Title
Evaluating a workforce development programme: bringing public health into architecture education in England.

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Authors
Rachael Marsh[a,b †], Paul Pilkington[a,b], Elena Marco[c], Louis Rice[b,c]

Author Affiliations
[a] Faculty of Health and Applied Sciences, Centre for Public Health and Wellbeing, University of the West of England, Bristol
[b] World Health Organisation Collaborating Centre for Healthy Urban Environments, Department of Architecture and the Built Environment, University of the West of England, Bristol
[c] Faculty of Environment and Technology, Department of Architecture and the Built Environment, University of the West of England, Bristol

[†] Corresponding Author
Rachael Marsh
Faculty of Health and Applied Sciences,
University of the West of England (Frenchay Campus),
Coldharbour Lane,
Stoke Gifford,
Bristol,
BS16 1QY

Email: rachaelmarsh@nhs.net

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 was collected using questionnaires, a focus group, interviews, and programme documentation from a Bachelor of Architecture cohort and stakeholders from 2011-2019. Participants developed a broad understanding of 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 future to help enable architects to create healthier buildings and places.

Key words
public health; interdisciplinary; workforce development; architecture; evaluation; education

Introduction

Architects as part of the wider public health workforce

Public health and environmental challenges facing the world in the 21st 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'*. (1)

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%). (1) 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. (3) Research on the impact of building design and quality on the health and wellbeing of occupants has been widely reported. (5) 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. (6) (7) (8)

Despite this, far too often unhealthy buildings exist. In Europe, one out of six people live in unhealthy homes. (3) 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 population of Scandinavia – live in unhealthy homes. This presents significant health and social care system challenges. (3) For example, in the UK it is estimated that the cost of unhealthy housing to the National Health Service is £2.5billion per annum. (9)

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 prevention of ill-health. (8) The remit, skills and contacts of architects places them in a key position, by influencing environmental determinants of health, to improve the health and well-being of the population. Despite this, there has been relatively little engagement between public health and this profession. (8) Education programmes are a key way of addressing this but globally few have been established and almost none evaluated. (8) (10) (11)

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'*. (11) 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*…'. (12) 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'*. (13)

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 well-being. There are no curriculum requirements by the architectural accreditation bodies across Europe to teach health in the broader sense, including health promotion. (14) (15) (16) (17) The UK curriculum only references health and safety legislation. (14) 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. (18) 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, (19) (20) and in-depth details about the programme itself (21) (22) 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. (22) 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 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. (23) (24) 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. (23)

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 well-being 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).

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, Implementation, Maintenance	Socio-demographics, knowledge, attitudes, skills	Basic descriptive analysis (SPSS) Thematic analysis
	Post (T_1)	28 (82)			
	8 years	17 (50)			
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

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 was collected using mixed methods at intervals; pre-intervention (T_0), immediately post-intervention (T_1), at four years (T_2), and at eight years (T_3) post-intervention (see Table 1).

In-depth details of the methods, analysis and results for T_0, T_1, (21) (22) and T_2 follow-up (20) 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 six 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. (22)

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 minutes. 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. (20)

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. (25)

Data saturation was reached when further coding was no longer feasible. (26) 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). (27)

Results

Reach
All 34 students in the original cohort participated in the PHPiR activities. Taking 34 undergraduate students per year for eight 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. (28)

By the eight-year data collection, five 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. (29)

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 to 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 to 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

Most participants (69%) were at a relatively senior level - project architect (licensed architect or non-registered graduate with more than ten years of experience; has overall project management responsibility) and had been based in their current organisation for between two and six 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 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**

Figure 1: Example of students' work showing understanding of wider determinants of health by mapping them against a life course approach.

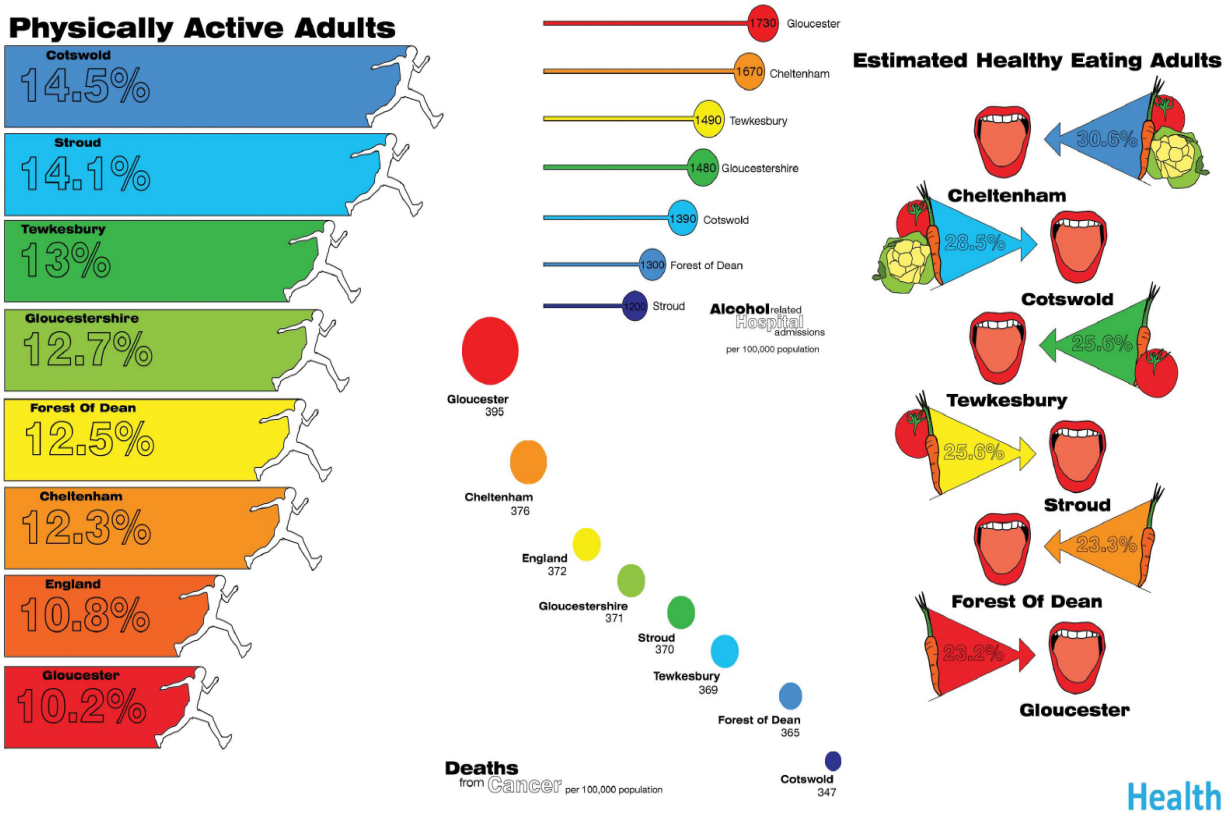

Figure 2: Example of students' work considering inequalities in risk factors for disease (physical activity, alcohol consumption and health eating, as well as mortality rates – to factor into decisions about urban design.

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).

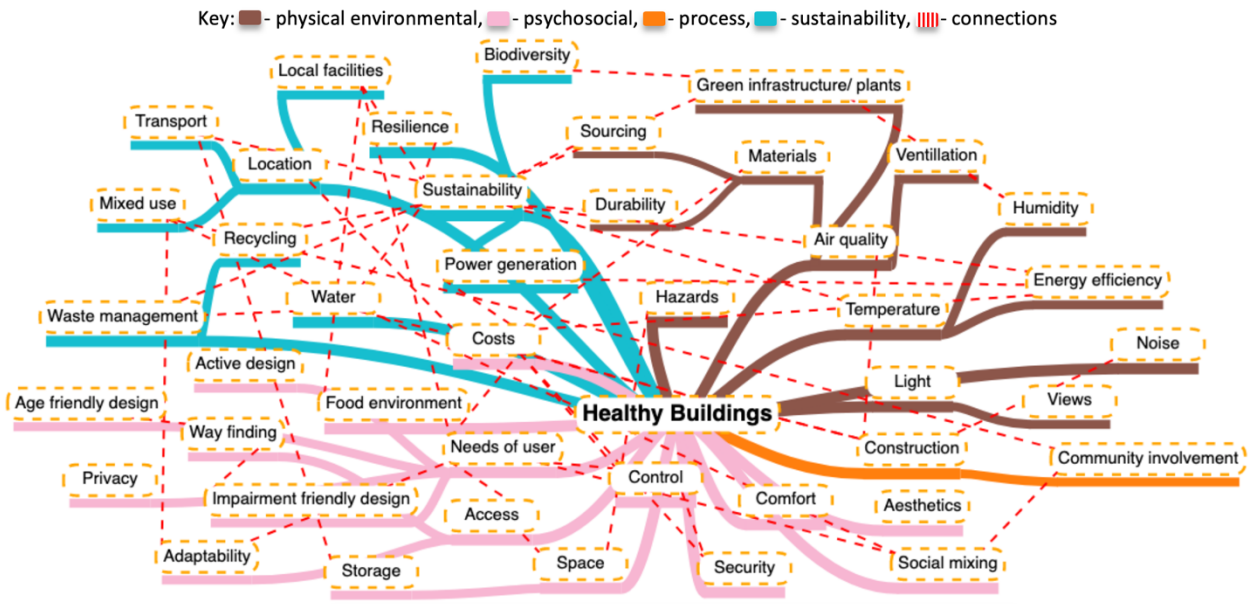

Figure 3: Aspects of buildings which can affect health and wellbeing that were mentioned by participants (Image: Marsh, R)

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 (way finding, 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 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 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 was 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 four years and lighter touch involvement for three 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 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, (14) 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 8 years follow-up (n=34)

Statement		**N (%)**						**Mean[a]**	**SD[a]**
		Total	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree		
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	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

determinants of health									
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 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 other 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**

<u>Barriers</u>

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, (3) 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. (30)

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 numerous options to bring public health into architecture education (31); 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, buildings 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 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 is 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.

Biographical note

Rachael Marsh (RM)

Dr 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.

Paul Pilkington (PP)
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 (EM)
Elena 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.

Louis Rice (LR)
Dr Rice is a senior lecturer, architect and researcher. At UWE his research focuses on healthy and sustainable urban design and he is Head of the World Health Organisation Collaborating Centre for Healthy Urban Environments. He was programme leader for the Masters in Urban Design for many years and currently leads the final year Masters in Architecture. He is the author of numerous books and articles on architecture and urban design and is on the organising committee for numerous international conferences on the topic.

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Competing interests
None.

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Supplementary Files

Supplementary File 1: Consolidated criteria for reporting qualitative studies (COREQ) checklist

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group? **RM**	5
2. Credentials	What were the researcher's credentials? **BMBS, MSc, DFPH**	N/A
3. Occupation	What was their occupation at the time of the study? **Specialty Registrar in Public Health**	Biographical note
4. Gender	Was the researcher male or female? **Female**	N/A
5. Experience and training	What experience or training did the researcher have? **Undertook formal training on qualitative research methods from MSc. NVivo course.**	N/A
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement? **No**	N/A
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research **RM had met organisational-level stakeholders (course lead) on several occasions. PHPiR recipients were unknown to RM but were informed about the reasons for doing the research before the survey and again at the start of the interview.**	N/A
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic **None**	N/A
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis **Qualitative analysis was conducted using a thematic analysis.**	6
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball **Purposive (first PHPiR cohort)**	4
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email **A questionnaire was**	4, 5

	sent via email or social media from the course lead. Interview participants were approached via telephone or email by RM after ticking a box in a questionnaire consenting to be contacted.	
12. Sample size	How many participants were in the study? **17 participants responded to the questionnaire and of these, eight agreed to a follow-up semi-structured interview (N=34). Of organisation-level stakeholder, four tutors took part in a semi-structured interview (N=4). One PHPiR practitioner kept a reflective diary (N=1). Total N = 27.**	5, 6
13. Non-participation	How many people refused to participate or dropped out? Reasons? **Five participants were lost to follow up and 11 did not respond.**	6
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace **All interviews were conducted over the phone except one which was conducted at UWE.**	
15. Presence of non-participants	Was anyone else present besides the participants and researchers? **No.**	N/A
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date **Participants all attended the first cohort of the PHPiR programme.**	5
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested? **Yes. Yes.**	5
18. Repeat interviews	Were repeat interviews carried out? If yes, how many? **No.**	N/A
19. Audio/visual recording	Did the research use audio or visual recording to collect the data? **Audio recordings were made of each interview.**	6
20. Field notes	Were field notes made during and/or after the interview or focus group? **No.**	N/A
21. Duration	What was the duration of the inter views or focus group? **Average of 45 minutes.**	5
22. Data saturation	Was data saturation discussed? **Yes, RM discussed findings and data saturation with the other co-authors (PP, EM, LR).**	6
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction? **No.**	N/A
Domain 3: analysis and findings		
Data analysis		

24. Number of data coders	How many data coders coded the data? **RM and validated by PP. Final themes were agreed by authors.**	6
25. Description of the coding tree	Did authors provide a description of the coding tree? **No.**	N/A
26. Derivation of themes	Were themes identified in advance or derived from the data? **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. Analysis aimed to generate a balanced assessment of the programme and the factors that may have had an impact on the reach, effectiveness, adoption, implementation and potential sustainability of the PHPiR including barriers and facilitators to real-world implementation.**	6
27. Software	What software, if applicable, was used to manage the data? **NVivo 12 QSR.**	6
28. Participant checking	Did participants provide feedback on the findings? **No.**	N/A
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number **Yes. Yes.**	7-13
30. Data and findings consistent	Was there consistency between the data presented and the findings? **Yes.**	N/A
31. Clarity of major themes	Were major themes clearly presented in the findings? **Yes.**	7-13
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes? **Yes, minor themes.**	10-14