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Typologies of knowledge for healthy streets: the need for an interdisciplinary paradigm for public health and design practice.

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Abstract

Non-communicable diseases (NCDs) are a global health challenge and physical environment factors play a material role in NCDs. The residential street is a building block of the physical environment and has been identified a place to integrate health and placemaking. However disciplinary differences between the two disciplines of street design and public health frustrate this.

Street design is by nature interdisciplinary and beyond the control of one sub-group of designers. Some design and placemaking practitioners seek new frameworks for interdisciplinary understanding: however this article explores why such frameworks cannot emerge with validity across disciplines without an underlying position toward evidence and knowledge. This challenge is explored through epistemology; methods; and values in practice. Taking a social-ecologic systems perspective a new interdisciplinary understanding is proposed to integrate public health and street design at each of these levels.

Both street design and public health share, to some degree, values of promoting population health and have the potential to do so but this potential is not being realised. Opening interdisciplinary understanding between the two disciplines may reveal new ways to support population health. Where current disciplinary silos prevent investigation of these issues then both disciplines risk acting unethically measured against the benchmark of the values stated in their professional codes of conduct.

Keywords

non-communicable disease, healthy streets, epistemology

Introduction

Non-communicable diseases (NCDs) are a global health challenge and accounted for 68% of all deaths worldwide in 2012 (World Health Organisation, 2016, p.36). Risk factors for NCDs linked to physical environment include for example i) a lack of physical activity; ii) environmental risks such as air pollution, and iii) unhealthy diet. In Europe these three risk factors alone account for 26 million Disability Adjusted Life Years (DALYs), that is life lost to premature death or life lived in less than ideal health (WHO Regional Office for Europe, 2015, p.8). There is an emerging evidence base for these wider determinants of health as they relate to design characteristics of the physical environment too (Bird *et al.*, 2017).

Residential streets are part of that physical environment. The physical environment can be thought of as a series of scales: individual buildings are one of the building blocks of streets; streets are a component module of neighbourhood design; and neighbourhoods in turn are part of the wider settlement or city scale design (Barton, Grant and Guise, 2010). Streets, common with these other scales, can impact on health and the street has been suggested in physical environment design practice as an important scale at which to consider these impacts (Transport for London, 2017; Cain *et al.*, 2014; Royal Society for Public Health, no date). This contrasts with available practice based guidance (Barton, Grant and Guise, 2010; Sarkar, Webster and Gallacher, 2014; Barton *et al.*, 2015) much of which is focused at the neighbourhood and city scale. The same is true for research evidence, a systematic review (Pineo, Glonti and Rutter, 2018), identified only 13 out of 145 tools with a spatial scale smaller than the neighbourhood: the majority being at neighbourhood or city scale although the development of indicators for physical environment has increased over time.

This article identifies that in order to deliver healthy streets there is a need for practice-based design guidance at a street scale; informed by an evidence base at the street scale; that integrates disciplinary understanding of population health and physical environment design characteristics at the street scale.

The first of these disciplines, public health, has as its central focus population health and an approach to evidence creation based on a hierarchy of evidence that prioritises, for example, randomised control trials (RCTs) and systematic reviews. As investigated later in this article, street design is not a cohesive discipline. It comprises a wide range of participants undertaking practices in the design of streets. Their use of evidence is varied and different to public health but nonetheless used to inform design decisions about the street.

It is already identified (Carmichael *et al.*, 2016, 2013) that these differences between public health and practitioners in the physical environment amount to a disciplinary divide that needs overcome to facilitate healthy place creation. Therefore, this article aims to investigate these differences further and identify potential bridging points for interdisciplinary understanding. The differences are investigated comparing epistemology; methods; and values in practice for the two disciplines. Good health, not just access to healthcare when sick, is a fundamental human right and there is therefore an imperative to address interdisciplinary understanding in support of population health.

Characteristics of a healthy street

To introduce the concept of healthy street design it is of value to briefly identify what, within this article and underlying research hypothesis, a healthy street looks like. Healthy street design incorporates a multiplicity of design characteristics, the sum of characteristics appears to be more important than the specific individual ones (Sallis *et al.*, 2015). So, this article defines a healthy street as one that through a holistic approach to micro, meso, and macro scale design characteristics supports health as part of everyday life.

Three of the most important features are housing density at a level to encourage walkability; priority given to walking, cycling, informal play space, and social space in the street; and continuous incorporation of trees and greenery. House types will promote levels of density supportive of walkable streets (Sarkar, Webster and Gallacher, 2017; Forsyth *et al.*, 2007; Forsyth, 2015; Saelens and Sallis, 2002). Healthy street design prioritises walking, cycling (Badland *et al.*,

2013; Jennifer, James and Duncan, 2016), and use of public transport over the private car whilst also providing for those, for example, of limited mobility and essential access for emergency vehicles. A healthy street is designed to provide for informal play by children which may be more important than formal neighbourhood play facilities (Aarts *et al.*, 2012). The Dutch Woonerf is an example of a street design that provides many of these characteristics (Curl, Ward Thompson and Aspinall, 2015; Young *et al.*, 2010; Baldwin Hess, Hata and Sternberg, 2013; Coulson *et al.*, 2011) and notably the holistic basket of characteristics appears important – only implementing traffic calming is less likely to be successful (Biddulph, 2012). Opportunities for seating and shade should aim to encourage social interaction. This may manifest as trees and other planting which can also encourage physical activity: a continuum of greenery appears important (Sarkar *et al.*, 2015). Healthy streets may be able to promote healthy eating and social engagement through, for example, vegetable planters in the street and street-based corner shops. Finally, healthy streets are part of a wider system: connecting outward to healthy neighbourhoods and inward to healthy housing design.

The need for interdisciplinary understanding

Whilst such a description provides a working prototype for street designers it does not resolve the challenge that much of the evidence for healthy street design is viewed as poor, low, or moderate quality by public health hierarchies of evidence. For example, an umbrella systematic review (a review of reviews) found only four of 39 included studies to include high or moderate to high quality evidence (Bird *et al.*, 2017). If designs cannot be evidenced to a credible standard then they are unlikely to be funded and created.

Opening up interdisciplinary understanding between public health and design practice may reveal new ways to support population health. Where current lack of understanding prevents investigation of these issues it is unethical when measured against certain codes of conduct for professional practice.

Healthy street design has potential to influence population health positively. First however, a shared interdisciplinary understanding between public health and street designers is needed and that is the primary focus of this article. This article analyses i) how the disciplines of public health and street designers position themselves toward evidence and knowledge creation (epistemology); ii) the methods public health and design practice employ in knowledge creation; and iii) the values in practice of each of these two disciplines as contained in codes of professional conduct and ethics as this would be expected to define how and what knowledge is valued. Two previous attempts to cross this divide are then considered to assess their success in doing so. Discussion of each section is drawn together at the end of the article where potential bridging points for future research are also identified.

The use of a lens from design practice on the links between physical environment and public health and investigating the divide between the two disciplines is this article's contribution to knowledge.

The World Health Organisation defines health as: *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."* (World Health Organisation, 1946, p.100). The accompanying principles are rarely quoted alongside but are of importance to this article's call for action: health, indeed the: *"highest attainable standard of health"* is a fundamental human right (UN Economic and Social Council, 2000, p.1).

If prevention of ill health; promotion of health, and reduction of health inequalities were being achieved by other means then a disciplinary divide between street design practice and public health may be neutral but they are not and the divide therefore needs investigated to identify barriers to improving health.

Evidence in fact points to the opposite is happening: pressures on healthcare and social care services results in disinvestment in long term prevention measures including healthy streets. Long term conditions (of which many are NCDs) account for 70% of costs to health and social care systems in England (Iacobucci,

2017). Multi-morbidities compounds this pressure (The Academy of Medical Sciences, 2018). These trends are found globally and therefore highlight in the context of this article the need for a new interdisciplinary understanding.

Methodology

This article, through review of the literature evaluates qualitatively the domains of i) epistemology, ii) methodology, and iii) values in practice of a) public health and b) street physical environment design practice.

An analysis and definition of street designer is also developed.

Defining the street

Barton et al. (2010, p.32) define three scales: district / small town (population 15,000-40,000); neighbourhood (population 2,000-10,000); and home place (20-200). Home place which broadly equates to a definition of the street is defined as: *"A cluster of dwellings often developed at the same time, with shared identity or character, grouped round a common access (e.g. square, street, cul-de-sac or shared semi-private space), and ideally enjoying pedestrian priority."*

The street is more than a spatial dimension, it is a social definition that includes a sense of belonging and ownership. Appleyard summaries that, "Nearly everyone in the world lives on a street. People have always lived on streets. They have been the places where children first learned about the world, where neighbors met, the social centers of towns and cities, the rallying points for revolts, the scenes of repression." (1981, p.1)

The appropriate scale at which to investigate associations between health and physical environment design is debated (Koohsari et al., 2013; Learnihan et al., 2011; Sandalack et al., 2013). This article posits that this is an important methodological consideration which has resulted in the street or 'home patch' (Gray *et al.*, 2011) being relatively overlooked.

The street already has a significant historic role to play in in addressing previous population health challenges. As previously identified (Carmichael *et al.*, 2013)

this was a key factor in the development of the town planning system prior to 1914: it is the last century where health and practice have become separated.

Who designs the street?

The street is an interdisciplinary space itself, not the domain of one single profession or group. By street design discipline this article means those involved, as currently practised, intentionally or implicated by their actions in influencing the physical constructed environment of the street. Generalising this discipline which may change over time is not straight forward and also highlights potential reasons why operationalising effective interventions through practice in the street is challenging. This definition excludes maintenance issues and incivilities such as broken windows, litter, or dog mess: these have been found to be important (Dunstan *et al.,* 2013, 2005) but are beyond the direct control of a designer and therefore this article.

The Construction Design and Management (CDM) regulations in Great Britain have a similar challenge in identifying such a wide range of actors with an influence on design and is an example of an attempt by regulatory systems to define designers, a similarly disparate group:

"Designers can be architects, consulting engineers, quantity surveyors and interior designers, or anyone who specifies and alters designs as part of their work. They can also be principal contractors, specialist contractors, tradespeople or even commercial clients, if they get actively involved in design work for their project.

A designer's decisions can affect the health and safety of all those involved in constructing a building and those who use, maintain, refurbish and eventually demolish it." (Health and Safety Executive, 2015)

A broad range of actors who may not be thought of as designers can in fact influence street design and design is recognised as having an important role within statutory regulations in Great Britain for health. In this article the discipline of 'street designers' is defined and grouped as shown in Table 1.

Table 1: Street design discipline: sub-groups of designers of the street physical environment, ‘street designers’:

Sub-Group	Description
1. Design practitioners	Those who intentionally create designs; are commissioned to do so; including formally regulated professions (e.g. planner, highways engineer) and others that are not (e.g. urbanist; urban designer; public space artist) but have some training or practical experience in the intentional design of streets. They would self-refer as a designer. Their designs are intentionally prepared to create or change the physical street environment.
2. Decision-taker designers	Those who direct or influence the decisions of design practitioners including funders, commissioners, regulators and clients of designers. They do not necessarily self-refer as a designer. They have an intention to create or change the physical street environment.
3. Designers-in-use	Those who influence the physical environment design characteristics of the street in use.

Across all sub-groups are a range of types of organisation including, commercial, public sector, charities, and professional bodies.

The first sub-group, design practitioners, vary by geography and jurisdiction: IN the United Kingdom they include: landscape architects, town planners (in a plan making role), architects, urban designers, highways engineers, transport and travel planners. Some of these professions are defined through training and professional accreditation such as landscape architecture: others are less defined such as urban designer or urbanist. This group are intentional in their actions and define themselves as designers.

The second sub-group, decision taker designers, extends to those who take design decisions including property developers; house builders; funders; and town planners (in a development control role) who direct the work of designers; and construction and infrastructure contractors who take decisions about design issues. This group may not identify themselves as designers, however their decisions can have a direct impact on street design including through the actions they instruct the first sub-group to take.

The third sub-group, designers in use, comprises bodies that own, operate, and maintain streets. This sub-group take decisions about how the space can be used that change the physical form of the space. They may not self-refer as a designer. Their actions and motivations may be completely unconnected to the physical street environment. They nonetheless have an impact on the physical street design characteristics (e.g. designation of a parking space, traffic restrictions, or installation / removal of street features such as trees as part of maintenance). This sub-group includes highways authorities who commonly have duties to maintain and regulate activity on the street in use.

This broad range of street designers can wield significant power over decisions that have an impact on health, for example as Carmichael *et al.* identify:
"...regulatory authorities may often have much less influence than the land owners, developers, investors, operators, designers, builders and users who are

the other players in the development process, who can generate actual change to the human environment and can influence health and well being." (2013, p.260)

This article's definition of the discipline of street designer is a broad group: to a greater degree than other scales, no single practitioner controls the design of the street: it is an interdisciplinary place.

Having set out a protype for healthy streets and defined street designer as a discipline this article now considers the disciplinary differences between street design and public health through epistemology, methodology, and values in practice.

Epistemology in design practice and public health

Epistemology does not form part of the lexicon of design practice which may view design as: *"hard enough without making it harder by applying esoteric theories inappropriately or by simplifying to such an extent that it is no longer functional or recognisable as design."* (Jones *et al.*, 2016, p.4). Practitioners may naturally look to methods and methodology when comparing differences between disciplines. However, epistemology or position toward knowledge affects how methods are operationalised into practice and it is therefore necessary to first consider how positions toward knowledge influence what value is ascribed to evidence.

Samuel and Dye again single out architecture as: *"…built on values that remain largely tacit."* (2015, p.ix) Design practice has a lack of common epistemological foundation (Jones *et al.*, 2016, p.6). Even though design practice can demonstrate methods, as above, Jones *et al.* raise concerns that: *"they do not address a position or attitude towards knowledge."* (Jones *et al.*, 2016, p.3) So on the part of design practice there appears less a divide and more an absence of position toward knowledge, or it may be hidden. This has been noted by designers themselves calling for this to be addressed:

"We have to be able to demonstrate that standards of rigor in our intellectual culture at least match those of the others.." (Cross, 2011, p.55)

Studies in the field of street and neighbourhood design, particularly those considering walking and physical activity have often taken a conceptual framework based on behavioural models of the environment including theory of planned behaviour, social cognitive theory (Forsyth *et al.*, 2008; Lee and Moudon, 2008; Cunningham and Michael, 2004). Cohn however raises concerns from a practice theory standpoint that such frameworks exclude vital components that influence human behaviour and put the focus on the individual, not population level outcomes (Cohn, 2014). Street designers should consider the Cohn's challenge that "surprising little critical attention has been paid to how health behaviour is actually conceptualised." (Cohn, 2014, p.157)

By comparison to design practice, public health has a clear position towards knowledge: albeit one that equally practitioners or academics might not refer to as epistemology but they would recognise it in action in practice. Indeed public health has developed through a series of paradigms (Eve *et al.*, 1978; Krieger, 1994; Susser and Susser, 1996; McMichael, 1999). Susser and Susser (1996) identify these as: 1) sanitary statistics: miasma paradigm; 2) infectious disease epidemiology: germ theory; 3) chronic disease epidemiology: black box paradigm (#3 Figure 1); 4) eco-epidemiology paradigm (#4 Figure 1).

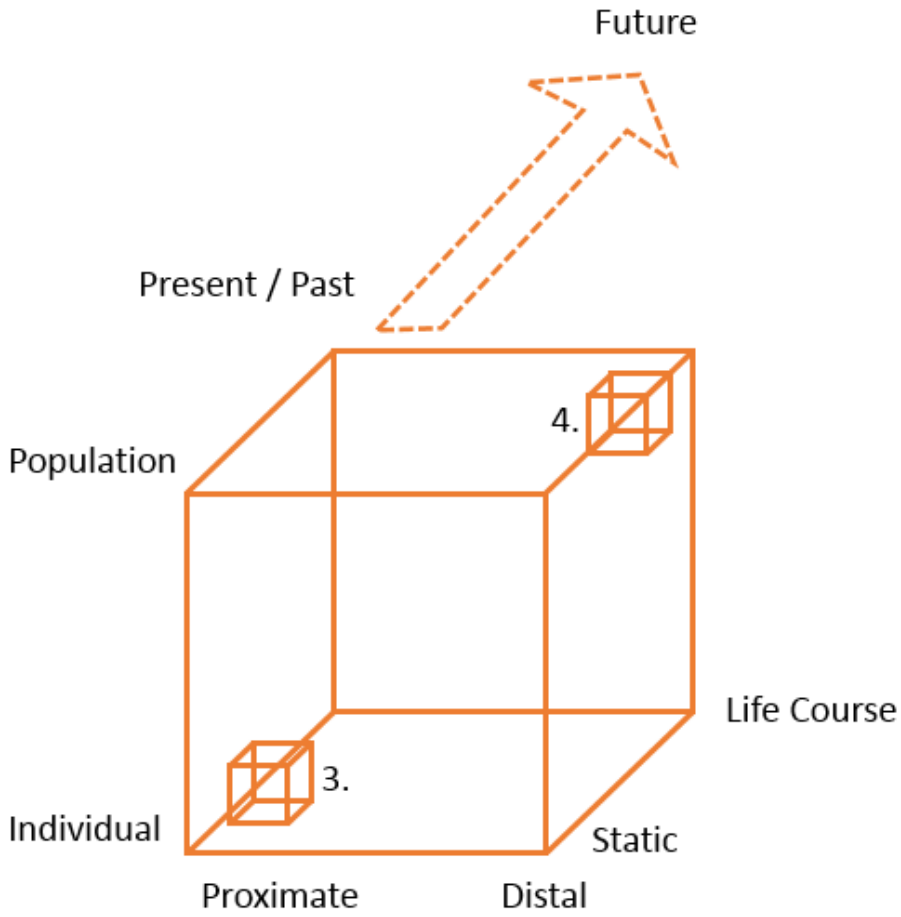

Figure 1: Social-Ecologic Systems Model

(Redrawn and annotated from McMichael, 1999, p.890)

McMichael calls this current paradigm the social-ecologic systems model. Ecology is taken: *"liberally to refer to contexts characterized by interdependencies between individuals and groups of humans and their environments."* (McMichael, 1999, p.889). Its key features are best understood as the transition from the positivist black box paradigm: first, to population health from individual health. Second, the new paradigm does not say proximate risk factors should be ignored but that only focusing on these is a problem and: *"looking upstream for a fuller account of disease causation within a population context; we must extend our focal length."* (McMichael, 1999, p.891). Third, refocussing from life stage to life course. Fourth and finally, McMichael calls for

research to not just look backwards at empirical evidence but to develop methods to respond to projecting changes in complex systems to address long term changes that are a risk to whole population health such as environmental change.

This model has gone on to be adopted broadly within the discipline of public health. As will be discussed the social-ecologic systems paradigm appears highly appropriate for adoption in interdisciplinary understanding in street design.

Epistemology and position toward knowledge are critical to the development of methods to investigate and create evidence. Methodology in each discipline is now appraised.

Methodology in design practice and public health

Differences in methods are identified in this article as highly problematic for interdisciplinary understanding between street designers and public health; or more precisely methodology for valuing evidence.

Design practice methods are numerous and multifarious and, compared to epistemology, progress has been made in methodology to investigate these diverse approaches. Roschuni *et al.* (Roschuni *et al.*, 2015) propose the following groups: Research, Analyse, Ideate, Build, and Communicate.

Jones *et al.* summarise existing types of thinking applied in design and other creative disciplines as *"divergent or convergent"* (2016, p.3) which broadly equates to coming up with ideas versus analysing and making decisions.

These methodologies approach methods in design practice according to their function and type. This appears to be based on their utility in supporting a pragmatic approach in design practice. The underlying position toward the use of evidence or knowledge manifests itself within these methods. This gets to the methods by which evidence may be created but not a position toward that evidence. Samuel and Dye note of one group of practitioners: *"architects… had little knowledge of the language of research which is rarely taught in any formal way in schools of architecture."* (2015, p.ix)

This approach in design practice is contrasted to methodology in public health where there are similarly a range of methods but grouped precisely and rigidly according to a hierarchy of evidence with the aim of identifying knowledge that is least at risk of bias.

Table 2 contrasts a clinical and public health hierarchy of evidence Guyatt, *et al.* (2008) with Davis' (2017) hierarchy of evidence for policy-makers, some of which reflects how evidence is valued by some sub-groups of street designers. As Davies (2017) identifies the *bottom* of a clinical hierarchy of evidence equates to the *top* of a hierarchy of evidence for policy makers.

Table 2: Combined Hierarchy of Strength of Evidence for Prevention and Treatment Decisions (following Guyatt *et al.*, 2008, p.7) and Policy makers hierarchy of evidence (from Davis, 2017).

Discipline	**Hierarchy Item**	**Source**
Clinical including Public Health	N-of-1 randomised trial	Guyatt, et al. (2008)
	Systematic reviews of randomised trials	
	Single randomised trial	
	Systematic review of observational studies addressing patient-important outcomes	
	Single observational study addressing patient-important outcomes	
	Physiologic studies	
	Unsystematic clinical observations	
	Expert opinion, testimonials	Davis (2017)
	Expert advice	Davis (2017)

Policy-makers' hierarchy of evidence	Ideological evidence: including party think tanks and manifestos	
	Evidence from professional associations	
	Opinion based evidence: including lobbyists / pressure groups	
	Media evidence	
	Internet evidence	
	Research evidence	
	Lay evidence	
	Street evidence: urban myths & conventional wisdom	

Public health of course extends to other areas of practice the position toward knowledge through the hierarchy of evidence is consistent though and Bird *et al.* identify a such a hierarchy as "the public health hierarchy of evidence" (Bird *et al.*, 2017).

The divide this reveals is that methods in design practice are chosen for their utility to practitioners in problem solving: methods in public health, whilst also targeted at problem solving, are selected according to their value as evidence.

What this means for street designers is that they have little or no understanding or access to the methods of public health; and they lack methods to rigorously assess health outcomes. For the public health discipline it is observed that evidence created and valued by street designers does not even register on its hierarchy of evidence; and tending toward more analytical and convergent methods public health has a shortage of divergent methods for ideas generation.

The apparent complementary strengths and weaknesses of each discipline's methodology may provide bridging points for interdisciplinary understanding.

In the absence of clear commonalities at the levels of epistemology and methodology this article now turns to consider values in practice for each discipline. If the disciplines have some shared values then potentially this provides a bridging point for interdisciplinary understanding.

Values in design practice and public health practice

Whilst design practice may lack a clear attitude toward knowledge currently, there are glimpses of parallels with public health paradigms, for example a focus on environmental risks to population health.

Some designers clearly do have a set of values that are held. One such value is that 'healthy' place remains a key characteristic for both new and existing places to thrive (Williams, 2014, pp.44, 48) and it should be possible to intervene in the world to positively influence complex systems for improved population health and wellbeing (Rutter *et al.*, 2017).

Design practice's values are partly reflected in codes of conduct of professional bodies. This is especially true for the first sub-group of street designers. A limitation is that not all roles identified as designers implicated in the street are represented by a professional body. Nevertheless, professions that might apparently use very differing methods have strikingly similar underlying values in codes of conduct and ethics. Two examples that demonstrate this from a UK context are:

"Standard 1: The Landscape Institute expects members who are carrying out professional work to have regard to the interests of those who may be reasonably expected to use or enjoy the products of their work. You have responsibilities to the character and quality of the environment. You should seek to manage change in the landscape for the benefit of both this and future generations, and should seek to enhance the diversity of the natural environment, to enrich the human

environment and to improve them both in a sustainable manner." (The Landscape Institute, 2012, p.3)

Engineering professions including transport and highway engineers may be perceived as more rule-based practices – this may be the case but does not curtail a clear set of values in practice: the Engineering Council and Royal Academy of Engineering Statement of Ethical Principles (a requirement for all engineering professionals they regulate) opens:

"Engineering professionals work to enhance the wellbeing of society." (Engineering Council and Royal Academy of Engineering, 2017, p.2)

Stated values are not consistent however and notably the Royal Town Planning Institute (RTPI) Code (Royal Town Planning Institute, 2016) contains no similar reference. Additionally the two examples do not state the role of evidence. This contrasts with values in public health practice. The Faculty of Public health, the single regulatory body for all public health practitioners in the United Kingdom, states:

"You have a duty to monitor, protect and improve the health of populations. This may include: investigating and acting on risks to health; poor outcomes in particular populations; or providing professional advice to others on emerging health issues, based on the best available evidence of information." (Faculty of Public Health, 2016, sec.A)

Here the role and requirement to use evidence is explicit: not just any evidence but the *"best available evidence"*.

This final domain of values is therefore where greater commonality is found: an aim to improve population health and create positive social value. Nevertheless problems remain: for public health the way that best available evidence is operationalised into methods restricts what evidence is valued; for street designers the ends are clear but not the means.

Having briefly surveyed epistemology, methods, and values in practice for each discipline bridging points are now sought. This article is not the first to identify

disciplinary differences though so before proposing new ones, previous attempts are first considered to identify lessons to be learned.

Previous attempts to cross the disciplinary divide

The disciplinary divide between public health and street design practice has been investigated at the level of methodology, epistemology, and values in practice. A number of studies have attempted to cross the disciplinary divide previously, most notably at the level of methodology. Such attempts have found that including evidence from street design fails to meet even a lowered bar of quality in public health and designing physical environment studies to be higher on the public health hierarchy of evidence result in such restrictive findings that they cannot be operationalised in design practice.

Audrey et al. (2015) investigates: *"Healthy urban environments for children and young people."* This study is considered as it is uses a systematic review method; for physical environment interventions; and undertakes quality appraisal using the Cochrane ROBINS-I assessment tool (Sterne, Higgins and Reeves, 2014).

Of the 33 studies identified for inclusion in Audrey et al.'s review the study designs were non-randomised. This demonstrates some flexibility within the method recognising that: *"…evidence from randomized trials may not be sufficient to answer questions of interest to patients and health care providers…"* (Sterne *et al.*, 2016, p.3). However, when subjected to appraisal, five studies were found to be at 'Moderate' risk of bias and all remaining studies assessed as being at 'Serious' risk of bias. The findings of the included studies were mixed and the strongest the authors concluded was for: *"some evidence of promise"* for road traffic safety, multi-component, and active travel interventions.

Audrey et al.'s review (2015) makes a significant contribution to exposing these challenges and identifying that when investigating population health, studies that fail to acknowledge basic confounding factors such as socio-economic status clearly result in risk of bias so improvement in the design of some physical environment studies is clearly needed.

An alternative approach to crossing the disciplinary divide has been to design physical environment study methods that will be assessed at lower risk of bias, Audrey et al. (2015) suggest:

- undertake more studies of interventions including repeatable experiments
- use consistent outcome measures
- define cohorts consistently
- research under-represented populations such as children and older adults

Some such studies have been able to be undertaken longitudinally thus with stronger evidence of causality Bradford Hill's criteria (1965).

Sarkar et al.'s study (Sarkar, Gallacher and Webster, 2013), selected for being of longitudinal design, investigates BMI in 684 older men aged 65-84 in the Caerphilly Prospective Study over 12 years. Beneficial impact on BMI was found for density of retail, density of churches (hypothesised link to social capital), density of recreation and leisure facilities, the space syntax measure of 'betweenness' (Al_Sayed *et al.*, 2014) at city scale, and steepness of roads around participants homes.

Compared to risk of bias challenges in other studies and from a public health lens the strengths of this study are in the quality and large size of the cohort. However this article questions how readily such evidence can be operationalised in design practice.

It appears from these two examples, that methods from public health cannot be readily applied to design practice questions. Design should certainly address issues of quality. Equally, designing studies to fit within the tight constraints of the hierarchy of evidence and definitions of causality may result in studies that whilst methodologically strong are of limited value for translation into actionable design principles for designers.

Findings

Healthy street design has potential to influence population health positively. First however, a shared interdisciplinary understanding between public health and

street design is needed. This article has analysed i) how the disciplines of public health and street design position themselves toward evidence and knowledge creation (epistemology); ii) the methods public health and street design employ in knowledge creation; and iii) the values in practice of each of these two disciplines as contained in codes of professional conduct and ethics. Table 3 sets out a summary of findings for each of these.

Two previous attempts to cross this divide have also been considered to assess their success in doing so and reveal that the differences are not overcome simply by taking methods or epistemologies from one discipline to another. This article finds that instead a joint approach of interdisciplinary understanding is needed at each level.

Table 3: Summary of findings

	Public Health	Design Practice
Methodology	Methods varied but led by the hierarchy of evidence pyramid. Systematic reviews of RCTs at the top of the evidence pyramid. (Guyatt *et al.*, 2008) Lack methods for projecting future population scale risks such as environmental risk. (McMichael, 1999)	Methods very diverse and numerous (e.g. brain storming, mind mapping, life cycle analysis, root cause analysis, prototyping). Divergent or convergent (Jones *et al.*, 2016) Research, Analyse, Ideate, Build, and Communicate (Roschuni *et al.*, 2015)
Epistemology; position toward knowledge	Social-ecologic systems perspective. (McMichael, 1999)	Lacks an agreed position toward knowledge. (Jones *et al.*, 2016)

		In narrower field of street design studies have tended toward behavioural models but these are critiqued from a practice theory epistemology.
Values in practice	*"…protect and improve the health of populations… based on the best available evidence..."* (Faculty of Public Health, 2016)	Various and some practitioners not represented by professional bodies. Responsibility to environment; future generations; natural environment; human environment (LI); Enhance the wellbeing of society (Engineering Council).

Discussion

Three proposals for future bridging points are considered between public health and street design: a shared social-ecologic systems paradigm; increased interdisciplinary understanding to share methodological strengths to fill gaps that both disciplines have; and finally to ensure that the values stated are delivered on to address the challenges of NCDs that societies globally face. The definition of street designer is also extended to consider how those who live, work, and play in streets can be empowered create health in the street too.

At the level of epistemology the finding is not a divide but rather an absence on the part of street design practice, at least within the limitations investigated in this article. With a well-defined and developed social-ecologic systems paradigm in public health this appears to be a clear gap between these two disciplines. If investment in healthy streets is to be encouraged then street designers need to present evidence in support of their ideas and demonstrate the population health benefits otherwise investment will be diverted elsewhere. Without such an epistemology or position toward knowledge creation designers risk breaching the very values some of their codes of ethics claim to hold. They risk an 'anything goes' approach to the use of evidence but with unclear knowledge, at best, as to whether their designs are benefitting or potentially harming population health.

The first proposal for future research and practice therefore is that the street design discipline adopts and develops its methodologies within a social-ecologic systems paradigm. This paradigm developed by public health prioritises population health; distal impacts (the very ones street designers trade in); and health over the life course all of which resonate with and support the values purported by the codes investigated here.

Second, at the level of methodology there is a clear divide between public health and design practice and it is not possible to simply apply some methods of public health to design practice: to do so results either in physical environment studies being classed as at risk of bias; or studies focussed on such limited design characteristics as to be of little application in design practice. However, as Audrey and Batista-Ferrer (2015) identify physical environment studies repeatedly fail to address basic requirements of high quality research such as considering the influence of socio-economic status and other confounding factors. Public health methods could help greatly in addressing such limitations and to design higher quality research. An apparent strength of street design methodologies is the broad range of methods including divergent ones to generate new ideas. With what could be called more convergent approaches public health could benefit from such design thinking particularly in developing and then

jointly analysing new design ideas in the street. Also, as highlighted McMichael (1999) identified the need for forward looking projections resulting from large scale events such as environmental change. New methods in this domain developed jointly could start to create interdisciplinary understanding to address such challenges.

Thirdly, at the level of values in practice some common ground is apparent and this article does not question the intentions of individual practitioners to do good. There is an evident commitment and professional duty to population health on the part of public health; and, albeit varied, to the health of society, wider environment, and future generations by street designers.

Public health has the benefit in the UK of a single regulatory body through the Faculty of Public Health which can regulate a single, consistent set of values. Street designers should aim for a similarly clear and consistent set of values: the approach of the Engineering Council which allows flexibility by individual institutions whilst incorporating mandatory ethical principles for the wellbeing of society is the sort of approach that should be adopted more broadly by all sub-groups within street design.

Where codes of conduct for street design exist, they do not state what the role of evidence is. This should be rectified. It requires a change in how evidence is valued by some street designers. However, addressing this would address the potential a lack of rigor in relation to evidence that risks putting some street designers in breach of the values stated in their codes of professional practice.

There is a risk too within public health that the strict interpretation of "best available evidence" (Faculty of Public Health, 2016, p.7) through clinical hierarchies of evidence may in fact exclude potentially effective healthy street interventions and therefore more broadly fail to fulfil the fundamental human right of the: *"highest attainable standard of health"* (UN Economic and Social Council, 2000, p.1).

For both disciplines values in practice is a challenging area and the consequences are nonetheless clear: NCDs remain a global challenge and are not being solved by other means and at a time of pressure on healthcare and social care systems a failure to develop a clear evidence base for investment in a broad range of different and new preventative measures such as healthy streets results in that same investment being diverted elsewhere.

Finally, having considered steps to be taken at the levels of epistemology, methodology, and values in practice this article finally considers the role that residents and users of streets should, and in the view of this article must have, in the creation of healthy streets. They suffer the consequences for good or bad of street designers but have little apparent power to shape street design within current conceptions of who is a designer. Residents and users of the street should be included as an additional sub-group, of equal status, within the definition of street designer.

Conclusion

The design of streets has great potential to contribute to improving population health and is an under-investigated scale compared to the neighbourhood and city. Disciplinary differences exist between public health and street design that frustrates attempts to create health in the street. This is not a straight divide however: there are commonalities and complementary strengths that can be used as bridging points.

Opening up inter disciplinary understanding for a new paradigm between public health and design practice may lead to new ways to support population health including healthy streets. When measured against the benchmark of values stated in a number of professional codes of conduct: where a current lack of understanding prevents investigation of these issues it is unethical.

Whilst methodology is the most apparent area of division it is the level of epistemology, or position toward knowledge, that appears most critical to address

as methodology flows from this. Where stated, values held in practice appear to be complementary to achieving this.

The street is more than a physical spatial measure it is a social space too. It is able to be influenced by design practitioners to a degree that larger neighbourhood or city scales cannot. By combining street design with the social-ecologic systems paradigm of public health the combined result is a nexus for interdisciplinary understanding.

Finally, this is not a call to push a new technocracy to replace the previous one. Rather it is anticipated that as communities, as street designers, start to consider what is important to them they will have questions and will need space to think about them. It is a vision is for new forms of practice to emerge that create space within which interdisciplinary thinking and making can be undertaken by coalitions of communities and practitioners working side-by-side.

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