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Obesogenic urban form: Theory, policy and practice

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ABSTRACT

There is a growing body of research, which suggests that many contemporary urban environments do not support healthy lifestyle choices and are implicated in the obesity pandemic. This paper reviews the evidence from this field in relation to theory, policy and practice, from three different disciplinary perspectives: urban design, geography and public health nutrition. In the UK, our development has been higher density and our urban form more varied, yet the paper concludes that it still may be making a contribution to our own obesity crisis. The dynamics of this, however, are highly complex and currently little understood.

Obesity

Obesity is an issue of international concern. Rates of obesity are rapidly rising, causing an associated increase in a number of serious medical conditions (Calle et al., 2003). It has been predicted that in the UK, by 2050 nearly 60% of the population could be obese (Foresight, 2007). The mechanisms by which the environment influences obesity include food intake and physical activity (Lake and Townshend, 2006). In the developed world, our environment supplies vast quantities of convenient, energy dense foods (Hill and Peters, 1998), yet our contemporary lifestyles often require relatively low levels of physical activity. No single theory, however, has adequately explained all the factors which contribute to the current obesity epidemic. The Foresight Obesity System Map highlights the complexity of the obesity issue (Vandenbroeck et al., 2007); the causes are multi-factorial and include biological, psychological, behavioural and social aspects. The term 'obesogenic environment' has been coined to express 'the sum of influences, opportunities, or conditions of life have on promoting obesity in individuals or populations' (Swinburn et al., 1999).[2]

Over the past two decades, there has been a growing recognition that our contemporary urban environments adversely affect our health in new and apparently more intractable ways than in the past. In the UK, the Foresight (2007) report suggests there is enough expert evidence to implicate the built environment in the obesity crisis and called for health to be embedded as a 'criterion for planning consideration'. There is still a general lack of understanding of how physical environments and social factors combine to create disparate environmental exposures and thus create health inequalities among populations. Moreover, recent research though relatively large in volume is mostly restricted to the USA and Australia; contains a great deal of correlation studies rather than exploring cause and effect and has produced a disparate and often seemingly contradictory body of evidence in relation to this issue.

In spite of this contradictory body of evidence, policy and practice are moving rapidly. At international, national and local levels there are moves to address aspects of the obesogenic environment. Using a trans-disciplinary perspective of urban design, nutrition and geography, the aim of this paper is to explore the topic of obesogenic urban forms in terms of theory, policy and practice. The paper addresses both sides of the energy balance equation in relation to the environment; energy intake, in terms of the food environment and energy expenditure, describing physical activity and the environment. Literature searches were conducted across databases including, Ovid Medline, Scopus and ISI Web of Knowledge. Key search terms included obesity, obesogenic environments, food environments, physical activity, perception and objective measures. In addition relevant policy documents were sourced, for example Department of Health, Commission for Architecture and the Built Environment (CABE) and Foresight. One thousand and seventeen references have been considered for

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[2] A measurement of obesity referred to in this paper is body mass index (BMI) which relates weight to height in the individual (e.g. m^2/kg).

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inclusion initially dating from 1968 to early 2008. Many of these were irrelevant and quickly rejected. Papers were selected for inclusion on the basis that at the time of publication they added a new direction to the subject; that they contributed to the trans-disciplinary nature of the field; that they supported or directly contradicted comparable studies undertaken in different geographical contexts or that they were seen to have specific implications for future research in the UK.

Food and the built environment

Environmental level characteristics, such as the availability of healthy food, have been implicated in the obesity epidemic (Black and Macinko, 2008). The food environment is one of the four major areas of the Obesity System Map developed by Foresight (Vandenbroeck et al., 2007). The food environment can be broadly conceptualised to include any opportunity to obtain food. This definition of the food environment can include physical, socio-cultural, economic and policy factors at both micro and macro-level. It includes food availability and accessibility in addition to food advertising and marketing (Lake and Townshend, 2006). Two food access pathways have been described; food for home consumption, i.e. from supermarkets and grocery shops and ready-made food for home and out-of-home consumption, i.e. from restaurants and take-aways (Cummins and Macintyre, 2006). Glanz et al. (2005) have described four aspects of the food environment; the community environment (type and location of food outlet), the consumer nutrition environment (availability of healthy options, price, promotion and nutritional information), organisational nutrition environments (home, school, workplace) and information environment (media and advertising). They identified that the community and consumer setting warranted much further investigation, both of which are a feature of the built environment.

Over the last 30 years there has been an exponential increase in the prevalence of overweight and obesity. Alongside this increase has been a change in the structure of society in terms of the food environment, which changed rapidly in the UK over the last 20 years (Burgoine et al., (in press)). Relative to research on physical activity and the environment, however, research that links food choices to the built environment is still relatively undeveloped. There has been little work which has looked at food access with obesity as an outcome (White, 2007). Comprehension of this relationship requires a step-wise approach: firstly to understand pathways and mechanisms by which the environment influences food behaviour (Giskes et al., 2007) and then to relate this to adiposity.

In a recent review Black and Macinko (2008) found evidence from North America, Britain and Australia suggesting that lower-socio-economic status (SES) neighbourhoods and those with larger minority populations have greater exposure to fast-food restaurants and fewer healthy food choices. Examining the UK, the picture appears more complex. Studies of 'food deserts' defined as 'populated urban areas where residents do not have access to an affordable and healthy diet' (Cummins and MacIntyre, 1999) failed to find any association between neighbourhood retail food provision and individual diet (Wrigley et al., 2003; White et al., 2004). A key issue highlighted by this research is that the geographical proximity of suppliers to these socio-economically deprived communities may be relatively unimportant when other factors may be more powerful determinants of shopping choice.

While studies have tended to use the local retail food environment as a single exposure variable (Ford and Dzewaltowski, 2008), there has been a body of work emerging around the influence of the 'out-of-home' food environment. The impact of the availability of fast-food and take-aways, however, is also unclear. Cummins et al. (2005) reported that the greater the level of neighbourhood deprivation in Scotland and England the more likely the neighbourhood was to be exposed to McDonalds restaurants. Conversely, work in Glasgow found no association between area of deprivation and access to take-away outlets (Macintyre et al., 2005). One US study suggested a significant link between provision of fast-food outlets and obesity at the state level in the US (Maddock, 2004) but this was not supported by a study on adults in Australia (Simmons et al., 2005) nor by one in the US on pre-school children (Burdette and Whitaker, 2004).

In the US, Jeffery et al. (2006), failed to find a link between BMI and restaurant proximity. This work pointed out that even though density of fast-food restaurants may vary, access in the US is still basically ubiquitous (Jeffery et al., 2006); a point undoubtedly pertinent for a large percentage of adults living in urban areas in the developed world, including the UK. The study also pointed out a number of methodological weaknesses in this type of study not least in linear distance being used to define exposure. In New Zealand travel distance to outlets selling fast-food were found to be twice as far for the least socially deprived neighbourhoods compared with the most deprived neighbourhoods (Pearce et al., 2007). This distance 'pattern' was also seen in outlets where healthy food could be purchased such as supermarkets and smaller food outlets. Pearce et al (2007) emphasised the need to explore all aspects of the food environment, not just the fast-food environment.

The UK has the ambition to be the first major nation to reverse the rising trend of overweight and obesity (Department of Health, 2008). The recent Foresight review (2007) recognised that we need to change both the physical activity and food-related environment in an attempt to support more healthful behaviours. Within the Department of Health 'Healthy Weight, Healthy Lives: A Cross Government Strategy for England' (2008) document there are areas which highlight the changes needed in the physical environment in order to tackle excess weight. This includes the food environment, for example the location of food outlets in relation to schools and parks.

In a systematic review, Giskes et al. (2007) highlighted several understudied environmental factors that are 'implicated' in the obesity epidemic including fast-food/convenience stores, marketing of unhealthy foods and availability of larger portions. In understanding the relationship between the *whole* food environment, food behaviours and ultimately adiposity, there is a need to move beyond only using local retail food environments. The relationship between the food environment and obesity is complex (Wang et al., 2006); understanding this relationship offers great potential for developing interventions, policies (Wang et al., 2006, McLaren, 2007) and 'lasting solutions' (Holsten, 2008) to address the social phenomenon of obesity.

Physical activity and the built environment: perceived and objective measures

Relatively more research has focused on physical activity and the environment, rather than eating behaviours and the built environment (Papas et al., 2007). A number of reviews have been published (see for example, Humpel et al., 2002) with conceptual models proposed exploring key dynamics, for example Fig. 1 (Foster et al., 2005). Elements in the built environment which are seen as drivers for physical activity include physical provision of appropriate opportunity spaces, and accessibility and urban design dimensions. Thus by providing highly accessible, good quality green space which is perceived as safe to use at the neighbourhood level this should lead to an increase in the

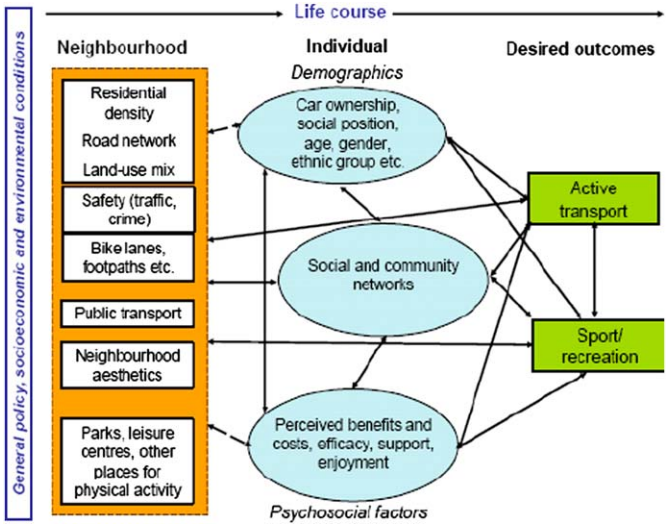

Fig. 1. Evidence informed model of potential determinants of sport/physical activity (Foster et al., 2005).

propensity of people to undertake exercise, either through active transportation or recreation. The filtering factors of demographics and psycho-social variables means this relationship is far from direct and this is a model with a limited amount of empirical evidence to support all of the interactions proposed.

One strand of investigation where there is increasing evidence is the link between perceived access to built or natural environments, which might support physical activity and actual use of these environments. A study in Belgium suggested that those who perceived themselves to be close to activity facilities were more likely to use them, though other factors particularly the socio-economic status of subjects was more strongly related (De Bourdeaudhuij et al., 2003). Similar findings were found in a US study (Huston et al., 2003). Further studies have incorporated notions of convenience, i.e. how easy someone considers it is to fit exercise into their daily life and perceived aesthetics, i.e. whether places are pleasant to be in. Studies in Australia and the US have both suggested a positive relationship between the convenience, perceived aesthetics of an area and peoples' willingness to exercise (Carnegie et al., 2002; Ball et al., 2001; King et al., 2003). An interesting relationship that seems evident from these studies relates to people who live in traditional mixed-use neighbourhoods. These are those neighbourhoods where local shops and services, school and employment opportunities are easily accessible within walking distance of people's home of a type prevalent in the UK up to the 1960s. Here, people tend to over-estimate the number of opportunities they have at their disposal for activity, contrastingly those in more recently developed neighbourhoods, designed around car use under-estimate opportunities. If use levels are linked to perception, as much as actual availability, then it appears that traditional mixed-use areas are doubly advantaged.

This is pertinent for the UK since mixed-use neighbourhoods dominated our town and cities from the 19th Century through to the immediate pre-WW II period. Employment and housing became increasing detached in the 20th Century, however, even suburban housing built in the 1950s, while providing for mass car ownership, would usually include 'convenient' parades of local shops, local schools, health clinics and so on. During the 1970s and 1980s more radical changes have occurred. Shopping habits have become increasingly more car-orientated: services, libraries, clinics, swimming pools, etc., have become more centralised; school attendance more dislocated from immediate housing and public transport eschewed in favour of private cars. Most recently large swathes of car-orientated housing with minimal provision have been built across the UK, to standardised patterns provoking criticism from the government's advisory body on urban design the Commission for Architecture and the Built Environment (CABE, 2005a, b). A further issue tied up with the notion of convenience, however, which is pertinent to the UK is that of equity and household income. A study of Norwich, for example, found that people in low income households, who were most likely to adopt low levels of physical activity, were likely to be the least well served by affordable facilities which would enable them to become active (Panter et al., 2008).

More studies, however, have explored the relationship between perceptions of safety in the built environment and peoples' propensity to take physical exercise than any other factor. This research has suggested a direct link at least for certain societal groups, particularly older people (over 65 s); women and some minority groups; with people far more likely to be physically active if they perceived their neighbourhood as safe (Centers for Disease Control and Prevention, 1999). A study in England showed that women who were concerned about safety during the day in their neighbourhood were nearly 50% less likely to take short daytime walks than those without concerns; though there was no relationship with men (Foster et al., 2004).

A pan-European (not including the UK) study again showed a significant relationship between women's perceptions of safety and taking occasional, or frequent, exercise (Shenassa et al., 2006). However, other studies in the US have been inconclusive either showing weak relationships or none at all (King et al., 2003; Brownson et al., 2001). A recent study of two neighbourhoods in Ireland explored interlinked themes of perceptions of the physical environment with perceptions of sense of community (and the individual's role within it). This study highlighted the need for routes perceived as aesthetically pleasant in order to encourage walking, however, emphasised the role of psycho-social influences in determining whether people took exercise or not (Burgoyne et al., 2008).

In recent research, objective measurements of environmental characteristics and their potential impact on walking and physical activity have somewhat overtaken perception studies (Lovasi et al., 2008). An association between neighbourhoods with poor socio-economic characteristics and sedentary lifestyles, with wider implications in terms of health risk for example, has been observed for some time (Frank et al., 2006). Further, neighbourhoods with low SES usually have fewer physical activity resources than medium to high SES neighbourhoods (Gordon-Larsen and Reynolds, 2006). There have also been a number of studies which have measured the specific impact of an environment or a site. For example, studies from Australia have associated proximity to recreational facilities, such as beaches and rivers as encouraging exercise (McCormack et al., 2006). In general most of these studies have measured three key factors: urban sprawl and/or residential density, connectivity of street networks and land-use mix. Most of these studies are US or Australian based and many have suggested positive associations between higher densities, greater connectivity and greater land-use mix and exercise in terms of walking. However there has been an inconsistency in approaches, methods and results (Oliver et al., 2007). A recent methodologically robust study from the US, for example, concluded that increasing residential density while having potential for many positive impacts (such as efficient use of land and encouragement of lively streets), did not have an impact in the overall amount of exercise taken in the study areas (Forsyth et al., 2007).

A number of studies have particularly focused on children's physical activity and the built environment, for example, showing the direct correlation between the distance a child lives from

school and the propensity to walk or cycle to it (Bricker et al., 2002). Research in Australia has suggested that micro-urban design environments, such as the quality of pedestrian realm and public crossings can also be significant in whether parents allow their children to walk to school (Timperio et al., 2006). Access to outside play space is another key aspect of the built environment that has attracted research, however, not just traditional parks and playgrounds. It has been argued that the streets near a child's home are actually more important, since they are readily accessible and are more 'exciting' than specifically set aside play areas (Moore, 1987). More recent UK research has highlighted benefits of children being allowed out on their own in terms of physical activity levels and richer social lives (Mackett et al., 2007).

A key issue with many physical activity and neighbourhood studies is that of self-selection, i.e. whether people who have a greater propensity to take physical activity deliberately choose to live in neighbourhoods which offer opportunities for such activity (of whatever nature, green spaces, walkable shops and services). A key study which has attempted to address this issue in Atlanta, USA found that people who preferred walkable environments[3] were actually less likely to sort themselves into that type of environment, than those who preferred low walkability neighbourhoods. However, the key finding of the study was that providing more walkable neighbourhoods would probably increase walking (both active travel and recreation) and reduce obesity most significantly among those populous who prefer these environments. Among those who preferred non-walkable environments the study concluded this approach would not in itself be an effective intervention (Frank et al., 2007). Thus this study in turn highlights the issue around who might benefit most from interventions in the built environment.

There is also an apparent trend in this area of research to bring together neighbourhood perceptions with objectively measured observations. In 2003, a cross-sectional comparison of two urban areas in the US looked at whether road conditions (high-speed traffic, lack of crossings and sidewalks) were a barrier to physical activity (McGinn et al., 2007). The study found little agreement between recorded perception and objective measurements. Moreover, the study concluded that perceptions of speed and volume were not associated with physical activity outcomes, though a perception of having places to walk was associated with higher physical activity, particularly walking. A more recent study which aimed to link perception and objective measures through to obesity, carried out environmental audits and perception-based telephone interviews in Savannah, Georgia (described as a high-walkable city) and St. Louis, Missouri (a low-walkable city). The study suggests that levels of obesity were significantly associated with both perceived and observed levels of limited accessibility to non-residential land uses and interesting places and poor/degraded pedestrian areas. However, the study also emphasises that both issues were closely associated with neighbourhood poverty and since many studies have attributed obesity to neighbourhood deprivation the underlying mechanisms associated with higher levels of obesity remained unclear (Boehmer et al., 2007) (Table 1).

Urban design factors and obesity

Research, therefore, suggests that certain neighbourhoods combine factors which enable and/or encourage people to lead more healthy, active lifestyles. It appears that these positive attributes include higher residential densities, good levels of connectivity between streets, greater levels of land-use mix, pavement provision and areas that are perceived to be aesthetically pleasing and safe to be in. These attributes are more associated with either traditional pre-war environments or ones laid out specifically on these principles. In contrast modern car-dominated suburban neighbourhoods, often labelled 'urban sprawl' in US literature, lack some or all of these positive qualities. It is suggested the resultant large tracts of single-use land patterns; few or no local shops, or services combined with housing; largely disconnected development, i.e. 'cul-de-sac' layouts; poor levels of pavement provision and monotonous, uninteresting views, may deter people from taking physical activity either active travel or recreation and that this in turn will have adverse health consequences.

There is some evidence which does link urban form through to health outcomes and obesity. The most widely cited study was carried out in Atlanta, Georgia (Frank et al., 2005). This found a significant correlation between the obesity of white males and the residential density of where they lived; decreasing from 23% to 13% from the least to the most-dense neighbourhoods (Frank et al., 2005). Another US study found comparable results, with cross-sectional analyses suggesting an association between the increased weight of adolescents and young adults in lower density neighbourhoods; however, longitudinal analyses found no relationship between the two factors (Ewing et al., 2006).

Studies have attempted to link obesity to a range of key urban design measures. A recent study explored more dense urban environments and the relationship between urban form and obesity. This large study ($n > 13{,}000$) of residents across residential neighbourhoods in New York concluded that while variations in neighbourhood characteristics could only explain a modest proportion of the total variation in BMI within the study groups, there were clear correlations. Individuals living in neighbourhoods with higher population density, greater access to public transport and a greater mix of land uses had significantly lower BMIs compared to groups living in neighbourhoods that did not display these characteristics; though the study found no correlation to measurements of connectivity (Rundle et al., 2007).

In relation to adults there have also been a limited number of studies which have examined the role of objectively measured green space with physical activity. A study of eight European countries found that levels of landscaping within neighbourhoods (Ellaway et al., 2005) was associated with more physical activity and studies in Australia have also suggested that access to 'attractive' green space may be key in encouraging more exercise (Giles-Corti et al., 2005). A study in Seattle has also stated that the quality and quantity of 'greenness' in a neighbourhood can be correlated to obesity. This study reported that in areas with good access to local shops and services, with high objective measures of natural vegetation, BMI was lower than in areas where there was a higher level of access to local shops and services, but where levels of greenness was low (Tilt et al., 2007). Thus in this case the greenness of neighbourhoods, it was argued, was more important in encouraging healthy behaviour than the number of opportunity locations that were accessible through active transportation. This important study builds on a trajectory of work which have explored the health benefit of natural environments to people's lives (Groenewegen et al., 2006).

Implications for UK policy, practice and future research directions

Overall, therefore, the body of research thus far is somewhat inconclusive. There certainly seems to be a relationship between

[3] For a definition of walkability see Craig et al., 2002.

Table 1
Summary of major findings: comparison between international and UK studies.

	International findings	UK findings
Nutrition and food	Unhealthy food availability inconsistently related to obesity (Black and Macinko, 2008)	Limited evidence for existence of food deserts; reasonable availability of food stores in more deprived localities (Cummins and MacIntyre, 1999), but socioeconomic factors may influence shopping choice (Wrigley et al., 2003; White et al., 2004)
	Disadvantaged neighbourhoods and minority ethnic groups have greater exposure to fast-foods, fewer healthy choices and increased risk of obesity (Black and Macinko, 2008; Ford and Dzewaltowski, 2008; Maddock, 2004; Pearce et al., 2007)	Exposure of disadvantaged areas to fast-food restaurants increases with deprivation at national level (Cummins et al., 2005), but limited evidence within a single city (Macintyre et al., 2005)
	No association between proximity to fast-food restaurants and overweight in pre-school children (Burdette and Whitaker, 2004) or adults (Jeffery et al., 2006)	
Physical activity and geography	Positive relationship between perceived proximity to facilities and exercise (De Bourdeaudhuij et al., 2003; Huston et al., 2003) and place aesthetics with willingness to physical activity (Carnegie et al., 2002; Ball et al., 2001; King et al., 2003; Burgoyne et al., 2008). Inconclusive outcomes in perceptions of area safety and physical activity (King et al., 2003; Brownson et al., 2001)	Disadvantaged households less likely to be served by facilities and more likely to adopt low levels of physical activity (Panter et al., 2008)
	Socioeconomically disadvantaged neighbourhoods offer fewer physical and recreational activity resources (Frank et al., 2006; Gordon-Larsen and Reynolds, 2006; McCormack et al., 2006), but limited evidence linking urban density and physical activity (Forsyth et al., 2007)	Significant association between perception of area safety and physical activity for specific groups, such as women (Foster et al., 2004) and children (Mackett et al., 2007)
	Significant relationship between children's physical activity and proximity to school (Bricker et al., 2002) or road safety measures (Timperio et al., 2006, Moore, 1987)	Positive benefits of children's outdoor activities and levels of physical activity and social lives (Mackett et al., 2007)
	Associations between adults' physical activity and area walkability (Frank et al., 2007), land use and aesthetics (Boehmer et al., 2007), but limited evidence on effect of traffic on physical activity (McGinn et al., 2007)	Note lack of research on walkable and aesthetic environments on adults' physical activity and exercise
Urban form	Neighbourhood features that discourage physical activity are associated with increased BMI (Black and Macinko, 2008). Associations between obesity/overweight and lower residential density or mixed land uses (Frank et al., 2005; Ewing et al., 2006; Rundle et al., 2007)	Evidence of lower levels of obesity with low levels of neighbourhood disorder and access to facilities (Stafford et al., 2007)
	Lower BMI for areas with higher greenness (Tilt et al., 2007), proximity to open recreational facilities (McCormack et al., 2006) and access to natural environments (Groenewegen et al., 2006)	Note lack of extensive research on effect on BMI of urban form, walkability and green or natural environments

physical activity and the built environment, though what factors within this relationship are paramount and which are peripheral is not agreed on. The relationship between diet and physical environment seems even more elusive and by the same token the relationship between all three remains unexplained. Further there are a number of specific issues which need to be considered in the context of UK and future directions of this research. A recent review has described an understanding of both access to healthy food and opportunities to be physically active as 'critical in obtaining a comprehensive picture of the built environment and obesity' (Papas et al., 2007).

The transferability of much of the research that has been carried out in the US and Australia to the UK has to be questioned. The density of modern suburban development in particular is completely different. Some of the very low densities of residential areas implicated in US research, for example, are simply not found in the UK. In Australia, for example, net residential densities of 8–10 dwellings/hectare are common, in US cities such as Phoenix, Arizona this drops to 5 dwellings/hectare; however, in the UK standard suburban development is around 25 dwellings/hectare, though even this is too sparse to maintain many local amenities, such as a bus service (Biddulph, 2007).

The highly regimented gridiron patterns of urban development in the US and Australia is also rare in the UK and detailed level issues like pavement (sidewalk) provision are also entirely different. This is not to suggest elements of UK development are not as obesogenic as the US or Australia. The Commission for Architecture and the Built Environment (CABE) has produced a series of damning reports on relatively high density, but poor quality, characterless and car-dominated housing developments which provide little in the way of local, accessible shops and services and have inadequate green space (CABE, 2005a, b). It is therefore likely that design quality will have far more impact on people's lives and behaviours than issues such as density in these neighbourhoods.

Further, a more sophisticated understanding of urban design dimensions is needed in these studies. Many studies exploring urban design factors rely on measuring (along with density) connectivity and mixed uses; but there is generally little examination of what might be called 'fitness for purpose'. Figs. 2–4 show St. James' Village, Gateshead, Tyne and Wear a typical contemporary urban brownfield development in the UK. The current development of the estate is on-going though planning permission for the first 534 homes was given in January 2001; it is designed and built by a major UK mass-housing developer, Persimmon. The estate is dominated by two bedroom apartments which sell from around £110 K, which is inexpensive in the UK housing market. There are some larger 3 and even 5 bedroom houses interspersed between the apartment blocks and the whole estate is arranged around a series of cul-de-sacs and courts. The estate has even seen the development of 93 IKEA, Boklok houses which are specifically designated for shared ownership schemes for those unable to afford entry to housing market. The apartments are bought or rented primarily by singles

Fig. 2. St. James' Village layout; the cul-de-sac layout is self-evident, the drive through fast food restaurant can be seen just to the northeast of the housing area.

Fig. 3. St. James' Village showing boundary walls and limited accessibility.

Fig. 4. View towards Sunderland Road, showing car-domination of the estate layout and adjacent mixed land-use.

or childless couples on low incomes. The estate is located just over a kilometre to the east of Gateshead's town centre, adjacent to the main Sunderland Road and an ex-local authority (now Gateshead Housing Company, an arms length management organisation) estate called 'Old Fold' which has the reputation of being 'rough' among the local population. The estate is also adjacent to Gateshead International Stadium (primarily used for athletics) and served by the stadium station on the Tyne and Wear metro system.

Here the development is high density, it is also constructed in a mixed-use area with nearby industrial units (visible in Fig. 3) and the international athletics stadium within 500 m of the centre of the estate. The estate is, however, surrounded by a boundary wall which means the development is in effect isolated from its surroundings and relatively impermeable. Pedestrian and cycling provision within the estate is poor and an adjacent dual carriageway, while providing a direct link to Gateshead town centre makes a bleak and uninviting walking/cycling environment. It therefore displays many of the problems associated with US suburban sprawl, poor pedestrian/cycling environment, non-integration of land uses, a dominance of private car use and little amenity space.

Preliminary research with residents on the estate suggested that some had walked to a local shop (attached to a garage) on an adjacent road until the construction of the boundary wall in the latter stages of development.[4] This had turned a short 5 min walk into a much more circuitous 20 min walk, which discouraged most from walking. The stadium sports facilities have limited availability to members of the public and it was perceived that few people on the estate worked in the adjacent industrial area. Moreover, the estate has a drive-through fast-food restaurant within 50 m of the main entrance/exit, which though adding to the 'mixed-use' nature of the neighbourhood may well be a more negative than positive influence. Finally there was little in the way of green space or planting within the estate and the overall character of the estate was relatively harsh and uninviting for pedestrian movement.

This analysis is based on a small number of interviews and observation analysis. It is suggested, however, that while this development would appear to be a densely developed mixed-use area, that micro-environment design decisions (such as a virtually continuous boundary wall and the extraneous nature of the mixed uses) may well mean it is as unsupportive of healthy active lifestyles as the low density, suburbia more readily targeted for criticism. It is possible that a variety of obesogenic built forms exist and only the application of mixed methods and more sophisticated urban design analyses in built environment/obesity studies will highlight these issues.

A further key issue is the limiting nature of current studies in that they primarily only examine physical characteristics of neighbourhood, when much research has shown the importance of social context on health. A recent study in the UK has attempted to address this by layering physical/urban design characteristics such as density, high street services and leisure centre access with socio-environmental characteristics of neighbourhood disorder, crime rates, policing and physical dereliction. The study concluded in particular that low levels of neighbourhood disorder were associated with lower levels of obesity among residents and that key factors were modifiable in this respect (Stafford et al., 2007). This multi-layering of neighbourhood characteristics is undoubtedly a further progression in the understanding of obesogenic environments. The relationship between the built environment and obesity is complex. Tackling obesity requires concerted multi-disciplinary effort to draw together interventions which target individual behaviours within an environmentally supportive context.

[4] Since this study was conducted a discount supermarket has been built adjacent to the estate; further research is now needed to assess the impact of this.

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