



## Letter to the Editor

## Coronavirus disease 2019 in Iran: the need for more attention to primary health care



While the global effort to prevent coronavirus disease 2019 (COVID-19) spread continues, some experts have suggested that the disease may be in its first stages.<sup>1</sup> After initial reports of the disease from China, recent reports of this contagious disease have also been reported elsewhere in the world, including in the World Health Organization (WHO) Eastern Mediterranean region such as Iran.<sup>2</sup> The Eastern Mediterranean is an area that has many public health problems.<sup>3</sup>

On February 20, the Iranian Ministry of Health reported the first cases of the disease. In fact, in Iran, the initial report, in addition to reporting two cases, also reported deaths.<sup>4</sup> Given that the incidence of these cases was unrelated to any direct source outside of Iran, and on the other hand, given the geographical location of the provinces where the Iranian Ministry of Health reported cases (central areas of the country), the probability of the epidemic situation of the disease could be considered.

In fact, it could be argued in the epidemiology of the current situation that despite the low number of the reported primary deaths, their importance in the secondary or tertiary transmission position could be very worrying. This was a prediction that came with the rapid spread of the disease throughout Iran in a short span. According to WHO statistics, at the end of March 9 and in less than three weeks after the first new case report in Iran, the total number of confirmed cases of COVID-19 in Iran was more than 6500 and the total deaths from COVID-19 was 194.<sup>5</sup>

In these situations, in addition to providing high-quality medical services to patients, there is a serious need for basic care, including education for the general public in various areas of prevention and related health care. In addition to considerations regarding the ability to manage the conditions ahead, given the wide scope of the issue across the country, the primary care system is important in identifying and correctly referring cases.

The primary healthcare system in Iran has had a good standing over the past few years. The structure has, implemented many WHO and other public health programs, including the polio eradication program.<sup>6</sup> Over the past few years, the capacity of primary health care in Iran has been maintained at an acceptable level owing to the use of appropriate and efficient methods, and the WHO has reported significant progress in this area, even as a model for some countries.<sup>7</sup>

But the important issue has been the shortage of resources in the health sector over the last few years, and especially in the last two years, owing to the numerous economic bottlenecks in Iran.

This, mostly, includes other issues related to the supply of needed medicines and the possibility of developing specialized hospital settings, including intensive care units that are necessary in these critical conditions.<sup>8</sup>

The use of high-capacity primary health care along with increased awareness of preventive methods is an effective step in the effort to control COVID-19 in Iran especially after the recent widespread epidemic situation. Increasing international cooperation and reducing economic constraints can be an effective step toward improving the current situation.

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## Letter to the Editor

## COVID-19: Immense necessity and challenges in meeting the needs of minorities, especially asylum seekers and undocumented migrants



At the best of times, there are immense challenges in meeting the public health and healthcare and social care needs of migrant, ethnic, racial and other minority groups in modern societies globally. Over 50 years, scholars, researchers and practitioners have developed principles and exemplars of how to provide culturally competent and effective services for diverse societies. In the midst of the COVID-19 pandemic, we are in the worst of times, and new thinking is required. We are already seeing the desperate plight of migrants, particularly those in camps and detention centres awaiting their asylum claims to be examined. Millions of people are on the march in countries such as India in scenes not seen since the partition of the country in 1947, when millions died.

There is, however, a group of migrants, i.e., those labelled undocumented or irregular, or in a derogatory and inaccurate way illegal, at even greater need than other populations. The numbers and whereabouts of undocumented migrants are unknown, at least to the statutory sector, for self-evident reasons. The immigration authorities and the public usually judge the numbers to be substantial, for example, with estimates in the hundreds of thousands in the UK. They have no legal rights to residence in the country they are in. They live in the shadows of society, fearful of authority, and with little access to services, which are mostly provided by the voluntary sector. Nonetheless, they contribute to the functioning of society usually through low-paid work in difficult settings. There are probably tens of millions of such people across the world. They are in danger of becoming the scapegoats, when they are going to be the foremost victims of the pandemic.

Undocumented migrants are at particularly high risk for obvious reasons including these: there is no prior bond of trust with the statutory authorities; there is no established means for communication of information to them through the public sector; there is often no suitable environment to observe the 2-m and other social distancing guidance relating to workplaces and homes; and there are minimal rights to health care. These obstacles apply globally. The needs of undocumented migrants and sometimes asylum seekers are usually provided by voluntary, charitable, non-governmental organisations, which themselves are struggling to cope with the burden. Donations are declining, and charity shops are closed.

The needs of asylum seekers and undocumented migrants are a sensitive topic, and opening up an objective dialogue is difficult at any time but especially problematic in the midst of a national emergency. In some places, xenophobia and racism are already evident, although there is also, perhaps paradoxically but not unexpectedly given the communal response, goodwill.

Sparse statistical and much anecdotal evidence indicates that the pandemic is affecting all migrant and ethnic minority groups especially badly. To emphasise, statistical information about the impact of COVID-19 on ethnic and racial minority groups and asylum seekers is sparse and on undocumented migrants is not available and high impossible to collect.

The Migrant and Ethnic Health Section of the European Public Health Association, comprising of more than 1800 people, has issued a statement setting out the potential core elements of actions to protect undocumented (as well as all other) migrants including as follows:

'Inclusion of all MEM (migrant and ethnic minority groups) in Europe into the ongoing protective measures, information campaigns and health services provision is essential. We call for temporary suspension of any policies that may exclude migrants from accessing these measures. It is imperative that no one should feel under the threat of prosecution or deportation during this period and safeguards need to be in place.' The full statement provides the context: [https://eupha.org/repository/advocacy/MIG\\_statement\\_on\\_COVID19.pdf](https://eupha.org/repository/advocacy/MIG_statement_on_COVID19.pdf).

The organisation Platform for International Cooperation on Undocumented Migrants (PICUM) which represents a European platform for those working on behalf of undocumented migrants has also released a statement setting out similar principles focused on undocumented migrants: <https://picum.org/wp-content/uploads/2020/03/COVID-19-Statement-March-20>.

Everyone working on the COVID-19 pandemic whether in state or international policy, planning for health care and containment, or researching on the causes, consequences and trajectory of the pandemic needs to give immediate attention to the needs of ethnic, racial, indigenous and migrant minority groups. There is a danger that they will be largely forgotten in the present and, worse, that they will be unfairly blamed in the aftermath of the pandemic, once control has been achieved in most populations but is still lingering in these.

In desperate times, we need to consider every possible solution. One that needs urgent consideration is to give temporary citizenship rights to every person in the country together with safeguards that by coming forwards people can expect confidentiality, respectful treatment and no detriment to their asylum and residency claims in the long term. We need everyone involved in the war against the pandemic—that includes asylum seekers and undocumented migrants. This is a radical proposal but what is better?

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The author is a contributor to the statement referred to in this letter that was issued by the Migrant and Ethnic Health Section of the European Public Health Association.

*Video*

The video setting out the principles raised in this letter is available on the website of the Royal College of Physicians of Edinburgh: <https://learning.rcpe.ac.uk/mod/page/view.php?id=7206>.

*Statement on prior publication of some ideas and content*

This letter develops arguments the author has raised in other forums and, given the emergency, with the agreement of the letters editor of the BMJ and the editor of Public Health draws upon some material in a recent publication in the BMJ where the author briefly summarised the arguments developed here. <https://www.bmj.com/content/368/bmj.m1213/rapid-responses>.

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## Editorial

## COVID19: The need for public health in a time of emergency



On 11 March 2020, the World Health Organization (WHO) declared coronavirus disease 2019 (COVID19) a pandemic. Three months on from when China first alerted the world to the emergence of this threat, there were more than half a million confirmed cases and 33,106 deaths reported worldwide.<sup>1</sup> Large epidemics have sprung up in Western Europe and the United States. Worryingly, the infection has also emerged in developing countries where the impact of the pandemic will probably be worst. Infectious disease modellers at Imperial College London estimate that without mitigation, COVID19 could result in seven billion people infected and 40 million deaths globally this year.<sup>2</sup> Consequently, the need for early and sustained suppression measures in these settings will be crucial to blunt the severity of the pandemic and save lives.

In Europe, Italy was the first to be most severely affected with numbers of cases exceeding China's tally, and a death toll already three times higher. In the worst affected areas, the outbreak was described as out of control and the response has been criticised for its 'systematic failure to absorb and act upon existing information rapidly and effectively'.<sup>3</sup> Key ingredients for an effective response appear to be the need for extensive testing, proactive contact tracing, an emphasis on home diagnosis and care and the monitoring and protection of health care and other essential staff. It is clear that the speed of response needed to keep pace with the epidemic spread is exponentially faster than that of bureaucratic processes in health systems. Crucially, there is a need for learning to identify and understand which approaches work.

The Italian epidemic was 2–3 weeks ahead of the rest of Europe and certainly the UK. The UK adopted a graded Contain–Delay–Mitigate–Research response to the threat, moving from an initial containment phase characterised by rigorous contact tracing and testing to a delay phase in mid-March. This approach was considerably less draconian than the lockdown measures introduced by the Chinese government, possibly based on the concerns of wider socio-economic and psychological impact of a full lockdown on society. It also did not align with the WHO approach and advice to 'test, test, test' all suspected cases. What was not clearly articulated was the government's policy goal at the time, that is, whether mitigation or suppression of the epidemic was the aim. What then emerged was an unverified narrative that the aim was to allow the infection to burn through the population to build up 'herd immunity' which would have meant health services being overwhelmed and the deaths of many, predominantly elderly or with complex comorbidities, in the population. Unsurprisingly, the UK government's approach was heavily criticised by academics who demanded the release of the evidence used to inform the government's approach.<sup>4</sup> The release of the evidence has been slow, and it is clear that the lack of transparency has affected trust in the government's response from academics and other allied professionals.

Transparency is crucial to retain the cooperation and trust of the scientific community, health workforce and the wider public.

The UK government belatedly introduced lockdown measures and adopted a new strategy to Suppress–Shield–Treat–Palliate. However, this intervention may have come a little late in the course of the outbreak and cases of infection have taken off exponentially.<sup>5</sup> Compounded by supply issues for personal protective equipment for health staff and conflicting guidance on its use, this has further eroded trust in the government's approach. There was also a clear split in the public health community regarding the approach reflecting the uncertainties in what is known and not known about the virus and how best to tackle the pandemic. This has meant that the public health voice has been muddled and muted at a time when it needed to be crystal clear.

Another potential flaw to the UK's approach has been a strong focus on intensive care unit (ICU) bed capacity as modelling predictions forecast demand for these beds far outstripping available supply.<sup>6</sup> This has led to frenzied planning and efforts to boost ICU capacity. Unfortunately, this fails to build on learning from Italy: such as previous outbreaks of Middle East respiratory syndrome coronavirus (MERS-Cov), healthcare settings are possible sites of infection, 'as they are rapidly populated by infected patients, facilitating transmission to uninfected patients'.<sup>7</sup> The Western health system paradigm is biased towards hospital modes of care delivery. However, in this epidemic scenario, what is becoming clear is that it is not just 'an intensive care phenomenon, rather it is a public health and humanitarian crisis'.<sup>7</sup> In common with other humanitarian crises, the consequences are pervasive, wide and varied and therefore require a response beyond a hospital or healthcare response. As a public health emergency, it is concerning that there is not a stronger public health lead and response.

The societal impact needs to be considered. It is predictable that the poor, the marginalised, those on insecure employment, those living with disabilities and other vulnerable groups are at greatest risk not just from infection but the indirect consequences. After a decade of austerity in many European countries, where health and social care funding has been curtailed, coupled with disinvestments in public health systems, there are less resilient health systems to cope with this pandemic. Government fiscal ideology of running health care such as an airline, with for example bed occupancy rates of more than 90%, has been flawed as it has taken out vital surge capacity much required in emergency situations. The economic agenda has been prioritised over public health, and we are now seeing the fallout from this. Health and social care funding is an investment and a national insurance policy against disasters such as the COVID19 pandemic.

There have been some emerging positives from this crisis. Scientific advice, public health and the evidence-based approach to

decision-making is valued once more. There has been rapid and considerable information sharing by clinicians and academics enabled by social media, and in keeping with many other leading journals, *Public Health* has made its COVID19 content freely accessible. Innovation in ways of working by frontline teams is emerging. In the UK, primary care and community healthcare integration, as well as vertical integration between hospital and out-of-hospital care, is taking place where once it may not have been contemplated. Indeed, integration and coordination will be essential to augment existing health and care capacity to absorb the rise in health need.

On a final note, this pandemic is a global health threat, and this will require collaborative action to tackle. Whilst the focus of the response may very much be local at the present time, only through concerted public health action worldwide can it be successfully suppressed, and hopefully in time eliminated.

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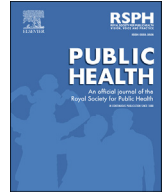
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## Original Research

# Ethnic variations in falls and road traffic injuries resulting in hospitalisation or death in Scotland: the Scottish Health and Ethnicity Linkage Study



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## ABSTRACT

**Objectives:** To investigate ethnic differences in falls and road traffic injuries (RTIs) in Scotland.

**Study design:** A retrospective cohort of 4.62 million people, linking the Scottish Census 2001, with self-reported ethnicity, to hospitalisation and death records for 2001–2013.

**Methods:** We selected cases with International Classification of Diseases–10 diagnostic codes for falls and RTIs. Using Poisson regression, age-adjusted risk ratios (RRs, multiplied by 100 as percentages) and 95% confidence intervals (CIs) were calculated by sex for 10 ethnic groups with the White Scottish as reference. We further adjusted for country of birth and socio-economic status (SES).

**Results:** During about 49 million person-years, there were 275,995 hospitalisations or deaths from fall-related injuries and 43,875 from RTIs. Compared with the White Scottish, RRs for falls were higher in most White and Mixed groups, e.g., White Irish males (RR: 131; 95% CI: 122–140) and Mixed females (126; 112–143), but lower in Pakistani males (72; 64–81) and females (72; 63–82) and African females (79; 63–99). For RTIs, RRs were higher in other White British males (161; 147–176) and females (156; 138–176) and other White males (119; 104–137) and females (143; 121–169) and lower in Pakistani females (74; 57–98). The ethnic variations differed by road user type, with few cases among non-White motorcyclists and non-White female cyclists. The RRs were minimally altered by adjustment for country of birth or SES.

**Conclusion:** We found important ethnic variations in injuries owing to falls and RTIs, with generally lower risks in non-White groups. Culturally related differences in behaviour offer the most plausible explanation, including variations in alcohol use. The findings do not point to the need for new interventions in Scotland at present. However, as the ethnic mix of each country is unique, other countries could benefit from similar data linkage-based research.

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## Introduction

Ethnicity has been defined as ‘the social group a person belongs to and either identifies with or is defined by others as a result of a mix of cultural and other factors including language, diet, religion, ancestry, and physical features’.<sup>1</sup> These factors have the potential to influence health in many ways and important differences between ethnic and migrant groups have been found for all-cause mortality<sup>2–4</sup> and numerous other health problems.<sup>5</sup> The Global

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Burden of Disease Injury and Risk Factors Study reported that in 2013 there were an estimated 56.2 million injuries requiring hospitalisation. The commonest causes were falls (36%) and road traffic injuries (RTIs) (20%).<sup>6</sup> Of 4.8 million deaths, about 29% were due to RTIs and 11% to falls. In Scotland in 2017, 61% of admissions to hospital for unintentional injury were owing to falls and 5% owing to RTIs.<sup>7</sup> Whilst the incidence of falls increases markedly in old age, many risk factors are involved including alcohol consumption, which may differ by ethnic group.<sup>8–11</sup> RTI rates vary according to mode of transport; intoxication with alcohol or other drugs is also a risk factor. In 2016, 13% of all road deaths in Great Britain involved at least one driver with an alcohol level over the drink-drive limit.<sup>12</sup> As these factors are socially mediated, it is reasonable to hypothesise that ethnicity could influence the risk of RTI. However, few studies have used whole populations or large representative samples to compare risks of fall-related injuries or RTIs in different ethnic or migrant groups.<sup>13–15</sup> Most have typically involved smaller, often unrepresentative, samples, and self-reported falls rather than injuries.<sup>16</sup> Several more robust studies of RTIs have been conducted in different countries, often showing clear differences between ethnic groups.<sup>15,17–19</sup> However, no consistent picture emerges from these studies, probably indicating that the national context affects the patterns found.

The Scottish Health and Ethnicity Linkage Study (SHELs) was established in 2003 as a means of exploring in detail the relationships between ethnic group and health in Scotland. A retrospective cohort was created including 4.62 million people who took part in the Scottish Census 2001 and whose ethnic group was recorded.<sup>20</sup> By linking the Census results to hospitalisation and death records, it has provided a unique opportunity to explore differences in many health outcomes between the larger ethnic groups in Scotland.<sup>21–28</sup> The published findings have provided an important evidence base for developing race equality policy in Scotland.<sup>29</sup> In this article, we examine whether risks of injury or death due to falls or RTIs vary between ethnic groups in Scotland. Large differences could have implications for accident prevention policy.

## Methods

### Data sources

The SHELs methods have been published<sup>20,30</sup> and are described in more detail in [Supplementary File A](#). Individual records from the Scottish Census 2001, which included self-defined ethnic group, were linked to the Scottish Community Health Index (CHI), a unique identifier for everyone registered with the National Health Service in Scotland (NHS Scotland). A total of 4.62 million records were successfully linked, 91% of the estimated population of Scotland at that time and at least 85% of each ethnic group ([Supplementary File A, Table A1](#)). This enabled confidential linkage of the Census records to health-related datasets that included the CHI identifier.

### Outcomes

The Information Services Division of NHS Scotland provided data on hospitalisations and deaths for 12 years from May 2001 to April 2013. We used International Classification of Diseases 10th Revision codes for injuries due to falls (W00–W19) and RTIs (V01–89), selecting all cases with a relevant code in any of the six diagnosis positions in the hospitalisation records or the 11 cause positions in the death records. Deaths were combined with hospitalisations as the number of deaths were too small to enable separate analyses. All injuries of sufficient severity to at least require a stay in hospital were thus included.

### Ethnic groups

After extensive research and public consultation, the Scottish Census 2001 used an ethnic classification with 14 main groups. These reflect the pattern of immigration to Scotland over the past 70 years. Because of small numbers of cases, we added the Bangladeshi group to the Other South Asian group and combined the Caribbean, Black African, Black Scottish and Other Black groups into an 'African Origin' group. We did not report on the 'All Other Ethnic Groups' category owing to its heterogeneity. The study therefore examined 10 ethnic groups: White Scottish, Other White British, White Irish, Other White, Any Mixed Background, Chinese, Indian, Pakistani, Other South Asian and African Origin.

### Analysis

An analysis protocol was agreed before the data extraction and followed without modification.<sup>21</sup> We hypothesised we would find differences of at least 10% in the outcomes between the White Scottish majority group (reference) and minority ethnic groups, which could potentially be of public health importance. We analysed fall-related injuries and RTIs for males and females separately. We also conducted subanalyses of RTIs involving pedestrians (V01–V09), cyclists (V10–V19), motorcyclists (V20–29), and car occupants (V40–V49).

Person-years at risk over 12 years were used as the denominator, adjusted for either death or known departure from NHS Scotland, mostly to elsewhere in the United Kingdom (UK). We calculated age-adjusted rates and risk ratios (RRs) and their 95% confidence intervals (CIs) using Poisson regression with robust variance and stratified by sex. RRs were multiplied by 100 to be interpretable as percentages. We first interpret ethnic differences in our health outcome of interest based on a baseline model adjusted for age and further include additional risk factors to gauge their contribution in explaining the observed ethnic differences.

Following previously described methods,<sup>31</sup> we used a proxy measure of socio-economic status (SES), combining three indicators which were consistently associated in the same direction with the outcomes across ethnic groups and by sex: the Scottish Index for Multiple Deprivation (an area-based measure), household tenure and a combined measure of highest educational level. Country of birth was categorised as those who were born in the UK or the Republic of Ireland (RoI) compared with those who were born elsewhere. We examined the influence of SES and UK/RoI birth by adjusting for both separately and in combination.

Data were analysed using SAS version 9.4 (SAS Institute Inc, Cary, North Carolina, USA).

### Ethics, security and reporting

The Multicentre Research Ethics Committee for Scotland (REC 13/SS/0225) and the Privacy Advisory Committee of NHS National Services Scotland (PAC 36/13) approved the study. Individual consent for linking these records was not sought. Researchers with appropriate security clearance (GC, MS) carried out the analyses in a secure environment at National Records of Scotland (NRS). An NRS disclosure committee reviewed all outputs before release. For disclosure reasons, numerators and denominators were rounded to the nearest five in the tables; numbers of cases of five or less and their associated results were not released. However, the RRs were calculated using the real number of cases.

In reporting, we complied with the STROBE/RECORD checklist ([Supplementary File B](#)).



## Results

### Characteristics of the study population

The ethnic distribution of the SHELS cohort was similar to that of the Scottish Census 2001 population, including 89% White Scottish, 9% other White groups and 2% non-White groups (Table 1). The White groups were on average older than the non-White groups. Around 25% of White Scottish and Pakistani groups had the highest level of educational qualification compared with 40–52% in several other groups. People of African Origin were the most likely to live in the most disadvantaged areas but almost as many lived in the least disadvantaged. Household ownership was highest in the Indian and Pakistani groups. The proportion of people who were born in the UK/RoI was more than 95% for the White Scottish, Irish, and Other British groups, 75% for the Any Mixed Background group and 30–60% for other groups.

### Hospitalisations and deaths

During 12 years of follow-up and about 49 million person-years at risk, there were 275,995 hospitalisations and deaths due to falls and 43,865 due to RTIs. The RTIs included 17,965 car occupants, 10,630 cyclists, 7375 pedestrians and 6575 motorcyclists.

### Falls

Table 2 shows ethnic differences in hospitalisations and deaths due to falls. With 95% CIs that did not overlap with the reference value 100, age-adjusted RRs were higher for males in the White Irish (131) and Any Mixed Background (124) groups and lower in the Pakistani group (72). For females, RRs were higher for the Other White British (114), White Irish (118), Other White (110), and Any Mixed Background (126) groups and lower for the Pakistani (72) and African Origin (79) groups. Adjustment for UK/RoI birth and

SES either separately or combined resulted in small and inconsistent changes in the RRs in either direction.

### Road traffic injuries

Table 3 shows ethnic differences in hospitalisations and deaths for all RTIs combined. With 95% CIs that did not overlap with the reference value, age-adjusted RRs were higher for males in the Other White British (161) and Other White (119) groups. Among females, RRs were higher for the Other White British (156) and Other White (143) groups and lower for Pakistani (74) groups. Adjusting for UK/RoI birth and SES either separately or combined resulted in small and inconsistent changes in either direction.

When subgrouped into car occupants, cyclists, pedestrians and motorcyclists, there were typically fewer than 50 events in the non-White ethnic groups, including almost none among female cyclists and motorcyclists (Supplementary File C, Tables C1–4). Among the other ethnic groups, there were contrasting patterns. The Other White British group had higher RRs for car occupants (males 132; females 124), cyclists (males 195; females 245), and male motorcyclists (242) but lower for pedestrians (males 79; females 71). The Other White group had higher RRs for female car occupants (128), cyclists (males 138, females 281) and male motorcyclists (199) but lower for female pedestrians (54). Pakistani males had higher RRs for car occupants (135) and lower for cyclists (56). Adjusting for UK/RoI birth or SES made very little difference.

## Discussion

We found unexpectedly large differences between ethnic groups in Scotland in risks of hospitalisation and death due to falls and RTIs over a 12-year period. Compared with the White Scottish population, age-adjusted risks for falls were higher for White Irish and Mixed males, and for Other White British, White Irish, Other White, and Mixed females; they were lower for Pakistani males

**Table 1**  
Sociodemographic profile of the linked 2001 Scotland Census population by sex and ethnic group.

Sex and ethnic group	Population	Ethnic distribution	Age at Census	UK/RoI-born <sup>a</sup>	SIMD <sup>b</sup>		Highest qualification (individual)	Highest qualification (household)	Household tenure (owned)
					Most deprived	Least deprived			
	N	%	Mean (SD)	%	%	%	%	%	
<b>MALES</b>									
White Scottish	1,949,484	88.5	38 (22)	99.1	20.1	19.8	24.4	39.0	68.6
Other White British	160,235	7.3	42 (20)	95.3	8.0	29.6	48.4	61.9	72.3
White Irish	20,341	0.9	45 (20)	98.4	22.2	21.7	36.8	51.4	65.4
Other White	29,944	1.4	36 (21)	30.5	12.4	32.6	49.2	66.2	56.6
Any mixed background	5310	0.2	21 (18)	76.0	19.7	26.1	36.8	59.7	57.1
Indian	6448	0.3	31 (19)	48.4	9.7	38.5	50.9	64.5	72.2
Pakistani	12,929	0.6	27 (19)	58.0	15.8	24.8	26.5	47.5	76.2
Other South Asian	3549	0.2	29 (19)	38.9	24.2	28.3	46.4	58.7	53.7
African origin	3277	0.1	30 (18)	39.9	27.6	22.4	52.4	68.2	43.1
Chinese	6532	0.3	30 (18)	38.4	13.4	38.5	31.8	48.3	69.8
<b>FEMALES</b>									
White Scottish	2,138,643	88.6	41 (24)	99.1	21.3	19.2	23.8	37.8	65.2
Other White British	174,748	7.2	44 (21)	95.0	8.2	28.9	40.8	58.5	69.5
White Irish	23,162	1.0	49 (21)	98.6	20.1	22.8	38.0	53.4	64.1
Other White	35,711	1.5	37 (21)	26.4	10.8	33.4	51.3	68.7	58.7
Any mixed background	5799	0.2	24 (20)	74.5	18.7	27.3	37.8	60.2	55.8
Indian	5888	0.2	30 (19)	51.1	9.6	39.0	40.7	61.9	73.6
Pakistani	12,702	0.5	26 (18)	60.5	15.4	24.6	22.8	47.1	75.9
Other South Asian	2963	0.1	29 (20)	44.5	22.0	28.9	36.7	55.2	54.5
African origin	3056	0.1	30 (18)	42.1	27.5	24.5	46.1	67.6	45.1
Chinese	6672	0.3	31 (18)	33.9	12.1	39.1	33.3	50.3	70.1

<sup>a</sup> UK/RoI-born = Born in the UK or Republic of Ireland.

<sup>b</sup> SIMD = Scottish Index of Multiple Deprivation.

**Table 2**

Age-adjusted rates per 100,000 person-years at risk (PY) and risk ratios (RRs) for hospitalisations and deaths owing to falls (W00–W19) by sex and ethnic group. RRs are adjusted for age and additionally for socio-economic status (SES), born in the UK/Ireland (UK/RoI-born) and both, with 95% CIs.

Sex and ethnic group	Cases	PY	Rates/100,000 PY	RR (95% CI) Age	RR (95% CI) Age + SES	RR (95% CI) Age + UK/RoI-born	RR (95% CI) Age + SES + UK/RoI-born
<b>MALES</b>							
White Scottish	123,410	21,179,755	583	100	100	100	100
Other White British	6595	1,571,080	581	102 (97, 107)	107 (101, 112)	99 (94, 104)	103 (98, 109)
White Irish	1315	202,190	743	131 (122, 140)	127 (118, 136)	126 (117, 135)	122 (114, 132)
Other White	1035	278,515	579	102 (95, 110)	103 (96, 111)	105 (97, 113)	106 (98, 114)
Any mixed background	275	56,265	707	124 (110, 141)	121 (107, 138)	122 (107, 138)	119 (105, 135)
Indian	205	65,945	570	100 (88, 115)	107 (93, 122)	102 (89, 117)	108 (95, 124)
Pakistani	335	146,430	411	72 (64, 81)	75 (67, 84)	73 (65, 82)	76 (67, 85)
Other South Asian	105	35,500	517	91 (76, 109)	89 (75, 106)	92 (77, 110)	90 (76, 107)
African origin	95	32,160	539	95 (77, 117)	89 (72, 110)	96 (78, 118)	90 (72, 111)
Chinese	120	68,685	485	85 (73, 100)	88 (75, 103)	88 (75, 103)	90 (77, 105)
<b>FEMALES</b>							
White Scottish	130,075	22,581,190	576	100	100	100	100
Other White British	8745	1,644,435	638	114 (108, 120)	115 (109, 121)	111 (105, 117)	113 (107, 119)
White Irish	1600	216,905	660	118 (110, 125)	116 (109, 124)	114 (109, 122)	114 (106, 122)
Other White	1310	319,915	617	110 (103, 117)	110 (103, 118)	112 (105, 120)	112 (105, 120)
Any mixed background	210	59,970	710	126 (112, 143)	124 (109, 140)	124 (110, 140)	122 (108, 138)
Indian	110	59,925	498	89 (75, 105)	90 (77, 107)	90 (76, 107)	92 (78, 108)
Pakistani	200	143,940	402	72 (63, 82)	73 (64, 83)	72 (64, 82)	74 (65, 84)
Other South Asian	70	28,610	558	99 (80, 123)	99 (80, 123)	99 (80, 124)	99 (80, 123)
African origin	60	28,590	442	79 (63, 99)	77 (62, 97)	79 (63, 99)	77 (62, 97)
Chinese	125	68,010	577	103 (82, 129)	104 (83, 131)	105 (84, 132)	107 (85, 134)

CI, confidence intervals.

and females and African females. For RTIs overall, risks were higher for Other White British and Other White males and females but lower for Pakistani females. There were differing patterns for RTIs of car occupants, cyclists, pedestrians and motorcyclists, with virtually no recorded cases among non-White female cyclists and motorcyclists. Adjustment for SES or UK/RoI birth had little effect on the observed differences.

#### Strengths and limitations

The strengths and limitations of the SHELS methods have been discussed in detail.<sup>3,26</sup> Their strengths include using a national

census-based retrospective cohort of 4.62 million people with reliable recording of self-reported ethnicity, SES and country of birth. By linking the cohort to 12 years of hospitalisation and death data, we had enough cases to compare 10 ethnic groups, including four distinct White groups. However, the numbers of cases in some ethnic groups were too small to be analysed or CIs were very wide, particularly for transport subgroups. We combined hospitalisations and deaths as there were too few deaths to analyse separately. Limiting the analysis to hospitalisations was not part of our analysis plan but given the relatively small proportion of deaths, we think it unlikely this would have altered the findings. We addressed the differing age structure of the ethnic groups by adjustment for age:

**Table 3**

Age-adjusted rates per 100,000 person-years at risk (PY) and risk ratios (RRs) for hospitalisations and deaths owing to road traffic injuries (V00–V89) by sex and ethnic group. RRs are adjusted for age and additionally for socio-economic status (SES), born in the UK/Ireland (UK/RoI-born) and both, with 95% CIs.

Sex and ethnic group	Cases	PY	Rates/100,000 PY	RR (95% CI) Age	RR (95% CI) Age + SES	RR (95% CI) Age + UK/RoI-born	RR (95% CI) Age + SES + UK/RoI-born
<b>MALES</b>							
White Scottish	26,350	21,179,755	124	100	100	100	100
Other White British	1950	1,571,080	195	161 (147, 176)	151 (138, 165)	163 (149, 179)	153 (139, 167)
White Irish	155	202,190	110	91 (77, 107)	93 (79, 110)	93 (78, 110)	94 (80, 112)
Other White	270	278,515	144	119 (104, 137)	117 (101, 134)	117 (101, 135)	115 (100, 132)
Any mixed background	60	56,265	100	82 (65, 105)	83 (65, 106)	83 (65, 106)	84 (66, 107)
Indian	40	65,945	96	79 (59, 105)	75 (57, 100)	79 (59, 105)	75 (57, 100)
Pakistani	115	146,430	110	90 (75, 108)	91 (76, 109)	90 (75, 108)	91 (76, 109)
Other South Asian	40	35,500	153	126 (95, 168)	129 (97, 171)	125 (94, 167)	128 (96, 170)
African origin	20	32,160	92	76 (52, 112)	80 (54, 118)	75 (51, 111)	80 (54, 118)
Chinese	35	68,685	119	98 (73, 133)	98 (72, 132)	97 (72, 132)	97 (72, 131)
<b>FEMALES</b>							
White Scottish	13,170	22,581,190	58	100	100	100	100
Other White British	1230	1,644,435	89	156 (138, 176)	141 (125, 160)	163 (144, 185)	146 (128, 165)
White Irish	90	216,905	51	90 (72, 112)	91 (74, 114)	95 (76, 118)	95 (76, 118)
Other White	195	319,915	81	143 (121, 169)	133 (112, 157)	136 (114, 161)	128 (108, 152)
Any mixed background	25	59,970	41	73 (50, 105)	73 (51, 106)	75 (52, 108)	75 (52, 108)
Indian	20	59,925	53	93 (62, 140)	91 (60, 137)	91 (61, 137)	90 (59, 135)
Pakistani	50	143,940	42	74 (57, 98)	79 (60, 103)	74 (57, 97)	79 (60, 103)
Other South Asian	15	28,610	56	98 (60, 160)	97 (60, 159)	97 (60, 159)	97 (60, 159)
African origin	15	28,590	60	105 (65, 170)	111 (69, 180)	103 (63, 167)	110 (68, 178)
Chinese	20	68,010	66	115 (78, 170)	118 (80, 174)	111 (75, 164)	115 (78, 170)

CI, confidence intervals.

had there been enough cases to allow it, stratification by age could have revealed age-related differences. Some individuals may have left the UK during the follow-up period which we could not account for, possibly introducing some denominator bias. Individuals in some ethnic groups might be more reluctant than others to attend hospital but as the injuries were severe enough to warrant hospital admission, we think this is unlikely.

#### *Findings in the light of the published literature*

##### *Falls*

A review of published studies of ethnic and racial differences in falls in older adults found most studies involved small samples, restricted by age group and/or gender and relying on self-reporting falls rather than related injuries.<sup>16</sup> For example, in a study of mainly elderly women, African-Americans reported 23% fewer falls than Whites.<sup>32</sup> Elderly Italian-born men in Australia were about 40% less likely to report repeated falls than their Australian-born counterparts.<sup>33</sup> A study of self-reported falls in the elderly comparing Chinese people in Taiwan, Hong Kong and Australia with White people in Australia found 50–70% lower rates among the Chinese.<sup>34</sup> In none of the studies was socio-economic status found to be an important associated factor. A national study of deaths owing to falls in the Netherlands found no clear-cut differences between native-born Dutch and four minority ethnic groups.<sup>15</sup> However, as it only included 62 deaths across all ethnic minorities, the study had limited statistical power. Thus, although these studies are more limited in scope and statistical power, the overall picture of lower risks of falls in some ethnic minorities is consistent with our findings.

##### *Road traffic injuries*

Most previously published studies of RTIs and ethnicity have reported higher risks among disadvantaged ethnic or indigenous minorities. In the Netherlands, higher risks of death for pedestrian RTIs were found among Turkish, Moroccan, Surinamese and Antillean groups.<sup>15</sup> In Arizona, compared with non-Hispanic Whites, risks among Hispanics and African-Americans were broadly similar but American Indians had much higher risks of death among both car occupants and pedestrians, often associated with high blood-alcohol levels.<sup>17</sup> In New Zealand, risks of hospitalisation or death owing to RTIs were 65% higher among Māoris than the European/Other group.<sup>19</sup> In Australia, Aborigines had overall RTIs rates about twice that of non-Aborigines.<sup>18</sup> In London, both children and adults defined as Black were more likely than Whites to sustain RTIs, whereas Asians were less likely.<sup>35</sup> The increased rate among Black children was associated with higher neighbourhood deprivation, poorer local road conditions and a riskier commute to school.<sup>36,37</sup> In Israel, Arab children were 36% more likely to be hospitalised for an RTI than Israeli children and 57% more likely to be severely injured.<sup>38</sup> Poorer road conditions, more careless driving and less supervision of children in Arabic communities were highlighted.

##### *Possible causes of the ethnic differences in this study*

Although a descriptive study such as this cannot prove causation, it can usefully stimulate hypotheses for further research. In a major review, Davey Smith and colleagues considered the possible causes of apparent health differences between ethnic groups under the following headings: artefactual; migration; socio-economic factors; culture, beliefs and behaviours; racism; biology; and health service use and access.<sup>39</sup> Given the fall-related injuries and RTIs in this study were fatal or sufficiently severe to require hospitalisation, we can expect their assessment and recording to have been consistent regardless of ethnic group and therefore the observed differences are likely to be real. Adjusting for whether

individuals were born outside the UK made little difference to either set of findings, suggesting that recent migration to Scotland was not a major explanatory factor, although a smaller effect cannot be excluded.

We found that adjusting for SES, including the socio-economic profile of place of residence, had little effect on our age-adjusted findings for falls. This is supported by the findings of a review by Todd et al.<sup>40</sup> who did not find a consistent relationship between SES and falls in the elderly. Adjusting our RTI data for SES also had little effect. As aforementioned, this may appear to contrast with the findings of many other studies where disadvantaged ethnic minorities had higher RTI rates. However, the SES of the larger ethnic minority groups in Scotland is notably different from that of many other countries, typically being characterised by larger than average proportions with high educational attainment and home-ownership (Table 1).

Differences in culture, beliefs and behaviours may provide a more plausible explanation for the differences in fall-related injuries, such as the 70% higher risk among White Irish than Pakistani males or the 40–70% higher risks among the White minority females compared with the Pakistani and African females, even after adjusting for SES. One possible contributor is alcohol, long recognised as a risk factor for falls.<sup>11,40</sup> A health survey of ethnic minorities in Glasgow found 91% of Pakistanis reported they did not use alcohol compared with 30% in the general (White) population.<sup>41</sup> Another SHELS study found that White Irish males and females had risks of alcohol-related diseases 3.1 times and 3.6 times higher than their respective Pakistani counterparts.<sup>22</sup> Many other factors are associated with falls in the elderly, such as gait problems, vertigo, Parkinson's disease and antiepileptic drug use.<sup>8</sup> However, there appears to be no evidence currently to relate these to ethnicity. As for RTIs, differential use of modes of transport may largely explain the very low number of cases of cycle or motorbike injuries among Indians and Pakistanis, especially females. UK and Scottish data show much lower cycle use among these minorities.<sup>42,43</sup> The lower levels of alcohol consumption by some ethnic minorities may also play a part.

As risks of falls and RTIs were lower in the non-White minorities, racism does not appear to be a plausible contributor to the findings. Given the acute nature of the injuries, and the availability of emergency health services to all in Scotland, it also seems unlikely that differential access to or use of health services would play a part. This is supported by another SHELS analysis showing broadly equitable rates of all-cause hospitalisation between ethnic groups.<sup>26</sup>

#### *Conclusions*

We found unexpected and sometimes large ethnic variations in risks of fall-related injuries and RTIs in Scotland, being typically lower among the non-White groups. Cultural and behavioural differences offer the most plausible explanation but would require further research to be confirmed. Although the findings may not suggest the need for new accident prevention initiatives in Scotland at present, they demonstrate that the risk of unintentional injury can vary considerably between ethnic groups. As every country's ethnic mix is unique and many are undergoing considerable demographic change owing to migration, other countries could benefit from similar data linkage-based research.

#### **Author statements**

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#### Ethical approval

Ethical approval for the data linkage, security and analyses was granted by the Scottish Multicentre Ethics Committee and the Privacy Advisory Committee of NHS National Services Scotland.

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#### Competing interests

None declared.

#### Author contributions

All authors contributed to the design of the study. G.C. and L.G. drafted the article. R.B. was the principal investigator. L.G. chaired the study group including all the authors. A.D. managed the study. G.C. and M.S. carried out the statistical analysis. All authors commented on the drafts and approved the final version.

#### Data sharing

Researchers who wish to access the data should apply to National Records of Scotland (<https://www.nrscotland.gov.uk/>) and ISD (<http://www.isdscotland.org/>). They are maintained in a secure environment and governed by ethical and other restrictions on access.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2020.01.013>.

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## Review Paper

## How to improve adherence with quarantine: rapid review of the evidence

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## ABSTRACT

**Objectives:** The December 2019 outbreak of coronavirus has once again thrown the vexed issue of quarantine into the spotlight, with many countries asking their citizens to 'self-isolate' if they have potentially come into contact with the infection. However, adhering to quarantine is difficult. Decisions on how to apply quarantine should be based on the best available evidence to increase the likelihood of people adhering to protocols. We conducted a rapid review to identify factors associated with adherence to quarantine during infectious disease outbreaks.

**Study design:** The study design is a rapid evidence review.

**Methods:** We searched Medline, PsycINFO and Web of Science for published literature on the reasons for and factors associated with adherence to quarantine during an infectious disease outbreak.

**Results:** We found 3163 articles and included 14 in the review. Adherence to quarantine ranged from as little as 0 up to 92.8%. The main factors which influenced or were associated with adherence decisions were the knowledge people had about the disease and quarantine procedure, social norms, perceived benefits of quarantine and perceived risk of the disease, as well as practical issues such as running out of supplies or the financial consequences of being out of work.

**Conclusions:** People vary in their adherence to quarantine during infectious disease outbreaks. To improve this, public health officials should provide a timely, clear rationale for quarantine and information about protocols; emphasise social norms to encourage this altruistic behaviour; increase the perceived benefit that engaging in quarantine will have on public health; and ensure that sufficient supplies of food, medication and other essentials are provided.

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## Introduction

Quarantine is the separation and restriction of movement of people who have potentially been exposed to a contagious disease, to limit disease spread.<sup>1</sup> This differs from isolation, which applies to people who have been diagnosed with the disease,<sup>2</sup> although the terms are sometimes used interchangeably. Particularly during the early stages of a novel infectious disease outbreak, quarantine can be applied to large numbers of people. For example, in Toronto during the 2003 severe acute respiratory syndrome (SARS) outbreak, 100 people were placed into quarantine for every case

that was diagnosed.<sup>3</sup> The early stages of the 2019 coronavirus outbreak have already witnessed the quarantining of entire cities within China,<sup>4</sup> whereas thousands of foreign nationals leaving China are being asked to enter quarantine at home or in government facilities upon return to their home countries.

The efficacy of quarantine is uncertain, and in previous incidents its overuse has been criticised as lacking in scientific basis.<sup>3,5,6</sup> Regardless of this debate, one thing is clear: quarantine does not work if people do not adhere to it. Although officially sanctioned enforcement of quarantine orders is possible,<sup>7</sup> this can lead to legal dispute,<sup>5</sup> chaotic scenes of confrontation<sup>8</sup> and poor mental health (which can occur even under voluntary procedures).<sup>4,9</sup> Many nations are understandably nervous of these outcomes, especially given that confrontation can now result in harrowing mobile phone footage making its way to social and mainstream media. In many societies it might also be difficult to persuade the police or military

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to forcibly prevent healthy people who wish to leave quarantine from doing so. Seeking to avoid instances of public backlash, many countries rely instead on a combination of inducements and appeals to civic duty to encourage people to adhere.

We present a rapid evidence review<sup>10</sup> of factors that increase or decrease adherence with quarantine requests.

## Methods

We used a search strategy including terms relating to quarantine (e.g. quarantine, patient isolation) and adherence (e.g. adherence, compliance). For the full search strategy, see [Appendix 1](#).

Studies were eligible for inclusion if they (a) reported on primary research; (b) were published in peer-reviewed journals; (c) were written in English, Italian or French (which could be translated by a member of our team); (d) included participants asked to enter quarantine outside of a hospital environment for at least 24 h; and (e) included outcomes relating to factors associated with, or self-reported reasons for, adherence or non-adherence.

Two authors ran the search strategy on MEDLINE® on 27th January 2020, and two authors ran the search strategy on PsycINFO and Web of Science on 30th January 2020. Citations were downloaded to EndNote© version X9 (Thomson Reuters, New York, USA). The same authors who ran the search evaluated titles and abstracts excluding any which were obviously irrelevant. We obtained full texts of remaining citations, and two authors reviewed these, excluding any which did not meet inclusion criteria. Finally, reference lists of remaining papers were hand-searched for additional relevant studies. We then compared results from full text screening; there were only minor discrepancies, which were resolved through discussion with the whole team.

The following data were extracted from included studies: authors, publication year, country of study, infectious disease outbreak, design and method, participants (including sample size and demographic information), reason for quarantine, length of quarantine and key results. Data extraction was carried out by one author.

Narrative synthesis was used to analyse the results of the included papers and group results into related themes.

## Results

The initial search yielded 3163 articles, of which 14 included relevant data and were included in the review. Details of the screening stages can be seen in [Fig. 1](#). Characteristics of included studies and key results are presented in [Table 1](#). Eight studies reported adherence rates of quarantined individuals, which ranged from 0% to 92.8%. We identified nine factors associated with adherence which are discussed in the following context.

### *Demographic and employment characteristics of those quarantined*

There was mixed evidence as to whether demographic and employment characteristics of quarantined people affected adherence to quarantine protocol. Whether parents' employers provided paid leave did not affect adherence to quarantine recommendations during the H1N1 outbreak among children who had been sent home from school.<sup>11</sup> However, where parents nonetheless took time off work to supervise their children, adherence to quarantine was higher, as the alternative might have involved others supervising children which would have broken quarantine protocol regarding social mixing.<sup>11</sup> Porten et al.<sup>12</sup> found that during the SARS outbreak, unemployed or low-waged people were more likely to adhere to quarantine. For students, however, having an additional job alongside being a student did not appear to be a relevant

factor.<sup>13</sup> Being a healthcare worker was associated with higher adherence to quarantine during the SARS outbreak in Canada.<sup>14</sup> Within student populations, no differences were found in accordance with gender, age, full or part-time status, residing on or off campus or quarantine location.<sup>13</sup>

### *Knowledge about the infectious disease outbreak and quarantine protocol*

One of the major factors affecting adherence to quarantine is knowledge about the infection and the quarantine protocol. When five schools in an Australian city were closed during the H1N1 pandemic, a lack of clear quarantine instructions led some of those affected to invent their own quarantine rules,<sup>15</sup> seemingly based on what they thought constituted a visible symptom of the disease, the acceptable degree of contact with those infected and the risk of being affected or of infecting others. Parents in an Australian city who understood what they were meant to do during the quarantine period for H1N1 had significantly higher adherence to quarantine.<sup>16</sup> Caleo et al.<sup>17</sup> found that people in Sierra Leone who were put under quarantine due to Ebola also had problems adhering to protocols because they did not understand what 'isolation' meant. Adherence to quarantine in Taiwan during the SARS outbreak was significantly associated with higher awareness of the pandemic.<sup>18</sup>

However, in some cases, too much perceived knowledge might be a hindrance. Residents of villages that were quarantined during the Ebola epidemic who were health professionals often had more knowledge about Ebola than the volunteers sent in to support the village. They believed they knew more about the risk of infection than volunteers, but unlike the latter did not always adhere to the quarantine measures as they thought the restrictions were too overprecautionary.<sup>19</sup>

One study looked at the effect of where people got their knowledge of quarantine protocols from, finding no difference in adherence rates between those that sourced information from official vs unofficial sources.<sup>16</sup>

### *Sociocultural factors: social norms, cultural values and the law*

Social norms play an important part in adherence to quarantine protocols. Many individuals quarantined during the SARS outbreak in Canada reported social pressure from others to adhere to quarantine.<sup>20</sup> Desclaux et al.<sup>19</sup> noted that residents from villages in Senegal which quarantined during Ebola said that if there was favourable opinion for engaging in quarantine from the head of household, it was expected the rest of the household would follow suit and adhere. Residents also acknowledged a respect for the collective commitment to protect the community against Ebola which they did not want to be seen to be disrespecting.

However, social norms can also reduce adherence to quarantine. As rumours that others were breaking quarantine began to surface among Australian school communities quarantined during the H1N1 outbreak in Australia, those affected explained they were more likely to break quarantine protocols themselves.<sup>15</sup> Volunteers who were supporting villages in Senegal during quarantine for Ebola also mentioned 'relaxing their principles' and allowing non-adherence to quarantine at certain times to avoid direct challenges to containment which would then be seen by the rest of the village.<sup>19</sup>

Cultural values also play an important part in decisions to adhere to quarantine. Residents of villages in West Africa quarantined during an Ebola outbreak often did not adhere to quarantine as it was inherent in their culture to care for people when they are sick, rather than 'abandon' them.<sup>17</sup> Conversely, two studies noted that participants quarantined during SARS explained that they

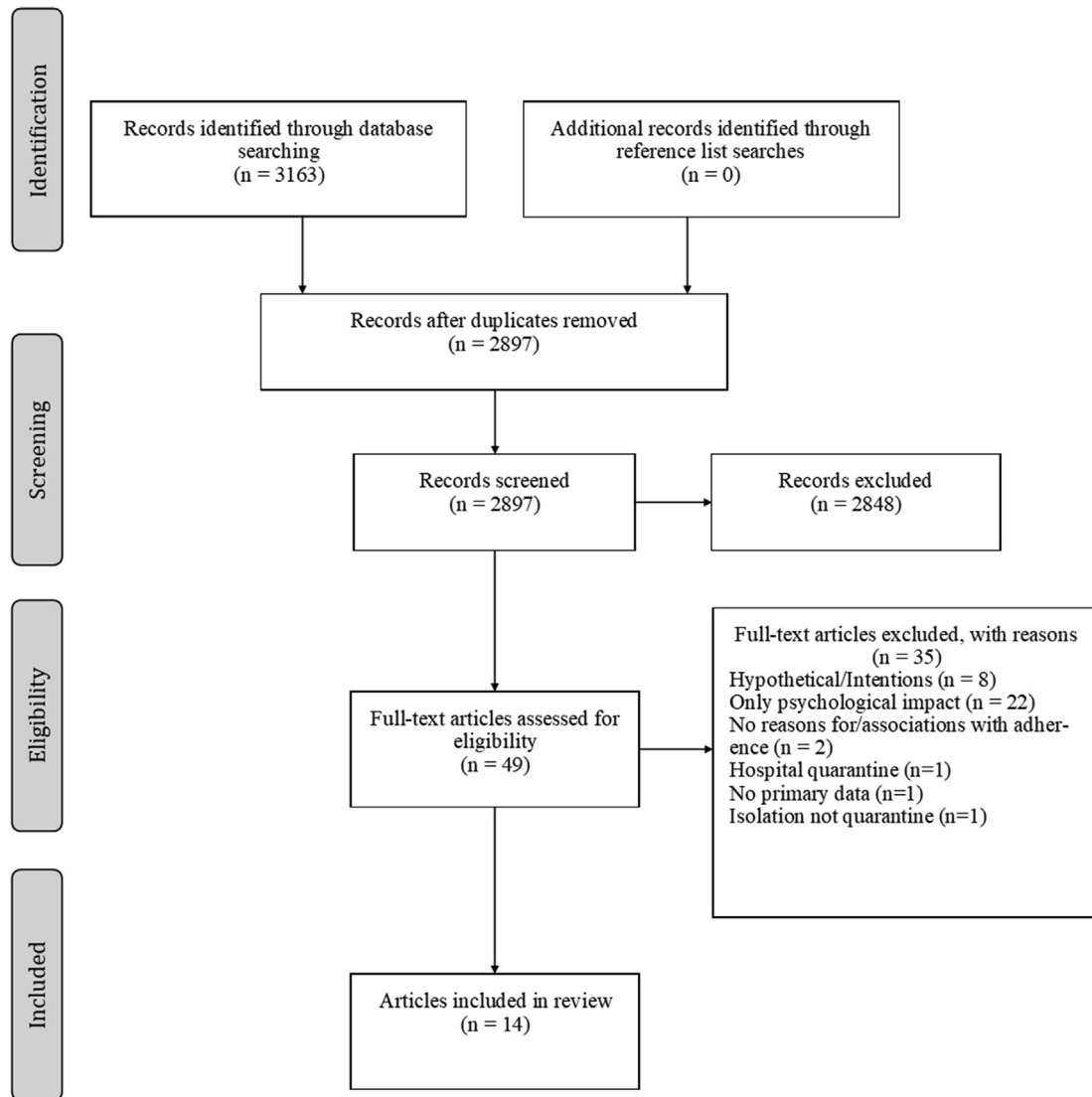


Fig. 1. Flow diagram of included studies and reasons for exclusion.

adhered to quarantine as it was their 'civic duty' and they wanted to be a good citizen.<sup>20,21</sup>

Two studies noted that 'following the law' was a reason for adhering to quarantine during the Ebola outbreak in Sierra Leone<sup>17</sup> and the SARS outbreak in Canada.<sup>20</sup> In these circumstances, if individuals were found breaking quarantine rules, they faced paying fines. Relatedly, where the term 'voluntary' was used to describe quarantine in Canada during the SARS outbreak, residents correctly understood this meant that adherence was at their discretion, rather than enforced by the government, something which then reduced adherence.<sup>21</sup>

#### Perceived benefit of quarantine

People who perceive a benefit of quarantine are more likely to adhere to it. For example, as village residents began to notice a slowing in the spread of Ebola, their attitudes changed and adherence to quarantine protocols increased.<sup>17</sup> Toronto residents affected by quarantine for SARS explained they adhered to protocols because they believed this would reduce the risk of transmission to others.<sup>21</sup> Similarly, Soud et al.<sup>13</sup> found that perceived

higher importance of avoiding others during isolation was associated with adherence to quarantine during a mumps outbreak at a university in the United States.

#### Perceived risk of the disease outbreak

People who perceive a disease outbreak to be riskier (in terms of disease transmission and severity of disease outcomes) are more likely to adhere to quarantine. Cava et al.<sup>20</sup> found that those who adhered to quarantine for SARS had higher perceptions of risk for the disease. Residents in Senegalese villages quarantined due to Ebola adhered because they thought transmission could happen even when asymptomatic.<sup>19</sup> Higher perceived fear of SARS was associated with adherence to quarantine measures in Taiwan.<sup>18</sup> Conversely, reasons for non-adherence to quarantine in Australia during the H1N1 pandemic included belief that the disease was not serious.<sup>22</sup> When comparing quarantine adherence during two separate outbreaks of SARS in Canada, adherence was higher during the second outbreak.<sup>14</sup> Indeed this may be due to the second outbreak increasing the perceived severity of the outbreak as it had not receded, or it could be due to people being more



**Table 1**  
Characteristics of included studies and key results.

Study	Country	Disease	Design and method	Participants (N, Age, % male)	Quarantine protocol	Adherence rates	Factors associated with adherence
<i>Reasons given for adherence behaviour</i>							
Braunack-mayer 2013	Australia	Swine flu	Qualitative, interviews	School principals, staff, parents and students in five schools from an Australian city (56, -, -)	Home quarantine for seven days	–	Knowledge, Sociocultural factors
Caleo 2008	Sierra Leone	Ebola	Qualitative, semi structured face-to-face interviews	Households with and without Ebola cases and key community informants from a rural village (48, 18 (median), 47.3)	Restriction of movements during August 2014	–	Knowledge, Sociocultural factors, Perceived benefit of quarantine
Cava 2005	Canada	SARS	Qualitative, semi-structured face-to-face interviews	Individuals who had been quarantined (21, 18->65, 23.8)	Home quarantine for 10 days	“People adhered with differing levels of vigilance”	Sociocultural factors, Perceived risk of disease, Practicalities
Desclaux 2017	Senegal	Ebola	Qualitative, semi-structured face-to-face interviews	Adult contact subjects and community volunteers (70, -, -)	Daily check-ups for physical symptoms with social distancing for 21 days	–	Knowledge, Sociocultural factors, Perceived risk of disease, Trust in government
DiGiovanni 2004	Canada	SARS	Qualitative, unstructured and structured face-to-face interviews, telephone polling, focus groups	Toronto residents affected by the SARS epidemic, affected by quarantine, and HCWs who had been quarantined (-1800, -, -)	Home quarantine for up to 10 days	–	Socio-cultural factors, Perceived benefit of quarantine, Practicalities,
Pellechia 2015	Liberia	Ebola	Qualitative, focus groups and face-to-face semi-structured interviews	Individuals from 7 neighbourhoods and 5 villages (462, -, 60.6)	State enforced home and neighbourhood quarantine for 21 days	–	Practicalities
Teh 2012	Australia	Swine flu	Quantitative, retrospective cohort study, telephone questionnaire	Participants tested for H1N1 and who were prescribed quarantine (538, -, -)	Home quarantine for seven days	92.8% reported adherence to quarantine measures	Practicalities, Perceived risk of disease
<i>Factors tested for associations with adherence behaviour</i>							
Hsu 2006	Taiwan	SARS	Quantitative, cross-sectional paper questionnaire	HCWs in charge of SARS epidemic control at Health Centres in Taiwan (301, ≤30 - ≥50, -)	Home quarantine for 10–14 days	0% - all nurses reported poor adherence from quarantined individuals	<b>Quarantine support characteristics, Knowledge, Perceived risk of disease</b>
Kavanagh 2011	Australia	Swine flu	Quantitative, Cross-sectional online or telephone questionnaire	Parents from households with children who were placed in quarantine during the outbreak (297, -, 14.5)	Prescribed home quarantine for 1–14 days	53% reported full adherence with quarantine within their household.	<b>Knowledge</b>
Kavanagh 2012	Australia	Swine flu	Quantitative, Cross-sectional online or telephone questionnaire	Parents who were employed from households with children who were placed in quarantine during the outbreak (113, -, -)	Prescribed home quarantine for 1–14 days	Half of all households fully adhered with quarantine recommendations.	<b>Individual characteristics</b>
McVernon 2011	Australia	Swine flu	Quantitative, Cross-sectional online or telephone questionnaire	Parents from households with children who were placed in quarantine during the outbreak (314, -, -)	Prescribed home quarantine for 1–14 days	84.5% reported full adherence at household level	Length of quarantine, <b>Perceived risk of disease, Practicalities</b>
Porten 2006	Germany	SARS	Quantitative, cross-sectional paper questionnaire	Respondents from local health departments (280, -, -)	Home quarantine for 10 days	-	<b>Individual characteristics</b>
Reynolds 2008	Canada	SARS	Quantitative, cross-sectional paper questionnaire	Adults who were placed in quarantine (1057, 49.2, 37)	Prescribed home or work (for HCWs) quarantine for 2–10 days	15.8% full adherence with all quarantine measures	<b>Individual characteristics, Perceived risk of disease</b>
Soud 2009	United States	Mumps	Quantitative, cross-sectional telephone or face-to-face questionnaire	Students at a Kansas University with suspected mumps instructed to stay isolated (132, <20- ≥22, 37)	Prescribed home quarantine for 1–9 days	75% stayed isolated for recommended number of days	<b>Length of quarantine, Perceived benefit of quarantine,</b> Individual characteristics

Note: -, not reported, HCWs Healthcare Workers.

In many cases, it was not clear how long participants were quarantine for. In these instances, we have given the best estimates based on guidance by public health officials at that time. SARS, severe acute respiratory syndrome.

knowledgeable about the disease and quarantine protocol the second time around. Relatedly, increased adherence to quarantine in Australia during the H1N1 pandemic occurred when there was an influenza case in the household, which again may be associated with increased perceived risk of disease transmission now that the disease is amongst family members, or an increase in knowledge of the disease and quarantine protocol.<sup>23</sup>

One study looked at the effect of the objective severity of disease on adherence to quarantine, finding no effect of the total probable cases of SARS or number of quarantined people on likelihood of adherence.<sup>18</sup>

#### *Practicalities of quarantine*

Two studies reported the need to work and fear of loss of income as reasons for not adhering to quarantine protocols.<sup>21–22</sup> In Teh et al.,<sup>22</sup> participants also mentioned factors relating to ‘life carrying on’ outside of quarantine as reasons for not adhering. Examples included needing to attend an important event or visiting family and friends.

Three studies reported that participants needed to break quarantine protocol to get supplies<sup>21,22,24</sup> or to seek medical attention.<sup>22</sup>

Sometimes factors relating to the household situation during quarantine influenced adherence. This could be due to people being preoccupied with the ill health of a loved one, such that they did not adhere to quarantine protocols themselves.<sup>20</sup> Similarly, if quarantined children were able to be cared for by adults within the household rather than by outside family, friends or hired help coming to the house, this made it easier for families to adhere to quarantine protocol.<sup>23</sup>

#### *Experience and belief of healthcare workers and functioning of health centres*

There was no evidence of healthcare workers' experience or beliefs surrounding the outbreak affecting adherence to quarantine protocol. Hsu et al.<sup>18</sup> found no effect of healthcare workers years of experience or perceived severity of the epidemic on individuals' adherence to quarantine protocol during the SARS epidemic in Taiwan. However, there was some evidence that the good functioning of health centres in Taiwan that were helping to control the SARS outbreak were associated with increased adherence. Hsu et al.<sup>18</sup> found that if health centres were functioning well and received adequate resourcing, this was associated with increased adherence by people in quarantine. What did not seem to influence adherence was whether the help came from volunteers or trained staff.

#### *Length of quarantine*

There was mixed evidence for whether the length of prescribed quarantine affected adherence to quarantine protocol. There was no effect of the length of prescribed quarantine for households during the H1N1 pandemic in Australia.<sup>23</sup> Conversely, a quarantine duration of one to four days was associated with higher adherence than a duration of five to nine days during a mumps outbreak at an American University.<sup>13</sup>

#### *Trust in government*

People in Senegal who had a pre-existing positive appraisal of the healthcare system and had trust in the national response to Ebola were more likely to adhere to quarantine.<sup>19</sup>

### **Discussion**

Although the effectiveness of quarantine is not always clear-cut<sup>3,5,6</sup>, if public health officials deem it is necessary then it is important to understand how to encourage people to adhere to quarantine protocols. Our review found that adherence to quarantine during infectious disease outbreaks can be variable. In the studies we reviewed, adherence ranged from 0 to 93%. The most common factors affecting people's adherence to quarantine were their knowledge about the infectious disease outbreak and quarantine protocol, social norms, perceived benefits of quarantine, perceived risk of disease and practicalities of being in quarantine. These factors have also been found to influence adherence to other protective health behaviours with regards to infectious diseases such as handwashing, wearing face masks, avoiding crowds and vaccination.<sup>25,26</sup> The recommended actions for increasing adherence to voluntary quarantine are discussed in the following context, and a summary of key points is shown in Fig. 2.

As compulsory quarantine on any large scale is almost certainly not practicable in a democratic society, public health officials must do everything they can to encourage voluntary adherence to quarantine protocols. Key to this is making sure that information about the infectious disease outbreak and quarantine protocol is clear and consistent. Where information is unclear and open to interpretation, this can lead to people creating their own, possibly ineffective, rules.<sup>15</sup> In the era of ‘fake news’ and rumour, we appreciate consistent messaging is difficult, but it remains the case that leaving the information needs of the public unmet can be dangerous. Public health teams should regularly check with those under quarantine what they understand or are unclear on, and provide clear, authoritative information where needed.

When quarantine is deemed necessary, public health officials should take steps to minimise the risk of nonadherence by:

- Providing a timely, clear rationale for quarantine
- Providing clear information about the quarantine protocol
- Emphasising social norms to encourage this behaviour as altruistic
- Highlighting the benefit that engaging in quarantine will have on public health (in particular to those at heightened risk of the disease) and emphasising its importance
- Ensuring sufficient supplies are provided
- Providing assistance for those financially affected by quarantine.

**Fig. 2.** Summary of key recommendations.

It is also important to reinforce social norms and moral values around quarantine. These are recognised determinants of behaviour.<sup>27</sup> Many participants included in our reviewed studies reported social pressure from others to comply,<sup>20</sup> not wanting to be seen going against the collective commitment to protect against the outbreak,<sup>19</sup> and feeling quarantine was their 'civic duty'.<sup>20,21</sup> Emphasising the altruistic nature of engaging in quarantine may help promote these beliefs.

It is likely, however, that appeals to altruism would be quickly undermined if practical or logistical problems began to appear. Fear of losing income, running out of supplies, lack of staff and related issues must be anticipated and prevented.<sup>18,21,22,24</sup> Care must also be taken to monitor, and intervene in, emerging social norms that may not support quarantine, for example rumours of others breaking quarantine without apparent detrimental effect.<sup>15,28</sup> At the same time, the public need to be assured why quarantine is necessary (focussing on the perceived risks of the disease<sup>13,14,18,19,20,23,29</sup>) and that it is important for everyone affected to engage with it. As with other health behaviours,<sup>30,31</sup> as perceptions of the benefit of quarantine increase, so too should adherence.<sup>13,17,21</sup>

### Strengths and limitations

Given the rapid and evolving nature of the coronavirus outbreak and the need for guidance to support quarantine efforts, this rapid review was limited to peer-reviewed publications of primary data without searching grey literature and did not include a formal quality assessment of included studies. As such it is important to note the review is not exhaustive and may have missed key articles in the search results and relevant articles may have been excluded as they were published in languages other than English, Italian and French. In addition, readers should read our interpretations of the evidence with caution as the quality of the studies is not known. We did, however, search reference lists to identify articles that may not have been found in the initial search and engaged multiple members of the team in the screening process to improve methodological rigour.

Our recommendations are primarily based on results from studies of small groups of people in home quarantine owing to a small selection of infectious disease outbreaks in a limited number of countries. Whilst we anticipate that many of the risk factors for adherence would likely be similar for larger quarantine approaches, such as for whole towns or cities, and for other types of infectious disease outbreaks, there are also likely to be differences in such situations that mean the recommendations presented in this article should only be applied to such situations cautiously. However, although this review cannot provide recommendations that will encourage adherence in every future quarantined population, the lessons from our review may be a good starting point for those considering these situations.

### Conclusion

People vary in their adherence to quarantine during infectious disease outbreaks. Adherence depends on the psychological and practical factors associated with infectious disease outbreaks and quarantine. When quarantine is deemed necessary, public health officials should take steps to minimise the risk of non-adherence by providing a timely, clear rationale for quarantine and information about protocols; emphasising social norms to encourage this altruistic behaviour; increasing the perceived benefit that engaging in quarantine will have on public health (in particular to those at heightened risk of the disease); and ensuring sufficient supplies are provided.

### Author statements

#### Ethical approval

None declared.

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#### Competing interests

None declared.

#### Author contributions

G.J.R. designed the search strategy with input from S.K.B., R.K.W., and L.E.S. S.K.B., R.K.W., L.E.S. and L.W. carried out the literature searches and screening; discrepancies were discussed with G.J.R. and S.W. R.K.W. carried out the data extraction. R.K.W. wrote the first draft of the review with input from S.K.B., L.E.S., L.W., S.W., and G.J.R. The sponsor and funder of the study had no role in study design, analysis, interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2020.03.007>.

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## Original Research

# Lifetime prevalence of homelessness in housed people aged 55–79 years in England: its childhood correlates and association with mortality over 10 years of follow-up

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## ABSTRACT

**Objectives:** Since 2010, the number of homeless people in the UK has increased, and homelessness in its different types has become a major public health problem. Housed older people with past experience of homelessness are an understudied population that can provide valuable insight into this problem. For this reason, we examined the lifetime prevalence of homelessness and its associations with childhood adversity and mortality in a national sample of older people.

**Study design:** This is a longitudinal cohort study.

**Methods:** We studied 6649 housed individuals aged 55–79 years in 2007 from the English Longitudinal Study of Ageing (ELSA). We used logistic regression to model the association between adverse childhood experiences (ACE) and lifetime experience of homelessness (ever been homeless for  $\geq 1$  months) and Cox proportional hazards regression to model the prospective association between lifetime experience of homelessness and mortality.

**Results:** We identified 107 participants with lifetime experience of homelessness. We found a strong graded association between the number of ACE and lifetime experience of homelessness; participants with two ACE had 5.35 (95% confidence interval [CI]: 3.17–9.05) times greater odds of having experienced homelessness than those reporting none. Most ACE were individually associated with lifetime homelessness, but fewer remained so in the mutually adjusted model. Participants with lifetime experience of homelessness had 1.55 (95% CI: 1.01–2.37) times greater risk of mortality over a 10-year follow-up and after adjustment for covariates.

**Conclusions:** Exposure to childhood adversity is associated with increased risk of experiencing homelessness. Older housed people with past experience of homelessness are at increased risk of mortality.

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Since 2010, the number of homeless people and rough sleepers in the UK has increased worryingly.<sup>1–6</sup> Homeless people experience extremely poor health and have excessive morbidity and mortality in comparison with the general population.<sup>7–10</sup> They are also at greater risk of emergency health care,<sup>11,12</sup> whereas geriatric conditions such as functional, sensory and cognitive impairments and frailty are common in the ageing homeless population.<sup>9,13,14</sup> Homelessness is a dynamic phenomenon that takes different forms, such as rough sleeping, living in hostels, sofa surfing and living in temporary accommodation provided by the state,<sup>3,5</sup> and

follows different patterns over the life course.<sup>15</sup> The causes of homelessness are complex and include a broad range of structural, societal, and individual factors that interact over the life course.<sup>9,11,16,17</sup>

A fairly large proportion of the population in the Western world has experienced homelessness at least once in their lifetime, with prevalence estimates ranging from 7.7% to 5.1% in the UK and 6.2% to 4.2% in the USA.<sup>18–21</sup> Despite these high prevalence estimates and evidence suggesting that temporary homelessness is much more common than chronic homelessness,<sup>22</sup> people with previous experience of homelessness are underrepresented in health research. Further, limited research has examined homelessness and its life course determinants in general population settings. Previous

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research has mostly focused on homeless people without comparison with a control group or the general population, and thus cannot directly be informative of differences between homeless and non-homeless people and can only incrementally add to our understanding of the causes and health implications of homelessness at societal level. A better understanding of the pathways to homelessness over the life course is necessary to design more effective policies and prevention strategies and provide more efficient health and social care services to the population.

Adverse childhood experiences (ACE) are common in homeless people<sup>12,23</sup> and an established childhood risk factor for homelessness<sup>20,24</sup> and many other health and social problems in adulthood.<sup>25,26</sup> Studies have examined the association between ACE and lifetime experience of homelessness in adult US samples.<sup>27,28</sup> A study has examined this association in a national sample of persons aged 30 years from the 1970 British Cohort Study,<sup>20</sup> but we are not aware of any such study in the general population of older adults in the UK.

For these reasons, we explored the association between childhood adversity and lifetime experience of homelessness (ever been homeless for 1  $\geq$  months) in a national sample of housed community-dwelling English adults aged 55–79 years. Our aim was to add to our knowledge of the association between ACE and homelessness over the life course and within the context of general population. Moreover, because the positive association between current homelessness and mortality is strong<sup>7</sup> and little is known about the effect of past experiences of homelessness on health and survival,<sup>29,30</sup> we examined whether housed older people with lifetime experience of homelessness are at increased mortality risk. Our aim was to explore the long-term effect of homelessness on survival at older ages and examine past experience of homelessness as a risk for mortality in safely housed older adults.

## Methods

### Study population

The English Longitudinal Study of Ageing (ELSA) is a population-based observational panel study of community-dwelling older adults and their spouses/partners. The ELSA participants were recruited using stratified random sampling. The baseline ELSA interview (wave 1) took place in 2002–2003 and involved a sample of 12,099 individuals living at private addresses, of whom 11,522 were aged  $\geq 50$  years. Follow-up interviews took place at regular intervals every other year. We used data from the one-off ELSA Life History survey that took place in 2007 following ELSA wave 3 (that is the second ELSA follow-up interview). The Life History survey collected retrospective information about the experiences and life circumstances of the ELSA participants including homelessness, from earlier stages of their life before joining ELSA.<sup>31</sup>

Owing to a small number of cases of homelessness among those aged  $\geq 80$  years ( $n = 6$ ), we confined our analyses to participants aged 55–79 years. Thus, of the 7855 individuals who participated in the ELSA Life History survey, 6690 were aged 55–79 years and were eligible for inclusion in our study. The analytical sample for the lifetime experience of homelessness analysis included 6649 participants, after the exclusion of 19 participants who did not participate in ELSA wave 3 and 22 with non-valid/missing data on homelessness or childhood adversity. The mortality analysis used a slightly smaller sample of 6366 participants after the additional exclusion of participants who either did not consent to the mortality data linkage ( $n = 136$ ) or had missing data in any of the analysis variables ( $n = 147$ ).

### Assessment of lifetime experience of homelessness

The lifetime experience of homelessness question was part of a list of questions on experiences of living in institutions. Participants were shown a card with eight different non-mutually exclusive options and asked to report if they had ever experienced any of them ('Can I check, have you ever experienced any of the things on this card?'). The lifetime homelessness option read as follows: '... been homeless for 1 month or more?' Participants who had been homeless for  $\geq 1$  months in their life were assigned to the lifetime experience of homelessness category as opposed to everyone else who did not report so.

### Assessment of childhood adversity and covariates

All childhood variables were retrospectively measured and used in our study on an ad hoc basis. Childhood socio-economic position (SEP) was measured using paternal or main carer's occupational class when the participants aged 14 years and the number of books in the household when the participants aged 10 years. We measured the following ten ACE variables: (1) unfavourable childhood circumstances (this included multiple mutually exclusive categories such as having spent most of childhood in single-parent family or living with foster parents or in residential care (children's homes or other institutions), (2) separation from mother for  $\geq 6$  months at age  $\leq 16$  years, (3) leaving home at young age, (4) severe financial hardship at age  $\leq 16$  years, (5) victim of serious physical attack/assault at age  $\leq 16$  years, (6) victim of sexual assault at age  $\leq 16$  years, (7) physically abusive parents at age  $< 16$  years, (8) parents with substance abuse or mental health problems at age  $< 16$  years, (9) parents unemployed for  $> 6$  months at age  $< 16$  years and (10) parents argued or fought very often at age  $< 16$  years.

The 10-item ACE list we used taps into the childhood adversity domains that the original ACE study focused: abuse (physical and sexual abuse), household dysfunction (living with parents with substance abuse or mental health problems) and parental separation (separation from mother for  $\geq 6$  months).<sup>32,33</sup> It also refers to an additional two domains of childhood adversity: economic hardship (prolonged parental unemployment and financial hardship) and experiences with the social care system (any experience of institutional/residential care and foster parents) that have been included in later ACE measures.<sup>34–37</sup> The economic hardship domain does not refer to being of low SEP but struggling to make ends meet and having gone through a period of severe financial hardship.<sup>37</sup> Our ACE inventory also contains items (parents fought very often and having spent most of childhood in a single-mother household) that expand the family relationships/household dysfunction dimension.<sup>36</sup> Finally, because runaway behaviour<sup>24</sup> and leaving home early are risk factors for homelessness, our ACE inventory also included an item about leaving home at young age. ACE items similar to ours and inventories of childhood traumatic events have been used in major ageing surveys in the USA, such as the Health and Retirement Study and the Midlife in the US study and have been found to have good validity in older adults.<sup>38,39</sup>

With the exception of long-term parental unemployment and frequent parental fights, all other ACE variables were strongly associated with lifetime experience of homelessness in the bivariate analysis and were used in the multivariate analysis and the calculation of the ACE summary score. To derive the ACE summary score, we transformed these variables into binary ones (ACE case vs. other). Leaving home at young age was dichotomised around the cut point of  $\leq 18$  years (having left home at age  $\leq 18$  years vs. other). We also generated two binary childhood circumstances variables (having lived most of childhood with single natural mother vs. not and ever been with foster parents or in residential care in childhood

vs. not) that we used instead of the multicategory unfavourable childhood circumstances variable. We generated an ACE summary score by adding together all binary ACE variables. We also measured age, sex, marital status, education (A-level or higher, GCSE/O-level or equivalent and no educational qualifications) and total net non-pension household wealth, which calculation was based on a detailed assessment of wealth including housing wealth and different forms of financial wealth minus any debt owed by the household.<sup>40</sup>

### Mortality

Death registrations spanning the period between the date of the baseline interview in 2007 and April 2018 were obtained from the Office for National Statistics. These data were linked with the interview data for all consenting participants (>97% of the sample).

### Statistical analysis

We first analysed the sample characteristics and ACE in accordance with lifetime experience of homelessness (Tables 1 and 2). We then estimated two logistic regression models of the association between childhood adversity and lifetime experience of homelessness (Tables 3 and 4). The first model examined the potentially cumulative effect of the ACE summary score on the risk of experiencing homelessness at least once in one's lifetime (Table 3). The second model included all variables that were used to derive the ACE summary score (in their original form and before their dichotomisation) and examined their relative importance as predictors of the outcome measure (Table 4). Age and sex were included in both models. Finally,

after confirming that the proportionality assumption held (using both plots of the survival curves and the Schoenfeld residuals test), we estimated two Cox proportional hazards regression models of the association between lifetime experience of homelessness and all-cause mortality (Table 5). The first model was adjusted for age and sex and the second in addition for marital status, education and total net household wealth. Time-to-event was calculated in months as the difference between the interview date in 2007 and the month of death or censoring, which was April 2018.

### Results

We identified 107 participants who had been homeless for  $\geq 1$  months at some point in their life. Compared with those who had never been homeless, participants who had experienced homelessness were less likely to be older, married and wealthier (Table 1). They were also more likely to having been through the social care system in childhood, spent most of their childhood in a single-mother family, stopped living with their parents/guardians at a younger age, been separated from their mother for >6 months or experienced financial hardship or physical or sexual attack/abuse at age  $\leq 16$  years, and had abusive parents with mental health and substance abuse problems at age <16 years (Table 2). The association between the ACE summary score and lifetime prevalence of homelessness was graded (Fig. 1). The multivariable logistic regression analysis (Table 3) confirmed that the likelihood of lifetime homelessness increased along with the count of ACE after adjustment for age and sex. The risk of lifetime experience of homelessness was increased even among those who reported only one ACE, odds ratio (OR): 2.05, 95% confidence interval (CI): (1.26–3.34). Regarding

**Table 1**

The sample characteristics by lifetime experience of homelessness (ever been homeless for  $\geq 1$  months vs. not) in 6649 ELSA participants.

	Never homeless for $\geq 1$ months	Ever homeless for $\geq 1$ months	P value
	N (%) <sup>a</sup>	N (%) <sup>a</sup>	
No. of participants	6542 (98.4)	107 (1.6)	
Mean age, years (SD)	63.3 (8.1)	60.7 (7.4)	$\leq 0.001$
Sex			0.71
Men	2938 (44.9)	50 (46.7)	
Women	3604 (55.1)	57 (53.3)	
Married/living with a partner			$\leq 0.001$
Yes	4893 (74.8)	52 (48.6)	
No	1649 (25.2)	55 (51.4)	
Education <sup>b</sup>			0.89
A-level or higher including university degree	2781 (42.7)	44 (41.5)	
GCSE/O-level or equivalent qualification	2070 (31.7)	36 (34.0)	
No qualifications	1671 (25.6)	26 (24.5)	
Total net non-pension household wealth <sup>b</sup>			$\leq 0.001$
Wealthiest tertile ( $\geq \pounds 296,500$ )	2358 (36.7)	25 (23.8)	
Intermediate tertile ( $\geq \pounds 139,850$ to < $\pounds 296,500$ )	2173 (33.9)	19 (18.1)	
Poorest tertile (< $\pounds 139,850$ )	1888 (29.4)	61 (58.1)	
Father/main carer's occupation at age 14 years			0.89
Manager/professional/business owner/administrator	2117 (32.5)	35 (32.7)	
Trade/sales/care services	2039 (31.3)	34 (31.8)	
Plant worker/Casual jobs/Unemployed	2134 (32.5)	32 (29.9)	
Other including retired <sup>c</sup>	252 (3.7)	6 (5.6)	
No. of books in the household at age 10 years			0.24
Enough to fill two or more bookcases (>100 books)	1122 (17.2)	22 (20.6)	
Enough to fill one bookcase (26–100 books)	1933 (29.5)	32 (29.9)	
Enough to fill one shelf (11–25 books)	1571 (24.0)	16 (14.9)	
None or very few (0–10 books)	1630 (24.9)	26 (24.3)	
Other including missing <sup>c</sup>	286 (4.4)	11 (10.3)	

ELSA, English Longitudinal Study of Ageing.

<sup>a</sup> Unless otherwise stated, this denotes the number of participants in each category (with the respective percent in brackets).

<sup>b</sup> Education and wealth data were available for 6628 and 6524 participants, respectively.

<sup>c</sup> The other/missing category was not used in the calculation of the P value.

**Table 2**  
ACE by lifetime experience of homelessness (ever been homeless for  $\geq 1$  months vs. not) in 6649 ELSA participants.

	Never homeless for $\geq 1$ months N (%) <sup>a</sup>	Ever homeless for $\geq 1$ months N (%) <sup>a</sup>	P value
Ever experienced severe financial hardship at age $\leq 16$ years			$\leq 0.001$
No/Other incl. missing	5120 (78.3)	59 (55.1)	
Yes	133 (2.0)	4 (3.7)	
Yes, but respondent did not report the age that this happened	213 (3.3)	14 (13.1)	
Missing <sup>b</sup>	1076 (16.4)	30 (28.1)	
Parents unemployed for >6 months when participant aged <16 years			0.70
No	5086 (77.7)	71 (66.4)	
Yes	364 (5.6)	6 (5.6)	
Missing or did not complete the childhood experiences questionnaire <sup>b</sup>	1092 (16.7)	30 (28.0)	
Childhood life circumstances <sup>c</sup>			$\leq 0.001$
Lived most of childhood with both natural parents	5617 (85.9)	75 (70.1)	
Lived most of childhood with natural mother and stepfather	93 (1.4)	1 (0.9)	
Lived most of childhood with natural father and stepmother	25 (0.4)	1 (0.9)	
Lived most of childhood with single natural mother	356 (5.4)	10 (9.4)	
Lived most of childhood with single natural father	62 (1.0)	1 (0.9)	
Lived most of childhood with grandparents or other	197 (3.0)	3 (2.8)	
Ever lived in residential care or with foster parents in childhood	192 (2.9)	16 (15.0)	
Age stopped living with parents/guardians to live on one's own or establish one's own home			$\leq 0.001$
>20 years	3961 (60.5)	41 (38.3)	
19–20 years	1258 (19.2)	25 (23.4)	
18–17 years	947 (14.5)	25 (23.4)	
15–16 years	240 (3.7)	10 (9.3)	
<15 years	46 (0.7)	4 (3.7)	
Missing <sup>b</sup>	90 (1.4)	2 (1.9)	
Separated from mother for $\geq 6$ months at age $\leq 16$ years			$\leq 0.001$
No	5608 (85.7)	71 (66.4)	
Yes	934 (14.3)	36 (33.6)	
Ever been a victim of serious physical attack/assault at age $\leq 16$ years			$\leq 0.001$
No	5364 (82.0)	69 (64.5)	
Yes, at age $\leq 16$ years	82 (1.3)	7 (6.5)	
Yes, but respondent did not report the age that this happened	42 (0.6)	3 (2.8)	
Missing or did not complete the childhood experiences questionnaire <sup>b</sup>	1054 (16.1)	28 (26.2)	
Ever been a victim of sexual assault at age $\leq 16$ years			$\leq 0.001$
No	5236 (80.0)	68 (63.6)	
Yes, at age $\leq 16$ years	221 (3.4)	7 (6.5)	
Yes, but respondent did not report the age that this happened	33 (0.5)	4 (3.7)	
Missing or did not complete the childhood experiences questionnaire <sup>b</sup>	1052 (16.1)	28 (26.2)	
Parents had substance abuse or mental health problem(s) when participant aged <16 years			$\leq 0.001$
No	5145 (78.7)	65 (60.7)	
Yes	336 (5.1)	12 (11.2)	
Missing or did not complete the childhood experiences questionnaire <sup>b</sup>	1061 (16.2)	30 (28.1)	
Parents physically abused the participant at age <16 years			$\leq 0.001$
No	5293 (80.9)	69 (65.5)	
Yes	196 (3.0)	10 (9.3)	
Missing or did not complete the childhood experiences questionnaire <sup>b</sup>	1053 (16.1)	28 (26.2)	
Parents argued or fight very often when participant aged <16 years			0.036
No	4314 (65.9)	53 (49.5)	
Yes	1111 (17.0)	23 (21.5)	
Missing or did not complete the childhood experiences questionnaire <sup>b</sup>	1117 (17.1)	31 (29.0)	
No. of adverse childhood experiences at age (range:0–9)			$\leq 0.001$
0	3834 (58.6)	34 (31.8)	
1	1783 (27.2)	28 (26.2)	
2	623 (9.5)	28 (26.2)	
3	224 (3.4)	12 (11.2)	
$\geq 4$	78 (1.1)	5 (4.6)	

ELSA, English Longitudinal Study of Ageing; ACE, adverse childhood experiences.

<sup>a</sup> Unless otherwise stated, this denotes the number of participants in each category (with the respective percent in brackets).

<sup>b</sup> The missing category was not used in the calculation of the *P* value.

<sup>c</sup> The childhood life circumstances categories were exclusive; participants can be in only one of these categories.

specific ACE, the regression analysis indicated that after adjustment for age and sex and mutual adjustment for all ACE items, lifetime experience of homelessness remained significantly associated with unfavourable living arrangements, long-term separation from mother and experience of physical attack (Table 4).

Regarding mortality, we observed 1086 deaths over a mean follow-up time of 10.1 years among 6366 of our participants. Twenty-two of these deaths were observed among the 107

participants who had experienced homelessness at least once in their lifetime. The Cox regression models indicated that participants who had experienced homelessness at some point in their life had 90% increased risk of dying compared with those who had never been homeless after adjustment for age and sex (Table 5). Additional adjustment for education and total net household wealth partially explained the association and decreased the hazard ratio to 1.55 (95% CI: 1.01–2.37).



**Table 3**

The association between the ACE summary score and lifetime experience of homelessness (ever been homeless for ≥1 months vs. not) in 6649 ELSA participants aged 50–79 years.

	Odds ratio (95% CI)
Age	0.96 (0.94–0.99)
Sex	
Men	1.00 (reference)
Women	0.85 (0.57–1.25)
No. of adverse childhood experiences	
0	1.00 (reference)
1	2.05 (1.26 to 3.34)
2	5.35 (3.17 to 9.05)
3	6.86 (3.33 to 14.14)
≥4	11.24 (4.51 to 28.01)

ELSA, English Longitudinal Study of Ageing; ACE, adverse childhood experiences; CI, confidence interval.

**Discussion**

In a national sample of people aged 55–79 years, we found that ACE were strongly associated with the risk of experiencing homelessness at some point in one's life. On the basis of the Bradford Hill criteria for causation,<sup>41</sup> the graded 'dose-response' pattern and magnitude of the association between the ACE summary score and lifetime experience of homelessness may support a causal association. We also found that older adults who have ever been homeless were at increased mortality risk.

*Strengths and weaknesses*

The use of a national sample of older housed community dwellers, the measurement of many different ACE and SEP markers, the long 10-year follow-up and its novelty are strengths of our study. Nevertheless, our study also has limitations that need to be acknowledged. First, we could not establish when our participants became homeless or the type of homelessness that they had experienced. But given that a main exposure, ACE, refers to childhood, and a main outcome is mortality at older ages, there is still a strong temporal sequence in the analyses. Second, childhood measures and homelessness information have been collected in retrospect and may be susceptible to recall bias. Childhood SEP measures such as paternal occupational class at 14 years of age have successfully been used in previous studies to predict morbidity and mortality.<sup>42,43</sup> Nevertheless, the retrospective measurement of childhood experiences of abuse poses a particular problem as it is known to be problematic with many false negatives.<sup>44</sup> Third, we lacked data on dimensions of childhood adversity that were standard part of the original ACE scale, such as emotional/psychological abuse and incarceration experiences in the household. Fourth, by design, the baseline ELSA sample included older people who were living in private addresses and this reduced the applicability of our findings to the currently homeless population. Fifth, our study included a relatively small number of cases of lifetime homelessness and this resulted in uncertainty about the effect sizes.

*Interpretation of findings*

Our findings on the association between childhood adversity and homelessness concur with those of two reviews.<sup>12,23</sup> One of these reviews focused on the prevalence of physical and sexual abuse in childhood among young homeless people in the USA and Canada. They found much higher rates of physical and sexual abuse in homeless men and women compared with the

general population.<sup>23</sup> The other review examined risk factors for homelessness in US veterans and concluded that ACE are moderately associated with the risk of homelessness.<sup>12</sup> Together with these studies, our findings suggest that ACE is associated with homelessness in different settings and across generations.

Our study adds to the literature in different ways. Next to evidence suggesting that adversities tend to cluster together and are interrelated, our findings indicate that experiences of multiple severe adversities in childhood likely put people at considerably increased risk of homelessness. But we also found that having only one ACE was sufficient to elevate one's risk of subsequent homelessness. Further, our findings delineate the existence of several childhood adversity pathways leading to homelessness. One of these pathways is related to living circumstances in childhood and refers to lacking a two-natural-parent family, limited family resources and decreased provision to the child. Having left home at age ≤18 years is an important dimension of this pathway and likely a risk factor for subsequent experience of homelessness. A second pathway is related to abuse, traumatic

**Table 4**

The association between individual ACE variables and lifetime experience of homelessness (ever been homeless for ≥1 months vs. not) in 6649 ELSA participants aged 50–79 years.

	Odds ratio (95% CI) <sup>a</sup>
Spent most of childhood with a single natural mother	
No	1.00 (reference)
Yes	1.91 (0.97 to 3.78)
Ever lived with foster family or in residential care (children's home or other institutions)	
No	1.00 (reference)
Yes	2.37 (1.20 to 4.67)
Age stopped to live with parents/guardians to live on one's own or establish one's own home <sup>b</sup>	
>20 years	1.00 (reference)
20 to 19 years	1.51 (0.89 to 2.55)
18 to 17 years	2.06 (1.22 to 3.48)
15–16 years	2.11 (0.99 to 4.49)
<15 years	N/A <sup>c</sup>
Separated from mother for ≥6 months at age ≤16 years	
No	1.00 (reference)
Yes	2.07 (1.26 to 3.38)
Ever been a victim of serious physical attack/assault at age ≤16 years <sup>b</sup>	
No	1.00 (reference)
Yes, at age ≤16 years	3.14 (1.22 to 8.10)
Yes, but respondent did not report the age that this happened	N/A <sup>c</sup>
Ever been a victim of sexual assault at age ≤16 years <sup>b</sup>	
No	1.00 (reference)
Yes, at age ≤16 years	1.16 (0.47 to 2.88)
Yes, but respondent did not report the age that this happened	N/A <sup>c</sup>
Parents had substance abuse or mental health problem(s) when participant aged <16 years <sup>b</sup>	
No	1.00 (reference)
Yes	1.31 (0.65 to 2.65)
Parents physically abused the participant at age <16 years <sup>b</sup>	
No	1.00 (reference)
Yes	1.21 (0.53 to 2.79)
Ever experienced financial hardship at age ≤16 years <sup>b</sup>	
No	1.00 (reference)
Yes	N/A <sup>c</sup>
Yes, but respondent did not report the age that this happened	4.37 (2.31 to 8.29)

ELSA, English Longitudinal Study of Ageing; ACE, adverse childhood experiences; CI, confidence interval.

<sup>a</sup> The odds ratios presented here are adjusted for age and sex and mutually adjusted for all ACE variables included in this table.

<sup>b</sup> For clarity purposes, the odds ratios for categories representing missing values and non-valid responses are not shown.

<sup>c</sup> Category too small (<5 participants) to confidently calculate the odds ratio.

**Table 5**

The association between lifetime experience of homelessness (ever been homeless for  $\geq 1$  months vs. not) and mortality in 6366 ELSA participants aged 50 to 79 years.

	Never homeless for $\geq 1$ months	Ever homeless for $\geq 1$ months
No. of participants	6262	104
No. of cases	1064	22
Mean follow-up time in years (median)	10.1 (10.8)	9.8 (10.8)
Person-years	63,071	1014
Incidence per 1000 person-years (95% CI)	16.9 (10.9 to 13.2)	21.7 (14.3 to 33.0)
Cox proportional hazards analysis		
Model 1 <sup>a</sup>	1.00 (reference)	1.90 (1.24 to 2.90) <sup>c</sup>
Model 2 <sup>b</sup>	1.00 (reference)	1.55 (1.01 to 2.37) <sup>c</sup>

ELSA, English Longitudinal Study of Ageing; CI, confidence interval.

<sup>a</sup> Model 1 was adjusted for age and sex.

<sup>b</sup> Model 2 was adjusted for age, sex, education and total net non-pension household wealth.

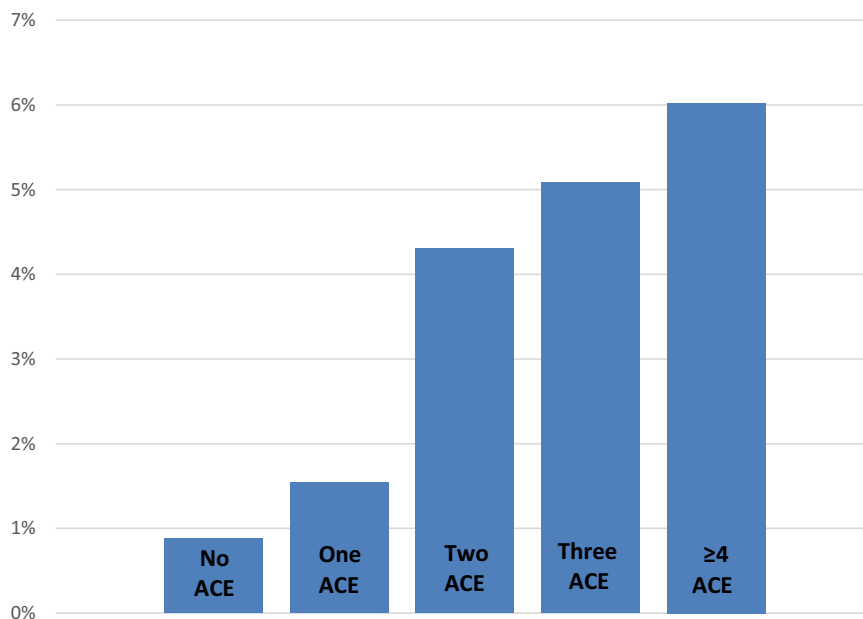
<sup>c</sup> The estimates are hazard ratios (95% CI).

events and highly stressful experiences. We can speculate that inadequacy of socioemotional resources to deal with trauma and mental health problems stemming from it possibly are parts of this pathway.

Commonly used childhood SEP measures such as paternal occupational class at age 14 years, long-term parental unemployment and number of books in the household at age 10 years were not associated with lifetime homelessness. This may be because these variables might not capture the levels of extreme disadvantage that are predictive of homelessness. Furthermore, these measures were not directly relevant to participants who did not spend most of their childhood with both natural parents. We also found that the risk of lifetime homelessness was not different in

men and women in our data, and this is discrepant with statistics suggesting that three-quarters or more of rough sleepers are male.<sup>45</sup> Notwithstanding the possibility of significant generational differences in experiences of homelessness and cohort effects, we can speculate that this discrepancy might be related to our focus on lifetime experience of homelessness, which is broader than current homelessness and rough sleeping, and includes 'hidden' forms of homelessness and episodes of transient homelessness. Furthermore, cases of homelessness in our study are by default survivors who managed to overcome homelessness. It is possible that survivorship in this context might be affected by factors that favoured women over men, such as men's greater exposure to long-term and more severe homelessness. Relevant to this speculation is our finding of an inverse association between age and the risk of lifetime homelessness, which is suggestive of the powerful impact of homelessness on survival and the decreased chances people with lifetime experience of homelessness have to reach old age.

To our knowledge, our study provides one of the first estimates of mortality risk in people who have 'recovered' from homelessness in the UK. Our findings suggest that having gone through the experience of homelessness is an important risk factor for mortality even among resilient older people who managed to overcome homelessness and are currently in stable housing. We found that people who had experienced homelessness had almost double the risk of all-cause mortality after adjustment for age and sex. Previous studies of older individuals who were homeless or living in shelters and hostels reported comparable mortality estimates.<sup>46–48</sup> Nevertheless, we anticipate that our findings likely are a conservative account of the true association between having experienced homelessness and mortality over the life course. This is because by design, our study ignored the impact of previous experience of homelessness on mortality risk at age <55 years, where many of the homelessness-related deaths occur.



**Fig. 1.** Lifetime prevalence of homelessness by the number of adverse childhood experiences (ACE) in 6649 ELSA participants aged 55–79 years. ELSA, English Longitudinal Study of Ageing.

## Conclusion

Severe adversity in childhood is associated with lifetime experience of homelessness in our sample of older housed community dwellers. Our findings add to the literature and can be used to inform strategies and initiatives to prevent homelessness and help vulnerable individuals and disadvantaged communities. They also suggest that people who have 'recovered' from homelessness remain at increased mortality risk, even after accounting from material deprivation in adulthood. This is a finding with major implications for practice as it delineates a 'hidden' population at risk and adds to the argument for the need to have adversity- and trauma-informed practice. There is need for continued support across the life course for people who have been homeless even after they become securely housed. Our work emphasises the importance of the life course dimension of homelessness for population health and pushes the boundaries of the current conceptualisation of homelessness, from a problem of a minority of marginalised people to that of a lifetime risk factor for mortality in the general population. Future research should explore the pathways through which ACE lead to an increased lifetime risk of homelessness, build better life course models of homelessness and add to the exploration of the impact of lifetime homelessness and hidden forms of homelessness on morbidity and mortality.

## Author statements

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### Ethical approval

The English Longitudinal Study of Ageing was approved by the National Research Ethics Service (London Multicentre Research Ethics Committee (MREC/01/2/91)).

### Competing interests

None declared.

### Patient consent

Informed consent was obtained from all participants.

### Data sharing

The raw data are available from the UK Data Service.

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## Original Research

# *Mycobacterium tuberculosis* lineages in Hawaii demonstrate distinctive demographic and migration characteristics

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## ABSTRACT

**Objectives:** The American state of Hawaii presents a tuberculosis (TB) burden more consistent with that of the Philippines and the Pacific Islands than that with the United States (US) or Europe. This study seeks to determine if the genetic families of *Mycobacterium tuberculosis* (*Mtb*) that are prevalent in Hawaii display differences in host demographics that may be of use for TB control in Hawaii and the Pacific.

**Study design:** This retrospective study was conducted by analyzing data from the Hawaii State Department of Health to investigate the demographics associated with the Beijing (global lineage 2) and Manila (lineage 1) families of *Mtb* in Hawaii.

**Methods:** Deidentified records of all culture-positive TB cases reported by the Hawaii State Department of Health Tuberculosis Control Program from 2004 to 2016 were analyzed to identify lineage-specific demographic differences and trends. Patients' countries of origin, age, sex, and time in the US before TB diagnosis were included in this analysis.

**Results:** Manila family isolates were found to predominantly enter Hawaii through Filipino immigrants, whereas Beijing family isolates originated from a diverse set of countries. Both families exhibited significant differences in age and sex demographics. In addition, Manila family cases presented from patients with significantly longer average time of residence in the US than non-Manila cases, whereas Beijing family cases presented from patients with significantly shorter time of residence in the US than non-Beijing cases.

**Conclusions:** Both the Beijing and Manila families of *Mtb* demonstrated demographic differences in Hawaii that may prove important for improving TB control and surveillance policy in Hawaii and throughout the Pacific. Areas with heavy Filipino immigration may benefit from directing more resources toward screening and education efforts for middle-aged men and those who have resided in the country longer, whereas other areas of the Pacific should consider a younger and more sex-balanced allocation. Specific to the US and Hawaii, effective screening of youths emigrating from the Compact of Free Association states remains vital.

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## Introduction

Tuberculosis (TB) continues to present a major global public health challenge despite continuous increase in global spending on TB care and prevention.<sup>1</sup> The most recent year for which global data

are available (2017) saw an estimated 10.0 million new cases, with an estimated 1.3 million deaths from TB among HIV-negative persons.<sup>1</sup> More locally, Global Tuberculosis Report 2018 of the World Health Organization (WHO) estimated that 62% of the incident TB cases in 2017 occurred in the WHO South-East Asia and Western Pacific regions.<sup>1</sup> The American state of Hawaii resides centrally in the Pacific Ocean and experiences a continual influx of immigrants from these two regions. Hawaii also displays the highest rate of TB in the United States (US) at 8.1 per 100,000 in 2017, which is far above the median state rate of 1.8 per 100,000.<sup>2</sup> Immigration from the Pacific is a major source of TB cases in the continental US as well. In 2017, the American national TB rate among non-US-born

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persons was nearly 15 times the rate among US-born persons (14.6 vs 1.0 per 100,000). Among those non-US-born persons, Asians held the highest TB rate of all racial/ethnic groups, at 27.0 per 100,000. Furthermore, of the top five countries of birth for non-US-born persons with TB in the US, three countries represent the Pacific area: the Philippines at 12.3% of cases, Vietnam at 8.3%, and China at 6.3%. Thus, understanding the characteristics of TB in the Pacific presents the potential for improving TB control strategies not only in Hawaii but also in the US and other countries that receive TB cases from the region.

This study seeks to examine not only the origins of the TB cases entering Hawaii but also the genetic lineages of *Mycobacterium tuberculosis* (*Mtb*, the etiological agent of TB) in Hawaii. Identifying associations between these lineages and their demographics (beyond countries of origin) may provide TB controllers throughout the Pacific with an improved understanding of international TB transmission trends that aid in targeting TB control resources.

TB in Hawaii presents a unique distribution in genetic lineages compared with the continental US. Data presented here reveal that two genetic lineages comprise two-thirds of the *Mtb* cases in Hawaii. Seven *M. tuberculosis* complex global genetic lineages have been identified through whole-genome analysis.<sup>3</sup> Of those, the Manila family comprises the majority of global genetic lineage 1 and radiates outward from the Philippines with Filipino immigration.<sup>4</sup> The Beijing family comprises nearly all of global genetic lineage 2, and although it is the dominant lineage throughout Asia, Beijing family isolates can be found worldwide.<sup>3,5</sup>

In this work, we analyzed the State of Hawaii Tuberculosis Control Program data from 2004 to 2016 to evaluate differences in demographics associated with patients who presented with *Mtb* infections belonging to the Beijing or Manila families during this period. We further analyzed annual data to identify chronological trends that could explain certain observed results. Finally, we searched for any differences in time from entry into the US until TB diagnosis that might be associated with these two families.

## Methods

Records of all culture-positive TB cases reported by the Hawaii State Department of Health Tuberculosis Control Program from 2004 to 2016 were reviewed to identify all Hawaii isolates that had been successfully genotyped through standard spoligotyping during that period. This retrospective observational study did not require full ethics committee review as it was limited to the use of existing deidentified data.

The spoligotype octal codes recorded by the United States Centers for Disease Control and Prevention (CDC) were analyzed, and lineage or family names were assigned to spoligotype octal codes using the SpolDB4 database.<sup>6</sup> Isolates with the 'EAI2\_MANILLA' designation in SpolDB4 were considered 'Manila family' in this study, and isolates with 'BEIJING' or 'BEIJING-LIKE' spoligotypes were considered 'Beijing family.'

Statistical determination of significance for demographics was conducted using the two-proportion z-test, with two-tailed *P*-values of <0.05 being considered significant. Statistical determination of significance for time of residence in the US before diagnosis was conducted using the *t*-test assuming unequal variances, with two-tailed *P*-values of <0.05 being considered significant.

## Results

In total, this study identified 996 records in which both isolate spoligotyping and patient nationality data were recorded. Of these, 448 isolates belonged to the Manila family (45%), and 229 isolates belonged to the Beijing family (23%). Of all Manila family isolates,

89.3% originated in Filipino persons, whereas the Beijing family isolates originated from persons from a diverse group of countries but primarily Pacific group of countries (Fig. 1). Countries or regions with fewer than five isolates from a specific *M. tuberculosis* family were placed into the 'other' category, as shown in Fig. 1. For the Beijing family, those countries were Indonesia; Thailand; Laos; Mongolia; China's Special Administrative Region, Hong Kong; the Commonwealth of the Northern Mariana Islands; Guam; Kiribati; Malaysia; Mexico; New Zealand; and South Africa. For the Manila family, those were the Commonwealth of the Northern Mariana Islands, the Marshall Islands, Vietnam, China, Mexico, and South Korea.

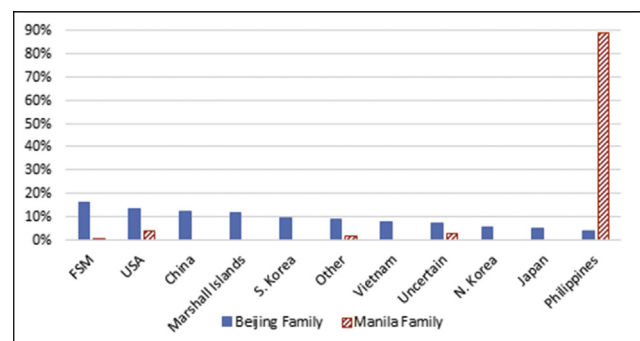
### *Mtb* in Hawaii: families and originating areas

Our data revealed that Hawaii has experienced an increasing number of Manila family isolates over this study period, whereas the number of Beijing family isolates has roughly remained steady. The Manila family's minor upward trend remains even when considering the percentage of Hawaii's annual TB burden presented by each of these families, whereas the Beijing family's annual TB burden percentage can be seen to be decreasing (Fig. 2).

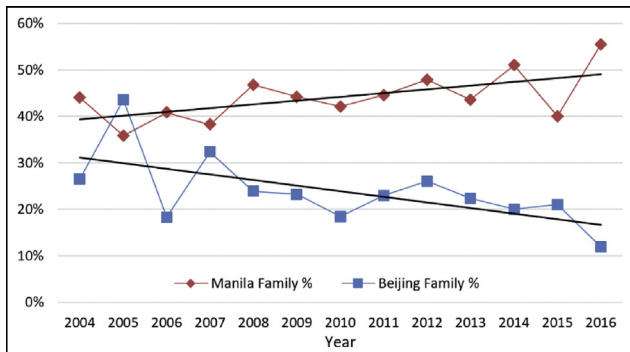
To determine if these trends could be the result of changing immigration to Hawaii, we examined the geographic regions from which patients with TB originated by year. No significant trends were identified for any region, with ~50–60% of culture-positive TB cases coming from the Philippines and ~10–20% each coming from the Pacific and Asian regions each year (data not shown). We considered the possibility that the families of *Mtb* entering Hawaii from each of these regions might be shifting over time, but again, no significant trends were observed (data not shown). The percentage of Manila family isolates coming from the Philippines remained relatively steady at ~70–80%, whereas percentages of Beijing family isolates from Asia and the Pacific varied considerably year to year, displaying no sustained trends.

### Age and sex trends associated with *Mtb* families in Hawaii

This study further investigated whether these two families of *Mtb* display differences in age or sex of cases in Hawaii. Examining the number of cases by age-group identified a substantial and expected upward trend with age (Fig. 3a). The Beijing family presented an exception when compared with non-Beijing isolates (i.e. all isolates not identified as belonging to the Beijing family), displaying a smaller percentage of cases in the 45- to 64-year age-group than were found with non-Beijing isolates (*P* = 0.002)



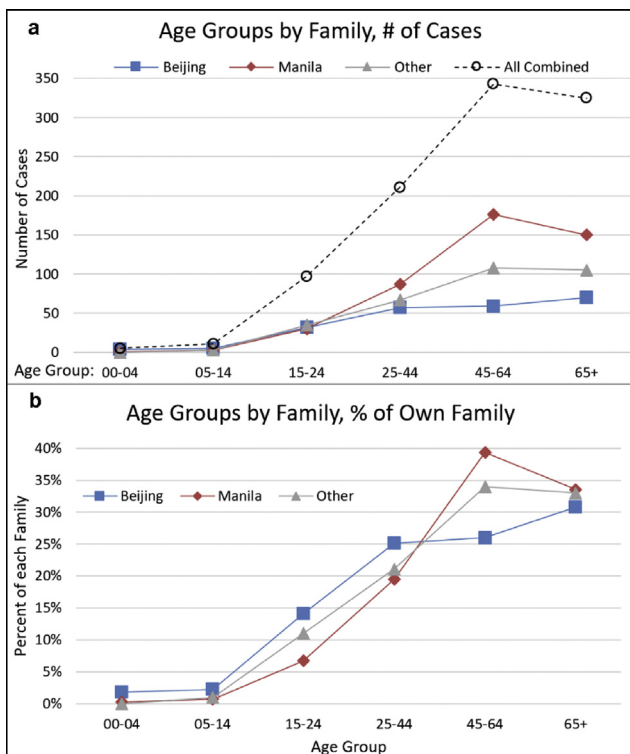
**Fig. 1.** National origins of Hawaii's TB cases, 2004–2016. Percentage of Hawaii's Beijing family (blue) and Manila family (red) *Mycobacterium tuberculosis* isolates originating from each country. Beijing family isolates in Hawaii are found in persons from a diverse group of countries, whereas nearly 90% of the Manila family isolates are found in persons from the Philippines. TB, tuberculosis. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)



**Fig. 2.** Genetic lineages of TB in Hawaii, 2004–2016. Percentage of total culture-positive *Mycobacterium tuberculosis* cases in Hawaii belonging to each genetic lineage by year. TB, tuberculosis.

(Fig. 3b). In contrast, the Manila family displayed more cases in that age-group than non-Manila family isolates in Hawaii ( $P = 0.004$ ). The Beijing family revealed an additional trend as well: a significantly higher number of cases than those found with the non-Beijing family in the 15- to 24-year age-group ( $P = 0.013$ ).

Patients' sex was also investigated in relation to these two *Mtb* families. Fig. 4 displays the percentage of Hawaii's total TB cases by age, sex, and family. Three trends are apparent: a higher percentage of men in the 15- to 24-year age-group for the Beijing family than for the non-Beijing family ( $P < 0.001$ ), a striking but non-significantly higher percentage of women in the 25- to 44-year age-group for the Beijing family than for the non-Beijing family



**Fig. 3.** Age trends of Hawaii's *Mycobacterium tuberculosis* families. (a) Percentage of total TB cases in Hawaii composed of each lineage in each age-group. Note that the Beijing family has significantly fewer cases in the 45- to 64-year age-group than other lineages. (b) Percentage of each lineage comprised by each age-group. The Beijing family displays significantly more cases in the 15- to 24-year age-group and significantly fewer cases in the 45- to 64-year age-group than the non-Beijing family. TB, tuberculosis.

( $P = 0.13$ ), and a weakly higher percentage of men in the 45- to 64-year age-group for the Manila family ( $P = 0.065$ ). Although not statistically significantly different from other lineages, the Manila family displays its largest proportion of cases (39.4%) in the 45- to 64-year age-group, in which men are significantly more common than women for all observed lineages (38.6% vs 29.0%, respectively,  $P = 0.002$ ). Overall, both families displayed significantly more women than men in the 25- to 44-year age-group (Manila family: 13.6% men vs 28.6% women,  $P < 0.001$ ; Beijing family: 15.8% men vs 35.5% women,  $P < 0.0001$ ).

#### Differences in length of time patients resided in the US before TB diagnosis were observed for the Beijing and Manila families of *Mtb* in Hawaii

A subset of these genotyped *Mtb* isolates comprising isolates from non-US-born persons with complete demographic data was further analyzed to determine if associations exist between genetic families and time of residence in the US before diagnosis. Of the 714 isolates in this subset, 606 (84.9%) had a known length of time in the US before diagnosis, whereas 108 (15.1%) did not have. Of 330 Manila family isolates, 302 (91.5%) had a known time in the US, compared with 75.2% (112 of 149) for the Beijing family and 81.7% (192 of 235) for non-Beijing or Manila isolates.

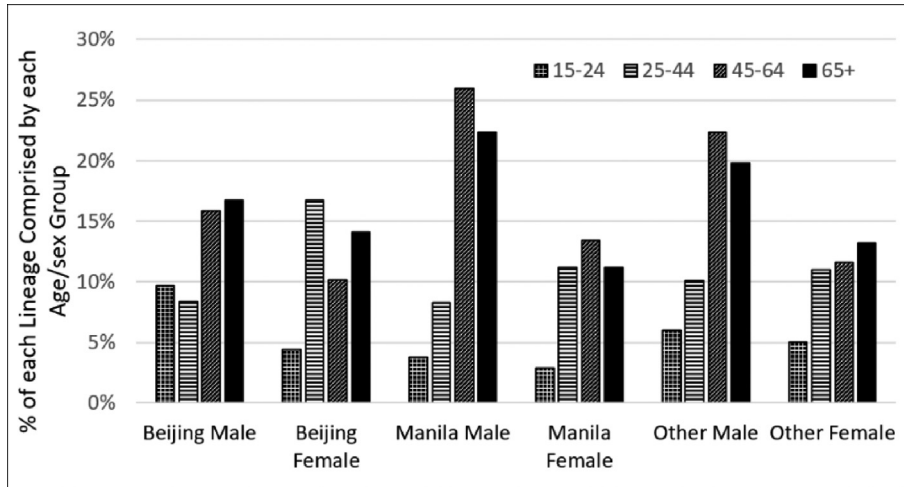
Fig. 5a presents the mean and median number of years in the US before TB diagnosis for each patient sex and *Mtb* family combination. As expected, owing to extensive efforts to catch active TB cases during or before immigration, the mean time in the US before diagnosis was longer than the median time. The mean number of years before diagnosis for Manila family cases was significantly higher than for non-Manila family cases (16.4 vs 14.0, respectively,  $P = 0.049$ ). In contrast, the mean number of years before diagnosis for Beijing family cases was significantly lower than for non-Beijing family cases (12.7 vs 15.8, respectively,  $P = 0.035$ ).

One trend of note is that although women with Beijing family TB exhibited a lower mean number of years in the US before diagnosis than their male counterparts (10.9 vs 14.4, respectively), they actually displayed a higher median number of years in the US than men with Beijing family TB (6.9 vs 5.8, respectively). Fig. 5b investigates this phenomenon further and reveals more Beijing family cases in women than in men in the '1–10 years in the US' group, suggesting an explanation for this difference.

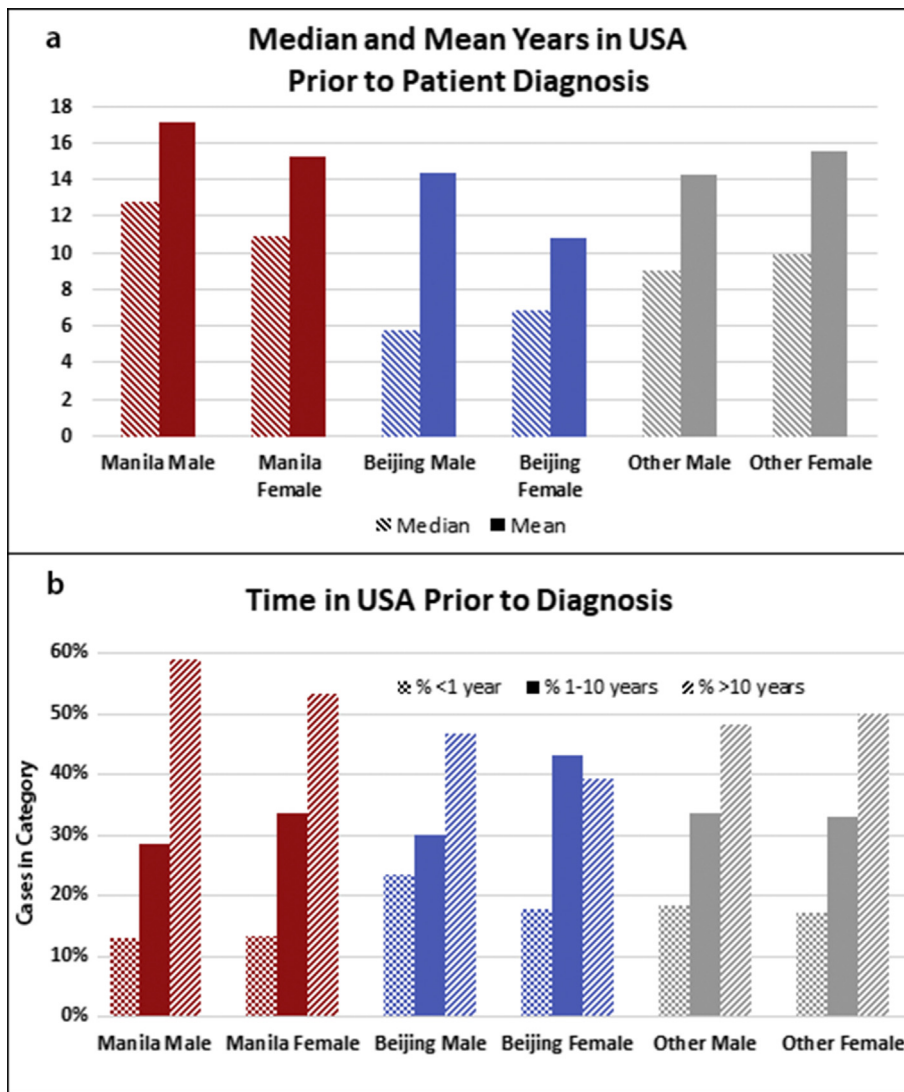
## Discussion

This work identified multiple differences associated with the Beijing and Manila families of *Mtb* in Hawaii. Most striking among them is the difference in the country of birth. With nearly 90% of Manila family cases originating in Filipino patients, the Manila family does not appear to have been able to gain a foothold in the Pacific outside of the Philippines. In contrast, the largest non-American sources of Beijing family *Mtb* entering Hawaii include the Federated States of Micronesia (FSM), the Republic of the Marshall Islands (RMI), China, and Vietnam. With 45% of the *Mtb* isolates in this study belonging to the Manila family and 23% belonging to the Beijing family, Hawaii's distribution of lineages resembles that of both the Philippines and other Pacific islands more than the continental US.<sup>7,8</sup> Thus, information identified here about the characteristics of the Beijing family will be of special interest to TB controllers throughout high-burden areas of the Pacific and Asia.

Hawaii saw a slight upward trend in its percentage of Manila family *Mtb* cases over this study period, accompanied by an



**Fig. 4.** Age and sex trends of Hawaii's *Mycobacterium tuberculosis* families. Percentage of isolates from each lineage comprised by each age-group and sex group. The higher percentage of men for the Beijing family in the 15- to 24-year age-group is significant, whereas the higher percentage of women for the Beijing family in the 25- to 44-year age-group and higher percentage of men for the Manila family in the 45- to 64-year age-group are not significant.



**Fig. 5.** Years in the US before TB diagnosis. (a) Average and median years in the US before TB diagnosis by family and sex. Note the opposing trends between the mean and median years in the US of Beijing family *Mycobacterium tuberculosis* cases in men and women. (b) Percentage of each family's/sex's TB cases falling into the groups of >1 year, 1–10 years, and >10 years in the US before diagnosis. Notably, the Beijing family's highest peak for women is in the group of 1–10 years. TB, tuberculosis.



apparent slight downward trend in its percentage of Beijing family cases. As the percentage of Manila family isolates from Filipinos has remained roughly steady at ~70–80%, the slight upward trend in the percentage of Hawaii's TB cases being found in Filipinos appears to explain this increase.

Both *Mtb* families showed distinct trends in patient age demographics in Hawaii. Although the Manila family presented significantly more cases in the 45- to 64-year age-group, it is notable that this age-group also contained the most cases among the non-Manila, non-Beijing isolates. Evaluation of class B1 immigrants in Hawaii suggests a high rate of TB in working-age men from the Philippines (65% of TB cases among Filipino class B1 immigrants diagnosed within one year of arrival); this may account for much of the Manila family's characteristic age and sex distribution in Hawaii.<sup>9</sup> More notable is the Beijing family's exception to this peak in the 45- to 64-year age-group. In contrast, the Beijing family had significantly more cases in the 15- to 24-year age-group. This is consistent with other reports of the Beijing family being associated with young adults.<sup>10,11</sup> Furthermore, the Beijing family exhibited a significantly higher percentage of men in that age-group, but insufficient information about Hawaii's immigration demographics prevents us from determining if this is simply an artifact of an immigration trend.

The difference in length of time in the US before diagnosis for these two *Mtb* families is perhaps the most salient of our findings for TB controllers. The Manila family showed longer mean time to diagnosis (16.4 years) than the mean for all lineages in Hawaii (15.2) and the mean for the non-Manila family in Hawaii (14.0). The median year values showed a similar trend (12.3 vs 10.6 and 8.1, respectively). In contrast, the Beijing family showed shorter mean time to diagnosis (12.7 years) than the mean for all lineages in Hawaii (15.2) and the mean for the non-Beijing family in Hawaii (15.8), with median values again reinforcing this trend (6.0 years vs 10.6 and 11.4, respectively). Directly comparing median years before diagnosis for the Beijing family and Manila family (6.0 years vs 12.3, respectively, over double the time) reveals a stark contrast that may be of importance to TB controllers in the region. Although host population-pathogen relationships are important, differences in immigration requirements for Compact of Free Association (COFA) countries may also contribute substantially to this time difference, partially explaining the large gap between *Mtb* families for time in the US before diagnosis. Immigrants entering the US from the Philippines undergo mandatory prescreening before entering the country. Thus, active cases of TB are readily identified in Filipino applicants for immigration, which removes those (most likely Manila family) *Mtb* cases that would otherwise present as TB cases soon after immigration. In contrast, the US does not require immigration visas for immigrants from two of the largest sources of Beijing family *Mtb* to Hawaii (FSM and RMI).

Mandatory screening for school attendees, food preparation workers, and healthcare workers in Hawaii may contribute to a high number of TB diagnoses near their time of arrival in the US. In addition, a high rate of examination of class B immigrants after arrival into Hawaii likely contributes to the substantial difference between mean years in the US before diagnosis (15.2 for all lineages) and median years in the US (10.6 for all lineages). Those policies quickly identify and treat TB cases after arrival to Hawaii, skewing the median time in the US to well below the mean.

How much of these observed trends are the result of *Mtb* lineage characteristics (as opposed to being artifacts of immigration demographics from regions dominated by each family) remains the topic of ongoing research. Local adaptation to specific populations in regions such as the Philippines could explain why more globally successful lineages have failed to displace the Manila family from its position of dominance there. *Mtb* has been shown to

preferentially transmit in sympatric host populations, even in cities with immigration from diverse sources, but it still remains unclear whether this is the result of social factors or local adaptation of *Mtb* lineages to specific host populations.<sup>3,12</sup>

## Conclusions

Both the Beijing and Manila families of *Mtb* demonstrated demographic differences in Hawaii that may be of use for developing TB control and surveillance policy.

These data identify potential areas for improving TB control throughout the Pacific or in other regions with similar immigration patterns. The peak in Manila family cases in middle-aged persons emphasizes the importance of allocating TB control resources for that age-group in areas of heavy Filipino immigration. In contrast, Beijing family cases in women peaked in the 25- to 44-year age-group (a group in which women outnumbered men for all lineages), suggesting that women throughout the Pacific will benefit from more screening or education resources directed toward their typically underprioritized demographic.

Specific to Hawaii and the US, youths making up a significantly higher percentage of Beijing family cases emphasize the importance of improved screening of COFA youths. Finally, more research is needed to identify why the Beijing family presented more cases than other lineages in women who have been in the US for 1–10 years.

## Author statements

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### Ethical approval

Not required. This research was performed through a retrospective observational study of existing data and used no identifiable patient information.

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### Competing interests

None declared.

### Author contributions

K.K. contributed to acquisition of data, analysis and interpretation of data, and drafting of the manuscript. A.L. contributed to acquisition of data, analysis and interpretation of data, and manuscript review and editing. L.Q. contributed to study conception and design. B.S.-C. contributed to analysis and interpretation of data. J.T.D. contributed to study conception and design and analysis and interpretation of data.

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Letter to the Editor

## Non-pharmaceutical intervention strategies for outbreak of COVID-19 in Hangzhou, China



Hangzhou, a city with a population of more than 9.86 million in the south of China, encountered a large-scale outbreak of COVID-19 with 169 confirmed cases reported from January 21 to February 19. As there were no vaccines or antivirals, the spread of the disease was controlled by non-pharmaceutical interventions for nearly 45 days. On February 28, 2020, WHO Director-General Tedros declared that the impact risk of COVID-19 had increased to 'very high at a global level'.<sup>1</sup> In countries such as Italy, the Republic of Korea, Iran, and Japan, the number of new cases has kept increasing, although the number of cases has been declining in China.<sup>2</sup> In the following paragraphs, we introduce intervention strategies in Hangzhou and hope these strategies will help cities still suffering from COVID-19.

The implementation of interventions can be divided into three stages in Hangzhou, as shown in Fig. 1. The first stage was from January 21, the first confirmed case reported, to February 2. The interventions were isolation of patients or suspected patients, quarantine of close contacts, and disinfection of locations where the patients had been previously. Fifty-five imported cases and 37 local cases who had been close contacts of imported cases were detected and isolated from a total of 109 confirmed cases in this stage. However, seven cases of unknown origin had been reported in succession in Tonglu, a county of Hangzhou, since January 28. This indicated that the disease might have spread locally. What is more, more than half of the confirmed cases exhibited only mild symptoms. Some patients were unaware that they were sick. This suggested that some cases unfortunately might not have been identified in time.

The second stage was from February 3 to February 18. The trigger for the government stepping up interventions was that

three districts/counties reported cases of unknown origin, including Tonglu on February 3. The trend of local transmission was obvious. Community-wide containment was added on the basis of the first stage to reduce individuals' contact with unidentified sources of infection. All enterprises and institutions closed except some essential functions, such as supermarkets and hospitals. People were advised to stay at home and allowed only to go out twice a week to buy necessities. In this stage, 19 imported cases and 40 local cases, including nine cases of unknown origin, were reported.

The third stage was from February 19 until now. After 15 days of containment, the outbreak was basically under control. The containment was canceled, and businesses were allowed to resume work orderly. Health status monitoring of workers and preventive disinfection of public areas were required to be carried out every day in this stage. Up to March 2, no new cases were reported for 12 consecutive days, except one imported case on February 19.

In the face of new infectious diseases, such as COVID-19, non-pharmaceutical interventions are effective choices for governments owing to the lack of treatment and immunity vaccination methods.<sup>3</sup> Although the effect of these interventions still needs further accurate evaluation, the large-scale outbreak was controlled in Hangzhou in a short time, and these interventions played an important role. We also find that the effect of non-pharmaceutical interventions is closely related to the timing and quality of implementation, and this might be the reason why similar strategies have different effects in different cities.

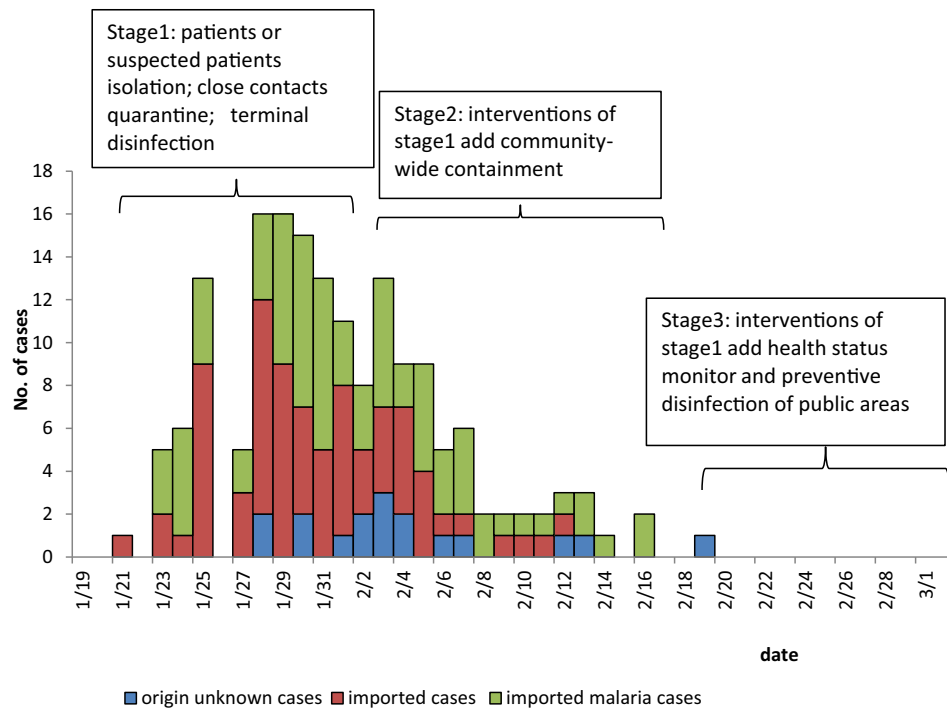


Fig. 1. Intervention strategies at different epidemic stages of COVID-19 in Hangzhou.

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## Short Communication

## Rapid point-of-care testing for SARS-CoV-2 in a community screening setting shows low sensitivity



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## ABSTRACT

**Objective:** With the current SARS-CoV2 outbreak, countless tests need to be performed on potential symptomatic individuals, contacts and travellers. The gold standard is a quantitative polymerase chain reaction (qPCR)–based system taking several hours to confirm positivity. For effective public health containment measures, this time span is too long. We therefore evaluated a rapid test in a high-prevalence community setting.

**Study design:** Thirty-nine randomly selected individuals at a COVID-19 screening centre were simultaneously tested via qPCR and a rapid test. Ten previously diagnosed individuals with known SARS-CoV-2 infection were also analysed.

**Methods:** The evaluated rapid test is an IgG/IgM–based test for SARS-CoV-2 with a time to result of 20 min. Two drops of blood are needed for the test performance.

**Results:** Of 49 individuals, 22 tested positive by repeated qPCR. In contrast, the rapid test detected only eight of those positive correctly (sensitivity: 36.4%). Of the 27 qPCR-negative individuals, 24 were detected correctly (specificity: 88.9%).

**Conclusion:** Given the low sensitivity, we recommend not to rely on an antibody-based rapid test for public health measures such as community screenings.

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## Background and aim

COVID-19 is rapidly spreading worldwide, and the number of cases in Europe is rising with increasing pace in several affected regions.<sup>1</sup> While there is an urgent need to contain the pandemic to protect the elderly and vulnerable population, there are several obstacles to control the spread of new infections. The vast majority of SARS-CoV-2–infected individuals appear to have only mild to moderate symptoms similar to the flu or other flu-like infections,<sup>2–6</sup> lacking defining symptoms. Thus, while we start losing the ability to trace all SARS-CoV-2–infected contacts,

identification of potentially infected individuals becomes increasingly hard.

To protect the vulnerable population, it is necessary to assess the infection status of potential contacts to patients with COVID-19 rapidly but also to approve employees to work with at-risk individuals in the hospital or nursing homes. The current gold standard for SARS-CoV-2 detection is a SARS-CoV-2–specific, quantitative real-time polymerase chain reaction (RT-qPCR) testing from a nasal or pharyngeal swab, sputum or bronchoalveolar lavage.<sup>7,8</sup> Following standard protocols, RNA needs to be extracted and the presence of viral RNA confirmed by RT-qPCR. This requires several potentially erroneous steps and several hours for sampling and evaluation. Even high-throughput laboratories require a minimum of 3–4 h from sampling to evaluation, and final information of the infection status may take up to 24 h. This bears the risk of a potential further spread of SARS-CoV-2 in the meantime and hinders widespread testing of all potential contacts. There is currently

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no rapid method to detect potentially SARS-CoV-2–positive individuals that would allow an assessment of their infection status in a reliable manner.

There is an urgent need for immediate targeted detection of infected individuals to slow the pandemic. We therefore evaluated a rapid antibody IgG/IgM–based testing system in the community setting for its ability, specificity and sensitivity to reliably identify infected individuals.

### Study design

The German Red Cross had established a COVID-19 screening centre in a high-prevalence area with more than 300 confirmed cases among 12,000 inhabitants. The cluster outbreak occurred after a carnival celebration and secondary transmissions in the families and rural community. The medical personnel at the screening site perform 150–200 throat swabs for SARS-CoV-2 diagnostics every day on symptomatic individuals.

Thirty-nine randomly selected individuals at the centre were tested simultaneously using the SARS-CoV-2 rapid test and the gold standard RT-qPCR method (Altona Diagnostics). In addition, collected and stored serum samples of 10 previously diagnosed individuals with known SARS-CoV-2 infection were analysed. All individuals accepted testing via written informed consent.

### Methods

The rapid test used for evaluation is a qualitative IgG/IgM detection system to test for a current or past infection of SARS-CoV-2. The chemical coupling pad contains gold-labelled SARS-CoV-2 antigens and mouse IgG controls. There are two detection bands (T1 = IgM and T2 = IgG) on the test strip, which are coated with mouse anti-human IgM and IgG antibodies, respectively. The control band (C) is coated with a goat anti-mouse IgG antibody. After discarding the first drop of blood from a fingertip prick, two drops of blood are applied onto the rapid test chip. In addition, two drops of a provided solution are added. The test indicates positivity for IgG after 15 min and for IgM after 20 min. When a test sample is

added to the sample-loading area, the antigen forms an immune conjugate with the gold-labelled antibodies and then move to the detection zone by a capillary action. The negative conformity rate has been described to be 100% for 68 negative controls. The positive conformity rate has been described to be 70% at early stages of infection (day 4–10) and 100% at late stages of infection (day 11–24).

### Results

The study population was well balanced in terms of age (median: 46 years, interquartile range [IQR]: 28–72) and gender (24/49 female [49.0%]). The majority described symptoms including dry coughing (70.8%), fatigue (64.6%) and a runny nose (45.8%). Only five individuals had no symptoms. Twenty-two individuals were tested positive by repeated RT-qPCR, while 27 were tested negative. Positive individuals reported five symptoms in median (IQR: 3–7), while negative individuals reported only 4 (IQR: 2–5) symptoms. We were able to identify the probable date of exposure of 22 individuals (44.9%). Median time between exposure and test was 18.5 days (IQR: 15–24).

All used rapid tests were valid; 38 of 49 (77.6%) tests were negative. We saw a weak response in 7 cases and a strong response in 4 cases (Fig. 1). There was no case of a singular IgM response indicating acute or recent SARS-CoV-2 infection. The manufacturer recommends to classify weak responses as positive which was supported via receiver operating characteristics (ROC) curve analysis (Table 1). Therefore, we defined 11 tests as positive in our study. Considering the PCR results, we found eight tests to be true-positive and 3 to be false-positive, whereas 24 tests were true-negative and 14 tests were false-negative (Table 2). The test reached a sensitivity of 36.4% [95% confidence interval (CI): 17.2; 59.4] and a specificity of 88.9% [95% CI: 70.8; 97.7]. Based on a prevalence of 44.9%, the test reached a positive predictive value of 72.7% [95% CI: 39.0; 94.0] and a negative predictive value of 63.1% [95% CI: 46.0; 78.2].

There was no statistically significant correlation between rapid test results and time from potential exposure (exact test,  $p = 0.636$ ),

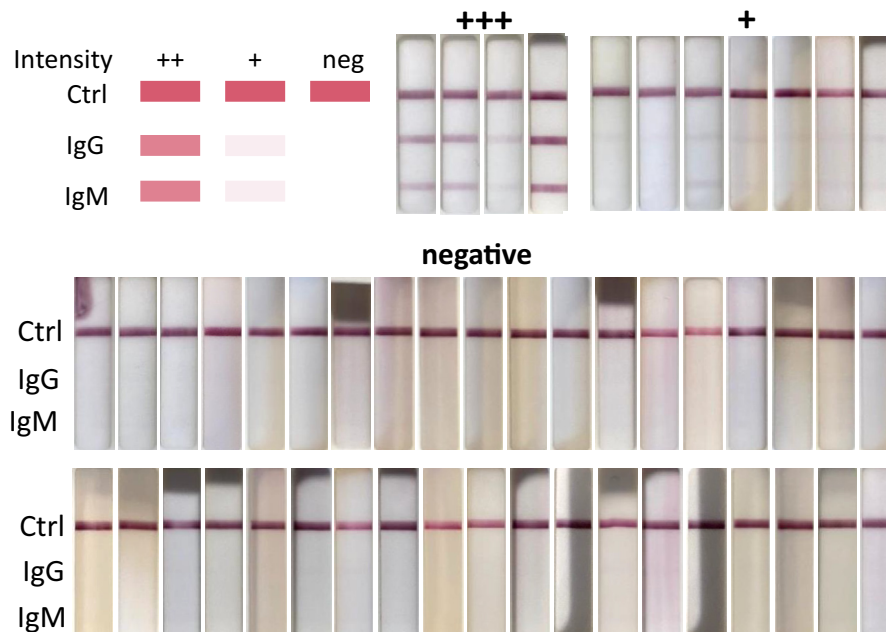


Fig. 1. Documentation of the 49 test results and their valuation. +++: Strong positive; +: positive; neg: negative; Ctrl: control.

**Table 1**  
Possible cut-off points for SARS-CoV-2—positive test results.

Cut-off point	Sensitivity	Specificity	Correctly classified	LR+	LR-
Weak and strong bands	36.36%	88.89%	65.31%	3.2727	0.7159
Strong bands only	18.18%	100.00%	63.27%		0.8182

ROC = 0.64 [95% CI: 0.52; 0.76].

Weak and strong is superior; the manufacturer's recommendation is also to interpret weak results as positive.

LR+: positive likelihood ratio; LR-: negative likelihood ratio; ROC: receiver operating characteristics; CI: confidence interval.

**Table 2**  
Comparison of SARS-CoV-2 RT-qPCR—positive samples and positive rapid tests

PCR	Rapid test		Total	
	Positive	negative		
positive	8	14	22	Sens: 8/22 = 36.4% [17.2; 59.3] Spec: 24/27 = 88.9% [70.8; 97.7]
negative	3	24	27	
Total	11	38	49	
	PPV: 8/11 = 72.7% [39.0; 94.0]		NPV: 24/38 = 63.2% [46.0; 78.2]	

Weak and strong responses were counted as positive.

Sens: sensitivity; Spec: specificity; PPV: positive predictive value; NPV: negative predictive value; RT-qPCR: real-time quantitative polymerase chain reaction.

Square brackets give the 95% confidence intervals.

presence of symptoms (exact test,  $p = 0.689$ ), age (exact test,  $p = 0.145$ ) or gender (exact test,  $p = 0.531$ ).

## Conclusion

The SARS-CoV-2 outbreak in 2019/2020 followed an unprecedented international response to contain the pandemic. High transmission rates and the vast majority presenting with only mild to moderate unspecific symptoms complicate the ability to contain the virus.<sup>9</sup> Moreover, laboratory methods to detect SARS-CoV-2 infection rely on RT-qPCR testing that require longer time for sample handling, preparation and diagnosis. While rapid point-of-care testing is critically needed, the current evaluation of an antibody-based system demonstrates only low sensitivity and is therefore not recommendable to detect potential infections as a stand-alone test. Indeed, studies demonstrated that seroconversion occurred sequentially for IgM and then IgG with a median time of 11 and 14 days, respectively. The presence of antibodies was <40% among patients in the first 7 days of illness and then rapidly increased to 100% at day 15 after onset of symptoms, which appear to be too late from a public health perspective.<sup>10</sup>

In this real-life study setting at a community SARS-CoV-2 testing site after a cluster outbreak, we investigated the superiority of an antibody-based rapid test in comparison with the current SARS-CoV-2 RT-qPCR gold standard. We tested screened persons of an official screening centre that we had selected by chance. This is a scenario that already occurs and will more often occur in all European Union (EU) member states within the next months.

The rapid test was substantially inferior to the RT-qPCR testing and should therefore neither be used for individual risk assessment nor for decisions on public health measures. As there is an urgent need for a sufficient rapid testing system for SARS-CoV-2, an antigen-based system may therefore be more appropriate. We recommend accelerating the development and evaluation of effective point-of-care testing systems.

## Author statements

### Ethical approval

The study has been approved by the local institutional review board in March 2020 (085/20).

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None declared.

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## Short Communication

## Sexual identity and low leisure-time physical activity: a population-based study

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## ABSTRACT

**Objectives:** To investigate associations between sexual identity and low leisure-time physical activity (LTPA).**Study design:** Cross-sectional study.**Methods:** The 2012 public health survey was conducted with a postal questionnaire in southern Sweden with 28,029 respondents, aged 18–80 years. Analyses were conducted with logistic regressions.**Results:** The prevalence of low LTPA among men and women were as follows: 13.9% and 12.3% among heterosexuals, 26.1% and 18.5% among bisexuals, 19.5% and 15.6% among homosexuals, 26.6% and 18.5% among others. Bisexual men and women and other men had higher odds ratio of low LTPA than heterosexuals in the final models, whereas gay and lesbian participants did not differ.**Conclusions:** The results should guide health promotion and prevention.© 2020 The Authors. Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Sexual minorities, i.e. lesbian, gay, bisexual, and transgender (LGBT) + or non-heterosexuals, have been reported to have higher mortality<sup>1</sup> and morbidity<sup>2</sup> than heterosexuals. The often high prevalence of chronic diseases such as cardiovascular diseases (CVD) and cancer<sup>1,2</sup> highlights the importance of their risk factors such as e.g. tobacco smoking, diet, and alcohol consumption for prevention.

Leisure-time physical activity (LTPA) is a highly modifiable risk factor for chronic diseases and among the top targets for interventions in public health. Low LTPA is not only a risk factor for CVD and some forms of cancer but is also associated with increased likelihood of poor mental health and suicide ideation.<sup>3</sup>

Recent literature reviews reveal that articles regarding sexual identity and LTPA are scarce internationally,<sup>4</sup> and that most research articles focus on gay men and lesbian women, often collapsing the bisexual with other sexual minorities.<sup>5</sup> A US population study including a wide adult age interval found significantly higher prevalence of vigorous LTPA (more than 150 min/week) among bisexual men and women compared with heterosexuals.<sup>6</sup> Still, another US study of only young adults found no differences in LTPA for gay men and bisexual men compared with heterosexual

men, as well as lesbian women and bisexual women in LTPA compared with heterosexual women.<sup>7</sup> Some studies have collapsed all sexual minorities,<sup>8</sup> disregarding different social circumstances and differing exposure to discrimination for different sexual minorities. Most studies on sexual orientation and LTPA have been conducted in the USA. This study is the first to investigate this association in Sweden to increase knowledge and facilitate health promotion and disease prevention. Given the scarcity of international articles regarding sexual identity and LTPA and given the propensity to collapse all sexual minority groups other than gay men and lesbian women, this study may increase knowledge also internationally.

The aim was to investigate associations between sexual orientation and LTPA.

## Study population

The 2012 public health survey in Scania, southern Sweden, was cross-sectional and included a stratified (weighted) sample of the registered adults aged 18–80 years population. Scania is a mixed region of urban, commuter and rural areas with approximately 1.4 million residents, which is 1 of 7 of the Swedish population. A postal invitation letter including a questionnaire was sent. There was also a possibility to answer online. Three reminders were also sent. A total of 28,029 responded (51.7% participation). Excluding

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internally missing on the variables included in the analyses, a total 23,585 respondents (10,865 men and 12,720 women) were included in the analyses shown in Table 1. The study was approved by the ethical committee (*Etikprövningsnämnden*) in Lund.

### Dependent variable

LTPA was assessed with a question with four alternative answers which include regular exercise (at least three times per week at least 30 min per occasion, leading to sweating), moderate and regular exercise (exercising at least once or twice per week at least 30 min, leading to sweating), moderate exercise (walking, cycling or equivalent activity at least 2 h per week not leading to sweating), and sedentary activity status in leisure-time (less than 2 h walking, cycling or equivalent activity per week). The dichotomization of this item was into high LTPA (the three first alternatives) and low LTPA (the fourth alternative). This dichotomization has also been conducted previously because most of the preventive effect protecting against CVD is achieved already by moving from a sedentary life style to just 30 min of moderate physical activity (e.g. walking without sweating) per day most of the days of the week.<sup>9</sup>

### Independent variables

Sexual identity was assessed by the question “Do you regard yourself today as heterosexual, bisexual, homosexual (exact phrasing in the questionnaire, here rephrased as gay participant or lesbian participant), or other?”.

Age was adjusted for and analyzed as a continuous variable, 18–80 years.

Country of birth was analyzed with the categories born in Sweden and born abroad.

Marital status had four alternatives: married/cohabitating, unmarried, separated, and widowed.

Socio-economic status (SES) by occupation entailed self-employed, high, medium, and low non-manual employees, skilled and unskilled manual workers, early retired (from position or for reasons of health before age 65 years), unemployed, students, old-age pensioners, unclassified, and long-term sick leave.

Prevalence (%) of low LTPA and other variables were calculated, stratified by sex. Odds ratios (ORs) with 95% confidence intervals (95% CIs) of low LTPA were calculated in bivariate logistic regression models, stratified by sex (not shown in Table 1). Adjusted odds ratios (AORs) with 95% CIs of the association between sexual identity and LTPA were calculated in multiple regression models: model A) adjusted for age and model B) adjusted for age, country of birth, SES, and marital status, stratified by sex. A sampling weight

was used in the analyses to account for the fact that the sample was stratified (weighted). The SPSS software, version 24.0, was used.

### Results

The prevalence of low LTPA was 14.8% among men and 13.5% among women. Among men, a 96.2% proportion reported heterosexual, 1.3% bisexual, 1.4% gay participants, and 1.1% other sexual orientation. Among women, a 96.1% proportion reported heterosexual, 2.2% bisexual, 0.8% lesbian participants, and 0.9% other orientation. The prevalence of the other variables has previously been reported.<sup>9</sup>

The prevalence of low LTPA was 13.9% among heterosexual men, 26.1% among bisexual men, 19.5% among gay participants, and 26.6% among other men. The prevalence of low LTPA was 12.3% among heterosexual women, 18.5% among bisexual women, 15.6% lesbian participants, and 18.5% among other women.

In bivariate logistic regression analyses, low LTPA was positively and significantly associated with bisexual identity, age intervals 35 and above, being born abroad, being divorced compared to married/cohabitating, and low SES, among both men and women. Low LTPA was also positively and significantly associated with other sexual identity among men and being widow (compared with married/cohabitating) among women (not shown in Table 1).

The high AORs of low LTPA remained statistically significant for bisexual men compared with heterosexual men throughout the multiple analyses: AOR, 2.14 (95% CI 1.46–3.14) in the full model. In contrast, gay participants had a significant AOR only in the age-adjusted model. In the fully adjusted model, it was 1.45 95% CI (95% CI 0.98–2.14). The AORs of low LTPA among men with other sexual identity remained statistically significant throughout the analyses, 1.87 (95% CI 1.25–2.80) in the full model. The AORs of low LTPA were statistically significant for bisexual women compared with heterosexual women in age-adjusted model A), and fully adjusted model B), AOR: 1.76 (95% CI 1.26–2.46). In contrast, the AORs of low LTPA remained not significant for lesbian participants both in the age-adjusted and fully adjusted model, AOR: 1.34 (95% CI 0.77–2.33). The ORs of low LTPA among women with other sexual identity were not significant throughout the analyses, with AOR: 1.31 (95% CI 0.77–2.25) in the full model B).

### Discussion

Bisexual men and women had significantly higher AORs of low LTPA compared with heterosexuals in the final models. The AORs of low LTPA did not significantly differ between gay participants and heterosexual men in the final model. In addition, the AORs of low LTPA did not significantly differ between lesbian participants and heterosexual women. Men with other sexual identity had significantly higher AORs of low LTPA than heterosexual men, but no significant association was observed for other women compared with heterosexual women.

Research concerning sexual identity and LTPA is scarce even in an international perspective.<sup>4</sup> Most research has focused on gay men and lesbian women. It has often collapsed all sexual minorities other than homosexuals.<sup>5</sup> Most studies are from the USA. Some of these studies have found higher prevalence of vigorous LTPA among bisexuals compared with heterosexuals,<sup>6</sup> while another US study did not find differences between bisexuals and gay and lesbian participants compared with heterosexuals.<sup>9</sup> The differing patterns observed in different US studies, as well as between different countries may be explained both by e.g. differences in study design and differences in policies and laws. The present results from Sweden which highlight the bisexual men and women, as well as men with other sexual identity may partly reflect current legal and social

**Table 1**

Age-adjusted and multiple adjusted odds ratios (AOR, 95% CI) of low leisure-time physical activity in accordance with sexual identity. The public health survey in Scania 2012. *n* = 23,585 (10,865 men and 12,720 women).

Sexual orientation	AOR (95% CI) <sup>a</sup>	AOR (95% CI) <sup>b</sup>
<b>Men</b>		
Heterosexual	1.00	1.00
Bisexual	2.24 (1.53–3.28)	2.14 (1.46–3.14)
Gay	1.51 (1.03–2.23)	1.45 (0.98–2.14)
Other	2.20 (1.48–3.27)	1.87 (1.25–2.80)
<b>Women</b>		
Heterosexual	1.00	1.00
Bisexual	1.93 (1.38–2.68)	1.76 (1.26–2.46)
Lesbian	1.43 (0.82–2.48)	1.34 (0.77–2.33)
Other	1.57 (0.92–2.68)	1.31 (0.77–2.25)

CI, confidence interval.

<sup>a</sup> Adjusted for age.

<sup>b</sup> Adjusted for age, country of birth, socio-economic status (SES), and marital status.

circumstances in Sweden. Same-sex partnership was granted in 1995 and same-sex marriage in 2009, which may be an explanation why gay men and lesbian women have the same prevalence of low LTPA as heterosexuals while particularly bisexual men and women do not. Discrimination and other economic and social adversities may have implications also for health behaviors.<sup>10</sup> Health promotion and disease prevention should thus be directed to bisexual men and women also in the form of aiming to increase their LTPA, taking e.g. social capital, social support, and economic barriers into account.

#### Strengths and limitations

This study is large and population-based, and includes relevant confounders. The participation rate is moderate in a western context and the risk of selection bias acceptably moderate to low when compared with register data of the population in Scania. The LTPA item has been used previously, and its dichotomization reflects the recommended levels of physical activity substantially reduce the risk of CVD.<sup>9</sup> The study design is cross-sectional and thus associational.

#### Conclusions

Bisexual and other men have higher AORs of low LTPA than heterosexual men throughout the multiple regression analyses, and this also holds for bisexual women compared with heterosexual women. No significantly higher AORs of low LTPA were observed for gay and lesbian participants compared with heterosexuals.

#### Author statements

##### Ethical approval

None sought.

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None declared.

##### Competing interests

None declared.

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## Review Paper

# The impact of the World Health Organization Health Promoting Schools framework approach on diet and physical activity behaviours of adolescents in secondary schools: a systematic review



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## ABSTRACT

**Objective:** To examine the effectiveness of interventions using the World Health Organization Health Promoting Schools (HPSs) framework approach in increasing physical activity (PA) and improving the diet of 11–18-year-olds.

**Study design:** A systematic review guided by the National Health Services Centre for Reviews and Dissemination framework and reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses.

**Methods:** Nine databases and trial registries were searched from 2013 to 2018 for cluster randomised controlled trials involving adolescents' aged 11–18 years. We also included relevant studies from a 2014 Cochrane Review of HPS approach on health behaviours. Data were extracted from included studies and assessed for quality.

**Results:** Twelve eligible studies were identified from seven countries. The studies varied in outcome measures, sample size, quality and duration of intervention and follow-up. Only four of the included studies were of high to moderate quality. We found some evidence of effectiveness for physical activity only interventions and limited evidence of effectiveness for nutrition only and combined PA and nutrition interventions.

**Conclusions:** There were no discernible patterns across the studies to suggest effective mechanisms for the HPS approach. The family/community component was poorly developed and superficially reported in all studies. Future research should seek to understand how best to work in partnership with secondary schools, to foster and sustain a healthy eating and physical activity culture, which aligns with their core aims. More attention should be paid to the restriction of unhealthy foods in the school environment.

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## Introduction

There has been a tenfold increase in child and adolescent obesity figures globally over the last four decades.<sup>1</sup> In accordance with the World Health Organization (WHO), 80% of the world's adolescents are not active enough,<sup>2</sup> have high sugar diets<sup>3</sup> and do not consume the recommended amount of fruit and vegetables.<sup>4</sup> There are many potential influences affecting adolescents physical activity (PA) and diet choices, however schools are seen as good

environments to role model and educate students on health behaviours from a broad social spectrum. As part of the Ottawa Charter, the WHO developed a Health Promoting Schools (HPSs) framework<sup>5</sup> to support schools globally to create a positive health environment. This whole-school approach has three main components: (1) health education in the curriculum; (2) changes to the school ethos and physical environment; and (3) involving families and/or communities to support health promotion.

Using a whole-school approach has been advocated globally by organizations such as WHO and many countries have adapted the HPS framework to fit their local context,<sup>6</sup> for example, England used this approach to develop a 'National Healthy Schools Programme' which ran between 1999 and 2011; however owing to government funding cuts,<sup>7</sup> this award is currently only

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operational in some parts of the UK. A previous review of the HPS approach found some evidence for it positively affecting body mass index (BMI), PA, physical fitness and fruit and vegetable (F&V) intake in children aged 5–18 years.<sup>8</sup> However, this review highlighted a high level of heterogeneity in study design and a lack of studies conducted with adolescents. Therefore, our review focused on secondary,<sup>a</sup> school-based, cluster randomised controlled trials (RCTs) taking an HPS approach to promote a healthy diet and/or increase the PA of 11–18-year-olds, highlighting the delivery methods used, as well as their scalability.

## Methods

The protocol for this review is registered on PROSPERO: CRD42018094335.<sup>9</sup> Relevant studies from the Langford et al. Cochrane review<sup>8</sup> that met our criteria were included alongside new studies resulting from the search strategy as laid out in the following context.

### Search strategy

The search strategy was developed using a combination of relevant controlled vocabulary and free text terms (Fig. 1). The search was run in May 2018 in: MEDLINE, Embase, PsycINFO (via OvidSP), CDSR and Central, CINAHL Complete, BEI, ERIC and AEI, a date restriction of 2013 to date was used to identify additional studies from the previous review. No language restrictions were used. Search results were downloaded into EndNote X8; two reviewers independently screened titles, abstracts and full texts using the inclusion/exclusion criteria. Backward citation searching was manually undertaken by the reviewers and forward citation searching was undertaken in the Web of Science Core Collection and Scopus using the 12 included articles; these results were single screened.

### Types of studies

Studies were included if they were RCTs clustered at the level of school, district or geographical area; studies where clusters were at the classroom level were excluded. Feasibility and pilot studies where only one school was allocated to intervention and control group were also excluded.

### Types of participants

All students in a mainstream secondary school setting, aged 11–18 yrs. Studies that included 11-year-olds but were in a primary school setting were excluded. Studies that focused on single sex but were in a mixed sex school were excluded.

### Types of interventions

Interventions aimed at changing diet and/or PA levels, which addressed all the components of the WHO HPS framework were considered.

### Types of outcomes measures

Self-reported or objectively measured primary PA and/or diet outcomes including weight status if this was available as set out in the study protocol.<sup>9</sup>

### Data extraction

Titles and abstracts were screened by two reviewers and any discrepancies were discussed and resolved by a third reviewer. Data were extracted on included studies as detailed in the protocol. In addition, we recorded how each included study addressed each HPS component, and if they had conducted a cost-effectiveness and/or process evaluation.

### Quality appraisal

The Cochrane Risk of Bias Tool for RCTs<sup>10</sup> was used to assess the risk of bias. Two authors individually assessed each study and any disagreements were discussed with the third reviewer. Each study was rated for overall quality and categorised as low, moderate, moderate/high or high.

### Data synthesis

Included studies were categorised as to whether they aimed to affect diet, physical activity or both. Intervention types were considered separately to assess heterogeneity and to ascertain whether the studies were sufficiently homogenous to allow a meta-analysis.

## Results

### Bibliographic databases searches

The databases searches found a total of 6672 results; of these, 4154 were screened at title and abstract and 74 full texts were retrieved for detailed inspection. Four new studies<sup>11–14</sup> were included from this search, as well as eight identified studies from Langford et al.<sup>15–22</sup> making a total of 12 included studies for this review (Fig. 2). Three trials registries ([Clinicaltrials.gov](http://Clinicaltrials.gov), ICTRP and TRoPHI) were searched in December 2018, as well as forward and backward citation chasing; no further studies were found.

### Study characteristics

Table 1 details the study characteristics; six studies were conducted in the United States,<sup>13,15,16,18,19,22</sup> and one each in Ecuador,<sup>11</sup> Belgium,<sup>21</sup> Finland,<sup>17</sup> France,<sup>20</sup> Australia<sup>12</sup> and India.<sup>14</sup> The sample sizes ranged from 462 to 25,000 participants, there was limited reporting of the schools' structure or organization. The age of students ranged from 11 to 15 years, no studies were found for students aged 16–18 years. All studies reported the age and gender of participants. Eight studies<sup>12–16,18,19,22</sup> reported ethnicity and nine<sup>11–13,15,18–22</sup> reported socioeconomic status. Four studies conducted long-term follow-up (more than 24 months),<sup>13,15,19,20</sup> six medium (24–12 months)<sup>11,12,16,18,21,22</sup> and two short-term follow-up (12 months or less).<sup>14,17</sup>

### Study quality

Eight studies were assessed as low quality,<sup>13,14,16–19,21,22</sup> two moderate,<sup>11,20</sup> one as moderate/high<sup>15</sup> and one as high<sup>12</sup> (Fig. 3). Nine studies<sup>11–13,17–22</sup> reported the theory used to develop the intervention, however, only two studies explicitly identified using

<sup>a</sup> For this review, we used secondary school to refer to schools following on from primary or elementary education. This includes high or middle schools. Students are aged 11–18 years.

1 teen\*.tw.  
 2 adolescen\*.tw.  
 3 young person\*.tw.  
 4 young people\*.tw.  
 5 youth\*.tw.  
 6 pupil\*.tw.  
 7 student\*.tw.  
 8 exp ADOLESCENT/  
 9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8  
 10 Physical\* activ\*.tw.  
 11 physical\* fit\*.tw.  
 12 nutrition\*.tw.  
 13 diet\*.tw.  
 14 fruit\*.tw.  
 15 vegetable\*.tw.  
 16 obes\*.tw.  
 17 bmi.tw.  
 18 body mass index.tw.  
 19 overweight.tw.  
 20 physical\* inactiv\*.tw.  
 21 weight.tw.  
 22 (sugar adj2 intake\*).tw.  
 23 (calorie adj2 intake\*).tw.  
 24 sedentary.tw.  
 25 (promot\* or policy or policies or educat\* or environment\* or ethos\* or attitud\* or curricul\* or  
 behav\* or intervention\* or cultur\* or family).tw.  
 26 health\*.tw.  
 27 (health\* adj2 (promot\* or policy or policies or educat\* or environment\* or ethos\* or attitud\* or  
 curricul\* or behav\* or intervention\* or cultur\* or family)).tw.  
 28 \*Health Behavior/  
 29 \*Health Promotion/  
 30 \*Health Education/  
 31 diabet\*.tw.  
 32 randomized controlled trial.pt.  
 33 controlled clinical trial.pt.  
 34 randomized.ab.  
 35 placebo.ab.  
 36 clinical trials as topic.sh.  
 37 randomly.ab.  
 38 trial.ti.  
 39 32 or 33 or 34 or 35 or 36 or 37  
 40 exp animals/ not humans.sh.  
 41 39 not 40  
 42 \*Schools/  
 43 school\*.tw.  
 44 42 or 43  
 45 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 27 or 28 or 29  
 or 30 or 31  
 46 9 and 41 and 44 and 45  
 47 "Health Promoting Schools framework".tw.  
 48 "Health Promoting Schools (HPS) framework".tw.  
 49 hps framework.tw.  
 50 47 or 48 or 49  
 51 46 or 50  
 52 limit 51 to yr="2013 -Current"

**Fig. 1.** Search terms.

the HPS framework one of which was rated high quality<sup>12</sup> and the other as low.<sup>12,14</sup> The extent to which studies developed the processes within each HPS component varied considerably (Table 2). Owing to the heterogeneity of the studies, a narrative synthesis was conducted.<sup>23</sup> Only three of the included studies<sup>11,15,16</sup> reported on adverse events. One described potential events but reported that none occurred,<sup>16</sup> one did not specify what was classified as an adverse event<sup>11</sup> and one reported the occurrence of non-intervention-related adverse events as dizziness during blood collection.<sup>15</sup>

### *Effect of the intervention*

#### *Nutrition studies (n = 4)*

Three studies primarily measured F&V consumption using self-report instruments, whereas one measured incidence of overweight/obesity by body mass index, standardised for age and gender (BMIz).<sup>16</sup> All studies in this category were of low quality (Fig. 3). These studies sought to promote and increase the consumption of healthy foods such as F&V, through increasing the availability of healthy options, with two studies also restricting

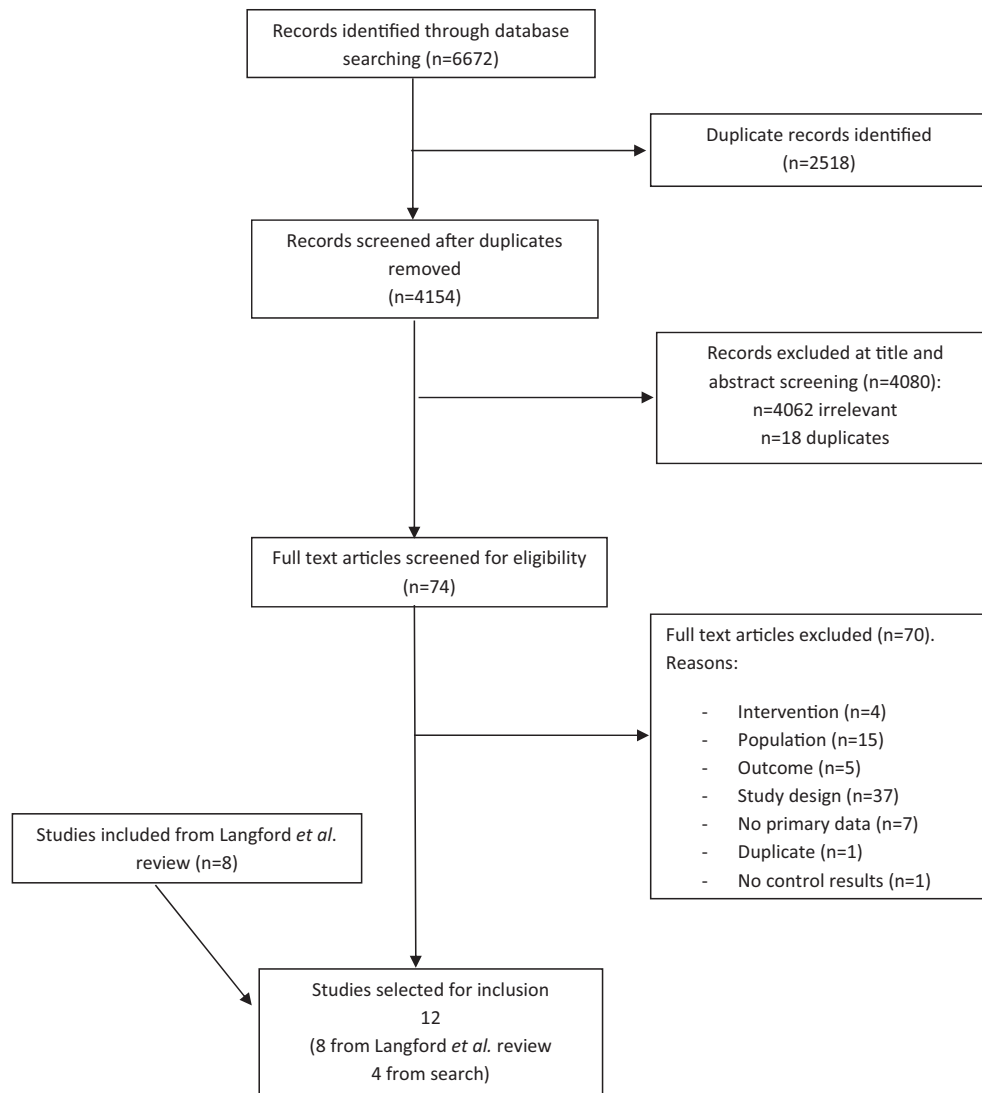


Fig. 2. Prisma flow chart showing the search process.

unhealthy foods.<sup>16,17</sup> Of the studies which increased the availability of healthy options, neither reported an effect on F&V intake.<sup>18,19</sup> The two studies that included the restriction of unhealthy foods, as well as increasing healthy options, reported a small decrease in sucrose intake (12.8%–10.5%) of the total energy intake<sup>17</sup> and in the incidence of overweight (7.5% fewer)<sup>16</sup> immediately after intervention. One study addressed the HPS components with more intensity, over a longer time period and resulted in fewer children becoming overweight after two years.<sup>16</sup>

#### PA studies (n = 3)

A different primary outcome measure was used for each of the PA only studies: physical fitness test,<sup>11</sup> daily moderate-vigorous physical activity level (MVPA) using accelerometry<sup>12</sup> and BMIz<sup>20</sup> making it hard to make comparisons regarding the magnitude of effect. All were of moderate to high quality (Fig. 3). These studies focused primarily on increasing individual PA levels, through a mixture of classroom activities, during existing physical education (PE) classes. All reported a significant positive effect (Table 1). All three addressed the family/community component in similar ways (Table 2); however, over two years Sutherland et al.<sup>33</sup> a high quality study, had the

most developed ethos and environment and curriculum component, possibly owing to explicitly using the HPS framework.

#### PA and nutrition studies (n = 5)

Most studies in this category were low quality with only one being rated as moderate/high<sup>15</sup> (Fig. 3). Three of these studies used PE lessons to address individual PA levels, and provide knowledge on nutrition,<sup>15,21,22</sup> whereas one study showed a short film about PA during class<sup>13</sup> and another had separate health education lectures<sup>14</sup> (Table 2). All of the studies increased the provision and marketing of healthy food options, with only one restricting the provision of unhealthy foods.<sup>15</sup> Four studies were looking to affect diet and PA to affect weight status and used objective weight measures, with the other study using observed PA levels and reviewed school menus for fat content<sup>22</sup> to assess effectiveness. There was no meaningful significant effect reported in prevalence of overweight/obesity and BMIz; one study reported a smaller increase in BMIz at follow-up, although this was only in girls and did not reach statistical significance.<sup>21</sup> One study which was rated moderate to high in quality, used an objective measure and had well-developed HPS components found no effect on the prevalence of obesity;<sup>15</sup> however, fewer students became overweight at follow-up. The study that

**Table 1**  
Study characteristics.

Author, year, country, programme	Number of schools, consented participants & mean age	Intervention duration	Number (time of follow up)	Theory	Primary outcome category/measure	Primary outcome results	Attrition numbers at final follow up (by group if reported)
<b>Nutrition</b>							
Foster et al., 2008 <sup>16,a</sup> USA, School Nutrition Policy Initiative	10 middle schools; 1349 (int 749, con 600); Mean age: 11.2 ± 1.0yrs	2yrs	2 (end of each yr)	NR	Incidence of overweight and obesity (BMIz and percentiles)	Significantly fewer children in the intervention schools (7.5%) than in the control schools (14.9%) became overweight after 2yrs ( $P = 0.03$ )	Int: 270 (36.0%), con: 235 (39.2%)
Hoppu et al., 2010 <sup>17,a</sup> Finland	12 secondary schools; 769; Mean age: 13.8yrs	8mths	1 (1 yrs)	SCT	F&V intake, consumption of rye bread and sweets. (food intake questionnaires)	No difference in F&V. In intervention girls rye bread increased ( $P = 0.03$ ); sweets decreased ( $P = 0.006$ ). Sucrose intake for intervention pupils decreased from 12.8% to 10.5% of total energy intake ( $P = 0.01$ ). Total F&V intake showed no significant difference.	110 (14.3%)
Lytle et al., 2004 <sup>18,a</sup> USA, TEENS	16 middle schools; 3878 survey, 640 24 hr recall; Mean age: 12–13yrs	2yrs	2 (end of each yr)	SCT	F&V intake (24hr recall interviews)		185 (28.9%)
Nicklas et al., 1998 <sup>19,a</sup> , USA, Gimme 5 PA	12 high schools; 2213; Mean age: 14–15yrs	3yrs	3 (end of each yr)	PRECEDE model	F&V intake (self-administered KAP questionnaire)	No significant difference.	unclear
Andrade et al., 2014 <sup>11</sup> Equador, ACTIVITAL	20 schools; 1440 (int 700, con 740); Mean age: 12.9 ± 0.8yrs	11mths (Study duration 28mths)	1 (28mths)	SCT, IMBSM, control theory, TTM and TPB.	Physical fitness (EUROFIT test battery)	Vertical jump (intervention effect 2.5 cm; 95% CI: 0.8–4.2; $P = 0.01$ ). Speed shuttle run (intervention effect –0.8 s, 95% CI: –1.58–0.07; $P = 0.05$ ).	Int: 150 (21.4%), con: 207 (28.0%)
Simon et al., 2006 <sup>20,a</sup> France, ICAPS	8 middle schools; 954 (int 479, con 475); Mean age: 11.6 ± 0.02yrs	4yrs	3 (end of 2 <sup>nd</sup> , 3 <sup>rd</sup> & 4 <sup>th</sup> yr)	SEM framework	BMI & BMIz	Intervention students had lower increase in BMI ( $P = 0.01$ ) and age- and gender-adjusted BMI ( $P < 0.02$ ) over time than controls.	Int: 105 (21.9%), con: 117 (24.6%)
Sutherland et al., 2016 <sup>12</sup> Australia, PA4E1	10 schools; 1233 (int 696, con 537); Mean age: 12yrs	2yrs	2 (end of each yr)	SCT & SEM framework	MVPA (daily mins by accelerometers)	Significant effect on daily minutes of MVPA 7.0 mins increase (95% CI: 2.7–11.4, $P < 0.002$ )	Int: 136 (19.5%), con: 112 (20.9%)
<b>Nutrition and PA</b>							
Bogart et al., 2014 <sup>13</sup> USA, SNaX	10 middle schools; 2439 (int 1178, con 1261); Mean age: 12.2yrs ± 0.68yrs	5wks	1 (2yr post-intervention)	Diffusion of innovation theory	BMI percentile (BMI and CDCP categorization)	Non-significant effect overall on BMI but those obese had reduced BMI at follow up ( $b = -2.33$ percentiles; SE, 0.83; $P = 0.005$ ) compared with control students.	Int: 349 (29.6%), con: 722 (57.3%)
Foster et al., 2010 <sup>15,a</sup> USA, HEALTHY	42 middle schools; 6358 (int 3189, con 3169) Mean age: 11.3 ± 0.6yrs	3yrs	1 (3yrs)	NR	Prevalence of overweight and obesity (BMI ≥ 85%) and BMIz	No difference in combined prevalence of overweight & obesity.	int: 882 (27.7%), con: 873 (27.5%)
Haerens et al., 2006 <sup>21,a</sup> Belgium	15 middle schools; 2840; Mean age: 13.06 ± 0.81yrs	2yrs	2 (end of each yr)	TPB, SCT, ASE model, TTM	BMI and BMIz	In girls BMI and BMIz increased significantly less in the intervention with parental support group <sup>b</sup> compared with the control group ( $P < 0.05$ ) or the intervention-alone group ( $P = 0.05$ ). Non-significant difference for boys.	Unclear

Table 1 (continued)

Author, year, country, programme	Number of schools, consented participants & mean age	Intervention duration	Number (time of follow up)	Theory	Primary outcome category/measure	Primary outcome results	Attrition numbers at final follow up (by group if reported)
Sallis et al., 2003 <sup>22,a</sup> USA, M-SPAN	24 middle schools; 25,000; Mean age: 11–14yrs	2yrs	2 (end of each yr)	SEM	PA levels and fat intake (SOFIT & SOPLAY observation & menu analysis)	PA: effect for total group ( $P < 0.009$ ); for boys ( $P < 0.001$ ) and not for girls ( $P < 0.40$ ). Fat: No effect for total fat ( $P < 0.91$ ) or saturated fat ( $P < 0.79$ )	Unclear
Thakur et al., 2016 <sup>14</sup> India	4 schools; 462 (int 201, con 261); Mean age: 13yrs	20wks	1 (1yr)	NR	Change in weight/BMIz	No significant difference in BMI. Intervention group showed decrease in weight by $-0.08$ (95%CI: $-0.15$ to $-0.00$ , $P = 0.048$ ) z-score units.	Int: 44 (21.9%), con: 45 (17.2%)

ASE, Attitude, social influence and self-efficacy; CDCP, Centers for disease control and prevention; con, control group; HPS, Health Promoting School; IMBMSM, information-motivation behavioural skills model; int, intervention group; KAP, Knowledge, attitudes, and practices; mths, months; NR, not reported; PA, physical activity; RCT, randomised control trial; SEM, Social Ecological Model; SCT, social cognitive theory; SOFIT, System for observing fitness instruction time; SOPLAY, System for Observing Play and Leisure Activity of Youth; TPB, theory of planned behaviour; TTM, transtheoretical model; wks, weeks; yrs, years.

<sup>a</sup> Studies included within the Langford Review.

<sup>b</sup> Three conditions were examined (an intervention with parental support group, an intervention-alone group and control group).

measured PA levels and fat intake showed a significant increase in PA for boys but there was no effect on fat intake.<sup>22</sup> It is hard to draw conclusions from these studies as only one assessed PA and diet behaviours directly<sup>22</sup> so it is unclear whether the intervention failed to affect these behaviours or did not affect them sufficiently to impact weight status.

Process evaluations and cost-effectiveness

Process evaluation data were collected within eight of the included studies.<sup>11,12,15,18–22</sup> There was considerable variability in the methods used and the type of data captured with the majority of the reporting on issues concerning implementation, reach and the acceptability of the intervention. The level of reporting varied from brief paragraphs alongside the outcome results<sup>12,18,20,21,24</sup> to separate publications.<sup>25–28</sup> The studies which assessed intervention fidelity reported the intervention as being delivered as

planned,<sup>12,15,20,25</sup> and one PA/diet study identified some issues around implementation and reported this as possible reason for lack of effect.<sup>21</sup> Three studies assessed parental engagement, and all reported that parental engagement with the intervention as low;<sup>11,15,18</sup> six studies looked at the acceptability of the intervention from a deliverer or pupil perspective and all reported that the intervention was widely acceptable and engaged students.<sup>12,15,18,20,25,28</sup> There were mixed results regarding the feasibility of delivering the intervention, with one study reporting that the intervention was ‘too burdensome’ for teaching staff to deliver<sup>18</sup> and another, which used research staff, highlighting the importance of the relationship between external and internal deliverers to successfully deliver the intervention.<sup>15</sup> Two studies sought to relate the underlying mechanisms of the interventions to the trial outcomes; both reported the level of implementation as affecting outcome.<sup>18,21</sup> One reported that low parent engagement may have adversely affected the outcome but did not articulate the

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Reported outcome power calculation	Attrition rate	Quality rating
<b>Nutrition</b>									
Foster et al., 2008 <sup>16*</sup>	?	+	-	-	-	?	NR	High	Low
Hoppu et al., 2010 <sup>17*</sup>	?	+	-	-	-	?	NR	Low	Low
Lytle et al., 2004 <sup>18*</sup>	?	+	-	-	-	?	80%	High	Low
Nicklas et al., 1998 <sup>19*</sup>	?	+	-	-	?	?	NR	Unclear	Low
<b>PA</b>									
Andrade et al., 2014 <sup>11</sup>	+	+	-	?	-	-	>80%	High	Moderate
Simon et al., 2006 <sup>20*</sup>	?	+	-	-	+	+	<90%	High	Moderate
Sutherland et al., 2016 <sup>12</sup>	+	+	-	+	?	+	>80%	Low	High
<b>Nutrition and PA</b>									
Bogart et al., 2014 <sup>13</sup>	?	+	-	+	-	-	NR	High	Low
Foster et al., 2010 <sup>15*</sup>	+	+	-	+	+	-	90%+	High	Moderate/High
Haeranset al., 2006 <sup>21*</sup>	?	+	-	?	?	?	>80%	Unclear	Low
Sallis et al., 2003 <sup>22*</sup>	?	+	-	-	?	?	NR	Unclear	Low
Tharkure et al., 2016 <sup>14</sup>	?	+	-	-	-	?	NR	Low	Low

\*included studies within the Langford Review; NR Not Reported; - negative/high risk; + positive/low risk; ?unclear risk

ψ Due to the nature of the RCT design, the blinding of participants would be considered as high risk for all studies hence this was not applied for the quality rating

Fig. 3. Bias summary of studies.



**Table 2**  
HPS components.

Study	Curriculum	Ethos and environment	Family and community
Foster et al., 2008 <sup>16,*</sup>	50 hrs F&N education per student per school year.	Self-assessment, nutrition policy, school food provision changed, restriction of unhealthy food, school social marketing and incentives.	Various parent meetings and weekly nutrition workshops (number and attendance unclear).
Hoppu et al., 2010 <sup>17,*</sup>	Nutrition education in lessons (amount unclear)	Drama workshops for staff and pupils, increase of healthy snacks, restriction of sugary snacks. School meals unchanged.	Invite to school meal, magazine sent home on healthy eating & information provided nutrition of school food.
Lytle et al., 2004 <sup>18,*</sup>	10 behaviour based nutrition lessons (goal-setting, skills, self-monitoring) used trained peer leaders	Worked with food provider to increase F&V and healthy snacks. School meal unchanged, school council used to create & promote a healthy school environment & policy.	3 parent newsletter (including 10 behaviour coupons with incentives). Parents part of nutrition council group.
Nicklas et al., 1998 <sup>19,*</sup>	5x 55 min workshops and 5-a-day messages in all other lessons	Increase in F&V options, school social marketing (5-a-day), and staff training.	Termly parent newsletter and magazine with recipes, media displays & tastings at school parent meetings. Calendar with tips & recipes in final yr.
Andrade et al., 2014 <sup>11</sup>	Every two weeks PE lessons used 2 curriculum based books to educate on health benefits and decision making skills.	Installed a walking trail, school social marketing.	6 one hr parent workshops and an event with well-known athletes.
Simon et al., 2008 <sup>20,*</sup>	Focus in PE lessons to encourage lifelong PA behaviour (detail unclear)	New/extra PA opportunities in school breaks and after school. Sporting and 'cycle to school' events.	Regular parent meetings (number unclear), community policy makers asked to support PA environment.
Sutherland et al., 2016 <sup>12</sup>	Extensive adjustment to PE lessons to maximise lifelong PA. Goal setting, incentives, fitness progress and reports. PE teacher training	New policy to enhance PA. Created a school committee, strategies manual for school, new equipment & opportunities during school lunch breaks, promotional materials.	Termly parents newsletter, info on school website, expo of local community providers.
Bogart et al., 2014 <sup>13</sup>	A short film during class	Increase healthy foods & chilled/filtered water, school social marketing, peer leader/advocacy group.	Take home activities to do with parents.
Foster et al., 2010 <sup>15,*</sup>	PE lessons focused on nutrition, goal-setting and increase in MVPA (detail unclear). Peer communicators used to help deliver intervention	Increase and promotion of healthy food/drink choices. School social marketing.	Parent newsletter and home packs.
Haerens et al., 2006 <sup>21,*</sup>	Over 2yr in PE lessons 4hrs to promote PA and 2hrs healthy eating. Fitness test and tailored computer feedback	School work group, extra PA equipment & opportunities. School fruit policy (low price or free). Free water bottle to promote drinking water.	Parent meeting & information folder (including a CD-ROM with computer tailored program for adults and students). 3 newsletters & info in school paper.
Sallis et al., 2003 <sup>22,*</sup>	PE lessons changed to increase PA at school (staff training)	Extra PA opportunities, equipment & incentives; increase of low-fat food choices, training for canteen staff and incentives. School social marketing, health policy meetings (x3) and student health committee.	Parent newsletters, information posters & brochure.
Thakur et al., 2016 <sup>14</sup>	Fortnightly health education lectures by health professionals. Student lifestyle journals with SR daily diet/PA record.	One period of daily PA. Increase healthy foods choices. School social marketing. Teachers involved in student health assessment.	Child tailored dietary recommendations from dietician to parents. Parent involvement in screen-time reduction. PTA involved in health assessment.

\* Studies included within the Langford Review.

F&N, food and nutrition; F&V, fruit and vegetable; hrs, hours; MVPA, moderate-vigorous physical activity; PA, physical activity; PE, physical education; PTA, parent-teacher association; SR, self-reported; yr, year.

rationale for greater parental engagement<sup>18</sup> whilst another three-arm study, which assessed the intervention plus additional parental involvement activities against the control and intervention only groups, reported no impact.<sup>21</sup> One process evaluation highlighted the fact that they became aware of a similar program, operating in control schools which they suggest could explain the lack of effect on outcome.<sup>25</sup> Only one of the studies carried out had published a separate cost-effectiveness evaluation on its primary outcome and demonstrated that it was a cost-effective intervention, although it did identify that scale-up might be an issue owing to the use of research personnel to deliver parts of the intervention.<sup>29</sup> No negative unintended consequences were reported in any of the studies.

## Discussion

This systematic review follows on from the Langford et al. review<sup>8</sup> which included 34 studies addressing diet and PA behaviours, with only 8 set in secondary schools; this review identified

four further trials which focused on 11–16-year-olds. The strongest evidence for the HPS approach came from interventions which sought to increase PA. Other reviews<sup>30–33</sup> that have looked more generally at school-based interventions to address PA in secondary school settings have reported mixed findings. One review looking at obesity prevention interventions found some evidence for PA interventions increasing levels of PA and reducing the risk of obesity in 13–18-year-olds;<sup>34</sup> however, Love et al.<sup>35</sup> reviewed school-based PA trials which had used objectively measured MVPA and found no overall effect on directly measured mean daily minutes of MVPA. Sutherland et al. conducted a high quality study in a socio-economic deprived area, explicitly used the HPS framework, collected daily MVPA and showed a significant positive effect, however scale-up might be an issue owing to costs associated with intervention delivery.

Similar to the 2019 Brown et al. review,<sup>34</sup> the HPS nutrition-only-interventions showed minimal effect on young people's eating behaviours. The interventions that restricted unhealthy foods<sup>16,17</sup> showed some effect on sucrose intake and prevalence of

overweight. Langford et al.<sup>8</sup> included both primary and secondary schools and found a positive effect for F&V intake; however, the current review only looked at secondary schools and found no effect for F&V intake. This may be due to a number of factors such as school structures and policies which make it easier to manipulate the food environment in the primary setting, as well as a wider selection of less healthy food choices in secondary schools. Unlike the findings in other reviews,<sup>34,37</sup> the combined PA and nutrition studies included in this review showed little effect on BMIz or prevalence of overweight or obesity, except one study which showed less of an increase in BMIz in girls.<sup>21</sup>

Interventions were heterogeneous in their design and delivery of the HPS components including the two studies<sup>12,14</sup> that explicitly stated that they used the framework. For example, one study<sup>13</sup> used a single lesson whilst another had more than 50 h of class time<sup>16</sup> to affect the curriculum (Table 2). Similarly, the ethos and environment component was equally diverse, with one school providing a walking trail and social marketing<sup>9</sup> whilst another changed school policy, set up committees, changed provision, and created strategies to support a whole-school culture change.<sup>10</sup> Whilst the studies which did not find any meaningful effect were all considered to be 'low' in terms of their delivery of the HPS components,<sup>13–15,18,19,22</sup> there was no consistent pattern in the design or delivery of the HPS framework and effectiveness. One study intensively delivered the HPS framework and had external research personnel to support the delivery of the components;<sup>12</sup> however, two of the studies<sup>11,20</sup> which reported an effect were considered to have 'low' fidelity to the HPS framework, thus making it hard to draw any conclusions about the nature and quality of delivery of the HPS components and effectiveness. Langford et al.<sup>38</sup> highlight that activities to address the family and community component are lacking and recommends that this needs to improve, using more creative methods to engage families. The family component in the additional studies is also lacking in development; arguably secondary schools face a far bigger challenge to engage families and communities which requires concerted effort and additional resources to enable partnership working and cultural change. Perhaps, with the limited resources available, secondary schools, may be better served by research focussing on the well-developed delivery of both the curriculum and ethos/environment components of the HPS framework. The absence of consensus regarding purpose, minimum content and integration for each component and how it might affect outcomes could be hampering efforts to further develop this approach.<sup>36</sup> In the evaluation of the effectiveness of HPS interventions, there seems to be a tension between HPS programmes that aim to address the whole-school culture and its policies, which take time and resources, thus being potentially burdensome for schools to implement vs the more simple and compartmentalized programmes which do not require culture change but may well be inadequate to impact behaviours sufficiently to address health outcomes to any great extent.

Despite the principles of the HPS approach, its implementation predominantly uses theories focused on individual behaviour change rather than system-level theories of change. As discussed by Bonell et al.<sup>39</sup> future research should take the emphasis off individual behaviours and use integrated theories to change the school system to support adolescent's health choices. However, the structure and practices of secondary schools are designed to achieve national academic targets, rather than national health targets. The lack of detailed process and cost-effectiveness data of most HPS trials make it difficult to understand what a truly HPS might look like and how it might be assessed for its impact on effect of the school culture and environment, as well as health behaviours and outcomes.<sup>40</sup> Although the HPS framework is a whole-school

approach there is currently no measure to assess its impact on school culture to see whether the intervention is operating at the level of the school.

In conclusion, evidence suggests that focussing on the school environment can effect PA behaviours; however, there is a lack of evidence of effect for diet behaviours partly owing to a limited number of studies conducted in adolescents, particularly in the UK. With some evidence suggesting that restricting unhealthy food choices in school environments vs only adding healthy options, this could be an avenue which warrants further study. However, researchers need to work with secondary schools to avoid overburdening them and aim to understand the school context and align any intervention development with the schools core aims. Future evaluation design also needs careful consideration, given approaches to change culture and policy are hard to assess in a RCT design and simple component approaches are insufficient to actually impact behaviours. The WHO HPS framework, shows promise and would seem to do no harm; however, it needs further consideration in secondary schools to agree the purpose, quality and content of each component and how these impact outcomes such that it can be integrated and sustained into school culture to support pupil health.

## Author statements

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### Ethical approval

None declared.

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### Competing interests

None declared.

### Author contributions

K.W., J.L., C.Mc and S.L. conceived and designed the review and K.W. supervised throughout. A.B. developed the search strategy with assistance from C.Mc and A.H. A.B. performed the electronic searches. C.Mc and A.H. conducted the screening of titles and abstracts, evaluated the eligibility of full text articles and extracted study data. K.W., A.H. and C.Mc assessed the included studies and interpreted the results. C.Mc drafted the manuscript with help from A.H. and A.B. K.W. and J.L. provided extensive comments on the initial draft. All authors approved the final document.

### Consent for publication

Not applicable.

## Availability of data and material

This is a systematic review study where all included studies are published and available in the public domain.

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