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Research Paper

Systematic review into city interventions to address obesity

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ABSTRACT

Background: Obesity threatens to undo the improvements that have been made in life expectancy over the last two centuries. It disproportionately affects lower socioeconomic and ethnic minority groups and has become one of the most important global health challenges of the 21st century. Whilst obesity is not confined to city populations, cities are home to more than half of the world's population with concentrated groups at high risk of obesity. Cities have also long been the forefront of social and technological change that has led to our current obesogenic environment. The aim of this study was to systematically identify city-wide interventions to address obesity, from which recommendations for policy makers, health system leaders and political leaders in cities could be made.

Methods: Systematic review, conducted according to PRISMA guidelines, examining Embase, Ovid Medline, Central, Scopus, Campbell Library, CINALH, Health Business Elite; Health Management Information Consortium (HMIC), PyschINFO and Prospero. No restrictions on article type, date range or geographic location were applied. Along with classic academic sources, books and policy white papers were sought and reviewed. Studies that described a city-wide intervention to reduce obesity were included, irrespective of study design or perceived methodological quality. Only studies in English language were included. The primary outcome indicators that were sought and extracted were: reduction in obesity, reduction in weight and/or reduction in BMI. Where a primary outcome indicator was not stated, any other secondary impact measure was identified and recorded. This manuscript represents thematic analysis of a sub-set of data from the Prospero study, registration number: CRD42020166210

Findings: Our search yielded 42,137 original citations of which 1614 met the inclusion criteria and 96 were coded as relating to obesity. The 96 citations, ranging in year of publication 1997 to 2019, were conducted in 36 cities, with 13 citations either not stating a city or covering multiple cities, across 5 continents. The highest proportion of publications were from North America (59 / 96) and in particular the USA (56/96) and New York City (23/96). Primary outcome indicators were only stated in one quarter of the identified studies (24/96). Overall, there was heterogeneity of study design, descriptive methodologies and publication types, with a majority being descriptive texts using qualitative instruments of assessment.

Interpretation: Multi-level and multi-component interventions, at the individual, community and city level, done in concert, are needed to address obesity. A composite of interventions that cities can utilise to address obesity is provided. These interventions will also be beneficial to the environment and make the case that personal health and planetary health are inextricably linked and should be considered as one.

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Introduction

Obesity threatens to undo the gains that we have made in life expectancy over the last two centuries [1,2]. It has rapidly become a global epidemic; more than half the population is now overweight in 34 out of 36 OECD countries with almost one in four people with obesity [3]. The impact of obesity disproportionately affects lower socioeconomic and ethnic minority groups [4–8] and has broader short and long term consequences including; children who are overweight do less well at school, are up to three times more likely to be bullied, are more likely to miss school, and, when they grow up, are less likely to complete higher education [3] and five times more likely to have obesity as an adult and therefore likely to have associated health issues [6]. Obesity has become one of the most important global health challenges of the 21st century and yet is largely preventable [9].

The aim of this review was to systematically identify the interventions being taken by cities to reduce the prevalence of obesity and

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Research in Context

Evidence before the study

The World Health Organization (WHO) estimates that more than 60% of global disease burden is the result of obesity related disorders. In this context, it is unsurprising there continues to be an increasing volume of research studies in the area of obesity. These studies include Cochrane reviews on interventions for preventing and treating obesity in children, adults, specific cohorts of the population and in specific settings. In addition, there are numerous systematic reviews on interventions for preventing obesity. and a significant number of studies covering individual city-wide interventions to address obesity, including the 96 studies found through this systematic review. There is a significant and growing body of evidence in respect of interventions to prevent and treat obesity.

Added value of the study

To our knowledge, this is the first systematic review of city-wide interventions to address obesity. Whilst obesity is not confined to city populations, cities are home to more than half of the world's population with concentrated groups at high risk of obesity. Therefore, a focus on city level interventions has the benefit of impact at scale on a significant number of the population that are disproportionately affected by obesity. This study adds to the literature by integrating identified studies to provide a comprehensive summary of city-wide interventions that cities have taken to address obesity. Using the evidence, the authors have produced a composite model of interventions that any city can consider within their local and national context when wanting to take action to reduce obesity.

Implications of all the evidence

Obesity is a global epidemic. There is emerging academic consensus that obesity is a complex problem that requires a multi-component and multidisciplinary approach. The interventions to address obesity do not provide quick fixes and there is a need for sustained focus and attention. The evidence from this systematic review demonstrates that multi-level, multi-component interventions carried out in concert, with the leadership of the Mayor (or equivalent city political leadership), give cities the best chance of reducing obesity.

provide recommendations that will be useful to academics, policy makers, politicians, city health system managers and anyone interested in improving the health of city populations. Whilst obesity is not confined to city populations, cities are home to more than half of the world's population with concentrated groups at high risk of obesity [10]. Cities have long been at the forefront of social and technological change that has led to our current obesogenic environment [11]. Therefore, a focus on city level interventions brings the benefit of offering the ability to impact at scale on a significant number of the population that are disproportionately affected by obesity.

Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [12]. The following databases were searched in March 2019 by one of the authors (SD); Embase and Embase classic; Ovid Medline ® in process and other non-indexed citations and Ovide Medline ® 1946-present; Central (Cochrane Central Register for controlled trials); Scopus; Campbell Library; CINALH; Health Business Elite; Health Management Information .Consortium (HMIC); PyschINFO; Prospero (Centre for Reviews and Dissemination). No date limitations were applied. Specific and pre-determined search terms were developed, tested and finalised for each database. These are available in the supplementary file Appendix A. The inclusion criteria was; city-wide interventions that aimed to transform health or healthcare. The definition of transformation, for the purposes of this research, was purposefully broad and includes any aim to improve health outcomes or healthcare services. The study was registered with PROSPERO (CRD42020166210). The data extracted was then coded to the issue it was seeking to address. The data used in this manuscript was the subset of data coded as relating to addressing obesity.

The inclusion criteria for this obesity subset was; city-wide interventions which had the primary purpose of supporting a reduction in obesity. The key factor was the study needed to state the intention was to address obesity; all interventions were included irrespective of how ambitious there were; all study design were included; the primary outcome indicators that were sought and extracted were: reduction in obesity, reduction in weight and/or reduction in BMI. Where it was uncertain whether the interventions was city-wide they were included. Studies that were an evaluation of how obesity has changed over time, without any description of an intervention, were excluded. Only studies in English language were included.

Predetermined data fields were agreed prior to data extraction. These were; date of publication; type of publication; intervention; how the intervention was implemented; city; city population; country; continent; quantitative outcome; authors qualitative conclusion. We developed a template (excel) for data extraction and analysis. Where any of this data was not presented, it was coded as 'not stated'. Studies that did not name a specific city were still included as long as they indicated they were from a city. The authors carried out inductive thematic analysis in line with the guidelines of Braun and Clarke, [13] as it offered optimum flexibility and breadth. The source of study heterogeneity and necessary contextual information for interpreting the results have been highlighted through the document. The authors applied a modified thematic approach to this data to arrive at the composite of interventions. The reporting of this study conforms to the STROBE statement [14].

Role of the funding source

The was no funding associated with any element this study. The corresponding author had full access to all the data in the study. All authors had final responsibility for the decision to submit for publication and all authors approved the final version of the manuscript submitted for publication.

Results

The database search yielded 42,028 original citations after duplicates were removed through Endnote standard duplicate check. These electronic searches were augmented with an additional 109 citations found through expert recommendations or internet searches, giving a total of 42,137 original citations. These were assessed independently by SD and HLP[1] against the inclusion criteria stated in the methods section. The level of inter-reviewer agreement on the articles was on average 96% (range 91%–98%) and resulted in 1614 citations meeting the inclusion criteria. The title and abstract of these 1614 citations were assessed and coded to the issue the intervention was seeking to address, with 96 papers being coded as

[1] See Acknowledgements section at the end of this manuscript

seeking to address obesity and therefore included in this manuscript (Fig. 1).

The 96 citations, ranging in year of publication from 1997 to 2019, were conducted in 36 cities, with 13 citations either not stating a city or covering multiple cities, across 5 continents. The majority of the publications were from North America (59/96) with a high incidence from the USA (56/96) and New York City (23/96). Only one quarter of the identified studies (24/96) included one or more of the predefined outcome measures of: reduction in obesity, reduction in weight and/or reduction in BMI. Where the predefined outcome measure wasn't stated a secondary impact measure was sought and, where found, recorded. This secondary impact measure was any measure of impact provided in the article. There was heterogeneity of study design and reporting of impact, with a majority being descriptive texts using qualitative instruments of assessment. The full list of the 96 citations is available in the supplementary file Appendix B

Schools and child care settings

Interventions to address childhood obesity in schools and childcare settings provided the most citations (27 representing 28%). These included programmes of education and support for children, teachers, parents and caregivers on healthy eating and physical activity in a range of cities [15–31], restricting unhealthy food provision and advertising around schools [24,32,33] and increasing the provision of free healthy school meals [34]. Two cities, New York [35–43] and Singapore [44,45] report a breadth of interventions within schools and child care settings.

Marketing and nutritional information labelling

Two cities, Amsterdam [28] followed by London [46], implemented city-wide unhealthy food advertising bans on public transport. Amsterdam went a step further and also banned unhealthy food and drinks sponsorship of sports events where more than 25% of the audience are children [28]. Two cities, New York City [47] and Philadelphia [48] mandated calorie labelling at fast food restaurants. Stevenson, a very small city (population 1200) in the USA, selected a grocery store as the location for a nutrition and food label education booth on the weekends [49].

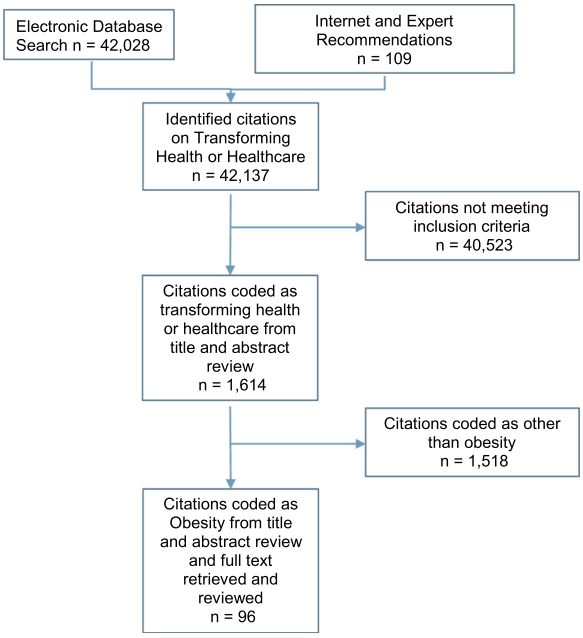


Fig. 1. PRISMA[12] Study Attrition Flow Chart.

Healthy food availability

Baltimore implemented a multi-level, multi component intervention to increase the availability and demand for healthier food, targeting low-income African American youth and their families [50–54]. Similarly, New York City implemented a number of interventions, from 2008 through to 2017, to improve healthy food availability and affordability. These included, mandatory nutritional standards for all food sold by city agencies (hospitals, prisons, aged care and health facilities) [55], providing zoning and financial incentives to heathy grocery stores in underserved communities [56] and launching 1000 mobile 'Green Cart' vendors selling only fruits and vegetables in more deprived neighbourhoods [57,58]. Philadelphia also targeted local stores with its 'Healthy Corner Store Initiative, a public–private initiative, to support corner stores operating in food deserts [59]. Three cities, New York City [24], Charleston [60], and Michigan [59] implemented interventions around farmers markets. Whilst Carson (USA), implemented a healthy vending policy [61].

Restaurants and food outlets

Los Angeles took firm action in 2008 by banning new fast-food establishments for one year [62]. London took a more targeted approach by restricting unhealthy food within 400 m 'super zones' around schools [63]. New York City tried – and failed – to limit restaurant portion sizes of most sugar sweetened beverages and restrict consumption of sugar drinks purchased through the federal Supplemental Nutrition Assistance Program (SNAP), with the State court overturning the regulation one day before it was to take effect [64,65]. San Marco took a voluntary partnership approach to change children's menus through removing sugar-sweetened beverages and increasing fruit and vegetable offerings [66]. Baltimore implemented an intervention which promoted heather options with significantly increased healthy food items sales [67,68].

Education and support programmes (including media campaigns)

Education and support programme interventions ranged from very targeted and limited to a proportionately small number of people from the city [69–75] with only Moose Jaw [69,70], Sydney [73], Rockingham and Geraldton [76] and a US city (name not stated) [74] reporting a direct impact on weight of participants. Other interventions were on a much wider scale, aiming to impact the whole population. These included, Singapore's creative campaign to draw parents' attention to their child's waistline which were placed all across Singapore [77], campaigns in New York City [78] and Philadelphia [79] to reduce sugar sweetened beverages. Liverpool [80] and Omaha [81] ran social marketing campaigns to challenge residents to lose weight and increase cycling, respectively. Fransen et al. [82] examined the Dutch cities of Nijmegen, Wijchen and Maasdriel and found there were numerous, ranging from 13 to 29, predominantly educational interventions in each city. The city of Oulu (Finland) introduced a cognitive behavioural based programme which was evaluated in a randomised clinical trial showing successful weight reduction [83]. The pioneer, in 1992, was the Dutch city of Alkmaar which lead on a community-based 'Fat Watch' campaign, which aimed for a 10% reduction in fat intake amongst the general population [84]. Cities have used their wider assets, such as professional sports teams, to promote and provide education and support programmes targeted at individuals who are overweight or have obesity [85–87].

Physical infrastructure to promote physical activity

Organisations in cities across Douglas County (Nebraska, USA) were supported to implement one or more policies to promote healthy eating or physical activity. In total, 952 individual policy changes, such as installing bike racks, were implemented [88]. Similarly, La Mesa (USA) made changes to the built environment to promote walking [24]. Somerville implemented community based environmental changes [89] with reported decreases in Body Mass Index (BMI) in males that were overweight or had obesity [89–91]. New York City [92] used legislation to change the way new buildings and renovations are designed, making stairways more visible and creating streetscapes. Indianapolis found that building recreation areas reduced the average weight of children from those areas [87]. Oklahoma City used the city's infrastructure development program to improve parks, sidewalks, trails, bike lanes, and sports facilities targeting neighbourhoods with high rates of heart disease [59,93]. In Atlanta Beltline (Georgia) they combined economic development with transportation planning and health to create new small businesses, housing, parks, and transit along 22 miles of repurposed trails [59]. Similarly, in Columbus (Ohio) they established 'Columbus Healthy Places (CHP)' to promote active travel through linking public health to urban planning [94]. Others looked to use the existing transport infrastructure. In Mexico City, motion sensors were installed in subway stations throughout the city and if commuters complete 10 squats they gained a free transport ticket [95]. In the Netherlands, a company called 'Wewatt' installs free bike riding stations that generate enough power to charge a phone [96]. These are available at stations and airports across the country and have since been replicated in France and Australia [96]. The Red Dear (Alberta) Primary Care Network invested in improving health not just treating ill health through working with the community and supporting ten outdoor gyms in city parks [97]. Other cities have temporarily changed the physical environment, such as, 'Play Streets' which is a popular intervention in many cities. It involves closing streets to traffic temporarily and opens up reclaimed space for children's play and physical activity [59].

Multi-component

Ten cities were identified that had taken a multicomponent approach. Multicomponent is defined as one or more interventions from two or more themes simultaneously. Each is worthy of a short description here. In Alexandria (Virginia (USA), a coordinated effort across school and pre-school facilities to increase active play; SNAP food stamps used at farmers' markets; starting gardens, gardening and nutrition clubs; and inter-agency agreement on healthy vending machines and breastfeeding promotion [98]. In Geelong (Victoria, Australia), their Healthy Together Geelong programme implemented a number of systemic changes to address determinants of health to improve people's lives where they live, learn, work and play. Healthy Together Geelong is one of 12 prevention areas under the Victorian State Government's Healthy Together Victoria initiative which is a $100 m cluster randomised trial of a novel, 'whole system' intervention [99]. 'The Healthy Auckland Together Programme' in Auckland (New Zealand) is a collation of 26 organisations which provides resources to support people living in Auckland to eat well, live physically active lives and maintain a healthy body weight [100]. Nizwa City (Oman) took a community based approach which included; training for teachers in physical activities, building of gymnasiums and pathways for communities and awareness campaigns [101]. These four city case studies did not report an outcome measure.

In Amsterdam, the Healthy Weight Programme took a comprehensive whole systems approach, from which they report to have achieved a reduction in children that are overweight or have obesity from 21% to 18.5% and the number of overweight children fell by 12% between 2012–2015 [28,102,103]. Anchorage (Alaska) achieved similarly impressive results with a 5.4% decline in the overweight and obesity rates amongst children from 2004 to 2014 (2.2% relative decrease) through a range of interventions across the childcare and school settings and community action plans [104]. In Cambridge (USA) a multidisciplinary team developed and implemented Healthy Living Cambridge Kids (HLCK), a comprehensive multicomponent intervention targeting community, school, family, and individuals to mobilize environmental and policy interventions. BMI and obesity reduced modesty [105]. Philadelphia launched 'Get Healthy Philly', an initiative to improve the city's nutrition, physical activity, and tobacco environments by making healthy choices easier for all Philadelphians [106]. They achieved a 6.5% reduction in childhood obesity rates for students and achieved a larger reduction amongst children of colour (African Americans and Asians) than whites – the only city in the US to have achieved this [107]. In Seinajoki (Finland) they adopted a health in all policies approach with interventions across various settings (maternity clinics, day care centres, primary schools and after school clubs and community clubs). This resulted in 1 in 10 five year olds being overweight or having obesity in 2015 compared to 1 in 6 in 2009 [108,109]. Finally, after decades of increases in obesity, New York City saw obesity decline 5.5% between 2006 and 07 to 2010–11, through a comprehensive programme of activities [110,111].

Discussion

This systematic review identified 96 original citations across seven themes. Schools and childcare settings had the most studies (27), with the remaining being distributed across; education and support (20); multi-component (17); healthy food availability (11); physical infrastructure (11); restaurants and food outlets (6) and; marketing and nutritional information (4).

Schools and childcare settings are ideal for interventions to address obesity in children. However, individual school-based interventions show mixed results. Only three studies [16,20,22] reported a positive impact on reducing BMI, obesity prevalence or mean weight reduction. All of these four studies had multiple reinforcing interventions within this setting (i.e. they were not a simple single intervention).

Interventions in schools to prevent and treat obesity are important. This is unsurprising given schools represent a contained setting where children spend one third of their day. However, single interventions of a time bound period have less limited impact compared to a coherent suite of interventions that are consistently and relentlessly pursued.

There is mounting evidence of the importance of 'first 1000 days [112–114] which is defined as conception to age two. Given this and the widely accepted importance this period has on broader child development, there was surprisingly little found in literature. Only Amsterdam, which screened for the risk of obesity in babies and provided intensive counselling for expectant mothers deemed to be at an elevated risk [28] took it to the very earliest opportunity to intervene. Others, such as Leeds (UK), [29] Seinajoki (Finland) [108], Geelong (Australia) [22], had a focus on early childhood.

People living in cities have numerous constraints to the maintenance of a healthy diet, including proximity to food sources and lack of various healthy foods in local food stores [68]. When it comes to food we are anything but fully autonomous; we are heavily influenced in what we eat by our food environment and our context [65,115]; this is particularly true for children [87,116]. It is well established that richer people have healthier diets than poorer people [6]. It is therefore understandable that cities are trying numerous interventions to improve access to healthy food for poorer communities. Whilst the interventions showed some positive results at ameliorating healthy food availability, this alone didn't show an impact on

obesity. Indeed, a study found that making the same healthy food available to poorer communities that are available to wealthier communities only addresses 10% of the issue [117]. The real issue – and solution – is that the poor need more money. So, whilst interventions to improve availability of healthy food are admirable, and in part beneficial, we should not lose sight of addressing the real issue – reducing poverty.

Results and impacts from the education and support interventions were variable. Leveraging existing assets [85–87] and developing a support network for the individual [69,70,80] appear to contribute to more positive impacts on reducing obesity. Whilst it is important to educate individuals to eat more healthily and do more exercise, the evidence would suggest solely educating or telling is not enough. What comes through as an important factor for success is involving parents (in relation to children with obesity) and peer groups generally [118] – there must be multiple reinforcing and supportive messages. Healthcare professionals, particularly family doctors, are well placed to deliver effective lifestyle interventions with high-risk patients, discussing weight loss strategies and providing referrals to weight management programmes [119,120].

Physical inactivity is also a key component to increased obesity. Changes in the structure and ability for active travel in cities and our work and home environments have led to declining rates of daily energy expenditure [121]. A report by the Children's Commissioner for England [122] identifies that children today are the least active ever, in part because the area around a home where children can play unsupervised has shrunk by 90% since the 1970s. Busy lives, busy roads, fewer communal spaces — all of these things are making activity something that needs to be 'planned, scheduled, supervised and often paid for' [122].

Cities are increasingly using multi-component programmes. Fitzgerald [123] examined residents perspectives using photographs and found participants spontaneously articulated the need for a multi-component and multi-level approach [123]. This approach shows the strongest impact on outcomes. It is however not a quick fix; Amsterdam and Anchorage – both of whom now show impressive results – have had multi-component programmes of work for over 5 years.

A number of multi-component programmes were Mayoral led [10,24,91,92,124]. Two of the most striking were Oklahoma and New York City. In Oklahoma City, Mayor Mick Cornett stood before the elephant cage at the zoo and challenged residents to lose one million pounds – it took them five years but they duly did it – whilst reportedly generating a culture shift towards healthier lifestyles and revitalising the economy [59,93]. Whilst in New York City, the city Health Commissioner credited their achievement to the multi-component approach taken [125,126] and decisive mayoral leadership [127]. The approach of having mutually supporting interventions at numerous levels is supported by other studies [121,128]. A number of authors [28,82,124] reference the EPODE approach. Ensemble Prévenons l'Obésité Des Enfants (EPODE) originated in France but has been implemented in more than 500 communities across different countries, it stress the importance of action at all levels and the prominent role of Mayors [129]. Mayors have a unique position to convene, champion and challenge stakeholders around a shared city-wide vision and action to reduce obesity.

If the ambition is to reduce obesity at a city population level then individual interventions whether it be in schools, an education programme or any other single area are simply not enough. The obesity epidemic is a result of the environment in which we live, which has been created by policies spanning building regulations to food quality standards to transport. The issue of systemic policy factors driving increases in obesity [130] will only be addressed by systemic policy action to reduce obesity. Again, Mayors, with their powers and access to the policy levers spanning areas such as planning and public transport, will be key. Therefore, in addition to their role in providing leadership, they must role model and take direct action on policy interventions to reduce obesity. In addition, the link between the drivers of and actions to address obesity and climate change have been known for a number of years [131] and building on this and more recently, Swinburn et al. [132] describe the interconnected nature of food security (including obesity) and climate change, which they call a 'Global Syndemic'.

This study has several limitations. Firstly, although it is a comprehensive systematic review it is likely it has only shown a snapshot of what cities are doing to address obesity. This is because of the limited nature of the information available and publication bias towards interventions that have a demonstrable impact. Notwithstanding this, only a quarter (24/96) of the included studies reported an impact on obesity, weight or BMI. Secondly, only publications in English language were included and the process of initial article selection was performed by just one author. This will negatively impact the comprehensiveness of the results but also bring in bias towards missing interventions with poor or negative results that may be published in local language journals. Thirdly, due to the variation in study designs, reporting types, and variation in intervention types and number (single intervention versus multiply interventions at multiple levels), along with the majority of results deriving from simple descriptive texts; we did not carry out any formal quality assessment. This limits the confidence on the relative impact of different interventions and ultimately our recommendations. Finally, almost a quarter of the studies came from New York City which will bring in bias. However, the purpose of this research was to develop a composite model of interventions, based on evidence, that cities could follow and further test. The authors are content it has served this purpose. In respect of the generalisability of the composite model of interventions to address obesity in cities (Fig. 2 below), it needs to acknowledge the important role that context has for the success or failure of a particular intervention. Context can be the prevailing political context, the legal context or precedents, the fiscal or economic context, the social context and vested interests. Entrenched health challenges cannot be addressed through simple, single, generic solutions, they require multiple context relevant interventions [133] This study did not specifically set out to study the impact of leadership of Mayors; this would be an interesting area of future study.

Obesity is a global epidemic. There is emerging academic consensus that obesity is a complex problem that requires a multi-component and multidisciplinary approach. However, for the most part action in cities has been at best piecemeal. Multi-level, multi-component interventions in concert are needed due to the multi-factorial nature of obesity and its proven links to both the social and built environment. This could be describe this as a composite approach.

The interventions to address obesity do not provide quick fixes and there is a need for sustained and a relentless focus. This is the bad news. However, there is good news. The diagnosis of obesity is not difficult and whilst the issue is complex the solutions are not complicated – they are very simple – and there is evidence from cities across the world that they work. Furthermore, action taken to address obesity will also be good for the environment. For example, active travel increases physical exercise and reduces air pollution from cars. Improved diet reduces processed foods and increases natural plant-based diet. Water availability to fill bottles reduces the use of single use plastic bottles. Personal health and planetary health are intimately and inextricably intertwined.

The objective of this research was to connect academic research with policy interventions to aid the real world. Based on this academic review, the authors debated the necessary interventions to reduce obesity and produced the following '*composite model of interventions to address obesity in cities*'. The interventions are a combination of educational, fiscal, regulatory and environmental approaches. They are across a range of settings and are set against five aspirational areas. It is important to acknowledge that it is not the case of

1. Eliminate Child Poverty
    a. Interventions to increase employment and, depending on city context, equally importantly reduce in-employment poverty (through policies such as city-wide minimum wage policies for example).
    b. Improve any existing food voucher schemes, for example SNAP in the United States, so that it incentivises healthy food and disincentivises unhealthy food.

2. Invest in the first 1000 days (from conception) to prevent obesity in children
    a. Culturally tailored healthy nutrition and exercise and obesity information to all expectant mothers.
    b. Screening of babies and infants for risk of obesity; intensive support for expectant mothers deemed to be at high risk.
    c. Benchmark and increase rates of breastfeeding, local government owned or licensed (for example transport system, libraries, high street cafes) to be required to allow / promote breastfeeding.

3. Make the healthy choice the easy choice
    a. Remove or reduce marketing and placement (availability) of HFSS (high fat, sugar and salt foods).
        i. Ban HFSS marketing on public transport, community/government owned or licenses buildings and events (e.g. sporting fixtures and concerts).
        ii. Restrict media and marketing of HFSS targeted at children.
        iii. Instigate a social media and behaviour change campaign which does not normalise obesity but equally does not stigmatise individuals with obesity. Making the links between obesity and the environment (personal and planetary) health.
    b. Make (free) water the drink of choice. Increase access to water by:
        i. Installing water fountains across the city and/or requiring high street cafes (and others) to top up water bottles free of charge
    c. Work with local business, shops, supermarkets and schools to transform the food environment
        i. Restrict HFSS fast food shops around schools
        ii. Manage portion sizes (restrict where possible – i.e. in schools) by standardised school plate and portion size
        iii. Work with food providers to reformulate foods to reduce fat, sugar and salt. Driven by a levy / tax (e.g. sugar tax plus)
        iv. Work with shops, supermarkets and others to remove products in 'impulse buy areas' e.g., checkout queues or in/around transport hubs / intersections and increase the amount and placement of healthy food (incentives through reduced tax). For example; fruit (instead of chocolate and crisps) at tube / metro stations
    d. Create safe and active streets
        i. Restrict traffic around schools during morning and afternoon start and finish times
        ii. In all planning considerations, prioritise firstly; play, pedestrians, cyclists/scooters, public transport, electric vehicles and finally cars and lorries. Physical infrastructure to enable and promote children being active should be part of all planning decisions. This will also improve air quality and asthma and reduce carbon emissions.
    e. Involve families and peers in the interventions to create multiple supporting and reinforcing networks

4. Create Healthy Schools and Child Care Settings
    a. All settings to be HFSS free. The link with the environment could be extended here and all settings could also become single use plastic free too.

Fig. 2. Composite Model of Interventions to Address Obesity in Cities.

b. Provide training for all existing and future education and childcare professions, including but not restricted to teachers and assistants, on healthy lifestyle and obesity and training in offering very brief advice related to obesity.
c. Increase physical activity of children, through interventions such as the 'daily mile'. Education regulators, for example OFSTED in England, to include provision of water and healthy school meals and exercise as integral part of their assessment. Only schools meeting this broader assessment criteria can achieve overall 'outstanding' status.
d. Fully utilise the built assets of schools; for example playgrounds as farmers' markets at weekends and halls for affordable community exercise classes
e. Instigate child measurement programme (or improve if existing);
    i. Annual childhood measurement across all schools
    ii. Children who are overweight or have obesity to be given supported action plan
f. Target support for schools and communities with high rate of children who are overweight or with obesity.

If the above are the ingredients or the 'what' of requirements, then the following can be learnt from other cities in terms of the 'how':

5. Maximise the cities' unique assets
Cities are, typically, seen as a coherent place based 'unit of transformation' that are linked by a Mayor and governance, single public transport infrastructure and public services, leading academic and research units, a diverse and transient population and are home to a range of arts, sports and culture. All of these assets should be utilised in the fight against obesity. The list below identifies what appear to be the critically important approaches to using these assets:
    a. Active support and leadership from the Mayor (or very senior politician) and clinical/public health leaders. Because of the multi-component and multi-disciplinary requirement – political leadership is essential.
    b. Co-create, with the public and a broad range of stakeholders, a shared vision for the health of the city. Around which, specific statements and ambitions are made, for example 'By 20XX we will have reduced child poverty by xx%'
    c. Engage and utilise the full breadth of the cities assets, including; transport infrastructure, professional and amateur sports clubs, creative industries such as media and the arts and the commercial sector.
    d. Sustained effort and resources, along with a relentless focus, are required over a number of years to make a significant impact on reducing obesity.

These composite of interventions need to be considered in the local city and national context.

Fig. 2 Continued.

simply choosing one or two interventions. The solution to decreasing obesity is multiple reinforcing interventions.

Declaration of Competing Interest

The authors declare there is no conflict of interest.

Contributors

SD and HA conceived the idea for the study. SD performed the data extraction and synthesis with input from TC, HA and AD. SD wrote the first draft of the manuscript and all authors made substantial contributions. All authors contributed to the study design, interpretation of findings, and critical revision of the manuscript. All authors approved the final version of the manuscript for submission.

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Data sharing statement

The authors declare that the data collected was gathered from publicly available studies and is available upon reasonable request. Request should be made to the corresponding author.

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Supplementary materials

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