Exploring urban parks and their peripheral food environments using a case study approach: young people and obesogenic environments

Rachel G. Gallo[a1], Tim G. Townshend[b], Amelia A. Lake[c]

[a] *Global Urban Research Unit, School of Architecture Planning and Landscape, Newcastle University, Newcastle-upon-Tyne, NE1 7RU, UK. +44 (0) 191 222 7814.* *Rachel.Gallo@ncl.ac.uk*

[b] *Global Urban Research Unit, School of Architecture Planning and Landscape, Newcastle University, Newcastle-upon-Tyne, NE1 7RU, UK. +44 (0) 191 222 7814.* *Tim.Townshend@ncl.ac.uk*

[c] *Centre for Public Policy & Health, School of Medicine & Health, Wolfson Research Institute, Durham University, Queen's Campus, Thornaby, Stockton-on-Tees, TS17 6BH, UK. +44 (0) 191 334 0668.* *Amelia.Lake@durham.ac.uk*

Total word count: 6,842

Main Text word count: 4,208

---

[1] Corresponding author Rachel G. Gallo: Rachel.Gallo@ncl.ac.uk

Exploring urban parks and their peripheral food environments using a case study approach: young people and obesogenic environments

UK policy response to childhood overweight and obesity has focused on improving eating patterns and increasing physical activity. This observational case study examined and evaluated attributes of two urban parks and 400m peripheries influencing eating and activity behaviours in young people (11–20 years).

Food environment healthfulness (P=0.001) and outlet provision (P=0.002) were significantly different, favouring affluent area. No single variable principally or consistently attracted young people to parks or facilitated activity however, usership favoured affluent area suggestive of socio-economic influence.

Inequity in obesogenic determinants are consistent with deprivation amplification and are incompatible with UK political strategy for health equity.

Keywords: obesogenic environment; park; physical activity; young people; deprivation amplification

Introduction

Prevalence rates of childhood overweight and obesity in the UK have reached 'epidemic' levels (NHS IC and LS, 2010) with the associated health concerns spanning: physiological, mental and social wellbeing. Moreover, only one third of boys and one fifth of girls meet government recommendations for physical activity (PA) (DH, 2004). Evidence suggests the tracking of of weight status, dietary and PA behaviour from childhood to adulthood (Craigie et al., 2011; Lake et al., 2006; Telama et al., 2005) the increased life-course co-morbidity risks are therefore manifold.

Foresight highlighted a web of casual factors for escalated weight status incorporating, but not limited to: energy intake and expenditure environments (Butland et al., 2007). Obesogenic environment literature is suggestive of environmental and societal level influence enabling of obesogenic (promoting overweight) or leptogenic behaviours (promoting leanness) beyond that of personal biological influence (Palma and Lüdorf, 2010; Hill and Peters, 1998).

Food Environment

The food environment (FE) is defined as "any opportunity to obtain food" (Townshend and Lake, 2009, p. 910). Environments containing multiple cues for accessible energy dense foods are liable to result in energy intake plausibly predisposing over-consumption. A study of adolescent eating behaviours found physical factors inherent in food to be of greater import than any other factor in determining consumption behaviour (Stevenson et al., 2007) thus implying this age group are at risk.

Young people have more limited geographical mobility than adults (Kestens et al., 2010); thus proximal environments to home, school and leisure locations play an important role in food access. A study of the peripheral school food environment in England found adolescents obtained at least 23% of their recommended energy intake

from food bought in these locations; almost all food items were high in fat and sugar (Sinclair and Winkler, 2008).

Energy Expenditure Environment

The 'physical environment' refers to the built environment, natural landscape and human use of public spaces (Handy, 2004). It is increasingly recognised that the environment an individual interacts with can encourage or discourage PA. Generally accepted facilitators of young people's PA are: access, or perceived access, to green space; green space aesthetic quality and maintenance; perceived and actual environment safety; independent mobility; access to shops and services; and neighbourhood walkability (Carter and Dubois, 2010; McCormack et al., 2010).

Urban parks are important assets for young people providing a setting for socializing and activity within the neighbourhood locality (Ward Thompson, 2011; Maas et al., 2006) with evidence suggestive that young people are mostly active in these spaces (Lachowycz et al., In press). Urban parks are thus the focus of this research. Positive correlates of park use by young people include: quality determinants of place; within park environmental diversity; presence of age appropriate recreation facilities; park maintenance, aesthetic quality and safety (Rahman et al., 2011; McCormack et al., 2010; Ries et al., 2009).

Health Policy

Health and planning policies in the UK recognise food and physical environments as influential on health. Issues surrounding food access; planning for health comprising Local Authority agency over spatial planning of food outlet location and environment facilitation of daily physical activity; and health equity are outlined in White Papers *Healthy Lives, Healthy People* (SSH, 2010) and *Planning for a Sustainable Future*

(Kelly et al., 2007). Commitments are also highlighted in framework and guidance documents (DEFRA, 2010; DH, 2009; NICE, 2008; CLG, 2006).

Objectives

Despite substantial literature, little inter-disciplinary work has associated physical, food and social environments (Feng et al., 2010) resulting in limited trans-disciplinary crossovers between Health and Planning (Lytle, 2009). There is a gap in understanding regarding the FE healthfulness within and immediately surrounding urban parks, young people's use of urban parks and PA facilitators within parks (Lake et al., 2009; Townshend and Lake, 2009). This study aims to redress shortcomings by undertaking a detailed case study examination of the energy intake and expenditure environments of two urban parks situated in areas of disparate economic and social deprivation. Study objectives were to:

(1) Examine the equity and healthfulness of park's within and immediate peripheral FE.
(2) Examine the equity of two urban parks according to: park environment, facilities and amenities, maintenance, safety and aesthetic quality.
(3) Analyse urban park facilitation of park use and PA in young people aged 11–20 years according to: park environment, exercise facility/amenity presence and age appropriateness, maintenance and safety variables.

Methods

Newcastle upon Tyne was the case study setting, Newcastle has higher than national average levels of childhood overweight and obesity (NHS IC and LS, 2010) and low reported levels of PA in young people (McLure et al., 2009; Basterfield et al., 2008) – these over-expressions of the health outcomes under examination made it an apt study

location. Two socially and economically disparate areas were contrasted (according to Indices of Multiple Deprivation (ONS, 2007)). For anonymity, areas are referred to by pseudonyms: Southville and Eastern. Southville Park represented a high-use urban park situated in an affluent area; Eastern Park a low-use urban park in a deprived area. Parks were matched for amenity provision, but not size, peripheral land use, or density.

A mixed-methods research approach was adopted facilitating data triangulation and robustness of conclusions. Surveys were made in winter (02/2009) and summer (07/2009) and accounted for week, weekend, school and non-school days. Research methods used are discussed sequentially according to objectives.

Food Environment Equity and Healthfulness

The within park and immediate park periphery (400m) FE was examined. A 400m radius represents a quarter mile walking distance and is a recognised standard in literature (Loukaitou-Sideris and Sideris, 2010; McMillan et al., 2010). For the remainder of this paper FE shall refer to the within park and 400m peripheral FE.

FEs were analysed once per season to account for seasonality and temporal change in outlet provision. Food outlet access were measured using a 21 point Food Outlet Classification Tool (Lake et al., 2012; Lake et al., 2010). Outlets were classified according to type facilitating comparison of outlet availability between areas. FE healthfulness was measured using Measuring Food Environment (MFE) tools for restaurants, shops and vending machines (Lake et al., Under Review). MFE positively or negatively weight variables yielding a percentage score interpreted to infer outlet healthfulness. Outlets were measured during office hours (9am – 5pm) and closed outlets were not re-visited outside of office hours.

Urban Park Environment Equity

The within park environment was analysed using the Observational Park Audit Tool (OPAT) tailored for the study of park use and PA facilitation in young people (Gallo et al., In preparation). OPAT had four overarching groupings: Park Environment, Facilities and Amenities, Maintenance and Safety each comprising a number of variables and sub-aspects known to influence park usage and PA in young people. OPAT was administered in six audit zones within each park. Zones were delineated by facilities/amenities, paths or planting; were matched for facility/amenity presence or general use; and were of approximate uniform size. Consistent with validated observation methods, parks were visited prior to data collection to identify zones (Floyd et al., 2008). Parks were audited once per season to capture seasonal variation in variables.

Supplementary Assessments (SA) were made to capture subjective and transient park characteristics not adequately captured by single seasonal analysis. A five-point Likert scale produced data on maintenance, safety, and aesthetics; and a reflective journal data on perceptions and observations of atmosphere. SAs were administered morning and afternoon to reflect time-of-day influence and temporal change over four days (one week and one weekend day in both school term and non-term time). Observations were made in auditing zones consistent with OPAT facilitating perception of correlating factors.

Local and national crime statistics (NPIA et al., 2010; HO, 2009) were obtained for an objective analysis of park and park periphery safety.

Park environment equity was examined by comparing OPAT and SA scores and crime statistics for all variables between parks.

Urban Park Facilitation of Park Use and Physical Activity

A PA Counting Tool (PACT) adapted from SOPARC (McKenzie et al., 2006) and SOPLAY tools (McKenzie et al., 2000) was developed. PACT recorded total number of park users categorised by auditor estimated age (<5, 5–10, 11–15, 16–20 and >21 years); and for young people 11–20 years, also, activity intensity (sedentary, moderate and vigorous) and type (i.e. sedentary: sitting or standing). Definitions for age according to observable physical maturation and PA intensity were established to facilitate consistency between observations. Data was collected four times per day consistent with validated observation times (McKenzie et al., 2006) over four days (one week and one weekend day in both school term and non-term time). Six 10 minute observations, in audit zones corresponding with OPAT and SAs, were made per hour. Pre-defined auditing positions were established and marked on park maps to ensure auditing consistency.

Analysis of park use and PA facilitation were made by combining park variable scores from OPAT, SA and Crime Statistics from both parks and stratifying by tertiles. Correlation and regression analysis with graded variable scoring, park user count and young people's activity intensity were assessed.

Statistical Analysis

Normally distributed data underwent comparative analysis using Analysis of Variance (F) and Logistic Regression (r^2). Nonparametric Chi Squared (χ^2), Kruskal-Wallis (w^2) and Mann-Whitney (U) tests were used to explore associations when distribution was not normal. All data was analysed using SPSS Statistics (Version 17).

Results

Food Environment Equity and Healthfulness

Availability of food outlets was significantly different between case study areas (χ^2 =31.589; *P*=0.017) (Table 1). Southville had significantly more variation in types of food outlets than Eastern: 46 outlets (16 outlet types) and 26 outlets (11 outlet types), respectively. Southville had significantly more sit-in food outlets[2] than Eastern (χ^2 =12.122; *P*<0.001) representing 57.4% of total food outlets compared to 15.4%, respectively. Eastern had significantly more convenience food outlets[3] than Southville (χ^2=6.386; *P*=0.012) representing 57.7% of total food outlets compared to 27.7%, respectively.

MFE scores between seasonal analyses were significantly different for Southville (*F*=4.464; *P*=0.038) but not Eastern (*F*=1.056; *P*=0.310). In light of the small and non-significant difference between seasonal scoring and for reporting comprehensiveness, MFE data is reported as a mean score. Healthfulness of FEs were significantly different between areas (*F*=9.917; *P*=0.002) on average favouring the area of greater affluence (Table 1).

---

[2] Sit-in outlets defined as: Restaurants, Pubs, Hotels/Associations, Pizzerias (sit-in), Sandwich shops (sit-in), Cafés, and Leisure Centre's.

[3] Convenience outlets defined as: Convenience stores, Takeaways, Pizzerias (takeaway), Sandwich shops (takeaway), Retail Bakers, and Mobile outlets

Urban Park Environment Equity

Park Environment

Eastern was more environmentally diverse than Southville (χ^2=14.400; *P*=0.002). Presence and density of planting did not significantly differ between parks (χ^2=2.274; *P*=0.132 and χ^2=2.819; *P*=0.420, respectively).

Facilities and Amenities

Exercise facility/amenity provision[4] did not significantly differ between parks (χ^2=1.500; *P*=0.221). Exercise facility/amenity suitability was not significantly different between parks for young people 11–15 (χ^2=1.200; *P*=0.549) or 16–20 years (χ^2=4.000; *P*=0.261). Despite non-significant findings, a number of differences were observed: Southville had fewer playground structures than Eastern (12 and 14, respectively), both parks had six types of equipment. Eastern playground was more age appropriate for young people 11–20 years having more physically challenging structures, as determined by OPAT. Eastern had larger lawns with pitch markings and ranges of gradients. Eastern had two formal sports fields, Southville had none. Southville had superior quality basketball and tennis courts.

Southville had more fixed eating facilities than Eastern (nine and three, respectively); neither park contained water fountain or barbecue facilities. During summer analysis one mobile food outlet was observed in both parks on one study day each. Distribution of signage did not significantly differ between parks (χ^2=0.343; P=0.558). Seating density was higher in Southville than Eastern: 3.57 and 1.25 benches/acre, respectively. Furthermore, Southville had two formal seating zones,

[4] Defined as presence of: Playground equipment, Exercise and Play areas

Eastern only one. Southville contained a public toilet and cycle racks, Eastern did not. Southville had four notice boards, Eastern had only one but advertised park events were better suited to young people.

Maintenance

Park maintenance was significantly different between parks (w^2=22.759; P=0.001); Southville Park was better and more consistently maintained (mean 91.53%; SD 6.68) than Eastern Park (mean 76.40%; SD 11.16). Park zones with highest maintenance scores also showed greatest maintenance consistency.

Safety

Evidence of anti-social behaviour was significantly different between parks favoring Southville (χ^2 44.509; P<0.001). Presence of park staff favored Southville however, difference failed to reach significance (χ^2 1.294; P=0.255). Local and national crime statistics yielded contrary results with Eastern listed as safer in national but less safe in local statistical data and Southville vice-versa.

Presence of fixed safety features (comprising: CCTV, lighting and fixed telephones) was not significantly different between parks (w^2 0.967; P=0.325). Southville had a greater density of lighting than Eastern 4.71 and 1.15 lights/acre, respectively; resultant in improved visibility outside daylight hours perceived in SAs to convey better safety. Neither park had fixed telephones but both had good mobile phone reception.

Aesthetic Value

Aesthetic value of the two parks significantly differed (χ^2=69.704; P<0.001). Southville consistently scored higher with lower standard deviation than Eastern indicating a more aesthetically pleasing and a more consistent quality of aesthetics. Both parks scored

significantly higher in summer than winter analyses; Southville χ^2=25.491 P=0.002 and Eastern χ^2=22.644; P=0.046.

Urban Park Facilitation of Park Use and Physical Activity

Park Use

Young people, of auditor estimated 11–20 years, represented 19% of total observed park users in Southville Park and 37% in Eastern Park (Table 2). Of all young people observed in Southville Park 68% were 11–15 years and 32% 16–20 years; 67% of total young people observed were male. In Eastern Park 59% of young people observed were 11–15 years and 41% 16–20 years. Marginally more males (56%) than females (44%) were observed. More total park users were observed in Southville however, as a percentage of total users Eastern had more young users.

Season was significantly associated with park use for young people 11–15 years (w^2=16.510; P<0.001) and 16–20 years (w^2=8.971; P=0.003). Significantly more users were observed in summer. Time of observation was significantly associated with use for those 11–15 (w^2=37.435; P<0.001) and 16–20 years (w^2=29.742; P<0.001). Regression analysis showed significant positive correlation between increasing time and use for 11–15 year olds in Southville (r^2=0.130; P=0.012) and Eastern (r^2=0.192; P=0.002). No correlation was observed between time and use for 16–20 year olds in Southville (r^2=0.063; P=0.086) or Eastern (r^2=0.070; P=0.069).

Variance in park use was not explained by environmental diversity, exercise facility presence or suitability, maintenance, safety or aesthetic value variables in 11–15 year olds (Table 3). Environmental diversity, exercise facility presence and safety variables showed significant negative correlation with park use in 16–20 year olds

r^2=0.069; *P*=0.010; r^2=0.071; *P*=0.008 and r^2=0.074; *P*=0.007, respectively. For all other park users all park variables were significantly associated with park use (Table 3).

Physical Activity

The majority of young people observed within parks were moderately active: 75% and 90% of 11–15 year olds, and 89% and 95% of 16–20 year olds, in Southville and Eastern Parks respectively (Figure 1). No young people were observed being vigorously active in Eastern Park.

In 11–15 year olds variance in sedentary behaviour was significantly associated with exercise facility suitability and maintenance (Table 4). Regression analysis showed significant negative correlation with exercise facility suitability (r^2=0.076; *P*=0.007), maintenance showed no correlation (r^2=0.033; *P*=0.077). In 16–20 year olds variance in moderate intensity activity was significantly associated with environmental diversity, exercise facility presence and safety variables (Table 4). Regression analysis showed significant negative correlation with variables r^2=0.067; *P*=0.011; r^2=0.076; *P*=0.007 and r^2=0.057; *P*=0.019, respectively.

Discussion

Inequity in obesogenic determinants in food and physical environments observed in this detailed case study are broadly consistent with deprivation amplification and are incompatible with national and local strategy for health equity in the UK.

Food Environment

Despite the small sample size, this research found FEs of two socially and economically disparate areas to be significantly different, favouring the area of greater affluence both with regards food outlet provision and healthfulness of food outlets. Findings are consistent with deprivation amplification and food desert research which asserts

constrained access and availability to high quality nutritive food for those living in areas of deprivation (Walker et al., 2010; Macintyre, 2007). Results show some complementarity with other studies from the UK observing greater density of multiple supermarkets and specialist traditional food outlets in affluent areas and a greater density of discount stores in deprived areas (White et al., 2004; Cummins and Macintyre, 1999).

Literature consistently correlates convenience outlet accessibility with elevated weight status with convenience outlets characteristically offering constrained availability of healthful foods (i.e. comparatively to supermarkets and specialist food outlets) (Howard et al., 2011; Bodor et al., 2010; Fraser and Edwards, 2010). The area of greater deprivation in this case study had greater ease of access to convenience outlets and poorer outlet healthfulness – potentiating negative FE influence on consumption behaviour, though to fully explicate this purchase behaviour information would be required.

Methodological strengths of the FE analysis were: two-pronged approach accounting for food outlet access and outlet healthfulness; use of direct observation – shown to yield robust data (Lake et al., 2012; Lake et al., 2010); and data duplication across seasons accounting for seasonality. Limitations include the lack of data for consumption and purchase behaviour impeding comment beyond access and availability which are not the only influences on consumption behaviour (Sinclair and Winkler, 2008; Stevenson et al., 2007). Lack of definitive MFE healthfulness cut off scores limit healthfulness inferences to ‘more’ or ‘less’ healthful rather than ‘healthy’ and ‘unhealthy’.

Urban Park Environment Equity

Significant physical environment differences were observed between case study parks. Environmental diversity favoured Eastern (deprived area); maintenance, absence of anti-social behaviour and aesthetics favoured Southville (affluent area); exercise facilities/amenities did not definitively favour either park. Findings corroborate deprivation amplification with the urban green space located in a more deprived area not disadvantaged by environmental resources but having poorer aesthetics and safety (Macintyre, 2007; Macintyre, 2000; Macintyre and Ellaway, 1998). These variables potentiate predisposition to poorer health status in line with factors implicated in the encouragement of active living previously discussed. In short environmental resource provision may be offset by less favourable environmental conditions inhibitory of park use and active behaviour.

Urban Park Facilitation of Park Use and Physical Activity

A greater proportion of male young people were observed in both parks consistent with trends in literature nationally and internationally (Loukaitou-Sideris and Sideris, 2010; Jones et al., 2009; Sallis et al., 2000). This may indicate a role of urban parks in the gender influence on PA participation. As a percentage of total park users more young people were observed in Eastern than Southville moreover, those observed were marginally more moderately active and fewer sedentary. Results may indicate greater reliance on low cost recreation facilities in deprived areas which is in line with Canadian findings (Pabayo et al., 2011; Castonguay and Jutras, 2009; Humbert et al., 2006). Furthermore, there were more 11–15 than 16–20 year old park users which may indicate preference for low cost socialisation and recreational activities in younger adolescents however, without leisure activity data from young people postulations remain supposition.

In this case study park usage and activity intensity in young people (11–20 years) did not consistently correlate with park variables. It may be that associations failed to reach significance due to small number of target population observed, or may indicate that no single variable principally or consistently attracts young people to parks or facilitates PA. Alternately there may be a determining variable beyond the scope of study.

In this study environmental diversity negatively correlated with park use and moderate activity intensity in 16–20 year olds which is in contrast to findings from Loukaitou-Sideris and Sideris (2010). Lloyd et al., (2008) found gender association with environmental diversity and park use; though this was not corroborated, in this case study association was marginally stronger in females (w^2=2.962 P=0.227) than males (w^2=2.323; P=0.313). Opposed to findings from the US (Loukaitou-Sideris and Sideris, 2010; Cohen et al., 2009) park size showed negative correlation with use – Southville had 2.6 times as many users despite being one third of the size.

Exercise facility/amenity presence negatively correlated with park use and moderate activity intensity in 16–20 year olds in this study. In contrast to findings from Norman et al. (2006), no association was found in young people 11–15 years. Exercise facility suitability negatively correlated with sedentary behaviour in 11–15 year olds; this is an intuitive and encouraging result – in park zones where age appropriate exercise facilities were present more young people were active indicating utility of parks for PA. Playground equipment is consistently shown to be of greater import to young children than young people (Timperio et al., 2008; Veitch et al., 2007; Veitch et al., 2006). This trend was corroborated in this research with 280 and 165 children (0–10 years) and 99 and 148 young people (11–20 years) observed within park zones containing playground equipment in Southville and Eastern, respectively. Greater

counts of children and young people 11–15 years in Southville and Eastern playgrounds correlate with equipment age appropriateness, determined by OPAT.

Maintenance was not associated with park use in young people opposed to findings from the US (Ries et al., 2009). Association was however observed between sedentary behaviour and park maintenance in 11–15 year olds though this correlation did not reach significance. It is reasonable to assume that this association is between increased likelihood of extended time spent in park (i.e. being sedentary) and good maintenance, however this was not explicated.

Objective researcher perceptions of park safety concurred with literature positively correlating: visibility, presence of fixed safety features with total park user numbers. However, though association was observed with park safety and young people 16–20 years correlation was counterintuitive – negative association with increasing safety. This remained unexplained. For young people 11–15 years lack of correlation is in line with literature showing personal safety is not a significant predictor of outdoor play in younger adolescents (Davidson et al., 2010; Page et al., 2010).

Aesthetic value was not associated with park use or activity intensity in this study. This contradicts studies of young people in the EU (Mota et al., 2005), Australia (Gill and Simeoni, 1995) and North America (Ries et al., 2008; Veitch et al., 2007).

Strengths of this study were: the mixed-methods in depth case study approach enabling thorough analysis of the park environment; direct observation by a single researcher limiting researcher bias; and development of bespoke audit tools. Limitations include the use of small scale cross sectional approach impeding elucidation of causal associations; limited data replication impeding generalizability; and single researcher observation impeded same-day study introducing bias by external park usage factors (i.e. weather). The observation only approach further introduced bias by researcher

subjectivity especially age estimation of park users, despite predefined definitions and training age-estimations were challenging especially in low lighting and at a distance. Lack of park user perceptions represents a significant limitation to this study in light of the importance of environmental perceptions. The creation of bespoke audit tools augments research method heterogeneity within this field and limits comparison with existing studies. Finally, park use and PA facilitators in urban parks are assumed from association and correlate measures of park variables. Whether such assertion can be made from isolated characteristics is questionable in light of their inter-relatedness. Exploration of this requires perception, opinion and value data from young people in conjunction with behavioural data.

Conclusion

Findings in this study generally support the concept of deprivation amplification both with regards the food and physical environment. Access to food outlets and availability of healthful food environments was shown to favour the area of greater affluence. Constrained access and availability to healthful foods can result in poor diet quality and undesirable weight outcomes (Auld & Powell, 2009; Powell & Bao, 2009; Rose et al., 2009); suggestive of environmental disadvantage for those using the park facilities in the more deprived area in this case study.

In this case study young people, estimated to be 11–20 years, were shown to underutilise urban parks for vigorous activity indicating significant potential for intervention by professionals from health and planning especially pertinent in light of low levels of adherence to PA recommendations in UK young people. Factors influencing park use and young people's activity were not explored in this study however; evidence suggests the importance of environmental diversity, exercise facilities and/or amenities and safety beyond that of maintenance and aesthetics

variables. If these factors are of greater importance there is a need for emphasis in planning policy. To fully explicate these findings more joined-up observational and perception and value explication from young people is required.

Finally, health and planning policy in the UK has committed to provide equitable health facilitating food and physical environments at national and local levels; this research highlights a failure to achieve commitments in case study areas. Consequentially there is further casual evidence for health inequity according to area deprivation.

Acknowledgments:

We acknowledge Antony McKenna, Newcastle City Council and park management staff for cooperation with study. Research was supported by a grant from the Economic and Social Research Council in association with North East Public Health Observatory.

References

Basterfield, L., Adamson, A. J., Parkinson, K. N., Maute, U., Li, P. X., Reilly, J. J. and GMS, Gateshead Millenium Study Core Team, 2008. Surveillance of physical activity in the UK is flawed: validation of the Health Survey for England Physical Activity Questionnaire. *Archives of Disease in Childhood,* 93 (12), 1054-1058.

Bodor, J., Rice, J., Farley, T., Swalm, C. and Rose, D., 2010. 'The Association between Obesity and Urban Food Environments. *Journal of Urban Health,* 87 (5), 771-781.

Butland, B., Jebb, S., Kopelman, P., McPherson, K., Thomas, S., Mardell, J. and Parry, V., 2007. *FORESIGHT Tackling Obesities: Future Choices – Project Report.* London: The Stationary Office.

Carter, M. A. and Dubois, L., 2010. Neighbourhoods and child adiposity: A critical appraisal of the literature. *Health & Place,* 16 (3), 616-628.

Castonguay, G. and Jutras, S., 2009. Children's appreciation of outdoor places in a poor neighborhood. *Journal of Environmental Psychology,* 29 (1), 101-109.

Cohen, D. A., Marsh, T., Williamson, S., Derose, K. P., Martinez, H., Setodji, C. and McKenzie, T. L., 2009. Parks and physical activity: Why are some parks used more than others?. *Preventive Medicine,* 50 (Supplement 1), S9-S12.

Craigie, A. M., Lake, A. A., Kelly, S. A., Adamson, A. J. and Mathers, J. C., 2011. Tracking of obesity-related behaviours from childhood to adulthood: A systematic review. *Maturitas,* 70, 266-284.

Cummins, S. and Macintyre, S., 1999. The Location of Food Stores in Urban Areas: A Case Study in Glasgow. *British Food Journal,* 101, 545-553.

Davidson, Z., Simen-Kapeu, A. and Veugelers, P. J., 2010. Neighborhood determinants of self-efficacy, physical activity, and body weights among Canadian children. *Health & Place,* 16 (3), 567-572.

DH, Department of Health, 2004. Choosing Health: Making Healthy Choices Easier. London: The Stationary Office.

Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F. and Schwartz, B. S., 2010. The built environment and obesity: A systematic review of the epidemiologic evidence. *Health & Place,* 16 (2), 175-190.

Floyd, M. F., Spengler, J. O., Maddock, J. E., Gobster, P. H. and Suau, L. J., 2008. Park-Based Physical Activity in Diverse Communities of Two U.S. Cities: An Observational Study. *American Journal of Preventive Medicine,* 34 (4), 299-305.

Fraser, L. K. and Edwards, K. L., 2010. The association between the geography of fast food outlets and childhood obesity rates in Leeds, UK. *Health & Place,* 16 (6), 1124-1128.

Gallo, R. G., Townshend, T. and Lake, A., In preparation. Measuring the Park Environment – Development of an Observational Park Audit Tool.

Gill, B. and Simeoni, E., 1995. Residents' perceptions of an environmental enhancement project in Australia. *Health Promotion International,* 10 (4), 253-259.

Handy, S., 2004. Community Design and Physical Activity: What Do We Know? - and what DON'T we know? *National Institute of Environmental Health Sciences conference on Obesity and the Built Environment: Improving Public Health through Community Design. Washington, DC.*

Hill, J. O. and Peters, J. C., 1998. Environmental Contributions to the Obesity Epidemic. *Science,* 280 (5368), 1371-1374.

HO, Home Office, 2009. Crime in England and Wales 2008/09 Findings from the British Crime Survey and police recorded crime. London: The Stationary Office.

Howard, P., Fitzpatrick, M. and Fulfrost, B., 2011. Proximity of food retailers to schools and rates of overweight ninth grade students: an ecological study in California. *BMC Public Health,* 11 (1), 68.

Humbert, L. M., Chad, K. E., Spink, K. S., Muhajarine, N., Anderson, K. D., Bruner, M. W., Girolami, T. M., Odnokon, P. and Gryba, C. R., 2006. Factors That Influence Physical Activity Participation Among High- and Low-SES Youth. *Qualitative Health Research,* 16, 467-483.

Jones, A., Coombes, E., Griffin, S. and van Sluijs, E., 2009. Environmental supportiveness for physical activity in English schoolchildren: a study using Global Positioning Systems. *International Journal of Behavioral Nutrition and Physical Activity,* 6 (1), 42.

Kelly, R., Miliband, D., Darling, A. and Alexander, D., 2007. *Planning for a Sustainable Future White Paper.* London: The Stationary Office.

Kestens, Y., Lebel, A., Daniel, M., Thériault, M. and Pampalon, R., 2010. Using experienced activity spaces to measure foodscape exposure. *Health & Place,* 16 (6), 1094-1103.

Lachowycz, K., Jones, A. P., Page, A. S., Wheeler, B. W. and Cooper, A. R., In press. What can global positioning systems tell us about the contribution of different types of urban greenspace to children's physical activity?. *Health & Place*.

Lake, A., Burgoine, T., Stamp, E. and Grieve, R., 2012. The foodscape: classification and field validation of secondary data sources across urban/rural and socio-economic classifications in England. *International Journal of Behavioral Nutrition and Physical Activity,* 9 (1), 37.

Lake, A., Tyrrell, R., Greenhalgh, F., Adamson, A. and Mathers, J., Under Review. Measuring the food environments of young adults: the development and validation process of four survey tools.

Lake, A. A., Burgoine, T., Greenhalgh, F., Stamp, E. and Tyrrell, R., 2010. The foodscape: Classification and field validation of secondary data sources. *Health & Place,* 16 (4), 666-673

Lake, A. A., Mathers, J. C., Rugg-Gunn, A. J. and Adamson, A. J., 2006. Longitudinal change in food habits between adolescence (11-12 years) and adulthood (32-33 years): the ASH30 Study. *Journal of Public Health*, 28, 10-16.

Lake, A. A., Townshend, T., Alvanides, S., Stamp, E. and Adamson, A. J., 2009. Diet, physical activity, sedentary behaviour and perceptions of the environment in young adults. *Journal of Human Nutrition & Dietetics*, 22, 444-454.

Loukaitou-Sideris, A. and Sideris, A., 2010. What Brings Children to the Park? Analysis and Measurement of the Variables Affecting Children's Use of Parks. *Journal of the American Planning Association,* 76 (1), 89-107.

Lytle, L. A., 2009. Measuring the Food Environment State of the Science. *American Journal of Preventive Medicine,* 36 (4), S134-S144.

Maas, J., Verheij, R. A., Groenewegen, P. P., de Vries, S. and Spreeuwenberg, P., 2006. Green Space, Urbanity, and Health: How Strong is the Relation?. *Journal of Epidemiology and Community Health,* 60 (7), 587-592.

Macintyre, S., 2000. The social patterning of exercise behaviours: the role of personal and local resources. *British Journal of Sports Medicine* 34 (1), 6.

Macintyre, S., 2007. Deprivation amplification revisited; or, is it always true that poorer places have poorer access to resources for healthy diets and physical activity?. *International Journal of Behavioral Nutrition and Physical Activity*, 4 (1), 32.

Macintyre, S. and Ellaway, A., 1998. Social and local variations in the use of urban neighbourhoods: a case study in Glasgow. *Health & Place,* 4 (1), 91-94.

McCormack, G. R., Rock, M., Toohey, A. M. and Hignell, D., 2010. Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health & Place,* 16 (4), 712-726.

McKenzie, T. L., Cohen, D. A., Sehgal, A., Williamson, S. and Golinelli, D., 2006. 'System for Observing Play and Recreation in Communities (SOPARC): Reliability and Feasibility Measures. *Journal of Physical Activity and Health* 3 (Supplement 1), S208-S222.

McKenzie, T. L., Marshall, S. J., Sallis, J. F. and Conway, T. L., 2000. Leisure-Time Physical Activity in School Environments: An Observational Study Using SOPLAY. *Preventive Medicine,* 30 (1), 70-77.

McLure, S. A., Summerbell, C. D. and Reilly, J. J., 2009. Objectively measured habitual physical activity in a highly obesogenic environment. *Child: Care, Health and Development,* 35 (3), 369-375.

McMillan, T., Cubbin, C., Parmenter, B., Medina, A. and Lee, R., 2010. Neighborhood sampling: How many streets must an auditor walk?. *International Journal of Behavioral Nutrition and Physical Activity,* 7 (1), 20.

Mota, J., Almeida, M., Santos, P. and Ribeiro, J. C., 2005. Perceived Neighborhood Environments and physical activity in adolescents. *Preventive Medicine,* 41 (5-6), 834-836.

NHS IC, National Health Service Information Centre and LS, Lifestyle Statistics, 2010. *National Child Measurement Programme: England, 2009/10 school year.* London: The Stationary Office.

NPIA, National Policing Improvement Agency, ACPO, Association of Chief Police Officers, APA, Association of Police Authorities and HO, Home Office, 2010. *Local Crime Mapping* [online]. Available from: http://maps.police.uk/ [Accessed 2 July 2010].

ONS, Ofice for National Statistics, 2007. *Indices of deprivation 2007 for super output areas* [online]. Available from: http://www.neighbourhood.statistics.gov.uk [Accessed: 19 April 2010].

Pabayo, R., Belsky, J., Gauvin, L. and Curtis, S., 2011. Do area characteristics predict change in moderate-to-vigorous physical activity from ages 11 to 15 years?. *Social Science & Medicine,* 72 (3), 430-438.

Page, A., Cooper, A., Griew, P. and Jago, R., 2010. Independent mobility, perceptions of the built environment and children's participation in play, active travel and structured exercise and sport: the PEACH Project. *International Journal of Behavioral Nutrition and Physical Activity,* 7 (1), 17.

Palma, A. and Lüdorf, S. M. A., 2010. Towards rethinking the discourse on obesity. *Obesity reviews,* 11 (1), 62.

Rahman, T., Cushing, R. A. and Jackson, R. J., 2011. Contributions of Built Environment to Childhood Obesity. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine,* 78 (1), 49-57.

Ries, A., Gittelsohn, J., Voorhees, C., Roche, K., Clifton, K. and Astone, N., 2008. The environment and urban adolescents' use of recreational facilities for physical activity: a qualitative study. *American Journal of Health Promotion,* 23 (1), 43-50.

Ries, A. V., Voorhees, C. C., Roche, K. M., Gittelsohn, J., Yan, A. F. and Astone, N. M., 2009. A Quantitative Examination of Park Characteristics Related to Park Use and Physical Activity Among Urban Youth. *Journal of Adolescent Health,* 45 (3, Supplement 1), S64-S70.

Sallis, J., Prochaska, J. and Taylor, W., 2000. A Review of Correlates of Physical Activity of Children and Adolescents. *Medicine and Science in Sports and Exercise,* 32, 963-975.

Sinclair, S. and Winkler, J. T., 2008. The School Fringe: What secondary school pupils buy from shops around their schools. Key Findings [online]. Available from: http://www.londonmet.ac.uk/londonmet/library/z13371_3.pdf [Accessed: 7 January 2010].

SSH, Secretary of State for Health, 2010. Healthy Lives, Healthy People: Our Strategy for Public Health in England. London: The Stationary Office.

Stevenson, C., Doherty, G., Barnett, J., Muldoon, O. T. and Trew, K., 2007. Adolescents' views of food and eating: Identifying barriers to healthy eating. *Journal of Adolescence,* 30 (3), 417-434.

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O. and Raitakari, O., 2005. Physical activity from childhood to adulthood: A 21-year tracking study. *American Journal of Preventive Medicine,* 28 (3), 267-273.

Timperio, A., Giles-Corti, B., Crawford, D., Andrianopoulos, N., Ball, K., Salmon, J. and Hume, C., 2008. Features of public open spaces and physical activity among children: Findings from the CLAN study. *Preventive Medicine,* 47 (5), 514-518.

Townshend, T. and Lake, A. A., 2009. Obesogenic urban form: Theory, policy and practice. *Health & Place,* 15 (4), 909-916.

Veitch, J., Bagley, S., Ball, K. and Salmon, J., 2006. Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health & Place,* 12 (4), 383-393.

Veitch, J., Salmon, J. and Ball, K., 2007. Children's perceptions of the use of public open spaces for active free-play. *Children's Geographies,* 5 (4), 409-422.

Walker, R. E., Keane, C. R. and Burke, J. G., 2010. Disparities and access to healthy food in the United States: A review of food deserts literature. *Health & Place,* 16 (5), 876-884.

Ward Thompson, C., 2011. Linking landscape and health: The recurring theme. *Landscape and Urban Planning,* 99 (3-4), 187-195.

White, M., Bunting, J., Williams, L., Raybould, S., Adamson, A. J. and Mathers, J., 2004. Do Food Deserts Exist? A Multi-Level, Geographical Analysis of the Relationship between Food Access, Socioeconomic Position and Dietary Intake. London: Food Standards Agency.

Table 1: Food environment equity results for two areas: outlet count, mean and standard deviation (SD) MFE score are grouped by area and outlet classification

Food Outlet Type	Southville			Eastern		
	Count outlets	MFE score	SD	Count outlets	MFE score	SD
Restaurant	5	44.22	6.03	0		
Pub/Bar	6	37.85	2.58	1	37.60	3.39
Hotel/Association	2	40.50	4.70	0		
Pizzeria sit-in	4	44.90	4.19	0		
Pizzeria takeaway	2	39.45	4.65	0		
Sandwich shop sit-in	4	45.89	6.35	0		
Sandwich shop takeaway	2	46.17	3.35	1	33.90	N/A*
Café/Coffee shop	5	45.88	5.68	2	37.75	8.03
Takeaway food	5	39.87	3.17	5	34.21	10.11
Convenience store	2	32.58	2.88	7	33.78	7.64
Supermarket	2	44.68	4.90	1	29.30	0.14
Specialist traditional	1	44.65	2.19	0		
Mobile outlet	1	36.90	N/A*	1	38.50	N/A*
Baker retail	1	32.55	2.47	1	32.60	2.4
Pharmacy	1	41.90	4.81	1	40.00	2.12
Non-food store	3	39.78	3.60	1		
Health & Leisure	0			1	55.25	12.8
Vending	0			5	45.94	13.4

** Standard deviation not given where data missing or not present between seasonal analyses*
*** A higher MFE score is indicative of a healthier food environment*

Table 2: Park user demographics

Park	Total park users count	Park users 11–15 years	Park users 16–20 years	Males 11–20 years	Females 11–20 years
Southville	3832	497	234	489	242
Eastern	1284	281	198	268	211

Table 3: Variance in park use of young people 11–15 and 16–20 years and all other park users according to environmental diversity, exercise facility presence, exercise facility suitability, maintenance, safety and aesthetic value (w^2 and (P) values)

Variable	11–15 years	16–20 years	All other users
Environmental diversity	3.368 (0.186)	9.107 (0.011)	30.132 (<0.001)
Exercise facility presence	1.891 (0.169)	5.224 (0.022)	11.101 (0.001)
Exercise facility suitability	2.840 (0.242)	3.763 (0.288)	N/A
Maintenance	1.025 (0.599)	0.0545 (0.762)	16.365 (<0.001)
Safety	3.226 (0.199)	7.765 (0.021)	20.917 (<0.001)
Aesthetic value	0.827 (0.661)	0.175 (0.916)	20.210 (<0.001)

Table 4: Variance in activity intensity of young people 11–15 and 16–20 years according to environmental diversity, exercise facility presence, exercise facility suitability, maintenance, safety and aesthetic value (w^2 and (P) values)

Variable	Sedentary	Moderate	Vigorous
Environmental diversity			
11–15 years	2.707 (0.258)	3.561 (0.169)	0.404 (0.817)
16–20 years	2.035 (0.362)	9.928 (0.007)	0.404 (0.817)
Exercise facility presence			
11–15 years	2.185 (0.139)	1.817 (0.178)	0.269 (0.604)
16–20 years	2.198 (0.138)	5.088 (0.024)	1.011 (0.315)
Exercise facility suitability			
11–15 years	6.419 (0.040)	2.859 (0.239)	5.159 (0.076)
16–20 years	3.364 (0.339)	3.514 (0.319)	1.011 (0.799)
Maintenance			
11–15 years	8.071 (0.018)	0.499 (0.779)	2.021 (0.364)
16–20 years	3.519 (0.172)	0.503 (0.777)	2.021 (0.364)
Safety			
11–15 years	5.581 (0.061)	2.482 (0.289)	1.832 (0.400)
16–20 years	4.177 (0.124)	7.459 (0.024)	1.922 (0.382)
Aesthetic value			
11–15 years	0.849 (0.654)	0.635 (0.728)	1.444 (0.486)
16–20 years	1.875 (0.391)	0.052 (0.974)	1.444 (0.486)

Figure 1: Number of young people in Southville and Eastern Parks grouped by age and activity intensity