

Obesogenic Environments: the built and food environments current evidence.

Abstract

INTRODUCTION

Ten years ago, the concept of obesogenic environments was relatively new and brought together evidence that linked the built and food environments in novel ways ^{1,2}. In the interim period, research exploring how aspects of the built environment may contribute to current obesity levels - by influencing physical activity and dietary behaviours at individual and community level - has burgeoned. However, as frequently stated, while the basic drivers of obesity are simple (more energy consumed than expended) the aetiology is multifactorial and complex ³. Therefore, establishing causal pathways is difficult. Moreover, the plethora of approaches, methods, metrics and environmental variables that have been employed in studies makes cross comparison and the search for definitive evidence difficult ⁴.

In the meantime, the problem of obesity shows no signs of abating, and globally, has doubled since 1980 ⁵. Latest figures suggest, by 2030, 48% of adult men and 43% of adult women in England will be obese ⁶. While rates of childhood obesity in England appear to have stabilised, over a third of children are currently overweight or obese ⁷. Obesity also has a strong socio-economic profile and disproportionately affects the lives of poorer groups in society, thereby contributing to growing health inequalities at all levels ⁸.

This paper will briefly outline current key themes relating to the influences of the built environment on physical activity and dietary behaviours. It explores themes of significance to the UK and highlights work on children and adolescents, since lifestyles set in this age group tend to track through to adulthood (as do overweight and obesity). It further focusses on the complexities of translating this knowledge into policies and suggests directions for future policy.

Methods

This paper is based on literature extracted from key-word searching of electronic databases. The databases used were Medline, SCOPUS and Web of Science. The data bases cover medical and social sciences plus humanities to reflect the interdisciplinary nature of obesogenic environment research. In addition a selection of journals known to carry papers on obesogenic environment were hand searched for completeness. A timeframe of 2006 to 2016 was used.

Built Environment and Physical Activity

The premise that physical design, land-use patterns and transportation systems may influence an individual's propensity to have an active lifestyle remains strong. Intuitively, neighbourhoods providing a range of local facilities within easy active travel (walking and cycling) distance, with good quality infrastructure (such as well-maintained pavements), which are regarded as safe and pleasant, in theory, should support physical activity. These type of environments are often referred to as 'walkable neighbourhoods' in academic literature; though supporting walking is only one element of physical activity.

Which aspects of walkable neighbourhoods might be more influential than others in encouraging active lifestyles, and therefore demand more focus and resource allocation, has been open to debate ¹⁰. Adams *et al.* studied combinations of neighbourhood attributes and devised five neighbourhood typologies, which they then examined in 11 countries. They concluded that four walkability attributes – access to shops and services, high residential densities, sidewalks, and transit

(public transport) stops – were associated with residents meeting physical activity guidelines. However, neighbourhoods that were ‘activity supportive’, with local recreational facilities, cycling infrastructure and so on, promoted the highest levels of physical activity¹¹. A study of 12 countries that correlated neighbourhood environments and walking, furthermore suggested significant factors were perceived residential density; land-use mix; street connectivity; aesthetics and safety; and walking for transport¹². Perceived safety from traffic and close proximity to local destinations have been associated with lower BMI, with an assumption that walking for transport was the mediator¹³.

The influence of greenspaces, such as urban parks, has also been a focus of interest. Early studies produced encouraging results, associating high quality parks near home with people being more active during recreational periods^{14,15}. In one study, parks were associated with recreational walking at levels that deliver health benefits¹⁶. Overall, however, studies associating greenspaces and physical activity have produced contradictory results. In some reviews, for example, park accessibility has been associated with use and physical activity¹⁷⁻¹⁹ and inversely associated with BMI^{20,21}. However, others have suggested weak or null associations^{22,23}. This is not necessarily surprising. A systematic review of obesogenic environment papers included seven studies, associating physical activity and greenspace, but none of the papers used the same definition of this metric⁴. The review provides a good example of the problem of the multiple approaches, metrics, and definitions employed in obesogenic environment research since its inception²⁴.

An area of research showing progress over the past decade is the consideration of the multiple environments in which individuals spend their lives. Many early obesogenic environment studies used a single administrative boundary (or specified ‘buffer’) around an individual’s home as a proxy measure of their home neighbourhood. However, this rarely reflects objectively measured, or perceived, reality²⁶. Moreover, while behaviour is moderated by home location, for many adults a large proportion of any physical activity is undertaken away from the home neighbourhood²⁷. Therefore, studies focusing on home neighbourhood are unlikely to capture an accurate picture of the influence of the built environment particularly in adult groups. Research has suggested that children and young people are also more mobile than often assumed^{28,29}.

Active travel (walking and cycling) to school is another area where debate has progressed in recent years. Here, research has emphasised that promoting and maintaining active travel to school is significant in incorporating physical activity in young people’s lives^{30,31}. Moreover, recent research has demonstrated that maintaining active travel through adolescence is associated with reduced BMI scores in young men³². Key environmental predictors of active travel are distance to school and parental perceptions of road safety and the inconvenience of using a car³³. Threshold distances of 1.4km for 10 years olds increasing to 3km for 14 year olds have been established³⁴ and recent work reiterates that children avoid busy roads. However, the impact of other factors, such as greener and more pleasant environments, are still debated³⁵. Further research is clearly needed.

Food Environments

Food environments encompass both food prepared and consumed at home, and out of home sources. These include vending machines, takeaways, cafes, restaurants, supermarkets and convenience stores³⁶. The influence of food environments on dietary intake and adiposity is a research area that has also increased over the past decade, but again, with contradictory evidence. In a systematic review of 38 studies (most assessing the consumption of specific foods, such as fruit or vegetables), moderate evidence was found to support an association between neighbourhood food environments, consumption and/or health³⁷; though evidence between fast food availability

and diet was found to be equivocal. However, there is evidence that outlets selling fast food have clustered in areas of deprivation in the UK ³⁸.

Recent studies have also found associations between fast food outlet density and weight in children/adolescents ^{39, 40}. An England-wide study, covering both heterogeneous socio-demographics and food environments established that the density of fast food and other unhealthy food outlets in neighbourhoods, is linked to higher levels of children who are overweight or obese (while the opposite is true for food outlets selling a range of healthy food); and that association is stronger in older children ⁴¹. Research also suggests an association between higher percentage sales of unhealthy foods at local supermarkets and the prevalence of overweight and obese children among Reception (4-5 year old) and Year 6 (10-11 year old) children ⁴².

Overall, food prepared out of home tends to be less healthful than food prepared in the home and is associated with fat intake and body fatness ⁴³. Eating food prepared out of home is a growing trend and makes a substantial contribution to dietary intake ^{44, 45}. A UK-wide study revealed that a quarter of adults and a fifth of children ate out once a week or more, and a fifth of adults and children ate takeaway meals at least once a week. Rates were highest for children in less affluent households and rates peaked for adults under 30. The research concluded that interventions aimed at reducing out-of-home consumption might be usefully targeted at under 30s, including children and adolescents, to prevent frequent consumption of out-of-home food ⁴⁶. In-depth research with older adolescents highlighted that food is regularly consumed outside of the home, particularly from takeaways, fast food outlets, and education establishments ⁴⁷. However, qualitative work with this age-group suggests that there are complexities attached to where food is purchased and consumed ⁴⁸.

A study exploring the multiple environments of home, work, and commuting and takeaway food access in the UK, found those with greatest overall access were nearly twice as likely to be obese compared to those with least access ⁴⁹. Further work sought to explore how educational attainment (used as an indicator of socio-economic status (SES)) might modify these observations. In this follow up research, while exposure to fast food outlets was associated with consumption and weight across all education groups, there was an exaggerated impact on the least educated. Lower SES groups consumed more fast food, tended to have higher body weights, and were more likely to be obese ⁵⁰.

Given that food prepared out of home remains a key concern, understanding the effectiveness of interventions to make takeaway, delivered, or eat-in foods more healthy has been highlighted ⁵¹. A systematic mapping and evidence synthesis of promoting healthy ready-to-eat meals highlighted that, while there has been take up, particularly where proprietors are positive and approaches are cost neutral, there is little evidence thus far on the effectiveness of these approaches⁵².

Considering Both PA and Food Environments

Though the research base has burgeoned, exploring environmental influences on both physical activity and diet within the same study remains relatively rare, though international examples exist ⁵³ and a number of themes have been highlighted. For example, an Australian study highlighted that high stress levels found in socially disadvantaged neighbourhoods were associated with poor weight management, less physical activity during leisure time, and frequent fast food consumption in women ⁵⁴. In the UK, a study of neighbourhoods with high concentrations of ethnic minorities found a mixed picture of food and physical activity environments. For example, a higher proportion of ethnic minorities lived in deprived areas, fast food outlets were higher, and outdoor recreation opportunities locally scarcer. However, supermarkets and numbers of indoor facilities were higher

for some groups. The study concluded these might contribute to ethnic difference in food choices and engagement in physical activity⁵⁵.

US studies of children and adolescents have correlated access to leisure facilities with physical activity, healthy weight, and diet^{56,57}. A French study similarly found that where access to physical activity facilities and general food outlets was low there was a higher risk of children being overweight, but only for lower socio-economic groups and the relationship did not hold true for more affluent children. In the UK, a detailed study of two parks and their peripheral environment, suggested that the quality of park provision and the healthfulness of surrounding food environments favoured the more affluent area⁵⁸. These studies support the concept of 'deprivation amplification'. In other words, poorer neighbourhoods often encompass aspects harmful to health, lacking the healthful resources found in wealthier areas. However, an earlier study of neighbourhoods in Leeds found high levels of obesity prevalent in both poorer and more affluent areas, though, the obesogenic covariates varied widely between the areas studied⁵⁹.

Taking a different slant, evidence suggests physical activity and healthy food environments can come together naturally. Garden allotments and community gardens are an example. Growing vegetables has been linked directly to improved diet⁶⁰⁻⁶², gardening has been demonstrated to provide beneficial physical exercise for adults⁶³, and allotments provide a safe place for children's outdoor recreation⁶⁴. Gardening has shown to improve mental health, by reducing tension, depression and stress^{65, 66 67 63}, which is important, since the role of stress in relation to poor weight management is increasingly highlighted⁶⁸. Evaluations have demonstrated the effectiveness of allotment gardening as occupational therapy for recovery from a wide range of injuries, diseases, disorders and conditions^{69, 70}. However, inclusion in programmes tackling obesity are rare and more evidence is urgently needed, not least because the number of allotments nationally have decreased dramatically due to the value of land and competing land uses.

Reuniting Planning with Health

A key change over the past five years with a notable impact on policy development has been the move to reunite town planning and public health in the UK. This has happened slightly differently in devolved parts of the UK, but in England, for example, it was principally spurred on by two changes. The National Planning Policy Framework (NPPF) 2012 was the first national planning policy to specifically mention 'healthy communities' as a key aim⁷², and the Health and Care Act 2012 transferred responsibility for public health to upper tier local authorities (in other words, the same bodies mainly responsible for planning). This has enabled the possibility of closer working of the two professions through mechanisms such as 'health and wellbeing boards'. It must be recognised, however, that bringing together two professions with very different knowledge bases, institutional settings, and legislative and policy frameworks is not straightforward, and progress has varied between different authorities.

There are however current mechanisms and instruments to integrate health into planning, particularly different types of impact assessments (IA). For example Strategic Environmental Assessments (SEAs) and Environmental Impact Assessment (EIA) are currently required under European Directives for certain plans and project and consideration for health is a key requirement. Though not a statutory instrument, Health Impact Assessments (HIA) can also be applied to a wide range of policies and projects. HIAs provide an opportunity for health evidence to filter through the planning process, in effect mainstreaming it through planning policy hooks⁷³. HIAs may be particularly effective when used in conjunction with SEA/EIA.

Some local authorities have also been developing planning policies with health colleagues to specifically address health issues, even before the NPPF. Policies to address the proliferation of hot food outlets are the key example (mostly through Supplementary Planning Documents)^a. London Borough of Barking and Dagenham's 'Saturation Point' policy, is a good example⁷⁴. This guidance recommends exclusion zones for new takeaways within a 400m 'buffer zone' around a primary or secondary school and restricts outlet clustering. Where hot food takeaways are deemed appropriate, a £1,000 levy is charged for obesity amelioration initiatives. Since adoption, the policy has had some success.

Nationally there is a mixed picture. Generally, local authorities with similar hot food SPD policies report successes, but there are many interrelated problems. For example, many premises not defined as takeaways in planning terms^b - such as corner shops – also sell energy-dense snack foods and some outlets defined as 'sit down restaurants' also primarily sell unhealthy food. A further complexity is that many local shopping streets in poorer areas are already a 'toxic' mix of takeaways and other unhealthy businesses (payday loan, betting shops, and so on). The supplementary impact of issues such as depression, due to indebtedness, or addictive behaviours associated with gambling on obesity levels in poorer communities, encouraged by the access and availability of these shops and services, is yet to be unravelled; but again research is urgently needed⁷⁵.

In terms of planning policies to encourage physical activity, again, more development is needed. As already stated, international research has suggested that, of all built environment influence, access to shops and services, high residential densities, sidewalks, and transit stops may be the most fundamental in supporting physical activity. However, in the UK, provision of pavements (sidewalks) is already universal, and most urban housing is above a threshold for density that is influential⁷⁶. Planners encourage the provision of local shops and services and access to public transport in substantial new housing developments, however these do not always prove viable. Where metrics-driven planning policies around land use mix, diversity have been developed in Australia there is some evidence to show that these policies increase local walking, but the applicability of these to the UK has yet to be seriously considered.

Discussion

While the evidence base around the influence of the built environment has increased significantly over the past decade, there are clearly still gaps in knowledge. The use of varying measures, definitions and approaches and the continual strive to be novel is unhelpful. However, it might be argued that there are strong indications around where change is needed.

Debates around greenspace proximity and physical activity demonstrate the problem of multiple metrics and approaches. However, these also demonstrates a broader issue, for it might reasonably be argued that the health argument for the provision of adequate greenspace has already been clearly established. A number of strands of academic literature have been brought together, demonstrating the healthful nature of greenspaces⁷⁷. These highlight that exposure to greenspaces have beneficial effects on mental health, reducing stress and aiding restoration and providing places for much needed leisure time; and social health by increasing socialisation and social well-being among communities – all factors that in their own way have relationships to obesity. Therefore, establishing whether there is a direct pathway between greenspace, physical activity and obesity at

^a A Supplementary Planning Document (SPD) forms part of the Councils Local Development Framework (LDF) – the plans for their local area. SPDs must be taken into account when deciding planning permissions.

^b Hot food takeaway establishments have a special planning land-use category – 'A5'

the neighbourhood level, is less important than examining greenspace quality and which types of provision may promote optimum all round health and well-being.

The importance of the journey to school has been highlighted from both PA and food environment perspectives. The introduction of restrictive planning policies around fast food outlets around schools is an interesting development and demonstrates encouraging cooperation between public health and planning. However, policies have not always been successfully applied, and furthermore there is some evidence of the overturning of planning refusals for outlets by the national Planning Inspectorate; this is cause for concern warranting further investigation. There is also a need to fully understand the proactive interventions that can be taken through the planning system to encourage and maintain active travel to school, but these are still somewhat unclear.

Studies are beginning to capture the multiple environments that people spend their time in. The greater use of increasingly available, reliable and user friendly technology (GPS, accelerometry and so on) will undoubtedly aid this. However currently, technology does not always represent reality. For example one study suggested that modelling underestimated walking route length by 21%, but over-estimated food outlet exposure by 25% ⁷⁸. A systematic review of GPS technology (six studies - five from US and one in the UK) found that while use of technology was in its infancy, being able to record and analyse patterns of mobility, is of huge value⁷⁹. However, two issues are apparent. The use of new technologies unfortunately may only increase the diversity of methods and metrics that has plagued obesogenic environment research from its inception. Furthermore, human perception must not be overlooked in the rush for more measurement. Research has shown that perception is a mediator between objectively measured exposure and interaction. Studies combining both measures are therefore preferable, but are still rare.

Another important theme relates to obesity impacting the poorest in society at higher levels than the more affluent; the reasons for this are not always clear. Some studies of the built environment appear to support the concept of deprivation amplification, but not all. Burgoine's observations, that the less educated seem to have an exaggerated impact from exposure to fast food outlets, may begin to provide an explanation⁵⁰; and this line of enquiry might be usefully applied to PA too. Overall the links between PA, food access, built environment and deprivation require more research. However, the opportunities that the built environment provides for healthy food access and exercise, for example the provision of community gardens, allotments and so on, and the impact these may have on overweight and obesity also deserve more examination.

While the evidence base is, therefore, imperfect and there are many gaps in the knowledge, it may also be argued that there is certainly enough to act on now. The opportunity for planners and health professionals to work together provides a crucial step forward towards the 'whole systems approaches' to tackle obesity that are called for by the Foresight report⁸¹. However, progress towards this goal seems slow. One problem is the level of inertia in both policy and practice pertaining to the built environment. Planners already juggle a huge number of competing interests and are often under pressure to meet decision-making targets. A convincing argument about why health should be prioritised in the planning system, therefore needs to be made. Aligning health with current sustainability priorities is one way. For example creating health supportive environments that improve active travel levels, would also diminish the production of harmful greenhouse gases, reduce particulate pollution from lower traffic levels, decrease pedestrian and cyclist accidents and deaths, and in turn help reduce the huge financial burden of treating obesity-related disease on the NHS, to summarise a few significant issues. However, importantly, rather than setting 'health' up as yet another 'goal' of planning to compete against issues of sustainability,

economic regeneration and on, more importantly health and well-being should be embedded as the 'golden thread' that runs through all built environment policy.

Furthermore and in relation to the development industry, the argument about the marketability of 'healthy development', also needs to be made. Again evidence already exists to support the argument that developers can charge a premium for developments with stronger place identity, adding in health supportive elements such as quality greenspace and landscaping is a key element of this. This message needs to be more forcibly made to the development industry, though here there is also a role here for planning to ensure these do not become the domain of a privileged minority. There is, therefore, a key role for training and education build environmental professionals with regard to these goals, but this will take time to feed through. More immediately public health professionals need to be somewhat tenacious in their approaches to influence decisions around the built environment.

Conclusion

In the UK the burden of obesity contributes to increasing health inequality, individuals' lives are severely impacted and rates are still rising, placing health care systems under huge strain. While there is an imperfect evidence base relating to the role of the built environment in the obesity crisis, planning and health professionals must work together and take action now where current evidence suggests changing policy and practice could be effective.

There are areas for immediate action. Firstly a wider more consistent use of HIA would allow for more cooperation between health and planning colleagues in local authorities, for example improving the translation of public health evidence (often collated at population level) to the local context to help deliver environments that support increased physical activity and improved mental wellbeing. Moreover a thorough review of hot food takeaway guidance and policy is needed to understand where it has been most effectively applied and why local decisions have not always been upheld in the appeal process. This will improve the quality and robustness of policy in the future, not just in relation to fast food, but to other areas where planning policy is needed to support healthier lifestyle choices. Mechanisms to enable the two professions to work together more effectively need immediate attention, as well as the sharing of good practice, while longer terms the training and education of both professions should facilitate inter-disciplinary cooperation and understanding.

The alignment of health concerns and planning will not happen overnight and linking them only addresses a certain part of the obesity systems map. However given the generally enduring nature of the built environment - its impact will be usually be spread over several generations - the importance of this cannot be overestimated.

References

1. Lake A and Townshend T. Obesogenic environments: exploring the built and food environments. *The Journal of the Royal Society for the Promotion of Health*. 2006; 126: 262 - 7.
2. Lake AA, Townshend TG and Alvanides A. *Obesogenic Environments: complexities, perceptions and objective measures*. Oxford: Wiley-Blackwell, 2010.
3. Foresight. Trends and drivers of obesity: A literature review for the Foresight project on obesity. 2007.
4. Mackenbach JD, Rutter H, Compermolle S, et al. Obesogenic environments: a systematic review of the association between the physical environment and adult wieght status, the SPOTLIGHT project. *BMC Public Health*. 2014; 14.

5. WHO. Obesity and Overweight: Fact sheet no. 311. WHO, 2015.
6. hscic. Statistics on Obesity, Physical Activity and Diet. Health and Social Care Information Centre (hscic), 2015.
7. van Jaarsveld CHM and Gulliford MC. Childhood obesity trends from primary care electronic health records in England between 1994 and 2013: population-based cohort study. *Archives of Disease in Childhood*. 2015; 100: 214-9.
8. Marmot M. Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England post 2010. 2010.
9. Van Holle V, Deforche B, Van Cauwenberg J, et al. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *Bmc Public Health*. 2012; 12.
10. Ding D and Gebel K. Built environment, physical activity, and obesity: what have we learned from reviewing the literature? *Health Place*. 2012; 18.
11. Adams MA, Ding D, Sallis JF, et al. Patterns of neighborhood environment attributes related to physical activity across 11 countries: a latent class analysis. *International Journal of Behavioral Nutrition and Physical Activity*. 2013; 10.
12. Kerr J, Emond JA, Badland H, et al. Perceived Neighborhood Environmental Attributes Associated with Walking and Cycling for Transport among Adult Residents of 17 Cities in 12 Countries: The IPEN Study. *Environmental Health Perspectives*. 2016; 124: 290-8.
13. De Bourdeaudhuij I, Van Dyck D, Salvo D, et al. International study of perceived neighbourhood environmental attributes and Body Mass Index: IPEN Adult study in 12 countries. *International Journal of Behavioral Nutrition and Physical Activity*. 2015; 12.
14. Giles-Corti B, Broomhall MH, Knuijan M, et al. Increasing walking: How important is distance to, attractiveness and size of public open space? *American Journal of Preventive Medicine*. 2005; 28: 169-76.
15. Giles-Corti B and Donovan RJ. The relative influence of individual, social and physical environmental determinants of physical activity. *Social Science and Medicine*. 2002; 54: 1793-812.
16. Sugiyama T, Francis J, Middleton NJ, Owen N and Giles-Corti B. Associations between recreational walking and attractiveness, size and proximity of neighbourhood open spaces. *American Journal of Public Health*. 2010; 100: 1752-7.
17. Limstrand T. Environmental characteristics relevant to young people's use of sports facilities: a review *Scandinavian Journal of Medicine and Science in Sports*. 2008; 18: 275-87.
18. de Vet E, de Ridder DTD and de Wit JDF. Environmental correlates of physical activity and dietary behaviours among young people: a systematic review of reviews *Obesity Reviews*. 2011; 12: e130-e42.
19. McCormack GR, Rock M, Toohey AM and Hignell D. Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health and Place*. 2010; 16 712-26.
20. Pate RR, O'Neill JR, Liese AD, et al. Factors associated with excess fatness in children and adolescents: a review of prospective studies. *Obesity Reviews*. 2013; 14: 645-58.
21. Casey R, Oppert J-M, Weber C, et al. Determinants of childhood obesity: What can we learn from built environment studies?'. *Food Quality and Preference*,. 2014; 31: 164=72.
22. Lachowycz K and Jones AP. Greenspace and obesity: a systematic review of the evidence. *Obesity Reviews*. 2011; 12: e183-e9.
23. Ding D, Sallis JF, Kerr J, Lee S and Rosenberg DE. Neighborhood Environment and Physical Activity Among Youth: A Review'. *American Journal of Preventive Medicine*. 2011; 41: 442-55.
24. Burgoine T, Alvanides S and Lake AA. Creating 'obesogenic realities'; do our methodological choices make a difference when measuring the food environment? *International Journal of Health Geographics* 2013; 12: 33.

25. Saelens B, Sallis JF, Frank LD, Cain KL, Conway TL and Chapman JE. Neighborhood environment an dpsychosocial correlates of adults' physical activity. *Medical Science and Sports Exercise*. 2012; 44: 637-46.
26. Townshend TG. Walkable Neighbourhoods Principles, Measures, and Health Impacts. In: Cooper R, Burton E and Cooper CI, (eds.). *Wellbeing and the Environment: Wellbeing: A Complete Reference Guide, volume II*. Chichester: John Wiley & Sons, , 2014.
27. Hillsdon M, Coombes E, Griew P and Jones A. An assessment of the relvenace of the home neighbourhood for understanding environmental influences on physical activity: how far from home do people roam. *International Journal of Behavioral Nutrition and Physical Activity*. 2015; 12.
28. Lake AA and Townshend TG. Exploring the built environment, physical activity and related behaviours of young people attending school, college and those not in employment. *Journal of Public Health*. 2013; 35: 57-66.
29. Jones AP, van Slujs EWF, Ness AR, Haynes R. and Riddoch CJ. Physical activity in children does how we define neighbourhood matter. *Health adn Place*. 2010; 16: 236-41.
30. Southward EF, Page AS, Wheeler BW and Cooper AR. Contribution of the school journey to daily physical activity in childern aged 11-12 years. *American Journal of Preventive Medicine*. 2012; 43: 201-4.
31. Cooper AR, Jago R, Southward EF and Page AS. Active travel adn physical activity across the school transition: The PEACH project. *Medicine and Science in Sports and Exercise*. 2012; 44: 1890-7.
32. Falconer CL, Leary SD, Page AS and Cooper AR. The trackign of active travel and its realtionship wiht boby composition in UK adolescents. *Journal of Transport and Health*. 2015; 2: 483-9.
33. Panter J, Corder K, Griffin SJ, Jones AP and Sluijs EM. Individual, socio-cultural and environmental predictors of uptake and maintenance of active commuting in children: longitudinal results from the SPEEDY study. *Int J Behav Nutr Phys Act*. 2013; 10.
34. Chillón P, Panter J, Corder K, Jones AP and Van Sluijs EMF. A longitudinal study of the distance that young people walk to school. *Health & Place*. 2015; 31: 133-7.
35. Dessing D, de Vries SI, Hegeman G, Verhagen E, van Mechelen W and Pierik FH. Children's route choice during active transportation to school: difference between shortest and actual route. *International Journal of Behavioral Nutrition and Physical Activity*. 2016; 13: 1-11.
36. Lake AA, Burgoine T, Greenhalgh F, Stamp E and Tyrrell R. The foodscape: classification and field validation of secondary data sources. *Health Place*. 2010; 16.
37. Caspi CE, Sorensen G, Subramanian SV and Kawachi I. The local food environment and diet: a systematic review. *Health and Place*. 2012; 18: 1172 – 87.
38. Maguire ER, Burgoine T and Monsivais P. Area deprivation and the food environment over time: A repeated cross-sectional study on takeaway outlet density and supermarket presence in Norfolk, UK, 1990-2008. *Health and Place*. 2015; 33: 142-7.
39. Fraser LK and Edwards KL. The association between the geography of fast food outlets and childhood obesity rates in Leeds, UK. *Health and Place*. 2010; 16: 1124-8.
40. Jennings A, Welch A, Jones A, et al. Local food outlets, wieght status and dietary intake: associations in children aged 9-10 years. *American Journal of Preventive Medicine*. 2011; 40: 405-10.
41. Cetateanu A and Jones A. Understanding the relationship between food environments, deprivation and childhood overweight and obesity: Evidence from a cross sectional England-wide study. *Health and Place*. 2014; 27: 68-76.
42. Wilsher SH, Harrison F, Yamoah F, Fearne A and Jones A. The relationship between unhealthy food sales, socio-economic deprivation and childhood wieght status:results of a cross-sectional study in England. *International Journal of Behavioral Nutrition and Physical Activity*. 2016; 31.
43. Lachat C, Nago E, Verstraeten R, Roberfroid D, Camp J and Kolsteren P. Eating out of home and its association with dietary intake: a systematic review of the evidence. *Obes Rev*. 2012; 13.

44. Bezerra IN, Curioni C and Sichieri R. Association between eating out of home and body weight. *Nutr Rev.* 2012; 70.
45. Nielsen SJ, Siega-Riz AM and Popkin BM. Trends in Food Locations and Sources among Adolescents and Young Adults. *Prev Med.* 2002; 35.
46. Adams J, Goffe L, Brown T, et al. Frequency and socio-demographic correlates of eating meals out and take-away meals at home: cross-sectional analysis of the UK national diet and nutrition survey, waves 1–4 (2008–12). *International Journal of Behavioral Nutrition and Physical Activity.* 2015; 12: 1-9.
47. Tyrrell R, Greenhalgh F, Hodgson S, et al. Food environments of young people: linking individual behaviour to environmental context. *Journal of Public Health.* 2016; 1.
48. Tyrrell RL, Townshend TG, Adamson AJ and Lake AA. I'm not trusted in the kitchen' food environments and food behaviours of young people attending school and college *Journal of Public Health.* 2015.
49. Burgoine T, Forouhi NG, Griffin SJ, Wareham NJ and Monsivais P. Associations between exposure to takeaway food outlets, takeaway food consumption and body weight in Cambridgeshire, UK: population based, cross sectional study. *BMJ* 2014 348 g1464.
50. Burgoine T, Forouhi NG, Griffin SJ, Brage S, Wareham NJ and Monsivais P. Does neighborhood fast-food outlet exposure amplify inequalities in diet and obesity? A cross-sectional study. *The American Journal of Clinical Nutrition.* 2016.
51. Hillier-Brown FC, Moore HJ, Lake AA, et al. The effectiveness of interventions targeting specific out-of-home food outlets: protocol for a systematic review. *Systematic Reviews.* 2014; 3: 1-5.
52. Hillier-Brown FC, Summerbell CD, Moore HJ, et al. A description of interventions promoting healthier ready-to-eat meals (to eat in, to take away, or to be delivered) sold by specific food outlets in England: a systematic mapping and evidence synthesis. *BMC Public Health.* 2016.
53. Burgoine T, Alvanides S and Lake AA. Assessing the obesogenic environment of North East England. *Health and Place.* 2011; 17: 738-47.
54. Mouchacca J, Abbott GR and Ball K. Associations between psychological stress, eating, physical activity, sedentary behaviours and body weight among women: a longitudinal study. *Bmc Public Health.* 2013; 13.
55. Molaodi OR, Leyland A, Ellaway A, Kearns A and Harding S. Neighbourhood food and physical activity environments in England, UK: does ethnic density matter. *International Journal of Behavioral Nutrition and Physical Activity.* 2012; 9.
56. Carroll-Scott A, Gilstad-Hayden K, Rosenthal L, et al. Disentangling neighborhood contextual associations with child body mass index, diet, and physical activity: The role of built, socioeconomic, and social environments. *Social Science & Medicine.* 2013; 95: 106-14.
57. Findholt NE, Michael YL, Jerofke LJ and Brogoitti VW. Environmental influences on children's physical activity and eating habits in a rural Oregon County. *American journal of health promotion : AJHP.* 2011; 26: e74-85.
58. Gallo R, Townshend TG and Lake A. Exploring urban parks and their peripheral food environment. *Urban Design International.* 2015; 20: 28-43.
59. Edwards KL, Clarke GP, Ransley JK and Cade J. The neighbourhood matters: studying exposures relevant to childhood obesity and the policy implications in Leeds, UK (vol 64, pg 194, 2010). *Journal of Epidemiology and Community Health.* 2011; 65: 77-.
60. Nelson J, Erens MB, Bates B, Church S and Boshier T. Low income diet and nutrition survey. London: Food Standards Agency, 2007.
61. Alaimo K, Packnett E, Miles RA and Kruger DJ. Fruit and Vegetable Intake among Urban Community Gardeners. *Journal of Nutrition Education and Behavior.* 2008; 40: 94-101.
62. Davies JN, Ventura EE, Cook LT, Gyllenhammer LE and Gatto NM. L. A. Sprouts: A gardening nutrition and cooking intervention for Latino Youth that improves diet and reduces obesity *Journal of the Academy of Nutrition and Dietetics* 2011; 111: 1224-30.

63. Hawkins JL, Thirlaway KJ, Backx K and Clayton DA. Allotment Gardening and Other Leisure Activities for Stress Reduction and Healthy Aging. *Horttechnology*. 2011; 21: 577-85.
64. Nordh H, MWiklund KT and Koppang KE. Norwegian allotment gardens - a study of motives and benefits. *Landscape Research*. 2016.
65. Wood CJ, Pretty J and Griffin M. A case-control study of the health and well-being benefits of allotment gardening. *Journal of Public Health*. 2015.
66. Hayashi N, Wada T, Hirai H and Houriuchi S. The effects of horticultural activity in a community garden on mood change. *Environmental Control in Biology*. 2008; 46: 233-40.
67. Van den Berg A and Custers MHG. Gardening promotes neuroendocrine and affective restoration from stress. *Journal of Health Psychology*. 2011; 16: 3-11.
68. Harding JL, Backholer K, Williams ED, Peeters A, Cameron AJ and Hare MJ. Psychological Stress is positively associated with body mass index gain over 5 years: Evidence from the longitudinal AusDiab study. *Obesity*. 2013; 3: 20:20423.
69. Wiseman T and Sadlo G. Gardening: An Occupation for Recovery and Wellness. In: Soderback I, (ed.). *International Handbook of Occupational Therapy Interventions*. Cham, Switzerland: Springer International Publishing 2015.
70. Parkinson S, Lowe C and Vecsey T. The therapeutic benefits of horticulture in a mental health service. *British Journal of Occupational Therapy*. 2011; 74: 525-34.
71. LGA. Tipping the scales: case studies on the use of planning powers to limit hot food takeaways. London: LGA, 2016.
72. DCLG. National Planning Policy Framework. London: DCLG, 2012.
73. Carmichael L, Lock K, Sweating D, Townshend TG and Fischer TB. Reuniting the evidence base for health and planning: Lessons from an ESRC seminar series. *Town and Country Planning*. Forthcoming.
74. London Borough of Barking and Dagenham. Saturation Point: Addressing the health impacts of hot food takeaways. Draft Supplementary Planning Document. London: London Borough of Barking and Dagenham, 2009.
75. Townshend TG. Toxic High Streets. *Journal of Urban Design*. 2015.
76. Townshend TG. What role can urban planning and transportation policy play in the prevention of obesity? . In: Crawford Dea, (ed.). *Obesity epidemiology: from aetiology to public health*. Oxford: Oxford University Press, 2010.
77. Ward Thompson C, Aspinall P and Bell S. Innovative Approaches to Researching Landscape and Health London Routledge, 2010.
78. Harrison F, Burgoine T, Corder K, van Sluijs EMF and Jones A. How well do modelled routes to school record the environments children are exposed to?: a cross-sectional comparison of GIS-modelled and GPS-measured routes to school. *International Journal of Health Geographics*. 2014; 13: 1-12.
79. Cetateanu A and Jones A. How can GPS technology help us better understand exposure to the food environment? A systematic review. *SSM - Population Health*. 2016; 2: 196-205.
80. Cetateanu A and Jones A. How can GPS technology help us better understand exposure to the food environment *SSM - Population Health*. 2016 2: 196–205.
81. Foresight. Tackling Obesities: Future Choices – Project report. London: Government Office for Science, 2007.