbourhood density. Van den Berg et al. (2021) used Structured Equation Modelling, which allowed them to analyse confounding and mediating pathways, and to incorporate both latent variables and observed variables.

Across included studies, participants tended to be middle aged and older, and often older than the control groups, and whilst there were intergenerational studies, none of them explicitly assessed health outcomes in children and young people. Kehl and Then (2013) found people aged 66–89 years accounted for approximately half of the participants in the programme group. Similarly, Scanlon et al. (2021) identified the highest number of participants in the cohort aged 60–69 years. The mean age of programme group participants was 43.7 years (Schneider, 2022), or 70.51 years (Van den Berg et al., 2021). Lang and Novy (2014) noted across study groups 67–75% of included households had no children in them, and 68% of participants in the programme group were aged over 50 years. This raises concerns about the generalisability of findings to other age groups.

Lastly, only three studies were longitudinal, carried out at repeated intervals over a period of two (Glass, 2012) or three years (Glass, 2009, 2013). This mean reverse causality cannot be discounted, and it may be that individuals with higher wellbeing or physical activity are more likely to self-select to participate in CLH.

A final limitation of this review was the decision to focus on papers from OECD countries. While results still included evidence from a range of countries where CLH is common, it is possible that evidence from other contexts, including developing countries where CLH is also increasingly being used as a form of housing delivery (CAHF, 2022), may offer alternative insights. For example, some favelas in Brazil are built and often self-managed by residents with community led forms of governance. However as they are not formal developments and may not have government support, they can face problems with safety and difficulties accessing services, such as sanitation and transport, and hence findings may be less positive.

Implications for researchers

There is a promising trajectory of research on the health impacts of CLH, with an increasing number of studies using mixed or quantitative methods in recent years, enabling them to control for confounding factors. The New Economics Foundation (2018) has been developing a Social Return on Investment analysis for a CLH scheme, and further economic studies would be useful to quantify the health costs and benefits of CLH. Although it is unlikely to be possible or appropriate to undertake an experimental approach, such as a randomised controlled trial, larger scale longitudinal studies would be plausible, enabling reverse causality to be ruled out. It would also be recommendable to incorporate residential mobility in subsequent studies.

Literature was heavily weighted towards cohousing ($n = 24$, 53% of included studies). The CLH sector tends to imagine groups of people being involved in developing long-term communities. However, temporary or short-term communities were important in this review—community housing for refugees and asylum seekers, and temporary communities for people experiencing homelessness are a small but important subsector of CLH which has been significantly under-examined to date. Given that the CLT movement is growing and adapting rapidly worldwide, future research is needed to understand the scope and opportunities for these models to contribute to resident health outcomes.

This review reveals many research gaps, where outcomes from CLH are not known, including primary health outcomes (e.g., respiratory, cardiovascular and infectious diseases, diabetes, injuries, and mental health conditions), and risk factors in the physical environment (e.g., mould, temperature, air pollutants, noise, and hazards). Future research on these

outcomes would strengthen the evidence base. Also, the current evidence base is mostly reliant on subjective findings from surveys or interviews. Exceptions include Hackett et al. (2018) and Schneider (2022) who use time of purchase/property stock, and administrative datasets respectively. Tracking objective impacts resulting from CLH on health is needed. Further observational studies with data linkage (e.g., to hospital health records) would be beneficial.

In particular, we report a significant gap in research with children and young people in CLH. There is little known about the demographics of people living in CLTs (Moore & McKee, 2012). Research has shown young children spend even more time at home than adults, so are especially vulnerable to health impacts of housing (WHO, 2018). Thus more research is needed, and a targeted descriptive or qualitative study would help evaluate the impact of CLH on younger age groups. Lastly, the impact on health inequalities is complex and not yet fully understood, and more research is needed on at scale access to CLH, especially for those living in more deprived circumstances.

Implications for policy makers

The findings from our review are relevant to policymakers from any country where there is a growing use of, or interest in, CLH. As for any housing delivery approach, there are advantages and disadvantages. CLH has, in the past, been viewed as complex and inefficient for delivering at scale or offering a good return on investment. However, this review indicates that CLH offers a potential route to delivering environmentally sustainable, socially inclusive housing, that can help meet people's support needs. However, it is not a ready-made solution to the 'housing crisis', and the points around definitions and different types of CLH discussed in this paper need to be borne in mind if policymakers are to take forward any of the findings of this review, particularly relating to affordability.

There are potential actions policy makers could take to better enable CLH as a form of housing delivery, and to further explore its potentially beneficial impacts on health and wellbeing. At a national level this might include:

- Raising the profile of CLH through conferences, events, communication strategies, country specific guides for planners or prospective residents, or awards, e.g., CLH awards projects spanning France, Indonesia and El Salvador (World Habitat, 2023).
- Providing dedicated and long-term financial support (through grants or loans), particularly for project-specific pre-development activities, such as becoming a registered group, securing a site, and having initial plans approved, e.g., UK's CLH fund (Homes England, 2021).
- Including explicit guidance on the role of different sorts of CLH in a range of national policies (e.g., spatial planning, affordable

housing and community services), and set expectations for local governments to incorporate CLH quotas into local placemaking strategies.
- Developing partnerships with other key stakeholders, such as investors, housebuilders and Registered Social Landlords to consider how aspects of CLH which relate to health and wellbeing can be best incorporated into their schemes.
- Setting-up networks to provide support to emerging groups, such as guidance, toolkits, peer-to-peer support and mentoring. This could be on a global (e.g., CoHabit Network, 2023), countrywide, regional or local (Community Led Homes, 2023) scale.

Conclusion

To our knowledge, this systematic review provides the first overview of the evidence of associations between all forms of CLH and impacts on health, wellbeing and health inequalities. Findings show CLH is associated with largely positive health impacts, including increased physical activity, healthy eating, and wellbeing. It is also positively associated with psychosocial housing factors which are known to be beneficial for health, including social contact, affordability, employment potential, safety, and environmental sustainability. Due to the varied funding and governance models, there are uncertainties over whether all forms of CLH provide a route to affordable housing, particularly regarding cohousing. The impacts of CLH on health inequalities is not yet fully known. Whilst CLH appears particularly beneficial for certain sub-groups, such as people with support needs, more research is needed on access to CLH, especially for those living in more deprived circumstances.

The review reveals a significant research gap, with very little research on the impacts of CLH on children and young people. Additional studies on forms of CLH other than cohousing, primary health outcomes and physical environment factors would strengthen the evidence base, along with larger scale longitudinal studies, which use objective measures such as linked datasets.

These findings provide an indication of the impact from community housing arrangements on health, which warrants further assessment by housing researchers, and indicates the importance of policies and actions to support this form of housing delivery to housing practitioners and policy makers.

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No potential conflict of interest was reported by the authors.

Ethics

No ethics approval was sought or required as all papers are available in the public domain.

Social media summary

International review finds a range of community led housing models support positive health and wellbeing outcomes.

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#4 Private Rented Sector Housing

Local government approaches to improving the health and wellbeing of tenants in private rented housing: developing initial program theory to inform evaluation in the United Kingdom

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Abstract
Background
Housing is an important wider determinant of health, and of inequalities in health. Private Rented Sector (PRS) housing is generally the worst quality of housing stock across tenures. Although a wide range of approaches are available to local governments to manage and improve the quality of PRS housing and therefore the health of tenants, there is limited evidence about the extent to which these are used, and what factors affect local governments in doing so. This study, the first realist evaluation conducted on this topic, aims to better understand these approaches and factors.

Methods
The early iteration of initial programme theories (IPTs) were informed by a Local Government Association toolkit. Consistent with realist approaches, retroductive analysis of context-mechanism-outcome configurations helped to refine and develop the

initial programme theories. Data sources included a review of housing documents, survey and eleven semi-structured interviews with housing officers.

Results
Using data for 22 out of the 30 local governments in the South West region of the United Kingdom, seven Initial Programme Theories (IPTs) were developed across three aspects; Local Housing Market, Philosophy, and Structure of the Local Government. The findings suggest that limited objective health outcomes are being used to understand impact, which hinders interpretation of the effectiveness of all mechanisms.

Conclusion
The approaches that bring about a positive outcome in managing Private Rented Sector housing are unlikely to be universal; they depend on the context which differs across place and over time. This highlights the need for strategies to be tailored considering the local context.

Keywords
Private Rented Housing; public health; realist evaluation; causal mechanisms; Local Government

Introduction

There is extensive evidence demonstrating the importance of housing as a wider determinant of health, and of inequalities in health (Gibson *et al*. 2011; WHO, 2018). There are interlinking pathways through which housing impacts on numerous health outcomes including cardiorespiratory diseases, infectious diseases, injuries, allergies and mental health conditions (DCLG, 2006; Gibson *et al.* 2011; Ige *et al.* 2020; WHO, 2018). Despite a substantial evidence base showing which features of housing are beneficial or harmful to health, 1.6 billion people, or 20 per cent of the world's population, live in inadequate, crowded and unsafe housing (Woetzel *et al.* 2014). This has significant implications on occupants lives and for wider health and social care systems. In the United Kingdom (UK), it is estimated that the National Health Service (NHS) spends £2.5billion/year on housing and health-related conditions (e.g., primary care visits, prescriptions, and hospital treatment), and £18.5billion/year on wider societal costs, such as those relating to care (Garrett *et al.* 2021). This suggests that the quality of people's housing has a similar impact on health as does smoking (£2.3-3.3billion/year) or alcohol consumption (£3.2billion/year) (Nicol *et al.* 2015).

Private Rented Sector (PRS) housing is generally the worst quality of housing stock across tenures. For example, in England, 14% of all homes are classified as non-decent; and this figure rises to 23% in the PRS (DLUHC, 2022a). In Australia, 9% of homes owned outright had a major structural problem, rising to 17% in PRS housing (Australian Bureau of Statistics, 2022). Studies have reported that people living in PRS housing are more likely to experience poor mental health, have higher levels of a stress biomarker, faster epigenetic ageing, and show higher mortality rates compared to homeowners (Clair & Hughes, 2019; Clair *et al*, 2023). Explanations for this include issues relating to affordability, landlord/tenant relationships and tenure insecurity (Harris & McKee, 2021). The proportion of households which are rented varies internationally, from 5% in Romania to 58% in Switzerland (Eurostat, 2021). In recent years the PRS has experienced significant growth in some countries, doubling over 20 years, from 10% of British households in 2000, to 19% in 2021/22 (DLUHC, 2022a). Tenancy lengths are increasing and families with children are remaining in the sector for longer periods (Harris & McKee, 2021).

To respond to these challenges and improve the quality of PRS housing, the Renters (Reform) Bill was introduced to the UK Parliament on 17 May 2023. Key proposals include scrapping Section 21 'No Fault' evictions and improving local government's ability to enforce against criminal landlords by introducing mandated landlord registration via a Property Portal. The Bill also confirmed plans to apply the Decent Homes Standard

to the PRS in England and provide local councils with a broader range of powers to ensure compliance. However, local authorities face significant challenges in implementing the law effectively in practice, and approaches to regulating the sector vary significantly between different local authorities (Harris et al, 2020).
In the PRS in England, a wide range of approaches are available to local governments to manage and improve the quality of PRS housing and therefore the health of tenants. Available interventions often involve multiple parties (such as tenants, landlords and housing officers), will occur across diverse policy and funding landscapes, and can lead to wide-ranging outcomes (Gibb & Marsh, 2019). However, there is limited evidence on the extent to which available approaches are used, and what factors affect local governments in doing so. Recent evidence reviews on housing and health inequalities concluded that there is an urgent need for research to explore effective approaches in the PRS (Munro *et al.* 2022), which takes a holistic approach and can understand the causal pathways to outcomes (Gibson *et al.* 2011).

Realist methodology is becoming an increasingly popular way to synthesise complex public health interventions as it allows a greater theoretical understanding of the intervention process, rather than simply deducing whether an intervention is effective or not. The realist position is that research needs to focus on 'what works, for whom, in what circumstances' (Pawson & Tilley, 1997).

To our knowledge there are no previous realist studies on delivering PRS housing and health. Rolfe *et al.* (2020) used a realist approach, but this was to understand how housing acts as a determinant of health, rather than how healthier housing can be delivered in practice. Therefore, this study uses a realist evaluation, to understand what drives different approaches in different local governments in the hope of better understanding and informing local policies, programs and interventions.

Aim

This study describes the development of initial programme theories (IPTs) to provide insight into the factors that influence local government approaches to managing the quality of PRS housing and therefore the health and wellbeing of tenants.

Set in the South West (SW) region of the UK, these IPTs should be evaluated in subsequent phases of study, to inform the development of local government approaches to improve tenants' health across the UK and beyond.

Methods

Initial Programme Theories

A realist approach allows evaluators to draw on a range of data sources to identify the important mechanisms and contextual factors that contribute to whether and how outcomes are achieved. These are captured in context-mechanism-outcome configurations (CMOCs) (Pawson & Tilley, 1997). Together, the CMOCs make up a programme theory, which highlights the configurations needed for an approach to work.

The development of IPTs for realist evaluation can occur through a variety of approaches including: realist synthesis of existing literature, further development of an existing program theory, qualitative research (such as, program documentation review, interviews, etc) and/or through the experiential or professional knowledge of the research team (Wong *et al.* 2016; Flynn *et al.* 2020).

Given the nascent nature of the realist evidence base on housing and health (Rolfe et al. (2020), the latter two approaches have been adopted in this study. The mechanisms that underpin this study were initially developed based on the Local Government Association 'Improving the PRS: A toolkit for councils' (LGA toolkit), which is a comprehensive collation of mechanisms available to local governments to improve the quality of PRS housing (LGA, 2020). Table 1 shows how the IPTs were produced in phases, following the approach set out by Gilmore *et al.* (2019).

Table 1. Summary of steps to develop and refine Initial Programme Theories (IPTs)

Stage of consultation	Source of expertise	Date
Early iteration of preliminary IPTs	Local Government Association 'Improving the PRS: A toolkit for councils' (LGA, 2020), housing documents and after five of the eleven interviews had been completed	October - November 2022
Discussion of IPTs	Research team	November 2022
Refinement following analysis of document, survey and interview data	Housing documents, survey and all eleven interviews	November 2022 – March 2023
IPTs finalised for testing	Research team	April 2023

Recruitment and setting

The SW region was chosen as the setting because the PRS as a proportion of the overall housing stock is similar in the SW (19.4%) to the England average (19.5%) making it representative (DLUHC, 2022a). There is a mixture or rural and urban localities, and a mixture of local government structures (single-tier and two-tiers) to facilitate the exploration of different contexts.

In September 2022, using contacts from the research teams' professional networks, a personalised email was sent to the PRS team leader in each single-tier and all districts within two-tier local authorities (as housing teams exist in each lower-tier local authority (LTLAs)) in the SW to complete an online survey (Gov.uk, 2021). In addition, each single-tier LTLA and a single district within each two-tier authority, were invited to take part in an interview by email and/or phone. Purposive sampling of which district to approach was based on the research team's professional experience of where there were examples of innovative work in the PRS.

Data collection

Three data sources collected between October and November 2022 were included: a survey, semi-structured in-depth interviews and a review of local government housing documents.

A survey, based on the LGA toolkit (LGA, 2020), was redesigned and abbreviated in Qualtrics software by the research team (Additional File 1). Whilst data on the LTLA respondents job grade and title was collected, individual survey respondents remained anonymous. Multiple responses from the same LTLA were encouraged to assess differences in responses between different cadre of staff.

An interview topic guide was developed to explore survey questions in-depth, with a particular focus on elucidating information on enablers and limitations in the use of different mechanisms. Questions addressing each theme in the LGA toolkit were included: evidence base, policy and policy making, resources, governance, partnerships, consumer regulation, and emerging issues (LGA, 2020) (Additional File 2). A pilot interview was conducted with a PRS team leader from a LTLA external to the SW. As per realist methodology, the topic guide was reviewed and updated with the research team after the first interviews (Wong *et al.* 2016; Gilmore *et al.* 2019). Each interview was recorded (video and audio) on Microsoft Teams. The automatic transcript was reviewed and cleaned immediately following the interview.

Housing documents (of any type, tenure, date) were downloaded from LTLA websites or requested from interviewees. These were summarised by type and date in Excel (Version 2210 16.0.1) with sections of text referring to strategic aims and action plans.

This spreadsheet was then uploaded and coded in Nvivo. Additional housing information on webpages only were excluded.

Data sources

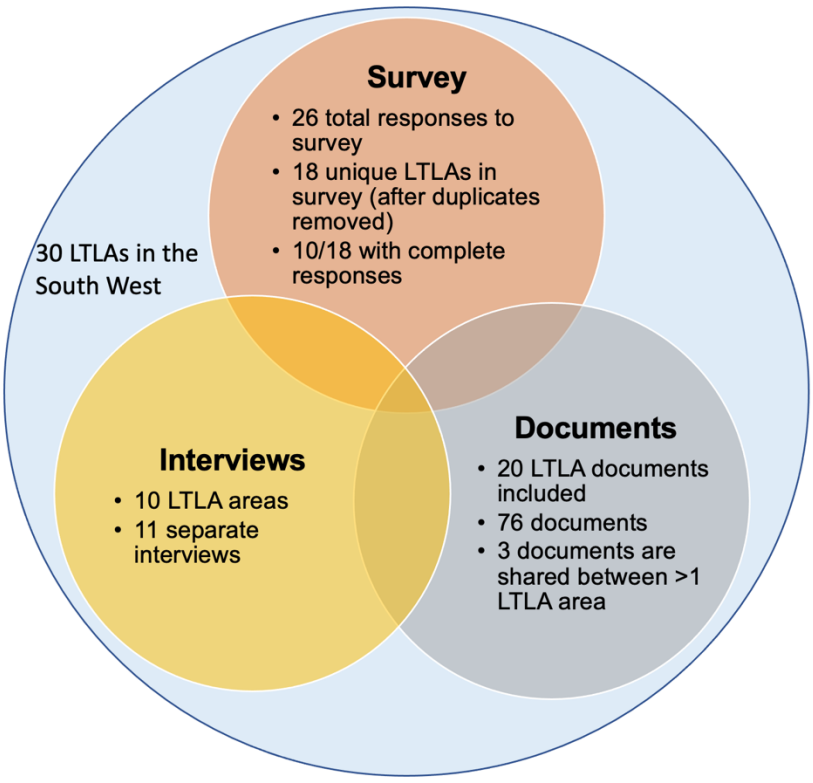
A total of 26 survey responses from 18 unique LTLAs were received. LTLA duplicates were reviewed and the least complete response removed. Notable discrepancies existed between duplicate responses from different cadre of staff from Enforcement Officer, PRS team leader to Head of Environmental Health, where estimates of the number of full-time equivalent (FTE) staff working on the PRS varied five-fold. 10/18 survey respondents answered all or nearly all questions within the survey with notable drop-off following Q3.6 (Additional File 1).

76 documents were included from 20 LTLAs, including at least one district from each two-tier local government. The main types of documents were housing strategies (n=36), enforcement policies, housing stock and other evidence reports, strategic action plans, and guides for tenants and landlords. The housing strategies for each LTLA varied from overall strategies to more specific topics such as PRS, homelessness prevention (most common), social housing or accommodation with care and support. Timeframes for strategies varied with the majority of LTLAs having at least one housing strategy in-date (up to or including 2022).

Eleven interviews were conducted with ten unique LTLAs; one LTLA had a second interview with the same interviewee due to not completing the topic guide questions within the initial allotted hour. A single co-author (CFF) attended all interviews and conducted 10/11, whilst LD attended 8/11 and conducted one. Eight interviewees were Private Sector or PRS team leaders and two were PRS enforcement officers. The interviews were conducted with 4/18 ‘predominantly rural’, 4/9 ‘predominantly urban’ and 2/3 ‘urban with significant rural’ LTLAs.

Of the 30 LTLAs, 22 had at least one data source included in the study and six were represented by all three sources (Figure 1).

Figure 1. Summary of data sources included in evaluation



Data analysis

Prior to coding, all transcripts, survey responses, and documents were read to gain a contextual understanding of the data. Survey data were exported from Qualtrics, cleaned, and merged with national Census data to generate a complete list of 30 LTLAs in the SW, including their three-fold Rural Urban Classification (DEFRA, 2021). The number of PRS households ("private landlord or letting agency" or "other private rented") and total households were downloaded from the 2021 Census (ONS, 2023). Graphs were produced in Microsoft Excel.

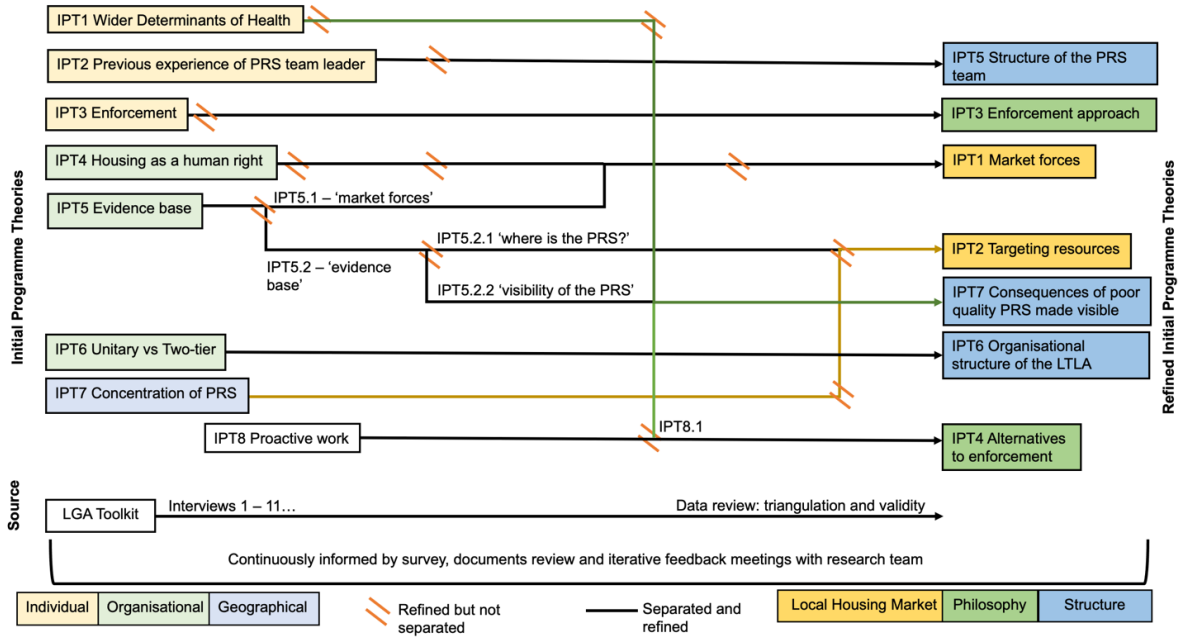
All data were imported into Nvivo (v20.6 QSR International) to be coded. Each piece of data was stored as an individual file and each row of the survey generated a 'case' for all 30 LTLAs. Relevant interview and documents for that LTLA were added as sub-folders to this case, and coding of each case was aggregated from 'children'.

Consistent with realist approaches, data analysis was retroductive (Wong *et al.* 2016). The themes in the LGA toolkit were used as initial deductive mechanism codes, but further inductive contexts and mechanisms were coded when observed in the data. All analysis in NVivo was completed by CFF with reflective notes from ET to aid interpretation of the data. Initial familiarisation with the data was conducted by comparing contexts and mechanisms between LTLAs to look for patterns and evidence of IPTs. A memo was developed for each preliminary IPT using the template described by Gilmore *et al.* (2019) so that each time an observable "context-mechanism-outcome" was found in the data source, this was re-coded and linked to the relevant IPT and the following headings of the memo were reviewed: context, mechanism, outcome, potential CMOC, supports/ refutes/ refines, how/ why/ decision-making process, links to other IPTs and additional notes. Refinement of IPTs occurred as additional data sources were coded and linked to the associated memos and where appropriate IPTs were merged to produce a final version of IPTs. The preliminary IPTs are in Additional File 3, with the final refined IPTs presented below, grouped into three overall categories for ease of communicating the findings.

Testing and refinement of IPTs

The seven preliminary IPTs were refined, separated and re-aligned to produce seven new versions, which are categorised into three overall aspects; Local Housing Market, Philosophy and Structure (Tables 2, 3, 4) (Figure 2).

Figure 2. Initial Programme Theory refinement process



Further exploration of how the IPTs were refined and developed is explored in the results section below.

Ethics and rigor

Ethics approval for this study was granted by Health and Applied Science Research Ethics Committee at UWE; Reference number HAS.22.06.128 on 15th July 2022. Informed consent was obtained from all subjects. An anonymous survey ID was generated to link survey data with interviewee respondents. All data was stored securely and only accessible by members of the research team.

To evidence transparency and rigor in the research approach, the RAMESES II reporting standards checklist has been completed (Wong *et al.* 2016) (Additional File 4).

Results

This section commences with a discussion of the PRS housing market and the structure of the PRS team working in each LTLA. It then presents seven IPTs and describes how their earlier iterations were refined, separated and re-aligned to provide a nuanced view of the different mechanisms and associative conditions which underpin local authority approaches to regulating the PRS within specific contexts. These IPTs were categorised into three overarching themes which are addressed in turn below: local housing market, philosophy and structure.

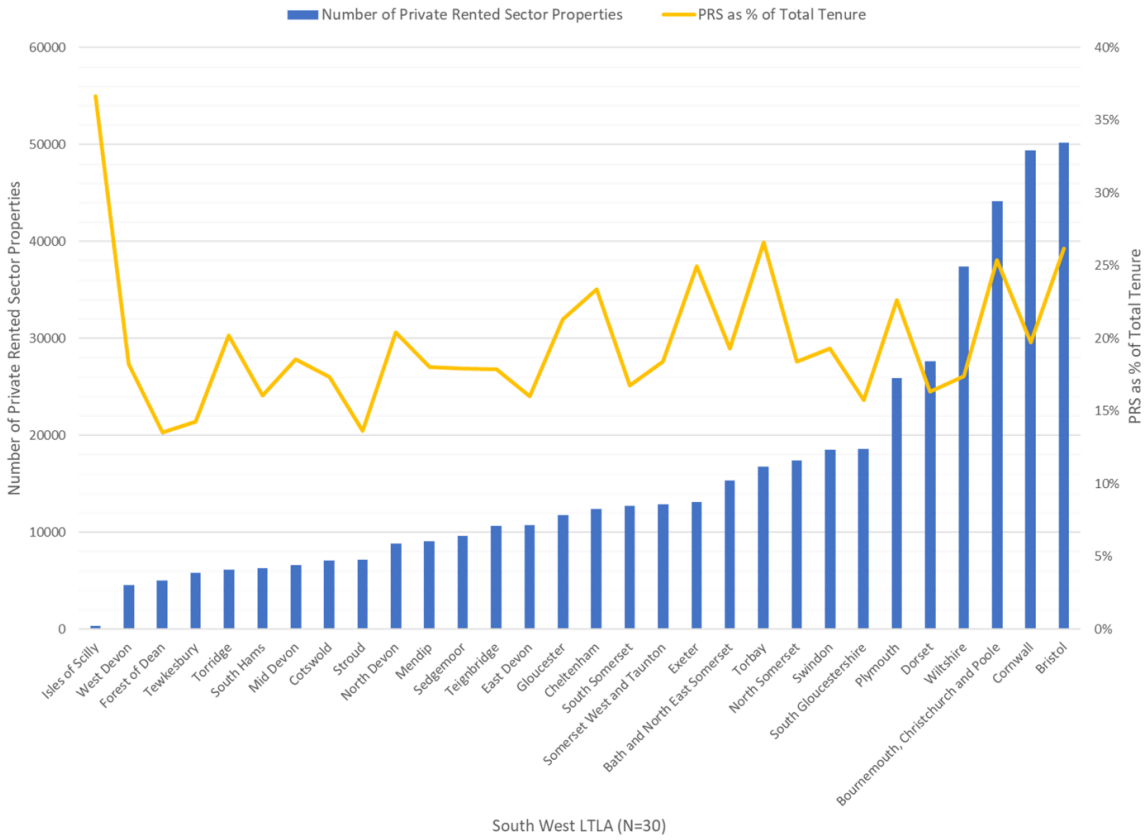
A key overarching finding is that there is a lack of objective outcomes being used to understand the nature and extent of impact of different mechanisms. There was evidence of softer outcomes such as improved relationships with colleagues, landlords, and tenants, and process measures using performance data such as the number of notices served, but the translation of this into positive impacts on PRS quality or health outcomes was absent. This hinders interpretation of the effectiveness of mechanisms in improving tenant health and wellbeing.

Characteristics of PRS teams and stock

There was variation across the SW in number of PRS properties and PRS housing as a proportion of total housing (Figure 3).

Of the 10 LTLAs with complete surveys; the number of FTE staff working on the PRS varied from 4 to 40, and the number of PRS properties per FTE staff varied from 479 to 2880, with a median of 2121, which is in-line with national figures (Battersby, 2018). There was no clear association between percentage of PRS stock and PRS to staff ratio. The 10 interviews were conducted in LTLAs with medium to large numbers of PRS properties and medium PRS to staff ratios.

Figure 3. Number and proportion of Private Rented Sector properties by local government



Theme 1: Local housing market

The findings provide insight into the ways which local housing markets influence the development and operation of local authority approaches to regulating the sector.

Table 2: Contexts, mechanisms, and outcomes within identified Initial Programme Theories (IPT): Local Housing Market

IPT#	Context (C)	Mechanism (M)	Outcome (O)
IPT1: Market forces			
	• Increased demand on housing supply • Cost of Living crisis • Refugee resettlement programmes and asylum seeker dispersal accommodation • Awareness of wider housing crisis and market forces influencing landlords' decision to stay in the sector	• PRS team works with housing options, homelessness prevention, housing development teams re supply • Escalate concerns about PRS market to senior leaders • PRS team highlight impact legislation has on PRS market • Maintain the balance of market forces	• PRS is key component of local housing supply to reduce risk of homelessness • Availability and affordability of housing

	• Awareness of the negative health and wellbeing consequences of experiencing homelessness	• Provide clear messaging about legislation • Restrict enforcement to prevent market failure	
IPT2: Targeting resources			
	• PRS concentrated in areas of deprivation • High student populations • Innovative use of data to find the PRS • Information governance and data quality issues • Hidden, more dispersed PRS properties in rural areas	In areas of high PRS concentration: • Targeted mechanisms with majority of landlords • Proactive work with landlords, tenants and other agencies • Reach threshold to introduce selective or additional licensing • Easier to use data to highlight areas of need • Political support to overcome information governance and poor data quality barriers In areas of dispersed PRS: • More reliant on complaint-led enforcement activities	• Facilitates improvements in PRS when concentrated in certain areas • Target certain areas • Find individual PRS properties more easily • Reveal greater need to improve quality in the PRS

IPT1 Market Forces | *Refinement of preliminary IPT4/ 5.1 to IPT1*
The first IPT captures how, housing officers understand their role in the PRS in the context of the wider housing crisis and want to improve standards without having a deleterious effect on the PRS market. PRS team leaders escalate their views to senior leaders about the importance of the PRS in relation to housing availability and affordability, particularly Houses in Multiple Occupation (HMOs). They also work closely with the housing options and development teams to improve housing supply and increase the visibility of capacity and issues within the PRS.

Whilst highlighting the links between housing and health was felt to be important, access to housing was rarely framed as a human right [IPT4]. Original aspects of IPT5 relating to the market forces within the PRS were combined with PRS team leader's determination to reduce homelessness by improving supply within the PRS and avoiding Section 21 evictions or rent increases. There is evidence that PRS team leaders escalate concerns around housing supply to senior leaders and local politicians who also consider market forces when making decisions.

"If the Article 4 prevents unused houses or suitable houses being let as multiple accommodation, then that is an area that is blocking the opportunities that are available to help give move on accommodation for people". [Participant 3]

Some participants suggested changes in legislation has forced landlords out of the sector, and has led to an increased number of Airbnb's. Others felt there is no evidence of market failure and there remains competition for landlords to deliver a reasonable service.

The PRS team see their role as providing clear messages to landlords about local enforcement approaches but are conscious of setting thresholds which do not inadvertently drive them out, especially accidental or smaller portfolio landlords for whom profit margins may be tighter and inadvertent non-compliance more common.

Enforcement may improve the worst quality housing within the PRS but many team leaders are also conscious that it may result in rent increases being passed onto tenants, resulting in increased risk of homelessness for the most vulnerable.

IPT2 Targeting resources | *Refinement of preliminary IPT5.2.1/ IPT7 to IPT2*
IPT2 captures how the overall quality of PRS will improve through targeted mechanisms if PRS properties are concentrated in certain areas, for example in inner city areas of deprivation. This is because it is easier to find rented properties and apply innovative data approaches to highlight areas of greatest need. This enables the PRS team to use alternative activities to enforcement with universities, landlord forums or students directly in those areas [IPT4] or improving enforcement by introducing selective or additional licensing in areas meeting certain criteria [IPT3].

The original IPT5 split into two aspects. 'Where is the PRS?' [IPT5.2.1] merged with the concentration of PRS in certain areas [IPT7] allowing teams to better understand their local PRS market and target resources. One participant strongly felt that the dispersed nature of their small PRS stock in a large rural area limited the use of additional data or non-enforcement activities to find and improve the PRS, leaving them solely reliant on complaint-led enforcement.

Several LTLAs were trying to merge datasets such as council tax, parking penalties, and Energy Performance Certificates (EPCs), to identify PRS properties and prioritise the poorest quality ones for improvements.

"There's a drive within the Council to try and identify, digitally identify their customers, and in place to where they are and who they are for, how they can then engage with them productively... so they're working hard to cross match various data sets using algorithms probably to predict whether something's PRS or not". [Participant 5]

Whilst many PRS team leaders could identify geographical areas of concern, sometimes based on stock model estimates or deprivation data, very few used population health data to target resources. The innovative use of data has been limited by poor data quality, challenges with data merging, and limited staff skills and capacity for data analysis. One interviewee reported hesitation to use data, due to the potential risk in revealing ongoing gaps and high demand for improvements, with limited resource to meet this demand. However, adopting these data mechanisms and targeting resources at areas with a high concentration of PRS properties may leave greater capacity within the team to use enforcement with the few poorest performing landlords that require it.

Theme 2: Philosophy of local government
The findings suggest that an array of factors associated with the philosophy of local government influences approaches to governing the sector, particularly in relation to the adoption of formal or informal mechanisms.

Table 3. Contexts, mechanisms, and outcomes within identified Initial Programme Theories (IPT): Philosophy of the Local Government

IPT#	Context (C)	Mechanism (M)	Outcome (O)
IPT3: Enforcement approach			
3	• Political support for hard enforcement • PRS team leader previous experience	• Hard enforcement dominant activities • Maintaining professional	• Improvements in the worst quality PRS

	• Complex legislation • Resource limitation • Poor training of housing officers • Understanding limitation of enforcement-activities • Certain types of properties are more difficult to apply legislation effectively	relationships and boundaries as an enforcement agency • Regulatory partnerships to increase enforcement and referrals • Multi-agency partnership increase proactive and targeted enforcement activities	• Slow improvements through resource-intensive mechanisms
IPT4: Alternatives to enforcement			
4	• Limits of hard enforcement recognised • 'Silent' tenants disempowered to complain	• Landlord forums, registration schemes, star-rating • Building trust and mutual benefits • Education and engagement • Community-based activities • Tenant-focused education and support • Building partnership working based on clear evidence of links between housing and health • Referral of individual tenants who require support with health needs from other agencies	• Collaborative approaches to improving the PRS • Only engages the 'good' landlords • Improved pathways and referral mechanisms to respond to individual tenants' needs

IPT3 Enforcement approach | *Refinement of preliminary IPT3 to IPT3*
IPT3 captures the factors which contribute to the adoption of hard or soft enforcement approaches. If there is strong local political support for prioritising a hard enforcement approach, then this will be the main mechanism to improve quality by quoting their 'statutory duty' to improve standards or assess risks. This emphasis on formal enforcement was often influenced by previous experience of the PRS team leader and/or local political support. Where there is an acknowledgement of the limits of enforcement activities some LTLAs also invest in and prioritise alternatives to enforcement [PT4].

Three LTLAs reported taking a harder approach to enforcement than in the past, one specified taking a softer approach, and the remaining were not explicit. Opinions varied as to whether hard enforcement was effective. Some LTLAs believed it encourages compliance and more efficient ways of working, whilst others felt it improved awareness but resulted in an increased work-load. Current enforcement legislation is complex, costly and time-consuming to enforce, so often only the worst quality housing is improved to a minimum standard. The efficiency of hard enforcement is also limited by difficulties in recruiting, training and retaining quality staff who can apply the full range of legislation effectively alongside alternative to enforcement activities [IPT4].

"...it's diluting the quality I think of officers to do the work… It's used to be a very long, arduous journey to become a competent housing regulatory officer. Now people seem to

think you could do a training course for two days and you're competent and it causes delays in actually progressing cases, understanding diagnosing issues correctly... So I think more legislation will mean quicker training courses, more people thinking they could become qualified and actually not really bringing about that change that's needed, but it will help absorb all the low-level enquiries that's for sure but I think we don't need any more regulation, just better regulation". [Participant 6]

All areas were reliant on complaint-led reactive enforcement. A few areas also used regulatory and/or multi-agency collaborations to proactively identify problem-areas resulting in more enforcement activities. This proactive approach was enabled by meaningful partnerships and shared awareness of the consequences of poor PRS [IPT7] but was limited by resources and poor use of innovative and/or merged data.

"So, we're probably very much like other enforcement officers or agencies where we're in a position where actually a lot of the time we're just firefighting. So we'll get complaints in and we'll deal with them, and as and when, we do try to take a more proactive approach." [Participant 2]

The original IPT3 considered the difference between applying minimum standards and the risk-based Housing Health and Safety Rating System (HHSRS) approach. Whilst the pros and cons of each were often discussed there was little consensus on which was preferable. There was concern that new standards would be set too low to make a meaningful improvement to PRS stock but that the current complexity of the HHSRS prevented landlords' compliance and efficient enforcement.

There are certain types of properties within the PRS where enforcement regulation is more difficult to apply e.g. caravans, Airbnb's or holiday accommodation acting as HMOs and guardianship schemes.

IPT4 Alternatives to enforcement | *Refinement of preliminary IPT8 to IPT4*
This IPT captures PRS teams' efforts to improve the PRS through non-enforcement activities by working with landlords, tenants and other partners. This is associated with an acknowledgement of the limitations of enforcement activities to improve standards in the PRS, either due to insufficient resources or due to the nature of vulnerable 'silent' tenants who are disempowered to complain. The focus here is on building trust and mutually beneficial working arrangements shared with local landlords and sub-regional strategic partnerships. Specific approaches include improving education and engagement, sharing good practice, supporting tenant groups, introducing landlord forums, accreditation schemes or star-rating systems, and establishing referral pathways between partners. Examples of educational activities include providing tenant and community resources on council websites, YouTube or social media about the links between housing and health, how to reduce the risk of damp and mould, and information about rights and responsibilities.

This IPT did not feature in its own IPT originally so during coding, IPT8, labelled 'proactive work', was produced. There was separation of this into staff training which facilitated referral of individuals [IPT8.1] and other proactive partnership working which raised the visibility of consequences of poor quality PRS [IPT5.2.2]. The term 'consumer regulation' in the LGA toolkit which refers to non-enforcement activities to improve housing quality was not a term which was well understood by participants. However, it became apparent during interviews that several areas were adopting approaches in addition to, and in recognition of, the limitations of enforcement activities. Given that certain enforcement activities can be proactive, this IPT was renamed as 'alternatives to enforcement' to aid interpretation.

Given the limitation of objective outcome measures, the reported outcomes of this approach are mixed. Some areas have long-established landlord forums which are effective in collaboratively working to improve quality and pre-empt issues and potential

impacts from new legislation or housing developments. It allows signposting of financial grants, used as incentives to landlords to support local councils by providing accommodation to vulnerable tenants who may otherwise be facing homelessness. However, some LTLAs did not believe these approaches were effective because they only reach already engaged landlords and diverted resources away from enforcement activities which may improve quality in the worst PRS stock.

"It's [housing strategy] mainly focused on landlords within the private rented sector to try to incentivise those improvements and link it with a referral scheme that they will take tenants from our homelessness service". [Participant 10]

Alternatives to enforcement approaches depended not only on meaningful partnership working but also on making the links between housing and health explicitly visible [IPT7]. Partnership working may improve opportunities for training and cross-departmental secondment of jobs, sharing of grants between partners and referrals between organisations.

If partner organisations have appropriate information governance data sharing arrangements in place, then individual tenants in need of housing adaptions or improvements, or with specific health needs can be referred between partners. Several LTLAs reported the existence of these referral pathways, which included occupational health, social care, fire and rescue services, and fuel poverty/retrofit teams. There were fewer examples of referrals to other council departments, and no participants reported referral pathways with primary care or hospitals. Referrals rely on housing officers being trained and empowered to detect health needs of tenants they visit and know who to signpost to and how. It also depends on adequate resource within the PRS team for implementing referrals, and, visibility of the PRS to other agencies/services.

"Housing advice teams, they may notify us if somebody's been illegally evicted and then we can take that case on if they've been found rough sleeping somewhere". [Participant 8]

"...you know we're going into people's homes majority of the time and actually it's really hard for us to sometimes identify if people do have health needs". [Participant 1]

Theme 3: Structure of local government

The findings show that key factors relating to the structure of local government affect the application and outcomes of local authority enforcement in the sector. Practices relating to making poor housing visible were also key determining factors.

Table 4. Contexts, mechanisms, and outcomes within identified Initial Programme Theories (IPT): Structure of the Local Government

IPT #	Context (C)	Mechanism (M)	Outcome (O)
IPT5: Structure of PRS team			
5	• New team leader • Temporary contracts • Reduced core funding for decent salaries within PRS team • Meaningful partnership working • Information governance arrangements for data sharing	• Brings experience of a certain way of working • Dependent on short-term grant funding for salary	• Opportunity to change direction of LTLA approach to enforcement • Opportunity to bring in external funding to PRS team • Instability in core staffing in PRS team

	• Two-tiers add complexity to referral pathways • Clear understanding on links between housing and health • Clear referral pathways • Strong training of housing officers		
IPT6: Organisational structure of LTLA			
6	• Unitary vs Two-tier authorities • Large vs small size of authority • Resource capacity within teams	• Reduced complexity in partnership working within unitary authority • Capacity within team to do horizon scanning, grant applications and non-enforcement activities • Alignment of enforcement approaches following merging of smaller teams • Partnership building based on relationships and making clear links between housing and health	• Structure of council impacts on ease of partnership working but less certain impact on outcomes
IPT7: Consequences of poor quality PRS made visible			
7	• Clear understanding on links between housing and health, particularly for vulnerable tenants • Clear understanding on links between poor housing and wider societal issues • Clear understanding on links between appropriately adapted housing for elderly tenants or those with disabilities living in the PRS and health	• Improves strategic vision and visibility of the PRS team • Increase partnership working on PRS • Targeting of resources to the worst areas/properties • Clear information about links between housing and health on council resources • Awareness of insecurity of tenure limiting complaint-led enforcement activity • Increases investment in home adaptation	• Increased visibility of the link between housing, health and inequalities • Increased focus on improving the quality of the PRS and supporting the most vulnerable • Increased focus on improving existing housing quality as solution to other wider societal issues • Overall reduction in social care costs by investing in adaption of current stock

IPT5 Structure of PRS team | *Refinement of preliminary IPT2 to IPT5*
This IPT captures how the structure of the PRS team influences the approach adopted. It was created by adding greater detail to original IPT2. It demonstrates how, if a new PRS team leader is employed with a different background to the local team, for instance having worked with a hard enforcement approach (often from a London borough), then this presents an opportunity for the LTLA to change strategic direction in the way it conducts enforcement [IPT3].

"...so that was when I came in to post... I think it was the relationship really with landlords that we had, it was very much probably outside of the professional boundaries that should be there. So, it was about pulling that back in and knowing that to some degree or another we are an enforcing authority". [Participant 1]

There is some evidence of insufficient funding to offer competitive salaries and recruit to permanent positions within PRS teams. If team leaders are contracted on a temporary basis, then there may be more incentive for them to find external funding streams for their own salary. Sufficient funding relies on visibility of PRS teams across local government and may depend on whether the team is meeting their statutory duty in responding to complaints [IPT4].

There was no apparent association between the prioritisation of non-enforcement activities [IPT4] and the adoption of a hard or soft approach [IPT3] and where the PRS team sits; either alongside or separate to the rest of the housing department, or within Regulatory Services or the Adult/ Community Directorate. Several councils had experience of changing their internal structures to move toward either a soft or a hard approach, and there was no evidence of consistent impacts from this.

IPT6 Organisational structure of LTLA | *Refinement of preliminary IPT6 to IPT6*
This IPT captures how, if a LTLA is a unitary authority, partnership working is easier when geographical footprints match those of their external partners. This is because there are fewer housing teams attempting to communicate with external partners and governance of data sharing is easier within the same organisation. If a LTLA is large, or the PRS team operate across a larger footprint, they may have more capacity to do horizon scanning, grant applications and non-enforcement activities [IPT4], and wider council services such as digital innovation, communications and staff training are more accessible [IPT7].

The premise of IPT6 remains similar to the original version. Several LTLAs had experience of recently becoming unitary authorities from previous two-tier structures. Alignment of enforcement philosophies is often required following merging. Wider council services such as digital innovation, communications and staff training are more accessible in larger local governments, but challenges were noted around knowledge of, and access to services. Despite frustrations about the inefficiency of two-tier systems, there is evidence of good partnership working overcoming these barriers [IPT7].

IPT7 Consequences of poor quality PRS made visible | *Refinement of IPT5, via IPT 5.2.2 and merging with IPT1 and IPT8, to IPT7*
The final IPT captures, how, if there is good local understanding and visibility of the links between poor quality PRS housing and health inequalities, then improvements in the PRS are more likely. This is because the impact on the most vulnerable tenants are explicitly known and widely understood throughout the council. If the potential costs of not improving the PRS stock to address wider local issues are made visible, then this incentivises improvements in the PRS. This is because the increased visibility of poor quality PRS drives strategic vision and investment in the PRS team and wider partnership working, allows targeting of the worst properties, and encourages clear information on council documents and websites.

Good local understanding of the links between poor quality PRS housing and health inequalities, make improvements more likely because the impact on the most vulnerable tenants who are disproportionally affected (i.e. people on benefits, unemployed, elderly or who have disabilities) are explicitly known throughout the council and partners. It highlights why insecure tenure and complaint-led enforcement-only activities may not be successful in improving quality for the most vulnerable. If the potential impact of improving the PRS stock to address wider local issues such as zero carbon commitments, crime, waste management, antisocial behaviour, and illicit drug markets are made visible then this further incentivises improvements. In addition, if cost saving benefits from appropriately adapted housing are understood, greater investment may arise for adaptation of current and prospective housing stock. This is because the social care costs to the council may be reduced by upfront investment or diversion of grant funding to enable people to stay in their current accommodation.

This theory was refined and developed significantly to incorporate housing officers' understanding of the wider determinants of health [IPT1], evidence base [IPT5.2] and proactive work [IPT8]. Some PRS teams were very active and visible in strategic partnerships enabling escalation of the issues, whilst those who were more reliant on reactive enforcement-only had fewer outward-looking proactive partnerships and therefore potentially limited opportunities to highlight the links between housing and health. There was no clear association between being able to articulate an accurate understanding of the wider determinants of health [IPT1] and LTLA philosophy. However, there was strong evidence of local and national sustainability targets and associated funding schemes driving PRS teams' activities and improvements in housing quality.

Discussion

This study adds value to the evidence base by using a realist framework to understand which factors influence the development and choice of approaches in local government to manage the quality of PRS housing and therefore the health and wellbeing of tenants. The findings suggest that the mechanisms that bring about a positive outcome in managing the PRS are unlikely to be universal; they depend on the context which differs across place and over time. This highlights the need for strategies to be tailored considering the local context. It provides a starting point for researchers in the field to test these plausible hypotheses to refine and deepen our understanding of how PRS housing which is beneficial for tenants' health can be delivered. A key strength of this study was the multi-step, mixed method approach, which incorporates numerous sources of evidence to iteratively produce robust IPTs. Future work should now seek to refine and expand these IPTs through further testing in other parts of the UK and internationally, with the aim of reaching a Middle Range Theory (Wong *et al.* 2016; *Gilmore et al.* 2019).

The findings yielded seven new IPTs, across three categories (Local Housing Market, Philosophy, and Structure). Importantly, the lack of objective outcomes being used to understand the nature and extent of impact different mechanisms were having on PRS quality and the health and wellbeing of tenants', hinders interpretation of the effectiveness of all mechanisms. Notable mechanisms included; maintaining the balance of market forces, type of enforcement (hard/soft and proactive/ reactive), use of non-enforcement approaches, making consequences of poor quality PRS visible, and the ability to target resources. Example contexts which affected the use of these mechanisms included; local demands on housing supply, location and density of PRS housing, data sharing arrangements, team leaders individualised approaches, the size, funding, contracts and political views within a LTLA, and the understanding of links between housing and wider societal issues.

Some of these contexts and mechanisms were already known. For example, there has long been debate about the optimal enforcement approach. Our finding of mixed views towards hard enforcement are consistent with earlier studies (Harris *et al.* 2020; Marsh

et al. 2020). Similarly shifts in demand on PRS (Marsh & Gibb, 2019), and the significant lack of resource and capacity within the public sector (Black *et al.* 2021; DLUHC, 2022c) have been previously described. Interesting null findings included that; unitary compared to two-tier authorities, the local government department which the PRS team sits within, and the understanding of the wider determinants of health of the housing officer were not found to have an impact on the ability to utilise mechanisms.

The lack of suitable outcome measures has been reported by other studies, whereby local governments tend to blur activity or process measures (e.g. number of prosecutions) with outcome measures (e.g. number of properties improved) (Harris *et al.* 2020). This is a critical issue because it limits the ability to reach consensus within the sector on what mechanisms are effective and how best to target the use of limited resources. This suggests increased support for local governments to understand the potential datasets available, and ways to merge them would be invaluable. It is recommended that in addition to housing stock condition databases (BRE, 2023) and deprivation data, that objective measures from local public health and healthcare datasets are used. This could enable better identification of vulnerable households within the PRS and therefore targeting of limited resources. The use of tools like the Housing Health Cost Calculator (BRE, 2023), which quantifies the extent to which improvements in housing can reduce pressure on health services, could help make the consequences of poor quality PRS more visible. Although many of the factors which affect the demand for PRS housing are not within the control of local governments, data can be useful to monitor and predict the impact on tenants and their needs. For example, the rising cost of living that many high-income countries are experiencing is having a greater impact on people living in the PRS than other housing, with two in five renters finding it difficult to pay their rents, compared to one in five homeowners (ONS, 2023).

Given the finding that meeting environmental sustainability targets was seen as a potential driver for incentivising improvements to PRS housing, it is important to understand the interplay between climate and health agendas, such as health outcomes associated with energy efficiency interventions, e.g. increased insulation and reduced ventilation, as promoted widely during the Cost of Living Crisis.

There continues to be much regulatory change affecting PRS housing. These changes will have complex impacts and take time to emerge (Marsh & Gibb, 2019). As this evaluation was conducted at a similar time to the publication of ‘A fairer private rented sector’ White Paper (DLUHC, 2022b), there will be upcoming opportunities to evaluate additional mechanisms available to local government. If the Renters Reform Bill is passed, local governments will have more power to enforce and protect tenants’ rights, including a register of landlords and end to ‘no fault’ evictions (DLUHC, 2022b). Importantly, a new Decent Homes Standard may put social and PRS housing on the same level in terms of regulatory expectations (DLUHC, 2021) and there are new regulations to remove the requirement for accommodation for asylum-seekers provided on behalf of the Home Office to have an HMO license from local government (The Houses in Multiple Occupation (Asylum-Seeker Accommodation) (England) Regulations, 2023). Finally, the relevance of referral pathways has increased following a recent landmark case of a child’s death where housing conditions were held directly responsible (Kearsley, 2022). Health and social care teams referring priority patients with health needs for better housing conditions, could therefore become a more prominent mechanism in the future (Baraniuk, 2023).

The findings of this research illustrate the importance of considering the different contexts within which new local authority regulatory powers and responsibilities will be applied. The effectiveness of the Government’s plans for reforming the PRS in England, will crucially depend on the extent to which local authorities are able and willing to apply the legislation in practice. The findings demonstrate that although resources are a key determining factor, they are by no means the only driver. A full consideration of the

range of factors which influence the way in which the sector is regulated at a local level, should be an integral part of any impact assessment of the new regulation.

Strengths, limitations and future research

As with all realist evaluations, this study is inherently interpretative. The elicitation of CMOCs and the refinement of theories has been dependent on the researcher teams' judgment and existing knowledge introducing a possibility of bias (Gilmore *et al.* 2019; Masterton *et al.* 2020). Care has been taken to document in detail the "decision-making" processes within the analysis, to help to ensure transparency across this evaluation.

As the interviews were conducted by public health professionals, it is possible this led to reporting bias, with participants overemphasising their understanding of ability to influence health. Given the notable discrepancies between duplicate responses from different cadre of staff, for example on estimates of staff working within the PRS team, participant bias and the reliability of participant responses could be questioned. Using the research teams' professional experience in order to guide participant selection hopes to have captured innovative work in the PRS, however it may have also led to some selection bias, with housing teams more engaged in the health agenda being chosen. To minimise the extent of these biases, a high degree of rigor has been taken, as evidence by the RAMESES II checklist (Additional File 4).

The research was conducted in one geographical region, and whilst this is fairly representative of much of England, there are notable policy difference across the wider UK and internationally (Marsh & Gibb, 2019). Despite this, we propose that our findings could be generalisable to the wider UK and other countries, due to the breadth of local government structures, sizes, staffing, and approaches taken, which were included in the study. Many of the contexts and mechanisms that were present in this evaluation would apply to other countries, for example increasing demand on PRS from population changes and the Cost of Living crisis. Therefore, we suggest that the IPTs might also successfully translate to other international settings.

Conclusion

To our knowledge, this evaluation is the first to use realist methodology to examine factors which influence local government approaches to managing the quality of PRS housing to improve the health and wellbeing of tenants. This allowed identification of the extent to which different mechanisms are being used, and, crucially, the different contextual factors which affect this. Seven new IPTs (under three categories; Local Housing Market, Philosophy and Structure) about what works, for whom, under what circumstances have been developed. The findings are not only theoretically novel, but also have practical relevance for those developing and delivering new interventions on housing and health, and providing recommendations on how to optimise, tailor, and implement, existing mechanisms and design and measure outcomes to monitor improvements. These will be particularly relevant for academic researchers, and housing and public health professionals, especially those working in local governments.

List of abbreviations

CMOCs – context-mechanism-outcome configurations
DLUHC – Department for Levelling Up, Housing and Communities
EPC – Energy Performance Certificates
FTE – Full-Time Equivalent [staff]
HHSRS - Housing Health and Safety Rating System
HMO – Houses of Multiple Occupation
IPT – Initial Programme Theory/ies
LGA – Local Government Association
LTLA – Lower-Tier Local Authorities
NHS – National Health Service
ONS – Office of National Statistics
PRS – Private Rented Sector

SW – South West
UK – United Kingdom
UWE – University of the West of England

Declarations

Ethics approval and consent to participate
Ethics approval for this study was granted by Health and Applied Science Research Ethics Committee at UWE; Reference number HAS.22.06.128 on 15th July 2022.

Consent for publication
Signed UWE consent forms, including consent for publication, were obtained from all individuals interviewed during the research study.

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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Authors' contributions
RM designed and supervised the study, obtained ethics approval and led the writing of the manuscript. CFF collected and led the analysis of the data; the documents review was conducted by CFF and LD, CFF conducted all interviews except one which was led by LD but also attended by CFF. Data transcripts were cleaned by CFF and LD. CFF coded all the data in Nvivo and presented the initial findings to other authors for discussion. ET listened to 10/11 interviews and offered reflective and interpretative notes on each. CFF wrote the first draft of the methods and results section. All authors discussed and aided interpretation of the results. RM wrote the first full draft of the manuscript and revised this with input from all authors.

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Additional file 1: Survey

This additional file contains the survey, based on the LGA toolkit, that was redesigned and abbreviated in Qualtrics software by the research team.

3.1 ABOUT YOU

3.2 Job Title

_____

3.3 What aspects of private rented sector housing work do you have responsibilities for?

- Policy (1)
- Partnership (2)
- Enforcement (3)
- Managerial (4)
- Strategic (5)
- Homelessness prevention (6)
- Other (7)

_____

3.4 Which local authority or district do you work for?

_____

3.5 Is this local authority or district predominantly:

- ○ Urban (1)
- ○ Rural (2)
- ○ Both (3)

3.6 How many FTE employees work in the PRS housing team of your local authority / district excluding the Housing Service lead?

Please include all staff working in the PRS housing team including administrative support, enforcement staff, team leaders, head of PRS department.

_____

4.1 EVIDENCE BASE

4.2 Have you up-to-date and accurate information on the overall size and condition of the private rented sector?

- ○ Yes (1)
- ○ No (2)

4.3 What is the estimated size of the PRS stock?

- ○ Estimate size: (1) _____
- ○ Don't know (2)

4.4 What is this estimate based on?

_____

4.5 Have you a timetable in place to improve your evidence base (eg stock condition surveys and environmental performance) and that takes account of the 2021 Census results?

- ○ Yes (1)
- ○ No (2)

4.6 Do you have information on and/or understanding of the changing pattern of demands among different groups of tenants?

- ○ Yes (1)
- ○ No (2)

4.7 Do you have information on and/or understanding of any changes in the types of landlords and lettings agents operating in your area?

- ○ Yes (1)
- ○ No (2)

4.8 Do you have information on and/or understanding of the different types of private rented stock in your area eg houses in multiple occupation (HMOs), traditional family accommodation, purpose-built student accommodation and build-to-rent schemes?

- ○ Yes (1)
- ○ No (2)

4.9 Do you bring together and analyse relevant internal databases to improve your evidence base eg council tax records, planning applications and enforcement action?

- ○ Yes (1)
- ○ No (2)

4.10 Do you effectively collaborate with any of the following to help identify patterns of poor health and vulnerability within the private rented sector?

- Adult social care (1)
- Children's services (2)
- Public Health teams (3)
- Healthcare services (4)
- Third Sector Organisations (5)
- Private consultancies (6)
- Sub-regionally with other councils / districts (7)
- Other (8)

_____

- None (9)
- Don't know (10)

4.11 Does your local authority / district analyse and understand the role of the private rented sector in relation to the overall housing market (eg owner occupation and social renting)?

- ○ Yes (1)
- ○ No (2)
- ○ Don't know (3)

4.12 Does your local authority / district have agreements in place to share and exchange information with other organisations (eg fire and rescue, DWP, HMRC, Border Force and Gangmasters and Labour Abuse Authority [GLAA])?

- ○ Yes (1)
- ○ No (2)
- ○ Don't know (3)

4.13 Do you review research publications on the private rented sector by organisations such as the UK Centre for Collaborative Housing Evidence (CaCHE)?

- ○ Yes (1)
- ○ No (2)

5.1 POLICY and POLICY MAKING

5.2 Do you have an up-to-date strategy for the private rented sector?

- ○ Yes (1)
- ○ No (2)

5.3 Do you evaluate the implementation of your PRS strategy using any of the following measures:

- Regulatory compliance (1)
- Improvements to the housing stock outcomes (2)
- Health and wellbeing outcomes (3)
- Performance measures eg inspections, notices issued (4)
- Other (5)
- None (6)

5.4 When prioritising objectives in order to take account of resource constraints, is health taken into consideration?

- ○ Yes (1)
- ○ No (2)

5.5 In your opinion, is there an adequate balance between incentives and enforcement for landlords and letting agents?

- ○ Yes (1)
- ○ No (2)

5.6 Are your PRS strategy or policies aligned with

	Yes (1)	No (2)	Don't know (3)
Local authority / district strategies or plans, such as the local plan (including supplementary planning documents - SPDs), the housing strategy and the corporate plan? (1)			
improving the environmental performance of the PRS stock in the light of the climate change emergency? (2)			
other specific housing strategies, eg student housing? (3)			
strategies on neighbourhood renewal including empty homes strategies? (4)			
strategies to tackle modern slavery? (5)			
strategies to tackle poverty and deprivation eg fuel poverty, council tax reductions? (6)			
strategies to improve public health and wellbeing eg affordable warmth, trips/falls, overcrowding? (7)			
strategies on homelessness and rough sleeping and the use of the PRS sector for temporary and permanent accommodation? (8)			

6.1 RESOURCES

6.2 Do you have the capacity to effectively respond to any external funding sources eg Department of Levelling Up, Housing and Communities (DLUHC) to support your work in the private rented sector?

- ○ Yes (1)
- ○ No (2)

6.3 Do you work with partners to maximise resources such as finance and skills?

- ○ Yes (1)
- ○ No (2)

7.1 GOVERNANCE

7.2 Are there effective links with other in-house services eg housing advice, homelessness, planning etc to achieve the wider aims and objectives of your housing strategy?

- ○ Yes (1)
- ○ No (2)

7.3 Is there a local councillor who advocates for improvements in the private rented sector effectively?

- o Yes (1)
- o No (2)

7.4 Are monitoring reports regularly presented to senior management teams and to cabinet/ committees?

- o Yes (1)
- o No (2)

8.1 PARTNERSHIPS

You told us that you effectively collaborate with the following to help identify patterns of poor health and vulnerability:

Other key partners and stakeholders may include landlords' associations, tenants' groups, community organisations and universities.

8.2 Are the objectives, requirements and views of partners and stakeholders understood and acted upon?

- o Yes (1)
- o No (2)

8.3 Are there regular meetings with partners and stakeholders at an officer level to discuss policy and operational issues?

- o Yes (1)
- o No (2)

9.1 LANDLORDS AND TENANTS SUPPORT

9.2 Is supporting landlords and tenants a priority in the strategy for the private rented sector?

- o Yes (1)
- o No (2)

9.3 Do you operate or support a property management service / social lettings agency?

- o Yes (1)
- o No (2)

9.4 Do you support and encourage tenants' groups?

- o Yes (1)
- o No (2)

9.5 Do you operate a landlords' forum?

- o Yes (1)
- o No (2)

9.6 Do you operate or support a landlord accreditation scheme?

- o Yes (1)
- o No (2)

9.7 Do you operate or support a tenant advice service that covers the private rented sector?

- o Yes (1)
- o No (2)

9.8 Do you make use of or signpost initiatives such as 'marks out of tenancy' to tenants and landlords?

- o Yes (1)

- No (2)

10.1 ENFORCEMENT
10.2 Do you operate a reactive-only enforcement policy based on complaints by tenants and communities?

- Yes (1)
- No (2)

10.3 Do you operate regulatory partnerships with any of the following agencies:

- Fire and Rescue (1)
- Trading Standards (2)
- Department of Work and Pensions (3)
- HMRC (4)
- Border Force (5)
- Gangmasters (6)
- Labour Abuse Authority (GLAA) (7)
- Other (8)

- None of the above (9)

10.4 Are short-term lets (eg Airbnb) a growing issue?

- Yes (1)
- No (2)

10.5 Have you considered the implications over the next decade of a growth of the number of older households in the private rented sector?

- Yes (1)
- No (2)

10.6 If relevant, are you working with universities to map out future student accommodation needs?

- Yes (1)
- No (2)
- Not Applicable (3)

10.7 Are office conversions without the need for planning permission (ie permitted development) a growing issue?

- Yes (1)
- No (2)

10.8 Is the quality of 'exempt accommodation' (ie temporary accommodation) an increasing issue?

- Yes (1)
- No (2)

11.1 FINAL PAGE
11.2 Please complete the Captcha verification:

11.3 Here is your Survey ID number:

Please make a note of this ID number which you will need to provide if you wish to withdraw from the study within 30 days.
We will also ask for this ID number if we approach you to take part in a follow-up interview which will allow us to link your survey responses.

Once you've copied your ID number, click Submit to finish the survey.

Additional file 2: Interview guide

This additional file contains the interview topic guide used in in-depth interviews with participants.

	Research question	**Question area**	**Prompt**
1	Personal rapport	Thanks and introduction - [Confirm information from survey]	Introduce self & research team/topic Confirm consent (received by email prior to interview) Some questions from the survey will be repeated but then we will expand on them. Check documents shared so far – anything missing? How their info will be used Duration (45-60mins) Reassurances – anonymity, confidentiality, collective results Reminder about audio recording Any questions/concerns Press RECORD – then state Survey ID for recording
2	Personal rapport	What LA/district do you work for? How long have you worked there? Can you tell me a little about your current role?	Participant background / Build rapport – get them talking and at ease.
3	Personal rapport	Reflecting on your professional experience, what do you think are the wider factors which influences the health of people living in your area?	In Public Health we use the term 'wider determinants of health' to describe the range of factors which impact on people's health and wellbeing; from a person's individual characteristics and behaviours, to social and economic conditions, to the physical environment. Housing officers often work across the wider determinants of health, for example to improve the quality of housing. Can you tell me what this means to you in your practice?
4	Health impacts	Is there anything distinct about private rental sector housing and it's impact on the health and wellbeing of tenants?	Please give an example/ case study Can you think of particular exposures? Eg. physical but also psychosocial (security, affordability)
5	Health Impacts	[only ask if vulnerable people not discussed in question above] Do you feel there are any people living in this local authority/in this area that	Please give an example/ case study For example, lower income, in receipt of benefits, living with disabilities, etc

		are particularly vulnerable to the negative effects of private rented sector housing on health?	
6	Use of mechanisms	What are the main approaches you adopt to improve the health and wellbeing of tenants in private rented housing?	If prompts are required, interviewer may highlight below themes as options: 1. Evidence base 2. Policy and policy making 3. Resources 4. Governance 5. Partnerships 6. Consumer regulation 7. Enforcement 8. Emerging issues
7	Contextual factors	What is limiting your ability to improve the health and wellbeing of tenants in the PRS locally?	Why? Please give an example.
8	Contextual factors	What is working well currently and enabling you to improve the health and wellbeing of tenants in the PRS locally?	Why? Please give an example.
9	Contextual Factors	(Emerging issues) The Government has proposed to introduce a number of new laws and regulations to aim to improve standards in the PRS. What impact, if any, do you think this will have in the local area? Follow-up: are there any other emerging issues that you are aware of?	Prompt: How does this affect you <u>locally</u>? Reminder of main proposals in white paper [if required]: Landlord register, Update to Decent Homes Standard applying to PRS, Removal of Section 21 evictions.
I'd like to ask about some of the different mechanisms which are available to Local Government to improve the quality of private rented housing, and therefore health and wellbeing of tenants…			
10	Contextual factors	(Evidence base) How do you currently use data to inform your actions on private rented housing, and how could this be improved?	For example evaluations, stock surveys, rouge landlord database, mandatory register of landlords, financial data, administrative data from other departments, census, etc Please give an example.
11	Contextual factors	(Policies and Strategies) Can you tell me about your current housing policies or strategies – does it specify PRS as a sector? Do they have any links to other relevant health policies or strategies?	Other relevant policies, may include, Health and Wellbeing strategy and JSNAs, homelessness, modern slavery, affordable warmth, etc

		Follow-up Q: Conversely, do you know if local health strategies or policies link to housing docs?	
12	Contextual factors	(Partnerships) What internal and external partnerships do you draw on to support work on private rented housing and how could this be improved?	Internal, eg. Local authority public health teams, External, eg. health and social care (ICS/PCNs etc) VCSE, Sub-regional, fire and rescue, DWP, HMRC, Border Force and Gangmasters and Labour Abuse Authority [GLAA]
13	Contextual factors	Are there any other aspects of the survey which you would like to expand on which may have relevance to health?	Always prompt: Resources, Governance, Regulation, Enforcement
15	Close	Do you have any further comments? Thank you for your time.	End Recording

Additional file 3: Preliminary initial programme theories identified

This additional file contains the early iterations of preliminary initial programme theories which were identified using the Local Government Association 'Improving the PRS: A toolkit for councils' (LGA, 2020), housing documents and after five of the eleven interviews had been completed.

Theme	Initial Programme Theory (IPT) number	Context (C)	Mechanism (M)	Outcome (O)
Individual	1	Better understanding of wider determinants of health Depth and breadth of housing officer training Department the PRS team sits within the local government	Meaningful partnership working Increased education and engagement activities across departments	Multi-agency/sector response to issues in the PRS
IPT1: Understanding the Wider Determinants of Health If PRS team leaders have a good understanding of the wider determinants of health, they are more likely to take a multi-agency approach to partnership working to tackle issues and improve quality in the PRS. This is because they understand the interconnection of housing, employment, poverty, crime, education (i.e. wider determinants) and see the value in building working relationships and trust across the local government to find solutions.				
Individual	2	Previous career experience Local government shows support/prioritises PRS Depth and breadth of housing officer training Terms of employment contract	Stronger strategic and policy making activities emphasising PRS Transformational change in approach	PRS is a priority Take risks and try new things
IPT2: Previous experience of PRS team leader If PRS team leaders have previous experience of working in a local government which had a strong emphasis on partnership working, hard enforcement or strategic leadership, then this is likely to influence their current activities. If staff are working contractually, then they may feel able to make more bold suggestions. This is because they feel confident to make transformational change in how to run a department and take risks.				
Individual	3	Depth and breadth of housing officer training Insufficient resources for	Reliance on enforcement (hard/soft) Limited partnership working	Improvement of PRS where enforcement required but only meeting

		PRS/housing in local government (including salary/training)		a minimal standard
IPT3: Enforcement approach If housing officers are reliant on policy and standards for enforcement rather than applying a risk-based approach, then they are less likely to take into account the risk factors of the tenant, wider determinants of health and/or strengthen links with other partners. This is because insufficient resources restrict the housing officers to working in a fixed way and limit the ability to recruit high-quality/paid trained staff who are more adaptive and flexible.				
Organisational	4	Political leadership for housing in local government Better understanding of wider determinants of health	Strong strategic and policy making activities emphasising PRS Meaningful partnership working Strong leadership	Improvement in quality of housing, including PRS
IPT4: Housing as a human right If access to housing is viewed as a human right and an important determinant of health and the impact of poor quality on other aspects of community safety and cohesion are well understood, then local governments are likely to prioritise ensuring their local population has access to quality housing. If the PRS team are represented in strategic decision making about housing supply and reducing homelessness, then awareness of the issues associated with poor quality of the PRS will be made explicit. This is because the local government has strong leadership championing the importance of housing.				
Organisational	5	Better understanding of wider determinants of health Cost of Living crisis adding pressure to this inequality Focus on economic principles of a successful PRS	Links with public health/health data Meaningful partnership working Strong evidence base	Local governments have clear priority to improve health and wellbeing of tenants in PRS Motivation to improve the health and wellbeing of tenants Motivation to reduce inequality
IPT5: The evidence base linking housing and health If there is a strong evidence base around the impact of poor quality housing on health and wellbeing of tenants, the health and wellbeing needs of the most vulnerable in society will be better understood. This is because they have a strong moral imperative and motivation to improve this. If the health and wellbeing of tenants living in the PRS is poorly understood, then there is little incentive or awareness to improve this. If the success of the PRS is quantified by economics and the housing market, then the average quality of PRS stock will remain near a minimal threshold of ‘decent’. This is because landlords prioritise making a profit from their businesses over and above providing better quality housing.				

Organisational	6	Single unitary authority (vs two tier districts)	Meaningful partnership working Ease of data sharing within organisations Lack of multiple districts adding complexity to external/multi-agency communications	Improved ease and efficiency of applying multiple mechanisms leading to improvement in PRS stock
IPT6: Unitary vs Two-tier authorities If the local government is a single-tier unitary authority, then there is likely to be stronger easier partnership working. This is because there are better working relationships within the single organisation, better aligned strategic priorities, data sharing is easier, and there is a single authority (rather than multiple districts) for ease of communication.				
Geographical	7	Geographical location of PRS Areas of deprivation Rural/ Urban/ Mixed local government Density of student population living in PRS	Reliant on tenant-led complaints leading to enforcement-dominant activities Strong evidence base of where PR S located and other aspects of need (IMD, health data)	Local government not solely reliant on enforcement has capacity to expand to education and engagement Better trust and engagement of landlords with local government More time/capacity for Local government to follow-up with rogue landlords via enforcement where required Overall improvement of PRS quality
IPT7: Concentration of PRS If PRS properties are centralised in certain areas, for example of in areas of deprivation or areas with high student populations, then overall quality in the PRS stock will improve through targeted education and engagement activities with the majority of landlords. This is because the PRS team can scale these interventions appropriately leaving greater capacity within the team to use enforcement with the few rogue landlords that require it. If the PRS properties are spread out, then local governments are over-reliant on tenant-led complaints leading to enforcement-dominant activities.				

Additional file 4: RAMESES II reporting standards checklist for realist evaluations
To evidence transparency and rigor in the research approach, the RAMESES II reporting standards checklist has been completed.

Additional File 4: RAMESES II reporting standards checklist for realist evaluations

TITLE			**Reported in document Y/N/Unclear**	**Page(s) in document**
1		In the title, identify the document as a realist evaluation	Y	1
SUMMARY OR ABSTRACT				
2		Journal articles will usually require an abstract, while reports and other forms of publication will usually benefit from a short summary. The abstract or summary should include brief details on: the policy, programme or initiative under evaluation; programme setting; purpose of the evaluation; evaluation question(s) and/or objective(s); evaluation strategy; data collection, documentation and analysis methods; key findings and conclusions Where journals require it and the nature of the study is appropriate, brief details of respondents to the evaluation and recruitment and sampling processes may also be included. Sufficient detail should be provided to identify that a realist approach was used and that realist programme theory was developed and/or refined	Y	2,3
INTRODUCTION				
3	Rationale for evaluation	Explain the purpose of the evaluation and the implications for its focus and design	Y	5,6
4	Programme theory	Describe the initial programme theory (or theories) that underpin the programme, policy or initiative	Y	6,7
5	Evaluation questions, objectives and focus	State the evaluation question(s) and specify the objectives for the evaluation. Describe whether and how the programme theory was used to define the scope and focus of the evaluation	Y	6

6	Ethical approval	State whether the realist evaluation required and has gained ethical approval from the relevant authorities, providing details as appropriate. If ethical approval was deemed unnecessary, explain why	Y	13
METHODS				
7	Rationale for using realist evaluation	Explain why a realist evaluation approach was chosen and (if relevant) adapted	Y	6,7
8	Environment surrounding the evaluation	Describe the environment in which the evaluation took place	Y	8 - 11
9	Describe the programme policy, initiative or product evaluated	Provide relevant details on the programme, policy or initiative evaluated	Y	4, 5
10	Describe and justify the evaluation design	A description and justification of the evaluation design (i.e. the account of what was planned, done and why) should be included, at least in summary form or as an appendix, in the document which presents the main findings. If this is not done, the omission should be justified and a reference or link to the evaluation design given. It may also be useful to publish or make freely available (e.g. online on a website) any original evaluation design document or protocol, where they exist	Y	5, 6, 7
11	Data collection methods	Describe and justify the data collection methods – which ones were used, why and how they fed into developing, supporting, refuting or refining programme theory Provide details of the steps taken to enhance the trustworthiness of data collection and documentation	Y	8 – 11
12	Recruitment process and sampling strategy	Describe how respondents to the evaluation were recruited or engaged and how the sample contributed to the development, support, refutation or refinement of programme theory	Y	8

13	Data analysis	Describe in detail how data were analysed. This section should include information on the constructs that were identified, the process of analysis, how the programme theory was further developed, supported, refuted and refined, and (where relevant) how analysis changed as the evaluation unfolded	Y	11, 12, 13
RESULTS				
14	Details of participants	Report (if applicable) who took part in the evaluation, the details of the data they provided and how the data was used to develop, support, refute or refine programme theory	Y	9-11, 14
15	Main findings	Present the key findings, linking them to contexts, mechanisms and outcome configurations. Show how they were used to further develop, test or refine the programme theory	Y	14 - 30
DISCUSSION				
16	Summary of findings	Summarise the main findings with attention to the evaluation questions, purpose of the evaluation, programme theory and intended audience	Y	31
17	Strengths, limitations and future directions	Discuss both the strengths of the evaluation and its limitations. These should include (but need not be limited to): (1) consideration of all the steps in the evaluation processes; and (2) comment on the adequacy, trustworthiness and value of the explanatory insights which emerged In many evaluations, there will be an expectation to provide guidance on future directions for the programme, policy or initiative, its implementation and/or design. The particular implications arising from the realist nature of the findings should be reflected in these discussions	Y	34, 35
18	Comparison with existing literature	Where appropriate, compare and contrast the evaluation's findings with the existing literature on similar	Y	32, 33

		programmes, policies or initiatives		
19	Conclusion and recommendations	List the main conclusions that are justified by the analyses of the data. If appropriate, offer recommendations consistent with a realist approach	Y	35
20	Funding and conflict of interest	State the funding source (if any) for the evaluation, the role played by the funder (if any) and any conflicts of interests of the evaluators	Y	37

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Healthy buildings for a healthy city: Is the public health evidence base informing current building policies?

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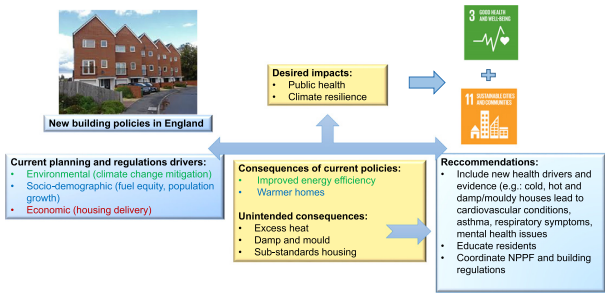
HIGHLIGHTS

- Review of English building policies and regulations revealed gaps in evidence use.
- Building policy in England focuses on climate mitigation rather than public health.
- Research found that building policy uses public health evidence in a patchy way.
- Lack of systems thinking has led to building standards ignoring health.
- A single policy regime must regulate different phases and scales of urban development.

GRAPHICAL ABSTRACT



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ABSTRACT

Research has demonstrated that housing quality is a key urban intervention in reducing health risks and improving climate resilience, addressing a key ambition of the United Nations Sustainable Development Goals. Yet housing quality remains a problem even in high income countries such as England. In particular, hazards such as excess cold, excess heat and lack of ventilation leading to damp and mould have been identified as a major issue in homes. Research shows that these hazards can lead to a range of health conditions, such as respiratory and cardiovascular disease, infections and mental health problems. This article explores the use of public health research and evidence in policy to regulate new buildings in England to deliver improved public health, climate resilience and a reduced carbon footprint, in particular exploring the policy drivers and awareness of the public health evidence.
Findings show that public health evidence is hardly referenced in policy and that the focus on other evidence bases such as on climate mitigation in building regulations results in both positive and negative impacts on

Abbreviations: BRE, Building Research Establishment; BREAAM, Building Research Establishment Environmental Assessment Method; BSI, British Standards Institution; BTO, Building Technologies Office; CISBE, Chartered Institution of Building Services Engineers; CSH, Code for Sustainable Homes; DCLG, Department for Communities and Local Government; DEFRA, Department for Food and Rural Affairs; DoH, Department of Health; EHS, English Housing Survey; HES, Mortality and Hospital Episode Statistics; HHSRS, Healthy Housing Safety Rating System; HMSO, Her Majesty's Stationery Office; HSE, Health and Safety Executive; MHCLG, Ministry of Housing Communities and Local Government; NPPF, National Planning Policy Framework; NPPG, National Planning Policy Guidance; ODPM, Office of the Deputy Prime Minister; PHE, Public Health England; SDGs, Sustainable Development Goals.

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English planning
Building regulations

health. This reflects a lack of a systems approach around urban interventions leading to weaknesses in standards regulating the private development sector. In conclusion, this paper recommends: 1. the consideration of health impact in future building regulations; 2. the integration and coordination of key policies covering various scales and phases of the development processes and 3. the better education of residents to understand advances in new energy performance technologies.

1. Introduction

Research for this article was funded by the Wellcome Trust's Sustaining Health programme. The project entitled "Upstream" sought to develop new approaches for integrating long-term health outcomes into urban development planning and delivery by using England as a case study (Upstream, 2018).

The United Nations' Sustainable Development Goals (SDGs) offer an overarching framework for improving the environment and health in cities (UN, 2015). Several SDGs and the resulting targets have a built environment dimension, aimed at improving both environmental quality and public health through interventions to enhance urban infrastructure or the quality of housing (Box 1). In particular, the SDGs indicator 11.1.1 explicitly refers to the need for adequate housing standards. Moreover, a number of SGDs are yet to establish implementation methodology and data sources, providing an opportunity for a timely intervention.

SDGs respond to the mounting evidence highlighting the links between our health and the living environment. In particular, a strong body of international public health literature is giving a fuller understanding of the impact design features at the building scale can have on health and identifies a range of health hazards in the home Research in high income countries has identified 14 actionable urban planning principles associated with improved health and wellbeing including enhanced neighbourhood walkability, increased provision of affordable and diverse housing and improved quality of housing (Bird et al., 2017). Further research in the Upstream project identified important associations between thermal quality, ventilation, housing affordability, safety and wellbeing of residents (Ige et al., 2018). These findings show that sub-standard housing is not the monopoly of low- and medium-income countries. In England, policy-makers are all too aware of this. The damning conclusion of the independent Hackitt Review, for instance, declared that building regulations are 'unfit for purpose'. Although the report relates more specifically to fire safety following the Grenfell Tower tragedy in London, the statement highlights the urgent need for regulation and policy to better recognise the interdependencies between different parts and ensure that buildings are both fit to tackle climate change and to support human health (MHCLG, 2018a).

Statistics further support that housing significantly affects human health in England. In 2017, 4.5 million homes (19%) in England did not meet the Decent Homes Standard, a policy tool used to assess the condition of the existing UK building stock through the yearly English Housing Survey (EHS). The survey accounts for a variety of criteria, including the provision of a reasonable degree of thermal comfort (DCLG, 2006a, 2006b). In addition, 11% of English homes are experiencing "*serious and immediate risk to a person's health and safety*" (MHCLG, 2019).

The high number of below standard homes is likely to have substantial associated health costs. The Building Research Establishment (BRE) calculated that the cost to the NHS alone is some £1.4billion per year to treat people living in the poorest[1] housing in England (BRE, 2015). Drawing from the outcomes identified in the systematic evidence review identifying strong evidence of impact of health hazards at building level (Ige et al., 2018), researchers have calculated that in the UK: 1. the total average annual cost of cold, excess heat and damp and mould per population of 1000 people could be respectively £240,500, £470,000 and £325,000 (Upstream, 2018). These figures remain tentative and reflect uncertainties in calculating impact on the risk of illness or odds ratios observed in the medical evidence, and uncertainties in the valuations related to the severity and duration of illness (Upstream, 2018). However, to place these figures into context, OECD estimated that in 2016 total healthcare expenditure in the UK per capita was £2892 (OECD, 2019 converted from USD).

This article aims to analyse the pathways between evidence and housing regulation and policy in England (Including the EU legislation applying to England at the time of writing) with three housing health hazards (damp and mould, excess cold and overheating) set out in the HHSRS (DCLG, 2006b). The reason for choosing hazards from the HHSRS list of hazards is developed in the theory section. In particular, the research team was interested in exploring the mismatch between the evidence currently available on these three hazards and the evidence used to inform policy around buildings.

2. Hypothesis and approach

2.1. Sub-standard housing in England: market failure

The existence of sub-standard housing in England can be seen as a market failure to deliver required standards. Market failure leads to an inefficient allocation of resources and is demonstrated in England through homelessness (even though there are empty homes), the high cost of housing, the number of affordable homes included in new developments consistently falling below local authority targets and design quality issues even in new homes. Key to this market failure even in new developments is the legitimate use of viability assessment findings by developers to reduce the number of affordable homes, quality of the design, or size of the homes they are required to build. If profits are predicted to fall below 20% then developers can reduce their commitments in negotiations with local authorities at the planning stage to ensure the future commercial viability of the development.

2.2. Recognising public health evidence in housing policy

This article argues that the market failure to deliver homes in sufficient numbers, quality and affordability is underpinned by the failure to comprehensively reflect the public health evidence in policy and regulation. Because health evidence is not systematically acted upon in policy, the health impact of sub-standard homes is not sufficiently recognised in negotiations between developers and local authorities. In addition, this article argues that the current lack of a systemic approach around urban health interventions is leading to weaknesses in standards regulating the private development sector. In particular, this article focuses on the contrasting positive and negative health impacts from improvements in design and build quality of new homes to reduce energy consumption and tackle fuel poverty. Thermal comfort is improved while at the same time problems with damp, mould, overheating and adequate ventilation are exacerbated due to increased insulation and air-tightness levels. A systematic approach is required

[1] BRE defines "poor housing" after extending the definition to include 3.5 million (15%) of the poorest housing stock in the country identified with a significant HHSRS hazard (BRE, 2015).

Box 1
Sustainable Development Goals (SDGs) and indicators related to the built environment.

Indicator 3.9.1: Mortality rate attributed to household and ambient air pollution Department for Environment, Food and Rural Affairs - DEFRA, 2013
UK data context: Percentage of adult deaths (aged 30 and over) attributable to particulate air pollution dataset from the Department for Environment, Food and Rural Affairs (DEFRA) (English dataset only)
Connection to built environment: Although the dataset groups household and ambient air pollution in one indicator, well-evidenced connections between housing quality and pollution will affect the performance of this measure.

Indicator 11.1.1: "Proportion of urban population living in slums, informal settlements or inadequate housing"
UK data context: Percentage of dwellings failing minimum standard decent homes criteria (English dataset only)
Connection to built environment: This indicator looks directly into the quality of housing based on the UK policy tool Housing Health and Safety Rating System (HHSRS)

Indicator 11.a.1: Proportion of population living in cities that implement urban and regional development plans integrating population projections and resource needs, by size of city
UK data context: methodology not yet established
Connection to built environment: This indicator pertains to the quality of strategic planning at the urban or regional level and therefore could inform the quality and quantity of housing built in the future. As the implementation methodology has not been established, there is an opportunity for the researchers to advise on the choice of data.
Source: ONS, 2019

that reflects the need to consider both energy efficiency and health. A review of building regulations across Europe found that every country studied had similar structures for building control systems and technical requirements (Branco Pedro et al., 2010), meaning these findings are likely to be transferable to other countries.

2.3. Damp and mould, excess cold, and overheating as key hazards for health in homes

The research presented in this article centres on three health hazards in the Healthy Housing Safety Rating System (HHSRS) associated with poor building design and the thermal performance and quality of housing: damp and mould, excess cold, and overheating. The 2017–18 English Housing Survey shows that 4% of English homes had damp, 2% had problems with condensation and mould and 7% of residents also reported their homes as uncomfortably hot (MHCLG, 2019). In Europe this problem is even greater, with the EU statistics on income and living conditions from 2016 show that 15.4% of homes had damp and 8.7% of homes were not able to stay adequately warm (Eurostat, 2018). We saw above that research is starting to put a health cost on these hazards (BRE, 2015; Upstream, 2018).

The policy analysis focuses on these health hazards in particular due to the size and quality of the existing evidence base identified in the project's systematic review linking the thermal quality of buildings with health and well-being in high income countries (Ige et al., 2018). Though thermal quality issues such as mould and damp are often associated with older homes, thermal quality of housing is an issue in *new* buildings in England as mentioned above. Arguably, regulations on new and existing buildings have been less successful in supporting broader health outcomes, despite building energy performance standards having improved over the years in response to climate change mitigation and fuel poverty rising up the policy agenda.

A number of studies conducted outside the UK have called for better consideration of thermal quality in building design and regulations (Howden-Chapman et al., 2008; Healy, 2003). Findings from Healy, 2003 showed that four European countries with the poorest standard of housing, Portugal, Greece, Ireland, and the UK, recorded higher scores for excess winter deaths. A randomised controlled study conducted in New Zealand examined the impact of improved home heating on asthma and respiratory outcomes among children (Howden-Chapman et al., 2008). Findings from this study showed that children living in homes with improved heating had fewer reports of poor health, reported fewer visits to the doctor or pharmacy for asthma related conditions, and had fewer days off school than children who did not receive improvements to the heating system until the end of the trial.

2.4. The rational for a more integrated approach to protecting both the environment and human health

Policy had already identified them as risk factors (HM Government - Housing Act, 2004; DCLG, 2006a, 2006b). But a lack of integrated thinking in regulating new building quality has led to an uneven system favouring climate change mitigation at the expense of adaptation and securing broader health outcomes. As previous research shows, buildings in developed countries are becoming increasingly airtight as a response to stricter energy efficiency requirements (Milner et al., 2011; The findings section will retrace the evolution of policy drivers of building policy). This article therefore argues for a more systems-based approach to building policy that would consider both human health and climate change. Systems approaches are increasingly used to explain the interconnections between the built environment and health. The socio-environmental approach to health developed by Dahlgren and Whitehead (Dahlgren and Whitehead, 1991) has identified a complex web of social, economic and environmental risk factors on health and health equity. In particular, the link between our health and living environment has been well documented over the years at all scales from homes to city scale (Barton and Grant, 2006; Carmichael et al., 2019; Barton, 2017; Barton et al., 2015; Corburn, 2013). The socio-environmental approach has been developed further to link ecosystem conditions (biophysical, chemical or biodiversity) to wellbeing (Reis et al., 2015). This latest model is useful to advocate interventions at international/national (e.g. eliminating diesel engines) and local (e.g. urban planning) levels, it also advocates for the considerations of the co-benefits of an intervention (e.g. energy efficiency AND wellbeing). It is, however, not necessarily easy to translate the model to the real world. A number of issues emerge: 1. the strength of the evidence varies for different risk factors (e.g. PHE, 2017; Ige et al., 2018); 2. apportioning health risks to various factors is a complex issue within a system (e.g. Government Office for Science, 2007) and 3. regulatory regimes remain siloed with different scales of the built environment ruled by different sets of standards and regulations, reflecting different disciplines, professions, practices and policies (Siri et al., 2016). Yet, these can have a combined effect as they are linked (e.g. instance urban planning delivering homes and promoting sustainability but not regulating building fabric (Ige et al., 2018)) and research and practice should seek solutions which support human health as well as the environment.

3. Materials and methods

3.1. Identifying the current evidence base on the impact of buildings on health

The Upstream project provided the literature review on the impact of design features on health at the building scale. This article used only the evidence associating buildings' thermal quality and health

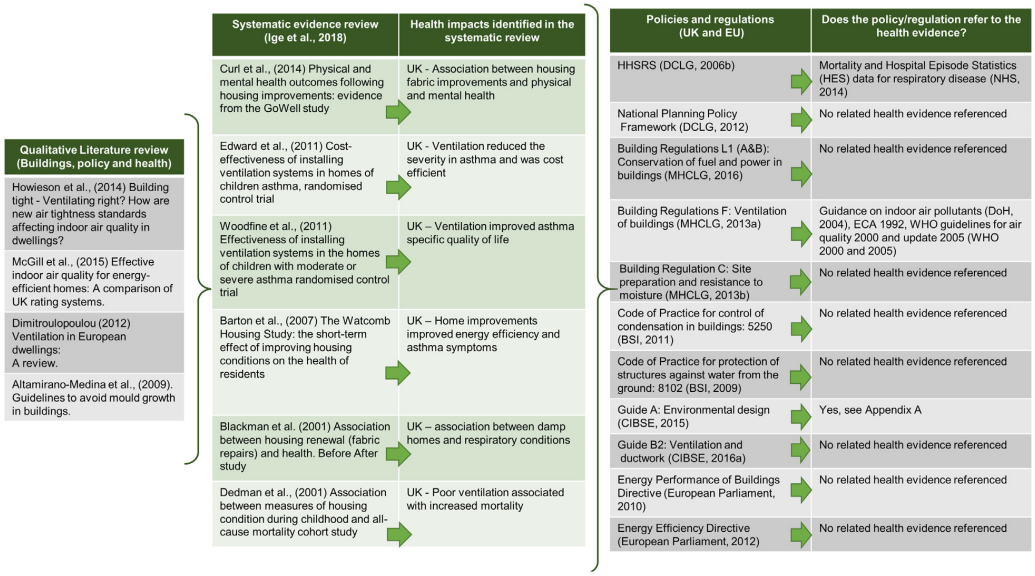

Fig. 1. Evidence pathway for housing hazard 'damp and mould growth'.

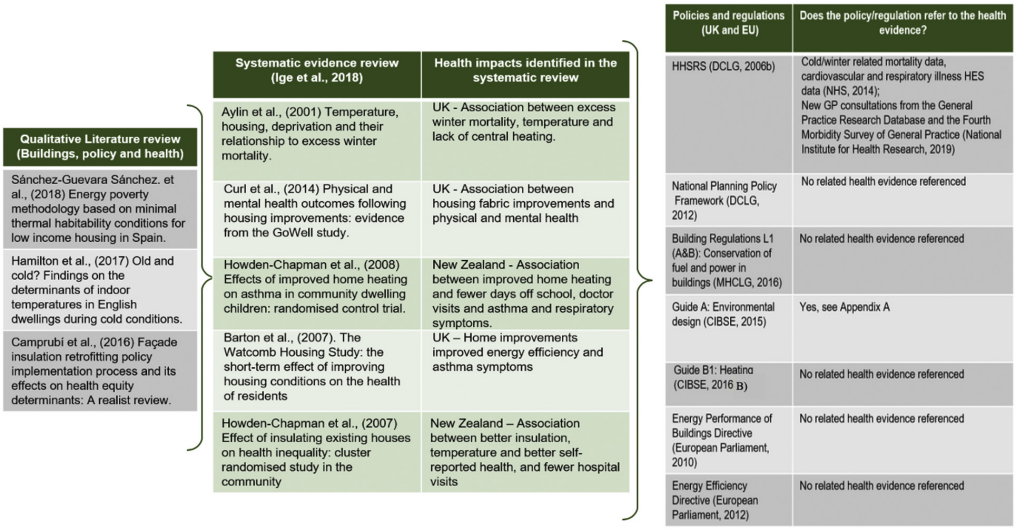

Fig. 2. Evidence pathway for housing hazard 'excess cold'.

that was identified in this review and listed in Figs. 1–3[2] (Aylin et al., 2001; Baborska-Narozny and Grudzinska, 2016; Barton et al., 2007; Curl et al., 2014; Department of Health, 2004; Dimitroulopoulou, 2012; European Concerted Action, 1992; European parliament, 2010; European Parliament, 2012; Hamilton et al., 2017; Howden-Chapman et al., 2014; McGill et al., 2015; Ministry of Housing Communities and Local Government (MHCLG), 2016; National Health Service, 2014; National Institute for Health Research, 2019; Sánchez et al., 2018; World Health Organisation, 2005; Ige et al., 2018). The full methodology for this evidence review can be found in Ige et al. (2018). Drawing from Ige et al. (2018), the authors undertook qualitative policy review and semi-structured expert interviews. This allowed to contextualise evidence-policy gap and provides a rich description of the current state of knowledge and practice in UK housing.

3.2. Qualitative review: identifying policy drivers of key regulations around buildings

The research then wanted to explore if English policy on building was informed by the public health evidence base. First the researchers identified key guidance and regulations on buildings. The initial list of

[2] The five environment themes included: buildings, transport, neighbourhood design, food and natural environment.

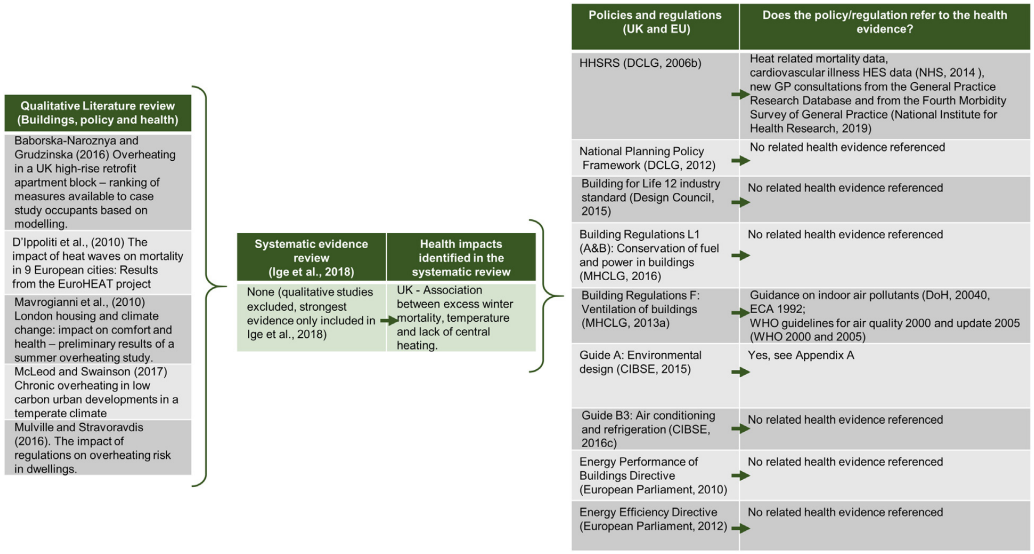

Fig. 3. Evidence pathway for housing hazard 'excess heat'.

key policies and building regulations (Figs. 1–3) for new housing development in England was elaborated through a full search of relevant governmental department policy libraries, in particular the Ministry of Housing, Communities & Local Government, and identified standards such as CIBSE. Initially, policy documents were reviewed using keyword searches for "health", "cold" "heat" "damp" "mould". Policy documents with positive matches to key words were subject to a more in-depth review to identify specific reference to the health evidence base, with in-policy references recorded in a database. Subsequently, in-policy health references were crosschecked with the evidence base identified in the systematic review (Ige et al., 2018) and studies identified in a 'buildings, policy and health impacts literature review.

Referenced studies in policy documents relating to workplaces and healthcare premises were not included as the emphasis of the analysis was on residential buildings. References related to increased productivity and comfort were also not included as they are not specifically health outcomes.

Once the policies were identified, researchers carried out qualitative review of literature on buildings, policy and health aimed to explore the evolution of drivers influencing English building policy and regulations and the extent to which public health evidence competes with other priorities.

The methodology for the qualitative literature review is as follows. In Scopus, searches were run using the terms: building *and* health *and* (policy *or* regulation *or* standard *or* directive) *and*… with the final term being each of the items in the HHSRS hazard list (DCLG, 2006a, 2006b). For each hazard, the results were exported to a separate spreadsheet and labelled before combining, sorting alphabetically and removing duplications. For the analysis in this article, results relating to damp and mould, cold and overheating were exported and screened. Abstracts were screened for relevance and categorised against the following criteria:

- Findings discuss i. the link between a health impact (e.g. asthma, obesity, injury, cancer, heart disease), ii. a building design feature (e.g.

Table 1a
Summary of pathways between damp and mould hazard from the HHSRS and health outcomes.

Hazard	Possible health effect	Pathway/cause	Design feature/defect	Value
Damp and mould	*Asthma *Depression, anxiety, social isolation *Allergy: rhinitis, conjunctivitis, eczema, cough and wheeze *Fungal infection Suppressed immune system	*Reduced ventilation levels *Increased humidity, especially beyond 70% *Warmer indoor temperatures in winter	*Lack of damp proof courses *External fabric allowing rain penetration *Lack of frost protection *Poor bath and sink design *Poorly installed drainage *Poorly installed rainwater goods *Poorly ventilated roof and under floor spaces *Inadequate means of ventilation *Poor extraction of moisture laden air	The health impact potential of damp and mould on respiratory illnesses, eczema and headaches could be valued at £325,000 per 1000 people per year (Upstream, 2018)

Table 1b
Summary of pathways between excess cold hazards from the HHSRS and health outcomes.

Hazard	Possible health effect	Pathway/cause	Design feature/defect	Value
Excess cold	Below 19 °C: small risk, Below 16 °C: serious health risks for the elderly, Below 10 °C: great risk *Cardiovascular conditions: stroke, heart disease, hypertension *Respiratory disease *Suppressed immune system	*Changes in outdoor temperature *Low energy efficiency ratings (poor insulation) *Absence of central heating/poor inefficient heating systems *Excessive damp which reduces thermal insulation	*Thermal insulation *Appropriate/properly installed or maintained occupant controllable heating system *Appropriate/properly installed or maintained occupant controllable low-level background ventilation *Means for rapid ventilation at times of high moisture production in kitchens/bathrooms *Properly sited/sized permanent openings (e.g. air bricks/open-able windows) *Properly fitting butt-jointed floor boarding/doors/windows	The health impact potential of cold on mortality, sickness absence, and hospital admissions could be valued at £240,500 per 1000 people per year (Upstream, 2018)

ventilation, thermal properties) and iii. a policy/ regulation/ standard/ directive;
- Has a UK or EU focus

Studies were categorised as 1, 2 or 3, with 1 fully meeting both criteria, 2 meeting the first criteria but not being UK or EU focussed and 3 not fully meeting either criteria. Studies categorised as 1 were subject to a more in-depth review of their findings with a focus on articles published since 2000. The choice of this date assumed an emergence of a body of literature on building thermal performance, policy and regulation linked to the adoption of the EU Directive on the Energy Performance of Buildings in 2002.

3.3. Semi-structured interviews with stakeholders

Two rounds of 14 semi-structured interviews with practitioners were carried out, confirming the key drivers for building policies and practice (Upstream, 2018). The urban development process is complex, involving a series of different actors with different agendas and no common understanding of the built environment as a determinant of health. The interviewees represented a wide range of key decision-makers from English principal urban development delivery agencies. The interviews with senior executives from the public and private sector sought to explore in particular the practitioners' understanding of health, the importance of health evidence in their decision-making process, barriers and opportunities to the creation of healthy and sustainable urban environments, and agencies and networks for delivering healthy urban sustainable environment. Each interview was undertaken using a framework of 13 thematic areas developed by the research team with input from four expert advisors representing real estate, city government, estate agency and volume house-building. Coding of qualitative interview transcripts used the NVivo software. Interviews helped clarify the role of evidence in the practice of housing delivery and the issues raised by practice around the research/practice synergy (Upstream, 2018).

4. Findings

4.1. Scope and limit of current policy to regulate damp and mould, excess cold or overheating in new buildings in England

The statutory HHSRS was introduced in 2006 following the Housing Act (HM Government - Housing Act, 2004; DCLG, 2006a, 2006b). It changed the way housing conditions were assessed to place the onus on local authorities and to look at the condition of properties using a risk assessment approach rather than a set of minimum standards. It is concerned with avoiding or, at the very least, minimising potential health hazards of which it lists 29. Hazards are classed as category 1 or 2 depending on the likely impact. The HHSRS is supported by extensive reviews of the literature and by detailed analyses of statistical data on the impact of housing conditions on health. It is a system applied to the *existing* housing stock only but can be used to assess housing of any tenure. In practice, it is often used as a reactive safeguarding method, largely adopted for housing in the socially or privately rented sector and often relying on complaints from tenants (House of Commons, 2018). If HHSRS highlights a hazard, a range of policy tools are available for local authorities to use such as providing advice; signposting to other agencies, financial assistance, and only after all informal avenues have been exhausted enforcement action (Planning Portal/MHCLG, 2019a; e.g. South Gloucestershire Council, 2018).

Table 1a–1c summarises the hazards, the associated possible health effects, pathway/cause and housing design defects identified in HHSRS with their data sources.

Despite this existing policy framework, the thermal quality of new buildings remains an issue. Hence two questions emerge for the future: is the public health evidence comprehensively reflected in policy regulating new buildings and why have some advances been made on health (tackling fuel poverty) while at the same time damp and mould and overheating are emerging more strongly in English housing? Is a lack of a systems approach in building regulations leading to the creation of new health issues?

Table 1c
Summary of pathways between excess heat hazard from the HHSRS and health outcomes.

Hazard	Possible health effect	Pathway/cause	Design feature/defect	Value
Excess heat	*Thermal stress *Cardiovascular conditions: stroke *Mortality increases in temperatures over 25 °C	*Poor ventilation *Smaller dwellings *Large areas of south facing glazing *Faulty or sub-standard heating controls	*Shuttering or blinds *Natural ventilation or air conditioning *Controllable heating systems	The health impact potential of excess heat on mortality could be valued at £470,000 per 1000 people per year (Upstream, 2018)

4.2. Thermal quality of buildings on health: the evidence base

Extensive reviews of the literature and statistical data on the impact of housing conditions on health informed the HHSRS which aimed to inform practice at the time of its development (DCLG, 2006a, 2006b). However, the guidance recognises the continuing process of the knowledge creation and that "*it is the responsibility of professionals using the HHSRS to keep up-to-date on current evidence*" (ODPM, 2004, p.7). The Upstream evidence review (Ige et al., 2018) identified 40 studies under the theme of 'buildings'. Within these, eight studies provided strong to moderate evidence of the impact of design features related to "improved quality of housing (thermal and ventilation)" on health (Figs. 1–3). In particular, the links were strong between building fabrics and excess cold as well as with damp and mould. Weak evidence was identified for excess heat. The HHSRS had similarly identified weak evidence for excess heat. Here, qualitative literature discussing the link between health impacts, building design feature and policy instruments further identified qualitative evidence on the impact of design features linked to thermal comfort and ventilation on health (Figs. 1–3).

4.3. Translating the evidence base to the practice of development

When interviewees reflected on the meaning of health for the built environment, they included the thermal quality of homes, in particular damp and mould and the need to ventilate. One developer for instance stated:

> "*Having enough houses so that people aren't homeless, having an address so that you can then apply for a GP, be part of the social fabric of which health is part of collective provision, the right not to live in a damp house* (…)".

Another (public sector developer) mentioned the need for properties to be

> "[properties need to be] *cost effective to heat, to ventilate. Those things are really important, so that people can live in a comfortable environment.* (…) *As a council,* (…) *we're trying to reduce the energy costs of the properties. Within that, within doing passive house, you also have to make sure the ventilation's right. Because otherwise you can get quite stifling environments*".

The HHSRS requires professionals to keep up to date with the current evidence base, but an issue raised by developers is how to find this evidence base. One developer asserted that '*what we're really keen to see is the evidence base for that impact of the built environment on health* (…) *because then we can build them in to our plans*. Another admitted knowledge translation into user-friendly guidance to be a problem: *That's always going to be any research on the environment trying to get the information to the right people at the right time is always tricky* (…)'. Organisations seen by developers as able to translate the evidence base included BREAAM, Well Standard, BREAAM communities, UK Green Building Council, Building Technologies Office, Institute of Civil Engineers, Building Technologies Office (BTO).

As for the role of policy and regulations, developers doubt whether health outcomes are reflected in policy. '*Well I think evidence might be lacking, everybody builds complying with statutory obligations as a baseline, building regulations* etc., *but I'm not sure how much health is considered within building regulations*. Another also fully admits focusing on building performance:

> "*A lot of properties we've just built this year are passive house… there are two drivers for it. One is the environmental sustainability, the zero-carbon issue. And the other one is anti-poverty. So, in a sense, these have not been influenced by a view on health*".

While health considerations do not typically inform development practices, issues like ventilation are raised by the residents:

> "*As building regulations have changed, the emphasis has been on energy efficiency… to achieve that, houses have had to be more sealed than they have been in the past, so there's a lot of air tightness tests now done. However, what we probably have seen is issues with problems with condensation that can cause, and you can get mould. I do see it coming through from customers, you know, complaints about mould and damp*".

4.4. Identifying the evidence base in the English planning and building policies

Five key governance tools regulating building conditions and design were identified from HHSRS (DCLG, 2006a, 2006b), the policy review and developers' interviews:

1. National Planning Policy Framework (NPPF) and Guidance (NPPG)
2. Three Building regulations:
   a) Site preparation and resistance to contaminates and moisture: Approved Document C;
   b) Ventilation: Approved Document F. Building Regulations;
   c) Conservation of fuel and power: Approved Document LMinistry of Housing Communities and Local Government (MHCLG), 2013b; Ministry of Housing Communities and Local Government (MHCLG), 2015
3. Two British Standards Institution (BSI) Codes of Practice:
   a) Control of condensation in buildings: 5250 British Standards Institute, 2009
   b) protection of structures against water from the ground: 8102. British Standards Institute- BSI, 2011
4. Four Chartered Institution of Building Services Engineers (CIBSE) Guides:
   a) GVA/15 Guide A: Environmental design
   b) GVB1/16 Guide B1: Heating Chartered Institution of Building Services Engineers - CIBSE, 2016b
   c) GVB2/16 Guide B2: Ventilation and ductwork Chartered Institution of Building Services Engineers - CIBSE, 2016a
   d) GVB3/16 Guide B3: Air Conditioning and Refrigeration. Chartered Institution of Building Services Engineers - CIBSE, 2016c
5. Two EU directives.
   a) 2010/31/EU; Energy Performance of Buildings
   b) 2012/27/EU; Energy Efficiency.

In addition, wider guidance and voluntary standards (e.g. Build for Life standard, Design Council, 2015) support good practice in the field without putting pressure on developers. The figures below identified the evidence referenced in policies regulating the three HHSRS housing hazards 'damp and mould' (Fig. 1), 'excess cold' (Fig. 2) and 'excess heat' (Fig. 3). Of the five governance tools only two types referenced health evidence. Specifically; Building Regulation ("F: Ventilation of buildings", MHCLG, 2013a) which referenced evidence including from the Department of Health and WHO. CIBSE (2015) Guide "A: Environmental design" also had extensive health references including WHO, DEFRA, NHS and the DoH (see Appendix A). This ranged from the most recent evidence being published in 2014 to the oldest cited evidence being from 1980.

In all of the other policies and regulations there was no related health evidence referenced. Some of the regulations referenced the

Health and Safety Executive (HSE) regulations and Her Majesty's Stationery Office (HMSO) acts and regulations.

4.5. Identifying policy drivers of key regulations around buildings

The health, building and policy literature reviewed has identified climate change mitigation as a key driver of the building policy agenda in recent years and this provides a possible explanation as to why so little health evidence was found in statutory and key guidance documents on new residential buildings. The requirement for higher thermal specifications in buildings has resulted from obligations to mitigate climate change by reducing energy use and carbon emissions, as well as reduce fuel poverty and improve the thermal quality of homes. As shown, this has led to a conflict with some health outcomes when a balance has not been struck between energy conservation and ensuring human health.

The literature also identifies an emerging issue for the UK context that should have higher significance in building policy, planning and practice: the problem of rising temperature and its impact on current building practices. While still difficult to evaluate the actual temperature increase across the globe, human activities are estimated to have caused approximately 1.0 °C of global warming above pre-industrial levels and likely to reach 1.5 °C before 2030 (IPCC, 2018). Building regulations have made clear the need to mitigate climate change. However, research has emphasised that the predicted temperature rise in temperate and cooler countries such as the UK also requires adaptation (Mulville and Stravoravdis, 2016). Overheating in residential buildings is now identified even in the UK (Baborska-Narozny a and Grudzinska, 2016; D'Ippoliti et al., 2010; Mavrogianni et al., 2010). The Upstream project's evidence review however did not identify strong health evidence related to overheating in building (Ige et al., 2018). For health and wellbeing to become a driver of holistic policy more research is needed into the health impacts of overheating in the UK.

Historically, building policy drivers included tackling equity in health in relation to cold homes, mitigating climate change and ensuring value for money. Building regulations agencies first aimed to regulate urban development, lack of sanitation and hazards and protect the health and safety of residents (Meacham, 2016). With rising awareness of the impact of increasing greenhouse gas emissions and the significant contribution of building energy use to UK greenhouse gas emissions, the debate shifted away from protecting the residents towards protecting the planet (Mulville and Stravoravdis, 2016). Building regulations started to focus on energy conservation and performance in an effort to tackle climate change, enhance resilience and sustainability (Meacham, 2016). The result has been an increase in energy performance targets required by the UK Climate Change Act (HM Government, 2008) and the EU Energy Performance of Buildings Directive, which is implemented in the new residential buildings through building regulations (UK Part L revised in 2010 and 2013).

This shift also resulted in a positive impact on health. In particular cold homes and fuel poverty have been identified as public health issues requiring policy interventions (Poortinga et al., 2017; Camprubí et al., 2016). Energy performance in buildings became a useful tool for delivering health and equity by reducing exposure to cold (Hamilton et al., 2015). Regulatory standards to tackle climate change also informed the now defunct UK Code for Sustainable Homes (CSH) from 2007, a compulsory (CSH level 3) standard for any publicly funded building projects also used by private developers.

5. Discussion

This article explored the use of evidence in policy to regulate new buildings in England to deliver public health, improve climate resilience and reduce carbon footprint, in particular we explored the policy drivers and awareness of the public health evidence.

The key findings of this work are as follows:

- Review of English building policies and regulations revealed gaps in evidence use
- Building policy in England focuses on climate change mitigation rather than public health
- Building policy uses public health evidence in a patchy, unstructured way
- Lack of systems thinking has led to building standards ignoring health
- A single policy regime must regulate different phases and scales of urban development

These key findings and other issues identified in the way public health evidence is used in building policy, are discussed in more detail, below.

5.1. Buildings are complex and a systems approach is needed for research

Building regulations have made progress towards addressing UK climate change mitigation and fuel poverty targets. However, with global temperatures predicted to rise over the next decades, housing providers need to build for new climate circumstances and place more effort on climate adaptation. This means that policy needs to continue to regulate for improved building fabrics and technologies to save energy while addressing the unintended consequences of more insulated and air-tight buildings, that are likely to be exacerbated by climate change. Meacham (2016) has suggested developing a better understanding of holistic building performance, along with the data and tools to assess performance, and more integrated regulatory and market measures to achieve societal expectations for safe, healthy, sustainable and resilient buildings. A systems approach might help the consideration of multi-risk factors on multiple aspects of health (mental, physical, environmental, equity).

5.2. At the policy level, a systems approach translates into the need for policy integration and coordination

Planning and building regulations offer a range of processes applied at different stages of development and scales of the built environment. Planning policy aims at shaping the urban form, local energy production and distribution, as well as increased urban density. Meanwhile, building regulations aim at building performance (McLeod and Swainson, 2017) but are not a condition of planning enforcement.

Research demonstrates that various scales and aspects of the built environment can affect health, including those regulated by planning (e.g. neighbourhood design, appearance of buildings and landscaping and highway access and wider transport infrastructure) and those regulated by building regulations (e.g. building design to ensure safety and health, energy conservation, disabled access). Yet planning and building regulations approval regimes differ to the extent that professional bodies themselves acknowledge that clarity is lacking on what building work each regime applies to (Planning Portal/MHCLG, 2019b).

Planning policy in England has recently championed the need to create healthy communities while tackling climate change. The NPPF (MGCLG, 2018b) and NPPG (DCLG, 2012) refer extensively to the creation of healthy and sustainable communities, in particular the NPPF introducing a "*presumption in favour of sustainable development*" (MHCLG, 2018b, para. 10–11). The NPPF links planning with climate change ("*Plans should take a proactive approach to mitigating and adapting to climate change*" para. 148; MHCLG, 2018b) and also highlights the importance of quality design ("*The creation of high-quality buildings and places is fundamental to what the planning and development process should achieve*", section 12, MHCLG, 2018b). Yet the NPPF does not reference public health evidence base directly.

Building regulations, which apply to new and retrofitted buildings since the 1984 Building Act (building standards are not applied

retrospectively to the existing stock), as shown, make limited references to health impacts, with the exception of Part F Ventilation, which refers to the impact of mould growth and pollutants on the health of people in buildings (MHCLG, 2013a). No approved tool focused on healthy design and, as this paper has demonstrated to an integrated systems approach.

Policy priority for both NPPF and building regulations has been placed on sustainable or energy efficient design of buildings and places without sufficient consideration of health impacts. As this article has documented, this has led to unintended health consequences and is likely inadequate for building a housing stock resilient to future climate change. To address this, planning could have a wider scope to regulate specific hazards (cold, heat, damp and mould), placing more pressure on developers to take a holistic approach to energy efficiency and climate change measures that have both positive and negative impacts on the thermal quality of housing and health. A focus in both the NPPF and building regulations on the full range of SDGs that link to our urban environment could aid this holistic approach, as indeed the now defunct Code for Sustainable Homes made steps towards creating.

5.3. English housing market is "broken" and needs to be fixed

The market context in which these governance tools should be implemented is problematic for a number of reasons. Firstly, local authorities are under pressure to maintain their housing delivery schedule. In case of under-delivery, The NPPF 2018 states that "*the* (*local*) *authority should prepare an action plan in line with national planning guidance, to assess the causes of under-delivery and identify actions to increase delivery in future years*" (para 75, MHCLG, 2018b). This reduces their ability to negotiate on building design as well as their capacity to incorporate recent research and learning on the health impacts of different features (Carmichael et al., 2019).

Secondly, the developers are understandably unwilling to build to higher design standard for health than set out in the UK Building Regulations. Setting out higher design standards for health in the UK Building Regulations would help create "a level playing field for the private sector", a point made in the stakeholder interviews. In particular, private sector developers (who deliver the majority of new homes in England) are answerable to their shareholders and so viability in terms of a minimum return on their investment is a key driver. While the revised 2018 NPPF puts the emphasis on assessing viability at the strategic planning level rather than project by project, the 'need to make a profit' barrier still exists for private developers. Therefore, additional market enablers are likely needed to make developer build to a higher design than the minimum standard.

5.4. The gap between expert knowledge and lay knowledge widens

Another issue is the growing gap between expert knowledge on design of energy efficient, green buildings and lay knowledge of house builders and house holders, particularly around indoor quality, and damp and mould. As design and construction of housing becomes more sophisticated with energy efficiency and carbon emission reduction key priorities, knowledge gaps widen between different groups. Firstly, the knowledge gap between building energy researcher, engineers and designers, and house builders that has contributed to a 'performance gap' between designed and built performance. Secondly, the knowledge gap between those who design and build homes and those who live in them, that can mean householders do not know how to effectively use more energy efficient homes. This was an issue highlighted in interviews with one stakeholder identifying the lack of knowledge about the need to open windows in more energy efficient, insulated, air-tight homes to stop mould growth.

The solutions to the first knowledge gap are complex but in terms of health impact a more holistic approach to both policy and skills training could lead to more considerate building practices where there is greater knowledge of the links between building design and health. For the second knowledge gap, improved access to education materials on new homes and how to use them could help. Even small and cheap appliances typically come with user guides, yet, the most expensive purchase in most people's lives, a home, does not. Is it time to consider mandating user guides for homes?

5.5. Gaps in public health evidence remain

The evidence review used in this article (Ige et al., 2018) found very limited evidence on the impact of mould, damp, cold or heat on mental wellbeing. In addition, it did not identify strong health evidence related to overheating in buildings. In the UK, no policy indicates indoor temperature levels for homes in summer that could be detrimental to health. It is difficult to conclude whether the health risks associated with living in an overheated house will be minimal or if, as an emerging concern for the UK, insufficient research has yet been carried out.

However, overheating was mentioned as a new trend in interviews and qualitative evidence review and there is a body of building energy research into the causes of overheating in homes and the possible implications of future temperature increases due to climate change (see, for example, Beizaee et al., 2013 and Gupta and Gregg, 2013). An often mentioned positive outcome of increasing temperatures is the reduction in health problems due to cold in winter. However, there are likely to still be issues with cold homes in the existing building stock, particularly in the private rented sector where improvements are dependent on private landlords. Therefore, policies and standards need to help deliver homes that are warmer in winter and cooler in summer. A focus on the health impacts of both in building policy and regulations could contribute towards a holistic approach. However, more research is needed on the wider health impacts of overheating in homes, particularly in the UK context.

With the exact extent of future climate change and the impact on the number of too cold and overheated homes in the UK uncertain, preparing for a warmer climate in England is a moving target for developers, without policy guidance. Yet, for purely commercial reasons developers cannot afford to ignore climate change and its impact on housing due to the future impact on house prices and their reputation. Developers will be eager to know the impact of overheating and respond to new demands on the market.

6. Conclusion

A key challenge identified has been the lack of systems approach and integrated policy environment to take into account all the factors and actors influencing the building policy process. Interviews from developers confirm that finding user-friendly evidence means relying on expert bodies. Building regulations can provide clarity for builders, and are not dependent on the competency of local authorities to interpret and integrate health evidence into building design. Yet health evidence needs to filter through the policy process and the research has identified a stark lack of influence of health evidence.

Research findings in this article further support the need for a holistic revision on the use of evidence in policy and regulation that considers interdependencies, and includes a specific focus on public health, rather than simply on environmental quality, climate resilience or reducing the carbon footprint of buildings in isolation.

In the future, to create a more holistic policy approach to housing – design, build and planning – an integrated framework is needed with a broader set of key drivers. A framework based on the sustainable development goals (SDGs) where indicators link to the built environment (as set out in the introductory section) could help ensure sufficient importance is placed on energy efficiency and climate change, equity, sanitation, cost effectiveness, and health and wellbeing. The aim would be to ensure firstly that unintended health consequences of focussing on one driver, such as energy efficiency (discussed in this article), are

avoided and secondly to improve the overall health and wellbeing impact of homes.

In view of the strong evidence base linking housing design and health, the next step of the research is to further review the scope and limit of public health evidence to inform policy and regulation in relation to a wider range of housing hazards. Based on findings in this case study over the thermal quality of homes, greater consideration of the public health evidence base is needed in (re)development of building regulations and other standards. Ideally, this should happen at the national level with a holistic review of the buildings regulations. At the local level, further work is needed to better contextualise the health evidence for local authorities in relation to local planning, and house building where local authorities are in the developer role.

By highlighting the available evidence and policies related to health and built environment, the article contributes towards closing the gap between SDGs and the relevant data. Furthermore, SDGs serve as a constant reminder that monitoring and evidencing key aspects of urban living will facilitate effective interventions. By compiling indicators related to both planetary and human health, SDGs emphasise the need for a systemic account of building regulations and practices. Finally, as the SDGs Agenda aims to enable sustainable development by 2030, the paper highlights the urgency for action and the requirement to consolidate the existing evidence and translate it to the practitioner-friendly formats, that could use the SDGs as a framework.

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ORIGINAL SCHOLARSHIP

Evaluating a workforce development programme: bringing public health into architecture education in England

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ABSTRACT

Architects can play a key role in the wider public health workforce, in ensuring building and urban design is health promoting. However, there is no requirement to teach health by architectural accreditation bodies across Europe. To evaluate the long-term individual and organisational impacts of the Public Health Practitioner in Residence (PHPiR) programme – an educational initiative in a British university to help realise the architecture profession's potential to contribute to improved population health. A longitudinal mixed-methods evaluation using the RE-AIM framework. Data were collected using questionnaires, a focus group, interviews, and programme documentation from a Bachelor of Architecture cohort and stakeholders from 2011 to 2019. Participants developed a broad understanding of the determinants of health, which was maintained when qualified architects. The programme became integrated into the university curriculum. Numerous facilitators and barriers affected the participants' ability to create healthier buildings in practice. The positive results from this evaluation suggest that there is value in exploring how the PHPiR approach could be replicated in architecture courses within other higher education institutions. Findings highlight barriers in practice to be addressed in the future to help enable architects to create healthier buildings and places.

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Introduction

Architects as part of the wider public health workforce

Public health and environmental challenges facing the world in the twenty-first century – the ageing population, increasing urbanisation, the rise of non-communicable diseases and climate emergency – require an interdisciplinary approach. The wider public health workforce has been defined as '*any individual who is not a specialist or practitioner in public health, but has the opportunity or ability to positively impact health and wellbeing through their (paid or unpaid) work*' (Centre for Workforce Intelligence and the Royal Society for Public Health 2015).

The importance of this wider workforce is increasingly being recognised. The Centre for Workforce Intelligence and the Royal Society for Public Health (RSfPH) identified 'environment' professionals (such as architects, town planners, surveyors, and ecologists) as the largest proportion of the wider public health workforce, by employment group (13%), the most interested (20%) but one with the lowest level of engagement with the public health agenda (1%) (Centre for Workforce Intelligence and the Royal Society for Public Health 2015). Most attention to date has been on town planners; however, other built environment professionals are equally important as members of the wider workforce.

Studies estimate that as much as 90% of our time is spent indoors, be that at home, work, school, or leisure activities (Klepeis *et al.* 2001). Research on the impact of building design and quality on the health and wellbeing of occupants has been widely reported (Ige *et al.* 2019). It shows buildings can be health promoting, not only in physical environment terms (light, temperature, ventilation, noise, hazards) but also in terms of accessibility, affordability, user-control, adaptability, sustainability, and how buildings address the health and wellbeing needs of a variety of groups across the life course (Public Health England 2017) (Rice 2019a) (Marsh *et al.* 2020).

Despite this, far too often unhealthy buildings exist. In Europe, one out of six people lives in unhealthy homes (RAND Europe 2019). The elderly, those with pre-existing health conditions, and the very young often spend an even greater proportion of their time inside and are especially vulnerable to the building environment. One out of three European children – equal to over 26 million or more than the entire

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population of Scandinavia – lives in unhealthy homes. This presents significant health and social care system challenges (RAND Europe 2019). For example, in the UK it is estimated that the cost of unhealthy housing to the National Health Service is £2.5billion per annum (Nicol *et al.* 2015).

As architects influence not only the design of new buildings but can be involved in regeneration/retrofitting of existing building stock and participate in urban design, they are in a position to contribute to the prevention of ill-health (Marsh *et al.* 2020). The remit, skills, and contacts of architects place them in a key position, by influencing environmental determinants of health, to improve the health and wellbeing of the population. Despite this, there has been relatively little engagement between public health and this profession (Marsh *et al.* 2020). Education programmes are a key way of addressing this but globally few have been established and almost none evaluated (Marsh *et al.* 2020) (Marmot *et al.* 2010) (Royal Society for Public Health 2015).

Education as a method of engagement

The RSfPH recommends to '*provide education and training to the wider workforce ensuring that they are equipped with the requisite skills, competencies and confidence to deliver public health across a variety of settings*' (Royal Society for Public Health 2015). The value of education programmes is widely recognised by the architecture sector as well as by the health sector. The Farrell report, a review of the state of architectural practice and the built environment in 2013 recommended that the architectural training model needs revising to '*prepare for broader decision making, cross-disciplinary understanding…*' (The Farrell Review Team 2015). The Town and Country Planning Association recommends that '*professional institutions in the built environment and health sectors should collaborate to create a shared competency for training and continuing professional development on the built environment and health and wellbeing*' (Town and Country Planning Association 2019).

Globally, there are few architecture courses that offer specific health-related content and modules. Any health labelled content is usually restricted to the design of healthcare settings themselves, with the exception of a small number of courses including links between the built environment, mental health, and wellbeing. There are no curriculum requirements by the architectural accreditation bodies across Europe to teach health in the broader sense, including health promotion (Architects Registration Board 2010) (Royal Institute of British Architects 2018) (Official Journal of the European Union 2013) (Rice 2019b). The UK curriculum only references health and safety legislation (Architects Registration Board 2010). This narrow scope has been acknowledged by the Commission for Architecture and the Built Environment, in their publication '*Future health: sustainable places for health and well-being*', which says that for good health not only do we need to modernise the healthcare system and its buildings, but we also need to promote health and wellbeing through encouraging the design of high quality, sustainable places (Commission for Architecture and the Built Environment 2009). This policy statement has had little influence – the innovative Public Health Practitioner in Residence programme (PHPiR) is one of the few programmes in the world to conduct research into the expansion of the public health workforce into the design professions and one of the first to evaluate the impact this has in practice.

Public health practitioner in residence programme

To address this situation, in 2010 the PHPiR was established as a workforce development initiative at the University of the West of England (UWE), Bristol. The need and justification for the PHPiR, (Pilkington *et al.* 2008) (Bennett-Britton *et al.* 2016) and in-depth details about the programme itself (Pilkington *et al.* 2013) (Grant *et al.* 2015) have previously been described. In summary, since 2010 public health experts (professionals in training with the UK Faculty of Public Health (FPH)) have been embedded within UWE's Department of Architecture and the Built Environment. The programme was mainstreamed into existing core modules on the BA Hons Architecture degree. The PHPiR differs from a guest lecturer model, as the practitioner is embedded within the Department, contributing to research and pedagogic programme development. Input included short lectures, group tutorials, and one-to-one support and mentoring. Three course themes included a life course approach, inequalities in health, and social capital (Grant *et al.* 2015). It sought to engage architecture students in public health issues and concepts, raise awareness of how their profession can impact on the public's health and thereby begin to address the potential of architects to improve population health and wellbeing.

The PHPiR is supported by the World Health Organisation Collaborating Centre for Healthy Urban Environments (WHOCC) which is based in UWE. This is one of the only two WHO Collaborating Centres in the world situated in a built environment faculty. The centre has been running initiatives to promote healthy built environments through research, teaching, and consultancy, and is recognised as a leader in the field.

Evaluation framework

The Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework is one of the most frequently used public health evaluation frameworks and is widely accepted (Glasgow *et al.* 1999)

(Glasgow *et al.* 2019). RE-AIM is a multi-level framework that aims to measure the impact of complex interventions including identifying the barriers and facilitators to real-world implementation, making it particularly suitable given the aim of this research. It has five dimensions which identify factors influencing internal and external validity: *Reach* of the intervention for the target population; *Effectiveness* of the intervention on desired outcomes; *Adoption* of the intervention at organisation and staff levels; *Implementation*, delivery of intervention as intended and participant adherence; *Maintenance* of intervention effects over time, at individual and organisational levels (Glasgow *et al.* 1999).

Aim

The aim was to evaluate the long-term individual and organisational impacts of the PHPiR on a cohort of architecture alumni. It aimed to inform whether the PHPiR is a model that should be rolled-out, to help realise the architecture profession's potential to contribute to improved health and wellbeing of the population through the design and creation of healthier buildings and places.

Methods

Evaluation design

To generate evidence on each dimension of the RE-AIM framework, a mixed-methods longitudinal study was conducted. PHPiR participants provided individual-level data while organisational-level data were collected from the architect tutors and the public health practitioner in residence. Data were obtained from a range of sources: questionnaires, a focus group, interviews, and programme documentation (Table 1).

Individual-level participants

Purposive sampling was used – a single cohort was selected for the longitudinal evaluation to minimise confounding from year to year variation in the programme in terms of staff and delivery. All students in the first cohort enrolled in the PHPiR (students in their fifth and sixth year of study on UWE's Bachelor of Architecture degree in the academic year 2010/11) were invited to participate. The first cohort was selected to give the longest time period possible for follow-up, including time when the participants were both students and qualified architects, to enable an assessment of whether the PHPiR had an impact in practice. Other than involvement in this cohort, there were no other inclusion or exclusion criteria. There was a total of 34 eligible participants. For an overview of participants please see Table 2.

Organisational-level stakeholders

A range of programme stakeholders involved in the first cohort were invited to share feedback on the PHPiR. This included all of the architect tutors (n = 4) and the public health practitioner in residence (n = 1). The objective of conducting data collection with PHPiR stakeholders was to gather evidence that could contribute to the Adoption, Implementation, and Maintenance dimensions of the RE-AIM framework and an organisational-level assessment of impact.

Data collection

Evaluation data were collected over an eight-year period from January 2011 to July 2019. Data were collected using mixed methods at intervals pre-intervention (T_0), immediately post-intervention (T_1), at 4 years (T_2), and at 8 years (T_3) post-intervention (see Table 1).

Table 1. Summary of data collection and analysis methods used to assess each RE-AIM domain.

Data source	When?	Sample *N* (%)	RE-AIM domain	What?	Analysis
PHPiR participants *n* = 34					
Questionnaires	Pre (T_0)	26 (76)	Reach, Effectiveness,	Socio-demographics, knowledge, attitudes,	Basic descriptive analysis
	Post (T_1)	28 (82)	Implementation,	skills	(SPSS)
	8 years	17 (50)	Maintenance		Thematic analysis
Focus group	Post (T_1)	8 (24)	Reach, Effectiveness	Knowledge, attitudes, skills	Thematic analysis
Interviews	8 years (T_3)	8 (24)	Implementation, Maintenance	Semi-structured interviews based on topic guide (30–60 mins) on knowledge, attitudes, and skills	Thematic analysis
Architecture tutors *n* = 4					
Interviews	4 years (T_2)	4 (100)	Adoption, Implementation, Maintenance	Semi-structured interviews based on topic guide (30–60 mins) on knowledge, attitudes, and skills	Grounded theory analysis
Programme documentation	Post (T_1)	1 (25)	Adoption, Implementation	Reflective diaries, university curriculum, student projects	Visual data analysis, impact estimation, barriers/ facilitators
Public health practitioner in residence *n* = 1					
Programme documentation	Post (T_1)	1 (100)	Adoption, Implementation	Reflective diaries, university curriculum, student projects	Visual data analysis. impact estimation, barriers/ facilitators

Table 2. Demographic characteristics of PHPiR participants at eight-year follow-up (n = 17).

Category	Parameters	Frequency *n* (%) or median (IQR)
Gender	Male	8 (47)
	Female	9 (53)
Age (years)[a]		34 (33–35)
Employment status	Employed	16 (94)
Position within organisation[b]	Architecture assistant	2 (13)
	Senior architect	1 (6)
	Associate/project architect	11 (69)
	Director	2 (13)
Length of time working in organisation (years)[b]		3.4 (2–6)
Type of organisation[b]	Private	16 (100)
Number of people in organisation[b]	<10	6 (38)
	10–49	4 (25)
	50–249	3 (19)
	>250	3 (19)
Reach of organisation[b]	Local	0 (0)
	Regional	6 (38)
	National	3 (19)
	International	7 (44)

Percentages may not equal 100 due to rounding.
[a]Some missing data for age.
[b]Percentage reported is for all those in employment n = 16.

In-depth details of the methods, analysis, and results for T_0, T_1 (Pilkington *et al.* 2013) (Grant *et al.* 2015), and T_2 follow-up (Bennett-Britton *et al.* 2016) have been previously reported. An overview of these and details for T_3 are below.

Questionnaires

Conducted at T_0, T_1, and T_3 to assess knowledge, skills, and attitudes of the PHPiR participants including how they change as participants progressed from students to working architects. Participants were emailed detailed information about the study and a link to a questionnaire which contained the consent agreement. Completion of the survey was voluntary, but three email reminders were sent to participants over 6 weeks to boost participation. The questionnaire protocol was developed and validated by the project team then piloted with six architecture professionals. The final questionnaire comprised 21 questions. The questions explored knowledge, skills, and attitudes about the role architecture plays in influencing wider determinants of health, the barriers, and facilitators of using these in practice and the potential for further development of the PHPiR.

Focus group

Conducted at T_1 with eight participants. The purpose of this was to explore some of the questionnaire responses in greater depth. The group was hosted at UWE and run by PP to ensure a familiar, comfortable environment. A summary of the discussion was transcribed (Grant *et al.* 2015).

Interviews

In the T_3 questionnaire, there was an option of a follow-up interview, of which 8/17 participants agreed to. Interviews were conducted face-to-face or by telephone by RM, were semi-structured, and lasted approximately 45 min. A topic guide was developed, validated, and piloted in the same way as the questionnaire. It comprised 12 questions with prompts, to inform dimensions of the RE-AIM framework. At T_2 interviews were also conducted with the four architect tutors by an independent researcher BB (Bennett-Britton *et al.* 2016).

Programme-related documentation

The public health practitioner in residence and one of the architect tutors kept reflective diaries of their experience of the PHPiR. Examples of students' project work were saved over the duration of the programme for visual data analysis. Lastly, the UWE curriculum before and after the practitioner's input was assessed for impact estimation all of which were incorporated to the qualitative data analysis (see below). Data on resource use and costs incurred during the programme were provided by the head of the Department of Architecture and the Built Environment.

Data analyses

Questionnaire data were entered into SPSS Statistics (v.22.0). A basic descriptive analysis was undertaken to assess Maintenance at T_0, T_1, and T_3. Due to the small numbers involved, testing of statistical significance using significance testing was not appropriate.

Interviews were audio-recorded and transcribed verbatim. Some elements of the survey allowed qualitative analysis. All qualitative data were imported into and analysed using NVivo 12 (QSR International). Qualitative data were explored using thematic analysis, with the coding process based predominantly on mapping data against each of the RE-AIM dimensions

in-line with recently published guidance (Summers Holtrop *et al.* 2018).

Data saturation was reached when further coding was no longer feasible (Fusch and Ness 2015). To confirm accuracy and interpretation of the data during the coding process and at theme development, findings were discussed and agreed between authors and reported in line with COREQ guidelines (see Supplementary File 1) (Tong *et al.* 2007).

Results

Reach

All 34 students in the original cohort participated in the PHPiR activities. Taking 34 undergraduate students per year for 8 years (since 2010/11) equates to roughly 306 health aware architects. To put this in perspective, in the UK in 2018, there were around 54,000 architects in employment (Statistia 2019).

By the eight-year data collection, 5 of the 34 (15%) student participants had been lost to follow-up. Of the 29 remaining student participants, 17 responded to the survey and 8 to an interview. Table 2 reveals that the median age was 34 at the time of assessment and there were a similar number of males and females, which is in-line with national figures for architecture students (Royal Institute of British Architecture 2018).

Most participants (69%) were at a relatively senior level – project architect (licensed architect or non-registered graduate with more than 10 years of experience has overall project management responsibility) and had been based in their current organisation for between 2 and 6 years. The majority of participants worked in small organisations (<10 employees) (38%) so had a smaller reach with immediate colleagues but operated at the international level (44%) so had a much larger reach in terms of clients and projects. The participants' work covered many sectors including residential, commercial (retail, office, hospitality), education, health and social care, conservation, and defence buildings, as well as urban design.

Effectiveness

Participants reported being enthused by the programme and felt that they developed a more comprehensive understanding of their role as future architects.

> Studying the wider determinants of health during my university education helped me to think more holistically about sustainable design and our duty of care to the wider community beyond just building users. Participant 13

They had a broad understanding of the term health which included physical, psychological and by most but not all, social elements.

> Previously, before I sort of looked into it in great depth, um, I saw it as physical, purely physical, so you know, medical health, whereas now … I see health is a very large myriad, so not only physical health, but social health, mental health … Health I see as a descriptor that you can attach to almost any part of your life now – work, play, physical health, financial … So, when you say 'health' before it was literally, in a doctor's check-up and now, it's everything, isn't it? For me. Participant 1

Similarly, the vast majority of participants had a very good understanding of term 'wider determinants of health', although one participant did talk about the health of the building itself rather than the people using the building (see Figure 1). Inequalities although not often explicitly stated were described by most participants (see Figure 2).

> I mean, obviously, there's the genetics and all of that sort of thing, and diseases passed on from person to person. But obviously, there are external factors such

Figure 1. Example of students' work showing understanding of wider determinants of health by mapping them against a life course approach.

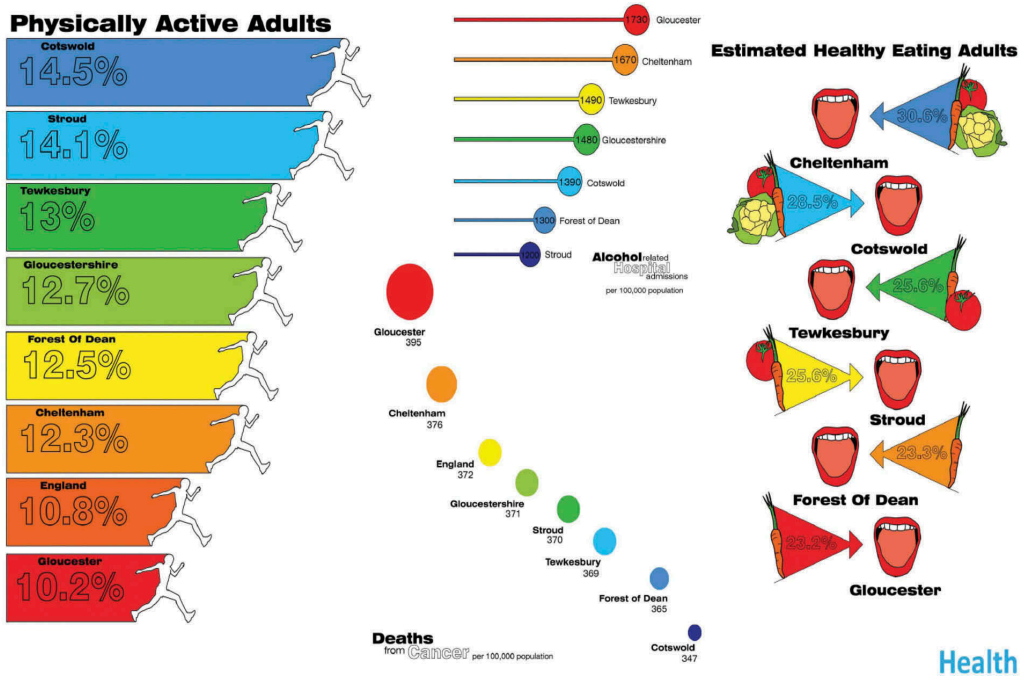

Figure 2. Example of students' work considering inequalities in risk factors for disease (physical activity, alcohol consumption, and healthy eating), as well as mortality rates – to factor into decisions about urban design.

> as your, your environment, your economic kind of classification, I don't like to use that phrase, but you know what I mean – the background they come from. Um, culture … environmental, socio-economic. Participant 3

> I suppose wider determinants of health forces me to think more about … where you're born and geographically what you're born into pretty much determines your wealth, which sadly seems to determine your health … I feel like we probably very much design – that white, middle class, privileged sector that makes up such a majority of architects. Yeah, design spaces that suit us and I think we need more education in how to make our buildings approachable to a more diverse community … I think we perpetuate that segregation through architecture. And I'd really like us to not do it. Participant 2

Participants felt understanding the wider determinants of health bought a greater personal satisfaction to their job and that working to produce healthier buildings and places was an ethical and social responsibility.

> I think we kind of have to as a profession have a responsibility to understand what we're doing will affect people's health in quite broad terms. Participant 5

> When you're dealing with things like housing … the care sector … and schools, you're actually working in an area of architecture, which your architecture and design has a big impact on the occupant. And that's something I find really satisfying. So, from a health point of view, not only do I get a huge benefit, because I've chosen to work in an area where my designs have an impact on people … but also, I feel that we're having an impact, a positive impact upon the health and wellbeing of the occupants … so it basically gave architecture a bit more purpose for me. Participant 1

The participants described a huge range of factors that were important for an architect to consider when designing a healthy building (see Figure 3).

In addition to traditional concerns, namely issues relating to aesthetics, and materials there were numerous descriptions of physiological parameters (light, air quality, temperature, sound, hazards). There was also very much an understanding of psychosocial parameters including space, accessibility (financial – social housing, affordable housing to purchase and run, and physical impairments), inclusivity, interactions and social mixing, community, connection to the outdoors and nature, needs of the user (wayfinding, age/dementia friendly, hard of hearing), adaptability and promotion of physical activity, healthy eating or social mixing (connections, interactions). There was a large prominence on wider impacts through climate change and sustainability. Participants thought about the location of the building and the surrounding area, and the construction process including economic benefits of this, as well as the building itself (see Figure 4).

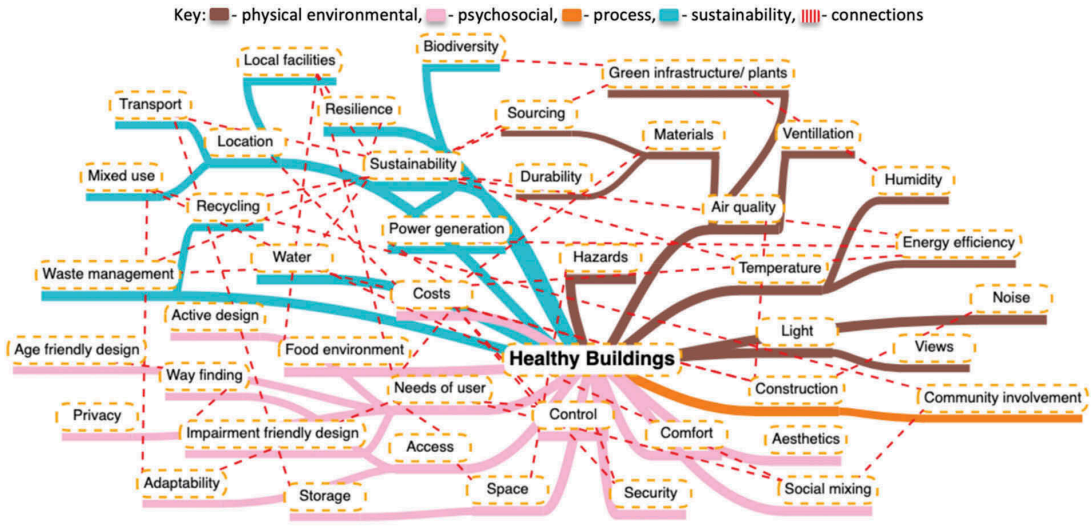

Figure 3. Aspects of buildings which can affect health and wellbeing that were mentioned by participants (Image: Marsh, R).

Figure 4. Example of students' work assessing site location and local facilities. Health promotion, in this case, healthy eating opportunities, as well as environmental sustainability of food sources are being considered in addition to traditional environmental hazards.

A negative finding was that some factors described by participants were not always evidence based. For example, there was a big emphasis on views out of windows, but this is not reflected in the public health evidence base.

Adoption

Due to the WHOCC, there was already a good level of support and understanding of the impact of the built environment on health amongst university staff.

Generally, tutors felt very positively about the PHPiR. They said it offered a constructive and novel approach for architecture students to form a better understanding of public health issues and the relevance of public health to their chosen field. It gave them a way of teaching students to critically appraise their approach to design from a different perspective, in this case the community, and that this was rewarding.

> It was very clear that they [the students] felt that public health was something that they'd never considered and they would do it and they would take it in to their practice work later on … So for me that residency made them look at the communities in a very different light and they then look at different aspects that they may have to consider. Tutor 1

There were also negative comments, for example, there was a perception that the PHPiR was complicated and at times lacked structure and focus. As well as the practitioner in residence it was important for the architecture module leader and head of the department to be behind the PHPiR, and a challenge described was repeatedly obtaining module leader and departmental awareness and commitment when there were staff change-overs.

Implementation

Organisational level

A small grant was received from the Centre for Education on the Built Environment (CEBE) to help with setting up the program but otherwise, the cost and resource required for the PHPiR were minimal. Public health professionals who acted as the practitioner in residence are on NHS funded posts as part of specialist public health training and so were no additional cost to UWE. The PHPiR has offered an ideal training opportunity for these public health professionals, addressing a range of competencies.

The disadvantage with this approach was that although the programme has been running since 2010 the availability of a public health professional has been intermittent. Over the study period, there has been a total of seven practitioners in residence and the level of activity delivery has been variable (with more intensive involvement for 4 years and lighter touch involvement for 3 years) or at times not possible.

Lastly, as requirements of architectural accreditation bodies leave very little room for new topics, sustainability which is already a curriculum requirement was used as a hook to introduce health. It was found that there was sometimes a lack of time/timetabling issues due to curriculum overload.

Individual level

Participants were very supportive of the PHPiR and many felt it helped them perform as a better, more rounded architect. They were supportive of health in the architecture curriculum and felt there should be more health-related courses and continuing professional development (CPD) events.

> I think it's [health in the architecture curriculum and CPD] important. It would help sort of your understanding of the industry as a whole and making sure that you were doing things for people and keeping the people that you are building the building for as your focus, rather than just making money. Participant 5

They produced numerous projects at UWE which had an increased reference to health inequalities and to wider determinants of health and health promotion, with topics including noise, air quality, crime, access to health services and food, physical activity, weight and diets, smoking, and alcohol intake (see Supplementary File 2). The knowledge and skills surrounding these topics continued into practice although participants felt differently about how able they were to implement these aspects into their work (see Maintenance section).

> I think you can't always apply those kind of amazing university ideas and sort of ideals, I guess, into a real life building, because there's commercial considerations, there's regulatory considerations, that are not really being applied, I guess at university. Participant 7

Maintenance

Organisational level

As a result of the PHPiR being established long-lasting changes to the curriculum have been made. Public health concepts including inequalities, a life course approach, and social capital have become embedded into the Bachelor of Architecture curriculum at UWE despite none being present in the national curriculum (Architects Registration Board 2010), and as a result, health is taught in a module on the architecture course as part of routine university practice. Therefore, the impact at the organisational level has been maintained even when a public health practitioner was not available to be resident.

Individual level

The importance of understanding the wider determinants of health was maintained, being ranked higher post-intervention and even more so once in practice than pre-intervention. This was both in order to produce healthy architecture (65% strongly agreed in practice compared to 43% immediately post-intervention) and for the participants own professional development (53% strongly agreed in practice compared to 36% immediately post-intervention). Whereas the feeling of successfully being able to integrate health into their work decreased from university to practice (just 9% agreed in practice compared to 24% immediately post-intervention) (see Table 3).

Table 3. Changes in attitudes from pre-intervention to eight-year follow-up (n = 34).

Statement		N (%) Total	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Mean[a]	SD[a]
For good architecture, it is important for the architect to have a good grasp of the wider determinants of health	Pre (T_0)	26 (100)	-	-	1 (4)	15 (58)	10 (39)	4.35	0.55
	Post (T_1)	28 (100)	-	-	-	16 (57)	12 (43)	4.43	0.49
	8 years (T_3)	17 (100)	-	-	1 (6)	5 (29)	11 (65)	4.59	0.62
For my own professional development, it is important for me to have a good grasp of the wider determinants of health	Pre (T_0)	26 (100)	-	1 (3.8)	1 (4)	15 (58)	9 (35)	4.23	0.70
	Post (T_0)	28 (100)	-	-	1 (4)	17 (61)	10 (36)	4.32	0.52
	8 years (T_3)	17 (100)	-	-	-	8 (47)	9 (53)	4.53	0.51
I feel able to successfully integrate considerations of the wider determinants of health into my work	Pre (T_0)	26 (100)	-	1 (3.8)	8 (31)	12 (46)	5 (19)	3.81	0.79
	Post (T_1)	28 (100)	-	-	-	24 (86)	4 (14)	4.14	0.27
	8 years (T_3)	17 (100)	-	3 (17.6)	1 (6)	9 (53)	4 (24)	3.47	1.01

Percentages may not equal 100 due to rounding.
[a]Rounded to 2 decimal places (1 = strongly disagree, 5 = strongly agree).

A number of themes emerged which explained the variation in views from participants.

Facilitators

Facilitators described by participants related to themselves, their organisation and the project type. Participants felt it was easier to make the case for creating healthy buildings if they were older, at a later stage of their career or had been in a firm for a longer period of time, when they had built more working relationships and their views were perhaps more respected. Working in larger architecture firms which generally have more resources was seen as helpful, particularly in enabling cross-disciplinary working. Psychologists, engineers, computer modellers, and sustainability consultants were all given as an example of roles that helped make the case for the importance of or the mechanism to producing healthy buildings. Projects in the education, residential, or healthcare sectors and which were presented to the architect firm at an early stage in the development process, such as the design brief, with time for consultation with the end users, were easier to influence to make health promoting.

> If you're working on a school or something like that, or a hospital, there's a different agenda, or different priorities so it might be a bit easier to work that in. Participant 3

Participants felt they were seeing a trend of rising awareness about mental health and wellbeing and that this would be helpful in advocating for healthier buildings. Just as sustainability moved from a marginal concern, a few decades ago to a mainstream issue today and is now an integral part of most architectural design processes, participant felt that health could do the same.

> … a greater interest in the, the wellbeing of building occupants generally, in terms of mental health, as much as anything, that's becoming much more prominent … culturally, there seems to be a shift much more in a greater awareness and understanding of people's, particularly mental health. Participant 3

> I think, in the same way that environmental sustainability is an integral part of teaching within architecture school these days, I think, having an awareness of the determinants of health and wellbeing and the role that buildings can play in that, I think is, is very useful as well. Participant 3

There were mixed views on the helpfulness of statutory requirements, regulations, and tools, with some participants feeling they could use them to their advantage and others feeling they made the process slow, laborious and restrictive. There were concerns that regulations evolved too slowly and did not always reflect up-to-date health evidence, but others suggested there could be a more explicit health and wellbeing in buildings regulation. Tools were viewed as most helpful when they were used as conversation starters rather than rigid tick-box exercises. Participants had made use of well-established tools including 3D modelling, acoustic studies, WELL Standard, British Standards, lifetime homes, and more relevant to sustainability – Building Research Establishment Environmental Assessment Method (BREEAM), and Leadership in Energy and Environmental Design (LEED). Participants also described some more innovative methods like profiling surveys, and a virtual reality headset to enable the professionals to perceive the building as a user would.

> … in the past I've done something along the lines of a journey in the life of somebody, so kind of like making different profiles of people and how they might experience a building, move around a building, and what their journey might be from home to said building … somebody told me a really great way of looking at people with different disability needs. Somebody was saying that, like, a really

> great way to capture this and make it truly embedded is that each person in the design team, holds you know, the avatar of somebody, so somebody sits on your shoulder, so somebody who has, or people who are very likely to use those buildings. So, somebody who has partial sightedness and somebody who's in a wheelchair, it's like, you almost take on that persona, as your designing the building. Participant 4

> You can manipulate those regulations sometimes to suit you. I suppose like the, the day lighting ones and those kind of levels of lux, I've definitely forced clients into having more windows than they want to pay for because we're like, well, your lighting levels don't meet a regulation and you can normally dig somewhere … occasionally when we work for developers who are just looking for maximum profit, I can normally find a loophole for getting some community structures or social housing in there. Participant 2

Barriers

The most common barrier faced was resource in terms of both budget (construction and upkeep) and time. Therefore, evidence on the economic value of health-promoting building designs, such as return on investment was suggested as a useful future resource.

> You've got to prove it from an economic point of view, unfortunately, my perspective of the industry is that money talks a lot of the time … I'd say that if there's an economic payback, and I'm pretty sure we could make the argument for making a building healthier, then I would definitely say that private developers would be interested in taking on some of those ideas. Participant 3

Another barrier included a poor understanding of the health and wellbeing impacts of buildings by others involved in the process. This was mainly in relation to clients, but also the general public and other professionals or team members, such as suppliers, contract managers, and project managers. Site restraints as a result of land ownership and economic realities of development patterns were particularly challenging. Participants also noted a set way of doing things and a reluctance to try new things in the industry, especially by more senior architects. Therefore, raising public awareness and engaging with developers, financiers, and landowners were suggestions of thing which could help in the future.

> I think the biggest challenge is getting people to go away from the way that they have always done things, if you see what I mean. It's the nature of the construction industry that they always want to recycle what worked well the last time, you know, when from a health point of view, it's not always the best option. Participant 3

> It's almost about making the public understand the impact of their buildings on their health … I think you just need to make that direct connection, and people will demand better. Participant 3

> … having the ability to engage commercial developers in the process of conceptual design to help the market understand the decisions we make and the benefits they can have to a building and its occupants. Participant 5

Participants felt there were sometimes conflicting priorities making it difficult to know what to recommend, for example, high insulation with minimal ventilation is beneficial for power conservation and therefore sustainability but detrimental to air quality, thick walls can reduce noise but also can be more material intensive and less sustainable, and there is a government drive for a greater quantity of housing but this can be at the detriment of the quality of housing.

Other challenges faced were a lack of evidence due to difficulties measuring and evaluating social or psychological parameters, such as social interactions. Participants raised the importance of evaluating health effects of projects and wanted evidence which was more accessible to people from non-scientific backgrounds, perhaps accompanied by examples of best practise or study trips.

> Further partnerships between academics and live projects to act as exemplars to follow. Participant 13

Concise overviews of benefits for the architectural layperson. Participant 1

Discussion

This evaluation applied the RE-AIM framework to assess individual and organisational impacts of the PHPiR.The collection of quantitative and qualitative data from a range of sources and the relatively long follow-up period helped to identify impacts from the programme while also highlighting barriers and facilitators to real-world implementation. The research is original in that it reveals for the first time, the effectiveness of the integration of public health input to an architecture undergraduate course.

As a result of the PHPiR, architects' understanding and integration of health into their work improved. Public health concepts became embedded in the architecture curriculum at UWE. Whilst this evaluation cannot be directly generalised to other countries it is of relevance globally (RAND Europe 2019), especially to the WHO Healthy Cities movement. Many higher education institutions contain both public health and architecture departments, so this is a feasible option for replication in other countries with a specialist public health training scheme. Universities in countries without formal schemes could explore self-funding public health posts but this would be more costly. Similarly, this approach could be applied to other subject courses, such as planning or urban design, to strengthen the public health workforce. Given the challenge of re-engaging with intermittent resource

from the FPH training scheme and staff changeover, ideally, health would be incorporated into the national architecture curriculum. This would have a more assured, standardised, and wide-reaching impact. It would be best if this was co-developed between public health, architectural and construction bodies, and/or used existing, approved frameworks, such as the Public Health Skills and Knowledge Framework. (Public Health England 2016)

Rather than directing training efforts at practicing professionals and encouraging hyper specialisation, targeting those still in primary training offers a more fundamental and wider-reaching model of spreading public health awareness amongst architecture professionals. However, more research is required to understand the most appropriate stages of training for the residency to be targeted, for example, additionally targeting architecture exams (RIBA Part 3) and CPD courses may address the barrier of a lack of understanding by more senior architects. The approach in this programme is just one of the numerous options to bring public health into architecture education (Bird and Grant 2011); other techniques could also be successful but have not yet been implemented or evaluated.

As well as expanding the education programme, future efforts need to address the facilitators and barriers that are faced in practice. In academia, public health can support architects to conduct opportunistic evaluations of health effects of future buildings and developments, and present evidence in a format which is accessible to people from non-scientific backgrounds. In practice, reviewing discrepancies in existing statutory requirements, building regulations, and tools and making health more explicit within them would address a current barrier. An interesting avenue will be engaging with the general public, developers, financiers, and landowners who possibly have a greater influence over architecture processes than architects through consultation, and by determining budget, site allocation and project briefs.

Strengths and limitations

Evaluation using a single cohort minimised confounding from variations in staffing and delivery of the programme; however, it reduced the sample size and may be overestimating the impact as the first cohort had a relatively high level of enthusiasm and support.

As it was voluntary not all participants provided names on their questionnaire. This meant individual comparisons were not possible and a grouped analysis was used, which risks information and more nuanced trends being lost.

By year eight, half of the participants had been lost to follow-up. There may have been selection bias, with those who completed the survey or accepted an interview being those who most enjoyed or felt the greatest impact from the PHPiR, potentially overestimating the impact. Additionally, as there was no control group, it is possible that participants would have become more health aware anyway, such as from the identified trend of increasing awareness about mental health and wellbeing among the architecture profession. The changes seen may not, therefore, be due to the PHPiR alone. Interviewing a comparison group of Bachelor of Architecture students who have not been through the PHPiR would be an interesting future study.

Lastly, due to UWE's WHOCC, there were already a number of very health-engaged tutors. This may not be the case in other educational institutions, where baseline knowledge and support are lower, making the generalisability of the PHPiR uncertain.

Conclusions

This evaluation has been successful in its aim by applying the RE-AIM framework to evaluate the long-term individual and organisational impacts of the PHPiR.

Despite intermittent practitioner availability, because public health concepts were mainstreamed into UWE's architecture curriculum, programme implementation was maintained throughout the follow-up period. An improved understanding of public health concepts was maintained once qualified architects; however, the real-world ability to create healthier buildings and places was influenced by numerous factors. Facilitating factors were being at a later career stage, working in larger firms, and working on projects on larger sites, in the education, residential, or healthcare sectors. There were mixed views on the helpfulness of statutory requirements, regulations, and tools. Barriers were budget, time, and the understanding of others involved in the architectural process (clients, other professionals especially those who are more senior, and the general public).

The research indicates that embedding public health professionals into architecture training offers a valuable model, at minimal extra resource, for helping to realise the architecture profession's potential to contribute to improved population health. Overall, findings provide insights on potential best practice for education-based public health workforce development initiatives.

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Disclosure statement

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Dr Rachael Marsh is a clinician who has worked in a variety of hospital departments before specialising in Public Health. She has experience working in local governments, Public Health England and academic institutions. Her main areas of interests are health, equity, sustainability and the environment (transport, planning, housing, nature). She has run many teaching sessions, contributed to numerous national consultations on aspects and produced publications relating to these topics. She is a member of a national group on healthy spatial planning and a European network of public health professionals.

Dr Paul Pilkington is a registered Public Health Specialist and Senior Lecturer in Public Health. Dr Pilkington has undertaken a wide range of research projects with impact in the field of healthy and sustainable environments, with funders including Wellcome Trust, NICE, NIHR, and Public Health England. Dr Pilkington was the first UWE Public Health Practitioner in Residence and therefore has detailed knowledge of the Public Health Practitioner in Residence programme.

Elena Marco is an experienced academic leader, educator, practitioner, and researcher, building a top-class reputation for the Department of Architecture and the Built Environment of which she is Head of Department. Before joining UWE, Elena built a strong profile in sustainable design at Feilden Clegg Bradley Studios, working on many pioneering and award-winning projects, some as part of Europe-wide research initiatives. Now in academia, she continues to develop her research, which focuses on the crossover between health, sustainability and architecture. Elena was selected by the Architects Journal as one of the 20 most influential Women in Sustainable Architecture in the UK.

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Ethical approval

Ethics approval was given by the University of the West of England Ethics Committee (REF: HAS.19.02.135).

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Short Communication

A guide to architecture for the public health workforce

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ABSTRACT

Background: Public health and environmental challenges facing the world in the 21st century, including the ageing population, increasing urbanisation, rise of non-communicable diseases and climate instability, require an interdisciplinary response. A significant proportion of the population's time is spent indoors, be it at home, school, work or in leisure time; the work of an architect can cover all of these sectors, but their role in health and well-being remains an under explored area.

Objective: This article examines the architecture profession's potential to contribute to improved health and well-being of the population through healthier buildings and places.

Methodology: This short communication adopts a descriptive approach. First, it maps the remit, skills and influence of the architecture profession and applies this to a well-accepted public health model, the prevention pyramid. Second, it uses themes identified by the Royal Society for Public Health to discuss ways to improve engagement with the architecture profession as part of the wider public health workforce.

Results: This article finds that the remit, skills and potential influence of architects places them in a key position to improve the health and well-being of the population. Despite this, there has been relatively little engagement between public health and this profession. Much more attention to date has been on integrating the planning sector with public health.

Conclusion: Opportunities for improved engagement exist through partnership working, incorporating health into both undergraduate and postgraduate education and continuing professional development training, building the evidence base and developing architecture and health-related policy and legislation.

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Background

Public health and environmental challenges facing the world in the 21st century, including the ageing population, increasing urbanisation, the rise of non-communicable diseases and climate instability, require an interdisciplinary response. The importance of this is now widely accepted and is reflected in the Faculty of Public Health (FPH) workforce strategy, which aims to '*enable the wider workforce to deliver improvements to the public's health*'.[1]

The Royal Society for Public Health (RSPH) identified 'environment' professionals (such as architects, town planners, surveyors and ecologists) as the largest employment group of the wider public health workforce (13%), the most interested (20%) but one of the least involved with the public health agenda (1%).[2]

Research on the impact of design and quality of buildings on the health of occupants has been widely reported for numerous outcomes including cardiovascular, respiratory and infectious disease, mental health, injuries and allergies.[3] Despite this evidence base, too often places of poor design, detrimental to health, are being created. It is estimated that the cost to the National Health Service of poor-quality housing is £2.5 billion per annum.[4]

How the architecture profession can contribute to the public health agenda

Architecture is the process and product of planning, designing and constructing buildings or other structures. Architects have a responsibility for building form, elevations and elements of construction.

It is estimated that as much as 90% of our time is spent indoors, be it at home, work or in leisure, and the work of an architect can cover all of these aspects.[5] Therefore, their influence on health is not only just limited to healthcare facilities, as has been the emphasis in the past, but also through social care facilities, residential buildings, educational institutions and commercial developments (retail, office, hospitality and leisure).

Architects not only work on new buildings; they can be involved in regeneration/retrofitting or choose to specialise in the relatively new field of urban design, thereby influencing site allocation, street pattern and many other elements that a town planner might.

Architects can play a vital role in ensuring that the design of buildings is health promoting—not only in physical environmental terms such as lighting, ventilation, heating and hazards but also more holistically, in how buildings encourage physical activity, social mixing, equity of access and address health and well-being needs across the life course. This is intertwined with environmental sustainability, such as sourcing of materials, water management and access to facilities.[3,5] Their work can also contribute to reducing inequalities. For example, buildings with better energy efficiency can have lower running costs and therefore lower risk of fuel poverty.[3]

Therefore, architects can play a vital role as part of the wider public health workforce, influence the wider determinants of health and contribute to prevention at numerous levels (see Fig. 1).

Architects are skilled professionals who require commercial awareness, making them well placed to consider the return on investment for healthy design. They can assess health impacts, with light, air quality and acoustic studies. The architectural process involves engaging numerous groups including developers, engineers, planners, construction staff and the general public, either directly as clients or through consultation processes, providing many opportunities to raise awareness of the effect of buildings on health and to influence the built environment sector to make healthier places.

Ways to engage with the architecture profession

The RSPH identified nine themes for engagement with other sectors.[6] In this article, the current level of engagement and potential future actions are discussed for three of these themes.

Partnership working

The professional body for architects is the Royal Institute of British Architects (RIBA), and for planners, the Royal Town Planning Institute (RTPI). In the Professional Code of Conduct from RIBA, the only mention of health is '*Members shall have reasonable knowledge of, and abide by, all laws and regulations relating to health and safety*'.[7] In contrast, in the RTPI Ethics and Professional standards public health responsibility is much more explicit: '*The planning profession is uniquely placed to promote equality and create inclusive places which meet the needs and aspirations of everyone … Planning also has a wider role in addressing the impact of the built environment on tackling poverty and inequality and contributing to social justice*'.[8]

Some architects are already interested in promoting health through their work, and the public health system needs to channel their proactiveness.[9] The RSPH suggested the development of a single brand to identify members of the wider public health workforce.[6] Professionals labelling themselves as health specialists should be regulated to maintain quality of advice and standards. This could be through credentialing or developing a new regulated profession such as sustainability consultants or urban designers. The Public Health Skills and Knowledge Framework could act as a tool for this.

In 2018, '*Improving Health and Care through the home: A National Memorandum of Understanding*' was signed by 26 organisations, including the RTPI. RIBA is not currently a signatory, but as the professional body would be key to the effectiveness of this agreement.

Workforce development initiatives have successfully brought together senior public health and planning professionals to share learning, develop relationships and experience sites of good practice. Approaches which could be used with architects include study tours or interdisciplinary think tanks, such as the BMW Guggenheim Lab.

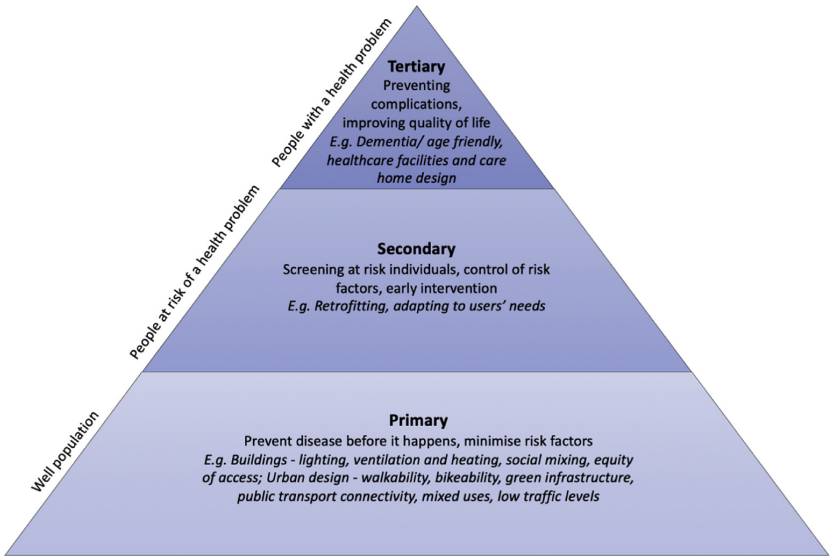

Fig. 1 – Prevention pyramid adapted to show how the architecture profession can contribute to prevention.

Addressing training needs

There is no curriculum requirement to teach health by the architectural accreditation bodies, and consequently, few architecture courses offer specific health-related content.[10] Any health aspects tend to be restricted to healthcare settings themselves although RIBA has started offering online continuing professional development (CPD) modules relating to health. Whereas in planning, although health is not explicitly mentioned in the curriculum guide (RTPI Policy Statement on Initial Planning Education), there are many hooks which allow the topic to be integrated such as '*enhancing the public realm for the benefit of all in society*', and correspondingly, this has a larger emphasis in many curriculums and CPD resources.

Healthy architecture is not yet a mainstream discipline. However, given the enormity of the challenges facing the world in the 21st century, it is likely to gain momentum; just as 'sustainability' moved from a marginal concern a few decades ago and is now an integral part of most architectural design processes.[5] In the short term, with sustainability already a curriculum requirement, health could be incorporated as a driver for sustainability. In the longer term, ideally public health should be directly incorporated into the RIBA curriculum, and any CPD materials would be co-developed with public health bodies such as RSPH and the FPH.

Building the evidence base

The focus of research and guidance has been minimal on buildings themselves. In an umbrella literature review of the impacts of the built environment on health, just 21 (12%) of the 178 studies that met the inclusion criteria were focussed on housing compared with 44 (25%) on neighbourhood design and 63 (35%) on natural and sustainable environments.[3] Government funding for the BRE, an organisation dedicated specifically to build environment research stopped in 1997, and it has since been operating as a charitable trust.

Most architecture and health conferences relate specifically to hospital design or environmental hazards in existing housing rather than health and architecture in the broader sense.[9] As a comparison, for planning, there have been many conferences and courses on healthy spatial planning; the RTPI holds events on well-being, mental health, dementia and healthy lifestyles, and there have been numerous events run by Public Health England.

The extent to which research has filtered through to policies, standards and tools is variable. Rules for housing and planning are spread across building regulations, national and local planning requirements, technical standards and voluntary standards. The Town and Country Planning Association (TCPA) is advocating for a Healthy Homes Bill, whereas the requirement is already explicit in the government's National Planning Policy Framework. The NHS Healthy New Towns, Transport for London's Healthy Streets, RSPH's Health on the High Street and the TCPA have all produced useful advocacy reports for improving health through planning.[9] Future efforts could be directed at making evidence and corresponding policy and tools more easily accessible in their structure and dissemination through appropriate channels to reach the architecture profession. In addition, joint conferences for architects and health professionals could be developed to share

emerging evidence, best practice and align recommendations on health in the broadest sense.

Conclusion

Despite the remit, skills and potential influence of architects, there has been relatively little engagement between public health and this profession. Much more attention to date has been on town planners.

Opportunities for engagement exist through improved partnership working, addressing training needs and building the evidence base. A partnership with RIBA is key, including their buy-in to the existing memorandum of understanding. Joint workforce initiatives could be helpful. Incorporating health into both undergraduate and postgraduate education and CPD ideally through co-developed content is recommended. Finally, public health should help build the architecture and health evidence base and make it more accessible to the architecture profession, for example with plain language summaries or infographics, so that it filters more effectively into corresponding policies and legislation.

Author statements

Ethical approval

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None declared.

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