Physical activity patterns of ethnic children from low socio-economic environments within the UK

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ABSTRACT

Many children fail to meet physical activity (PA) guidelines for health benefits. PA behaviours are complex and depend on numerous interrelated factors. The study aims to develop current understanding of how children from low Socio-economic environments within the UK, use their surrounding built environments for PA by using advanced technology. The environment was assessed in 96 school children (7 – 9 years) using GPS monitoring (Garmin Forerunner, 305). In a subsample of 46 children, the environment and physical activity was assessed using an integrated GPS and heart rate monitor. The percentage of time spent indoor, outdoor, in green and non-green environments along with time spent in MVPA in indoor and outdoor environments were assessed. A 2-by-2 repeated measures ANCOVA, controlling for BMI, BF%, assessed environmental differences. The findings show that 42% of children from deprived wards of Coventry fail to meet PA guidelines, of which 43% was accumulated during school. Children engaged in more MVPA outdoor than indoor environments ($p < 0.01$) and a greater amount of time was spent in non-green environments ($p < 0.01$). Increased time outdoors was negatively associated with BF%. In conclusion, outdoor environments are important for health enhancing PA and reducing fatness in deprived and ethnic children.

Keywords: Deprivation, South Asian, Fatness, Youth

1. INTRODUCTION

Large numbers of children are still obese and continue to have obesity related complications, causing a global health burden (WHO, 2010). The benefits of engaging in physical activity for weight management (Reichert, Baptista Menezes, Wells, Dumith & Curi Hallal, 2009), physiological and psychological health is well acknowledged (Janssen & LeBlanc, 2010; WHO, 2010). Children who engage in more physical activity have less adiposity and improved cardiovascular risk profiles (Andersen Riddoch, Kriemler & Hills, 2011). However, many children fail to meet the recommended 60 minutes of health enhancing physical activity per day, and even fewer when ethnicity (e.g. South Asian is considered (Eyre & Duncan, 2013; Eyre, Duncan, Smith & Matyka, 2013a; Owens et al., 2009).

The determinants of physical activity behaviour are complex and depend upon a number of factors including socio-economic status and environmental influences. The built environment refers to all features that children encounter in their neighbourhood (i.e. roads, buildings, recreational facilities) (Sallis & Glanz, 2006) and these features are associated with inactive/unhealthy behaviours (Mota, Santoa, Pereira, Teixeira & Santos, 2011; Swinburn et al., 2011; Zhu & Lee, 2009). Understanding how aspects of the environment shape physical activity and obesity is important because children spend a large proportion of their time in these environments, playing, living and being educated.

However, a systematic review by Dunton, Kaplan, Wolch, Jerrett & Reynolds, (2009) reports there is no strong empirical evidence for most environmental factors noting a lack of consistency in results and variances dependent upon population, age and socio-economic status. For example, the neighbourhood where an individual resides is affected by socio-economic status (Fernandes & Sturm, 2010; Kimbro, Brooks-Gunn & McLanahans, 2011) but the findings are equivocal. In some studies, low socio-economic areas are associated with greater public open spaces, increased amenities (i.e. cycle paths and trees) (Crawford et al., 2008), and increased walkability, thus increasing physical activity (De Meester, van Dyck, Bourdeaudhuiji, Deforche & Cardon, 2012, De Meester et al., 2013; Kimbro et al., 2011; Zhu & Lee, 2008). In others, low socio-economic status are associated with reduced physical activity (Bolte, Tamburlini & Kohlhuber, 2010; Griew, Page, Thomas, Hulsdon & Cooper, 2010; Pabayo, Belsky, Gauvin & Curtis, 2011; Panter, Jones, van Sluijs & Griffin, 2010; Spengler et al., 2011), the causes of which may in part relate to poorer access and provision of playground facilities.

Secondly, ethnicity is also a key socio-demographic variable that needs considering. Ethnicity appears to be associated with deprivation but the direction of these effects are also conflicting (Conrad et al., 2013; Franzini et al., 2010). In non-white neighbourhoods, Franzini et al. (2010) reported increased poverty, increased access to facilities for physical activity but low parental perceptions of these environments (i.e. less safe, comfortable and pleasurable for outdoor physical activity). However, Conrad et al. (2013) suggests that children in low socio-economic areas spend more time outdoors.

The lack of consistency in the role of the environment on physical activity patterns across studies may be due to methodological weaknesses and failure to account for the combined influences relating to the population and socio-economic status (Dunton et al., 2009). Scarce previous research has explored socio-economic status and ethnic differences in the physical activity of youth by objectively tracking young people's movement patterns. Using global positioning system monitoring allows the researcher a detailed insight into how youth from differing ethnic backgrounds may utilise their surrounding built environment for physical activity.

Furthermore, the wealth of information comes from non-UK studies and so the direct application in terms of built environments, socio-economic status and ethnic groups in the UK is limited. In order to undertake such a study within the UK, geographical areas are needed that have high levels of deprivation and an ethnic mix. In the UK, people from South Asian backgrounds have been described as living in the most socio-economically disadvantaged areas (Jayaweera, Hockely, Redshaw & Quigley. 2007; Williams, Steptoe, Chambers & Kooner, 2009). Coventry is ranked 52nd out of 326 local authority districts (1 being most deprived). In comparison to England as whole, the ethnic population of Coventry is increased (17% black and 6% Asian vs 26% and 12% Asian for England and Coventry respectively), with large ethnic populations residing in the most deprived areas (Coventry City Council, 2010). In the two most deprived wards in Coventry (Foleshill and St Michaels), Asian and Black people make up 34 - 58% of the total population. In addition, studies objectively measuring physical activity in Coventry have found that 67% of all children meet the current physical activity guidelines, but this adherence is lowered in South Asian children (35%) (Eyre et al., 2013a). Therefore, the primary aim of this study was to develop current understanding of how children from a low socio-economic area within the UK use their surrounding built environments for physical activity by using advanced technology (global positioning system). The secondary aim was to consider how ethnicity might impact on the primary aim.

2. METHOD

An observational design was employed to collect information on 96 primary school children's (7 - 9 years, white = 24, South Asian (Indian, Pakistani, Bangladeshi) = 60, other = 12) physical activity patterns during winter (23rd Jan 2012 - 13th Feb 2012). Data were collected from the two most deprived wards in Coventry with similar socio-economic status, UK (Coventry City Council, 2010). Schools were recruited using cluster sampling at ward level (two most deprived). Two schools (out of 5) participated as they represented 50% (113 out of 225 children available) of the primary school children aged 7 - 9 years within the geographical area. The second school within the two clusters were invited to participate. Once schools had agreed to participate, children within those schools were asked to participate. Study information was presented to the school, the children and their parents during an information session. A translator was present to communicate with parents whose first language was not English. Informed consent and assent was obtained from all children and parents. The protocol and procedures were reviewed and approved by Coventry University Ethics Committee.

2.1 Body Fatness

All measures were taken in light indoor clothing and bare feet. Stature was measured using a stadiometer (Leicester portable height measure, UK) to the nearest 1mm. Body mass was measured to the nearest 0.1kg using weighing scales (Tanita, Tokyo Japan, BF350). BMI was determined as kg/m2 and 1990 British reference curves for age-and-sex were used to identify overweight and obese children (Cole, Freeman & Preece, 1995; Cole & Pan, 1999). Overweight was defined as 85th centile and obesity defined as 95th in accordance with epidemiological monitoring (Cole & Pan, 1999). Waist circumference was measured using a non-stretchable tape midway between the 10th rib and the superior iliac crest. Leg to leg bioelectrical impedance was also used to determine the body fat % of participants. All measurements were conducted in the morning at least two hours following breakfast and with an empty bladder in light sports clothing in accordance with the leg to leg protocol in Sung, Lau, Yu, Lam & Nelson, (2001) validation paper. The stature and age of the child were input into the leg to leg bioelectrical impedance analyser (Tanita, Tokyo Japan, BF350). This is a reliable, acceptable and validated method for assessing body fat % in children (Sung et al., 2001; Tyrell et al., 2001).

2.2 Measurement of the environment and PA

The measurement of location was determined using a global positioning system device. This was synchronised and wirelessly connected with a heart rate monitor to measure PA (Garmin Forerunner 305, Garmin Ltd, USA), sampled at 10 second epochs. Global positioning system monitoring is a reliable measure of physical activity (Maddison et al., 2010) with its feasibility in both British (Collins, Al-Nakeeb, Nevill & Lyons, 2012) and international children reported (Duncan, Badland & Schofield, 2009; Fjortoft, Kristoffersen & Sageie, 2009; Fjortoft, Lofman & Thoren, 2010).

2.3 Procedure

The global positioning system devices were fitted to a wrist of all consented children at school on the initial wear day. Due to limitations, we were able to monitor heart rate in a subsample of 46 only. The heart rate monitor (Garmin Forerunner 305, Garmin Ltd, USA) was fitted around the chest at the sternum and tightened accordingly. All participants wore the monitor for 4 consecutive days including two weekend days (Friday, Saturday, Sunday, Monday) from 9:00am to 9:00pm. Any participants that did not record four days monitoring data were omitted. The reliability of a 4 day and 10-hour monitoring period of physical activity in children is reported

(Riddoch, 2004; Penpraze et al., 2006). Data were included in the analysis if there was 180 minutes of data for at least 1 day, this is consistent with previous global positioning system monitoring in British children (Collins et al., 2012). At this stage, 23 children failed to record 180 minutes global positioning system data. This left a final sample of 73 children (76% response rate) of which 9 were from other backgrounds and so data will be presented on 64 children from White or South Asian backgrounds. From the children excluded from the final analysis, 25% were overweight/obese. This is consistent with overweight and obesity data from the National Child Measurement programme for England and Coventry (NHS, 2010) and thus fatness is not deemed a bias in this physical activity study relating to lack of compliance. All the global positioning system units were given a cold start (initialised) in a stationary outdoors environment as recommended by Duncan and Mummery (2007). This took no longer than 1 minute (Maddison et al., 2010). Participants were instructed to remove the monitor for water based activity and sleeping. The battery on the global positioning system monitor operates a short life of 12 - hours and consequently the monitors needed to recharge at home during sleeping periods. Children and parents were shown how to charge the monitors and reminder instructions were sent home.

2.4 Global positioning system analysis

The data were downloaded from the monitor to the Garmin training centre and Garmin connect (Garmin Ltd, USA) where they were converted to the KML format. The KML file containing the data were manually cleaned for erroneous data points, mapped and analysed in ArcGIS 10 (ESRI, CA, USA) for time spent in different environments. These environments were classified into street, green space, house, school (school field, school playground, school indoors), garden and indoor building (any other indoor building). Calculations were made for time spent in indoor environments, which were classified as house, other building or school building. Outdoor environments were classified together as green space and non-green space. Greenspace was defined as park, public gardens, children play areas, outdoors sports facilities (playing pitches, sports grounds), woodlands, nature reserves, allotments, and linear green space in accordance with Coventry City Council, (2010) and is congruent with other studies (Jones, Hillsdon & Coombes, 2009; Wheeler, Cooper, Page & Jago, 2010). Non-green space was defined as buildings, built land (car park, hard surface play areas), road and pavements. This is consistent with prior definitions of such environments (Coombes, van Sluijs and Jones, 2013). Average daily minutes in each environment and the percentage of the total time spent (i.e. total minutes in school/ total recorded time for all environments) in each environment were calculated. These calculations were made for weekdays, weekends and all days and are consistent with the calculations used in the Personal and Environmental Associations with Children's Health (PEACH) project (Wheeler et al., 2010).

2.5 Heart rate and global positioning analysis

Heart rate and location (Garmin connect and Google earth) for time and day (Garmin training) were manually cleaned and calculated in a subsample of children. These data were then used to calculate time spent in environments such as indoor, outdoor as well as percentage of the time spent in these environments that represented moderate and vigorous physical activity. The intensity of physical activity was assessed as 50% of heart rate reserve (moderate) and 75% (vigorous) (Ridgers & Stratton, 2005). Resting heart rate reserve was assessed as the average five lowest heart rates during the sampling period in accordance with Ridgers and Stratton (2005). This method considers individual variation in resting heart rate and intensity thresholds between children instead of using generic physical activity cut points such as <120bpm (inactive), 120–139bpm (low to moderate), 140–159bpm (moderate to vigorous) and >160bpm (vigorous), which have been used in previous studies (Collins et al., 2012; Fjortoft, Lofman et al., 2010). The percentage of moderate to vigorous physical activity time (time spent/ total time recorded)*100) was then calculated for daily (average of all days), week (average of weekdays) and weekend (average of weekend). Total daily minutes in moderate to vigorous physical activity were also assessed to determine whether children were meeting current physical activity guidelines for health (60 minutes of moderate to vigorous physical activity daily) (World Health Organisation, 2010).

2.6 Statistical analysis

All analyses were conducted using SPSS version 20. The alpha level was set at p = 0.05 a priori. Kolmogorov- Smirnov and Shapiro-Wilk tests were used to assess normality of all variables. Data were normally distributed (p >0.05) and independent t-tests were used to assess ethnic and gender differences in anthropometric variables (BMI, BMI SDS, BMI centile and body fat %) reporting no significant differences (p >0.05). Following this, Pearsons product moment correlation's assessed the associations between environmental conditions and fatness (BMI, body fat %). A 2 (i.e. indoor weekday vs. indoor weekend) by 2 (i.e. male and female) repeated measures ANCOVA, controlling for independent covariates (BMI, body fat % separately) was used to assess any effects of day and sex on time spent in different environments. A 2 (i.e. White vs. South Asian) by 2 (i.e. male and female)

ANCOVA, controlling for independent covariates (BMI, body fat %, waist circumference separately) assessed ethnic differences in time spent in different environments. On the subsample who also had their heart rate recorded (n = 46, South Asian = 25 and White = 21) a paired t-test was used to assess differences in time spent in moderate to vigorous physical activity between environmental conditions (i.e. indoors vs. outdoors). Independent t-tests were used to assess ethnic differences in MVPA between environmental conditions. 95% confidence intervals (CIs) and effect sizes using cohens *d* were also calculated for ethnic and gender differences for descriptive variables and time spent in environments, and for estimated time spent in moderate to vigorous physical activity in different environments.

3. RESULTS

The means and SD's are displayed in Table 1 & 2. The final sample included 70% normal weight children and 30% of overweight/obese children (BMI = 17 ± 3 kg/m^2, body fat % = 23%) with an average global positioning system recording time of 388 ± 179 minutes. No significant ethnic or gender differences were found for anthropometric variables (Table 1).

3. 1 Global positioning system and environmental data

3.1.1 Environment and adiposity

The results showed a significant positive relationship between the percentage of total time spent in indoor environments on weekends with body fat % (r = 0.39, p = 0.02) and BMI-Age and sex percentile (r = 0.28, p <0.05). Spending a greater percentage of total time in outdoor environments was negatively associated with body fat % (r = -0.36, p = 0.02, Figure 1). The percentage of time spent in non-green space was negatively associated with BMI (r = -0.26, p <0.05).

3.1.2 Day (weekday vs. weekend) and sex effects on time spent in the environment

Results from repeated measures ANCOVA indicated a significant day by sex effect for percentage of time in outdoor environments (p = 0.02). Females spent less time engaged in outdoor environments on weekdays than weekends (32 ± 4% vs. 54 ± 3%, 95% CI, -23, -21%, d = 6.22, controlled for BMI). When body fat % was controlled, similar findings were observed. A day by sex effect (p <0.01) for percentage of time spent in outdoor environments also revealed that females spent less time on weekdays in outdoors than weekends (23 ± 4% vs. 53 ± 8%, 95% CI, -32, -28, d = 4.74). Percentage of time spent in non-green space was also significantly lower on weekdays (15 ± 7% vs. 31 ± 6%, 95% CI, -18, -14, d = 2.45, p = 0.01). In addition, males spent more time outdoors on weekdays than weekends (41 ± 5% vs. 33 ± 44%, 95% CI, -1, 17, d = 0.26, p <0.01).

3.1.3 Indoor vs. outdoor environments

No sex differences were observed between engagement in time indoor to outdoor environments for all days, weekday or weekend day. Children spent a significantly greater percentage of time in outdoor environments than indoor for all days (mean difference = 25%, p = 0.01) and weekdays (mean difference = 34%, p <0.01), controlling for BF% (Table 2). These differences were not found when BMI was considered or for weekend days.

3.1.4 Green space vs. non-green space

No significant sex differences were observed for green space compared to outdoors for all days, weekdays or weekend days. Children spent a greater percentage of time in non green space compared to green space for all days (mean difference = 17.4%, p >0.01), weekdays (mean difference = 21%, p = 0.01) and weekend days (mean difference =17%, p >0.01), adjusted for body fat % (Table 2).

3.2 Global positioning system, environment and activity intensity data

Heart rate data were also collected on a subsample, 42% of children met the current guideline of 60 minutes of moderate to vigorous physical activity. Of this time, 43% was achieved at school, 23% from playing outside (street/garden), 20% at home and 14% from active travel (walking one journey).

3.2.1 Percentage of time spent in MVPA in outdoor vs. indoor environments

Children spent more daily (average week and weekend) time in moderate to vigorous physical activity in outdoor than indoor environments (59 ± 45 vs. 27 ± 27%, 95% CI, 15, 49%, d = 0.86, p <0.01). Time spent in moderate to vigorous physical activity in outdoor environments was greater than indoor environments for both week (76 ± 24% vs. 31 ± 29 %, 95% CI, 29, 60%, d = 1.69, p <0.01) and weekend days (49 ± 35% vs. 23 ± 30%, 95% CI, 10, 42%, d = 0.80, p = 0.01), Figure 2).

3.2.3 Time spent in moderate to vigorous physical activity and fatness

There was no significant relationship found between BMI, BMI centile, body fat % and time spent in moderate to vigorous physical activity for outside, inside, on week, weekend or all days (p >0.05).

3.3 Ethnic differences

The results showed no significant ethnic differences in time spent indoors (week), outdoor (week and weekend), greenspace (week and weekend) or in outdoors other (week and weekend), p >0.05. However, South Asian children spent significantly more time indoors on weekends when compared to White children (52 ± 5% vs. 34 ± 7%, 95% CI of difference in time spent indoors in White vs. South Asian, 2, 34%, d = 2.96, p = 0.03). For moderate to vigorous physical activity, no significant ethnic differences were found for time spent in moderate to vigorous physical activity (weekdays or weekends) or moderate to vigorous physical activity outside (p >0.05). Yet, South Asian children achieved significantly less moderate to vigorous physical activity indoors than White children (17 ± 6% vs. 33 ± 46%, 95% CI for difference in moderate to vigorous physical activity in White vs. South Asian difference, -1, -32%, d = 0.49, p = 0.04).

4. DISCUSSION

The major novel finding of the study is that health enhancing physical activity adherence was very low in low socio-economic status groups with less than half of children (42%) meeting the 60 minute daily guideline. Secondly, children spent little time engaged in green space for activity. This might in part relate to environment and socio-economic status challenges within deprived areas such as limited provision and accessibility of green space in the area as well as high crime rates resulting in low perception of safety. Children thus spent greater time in non-green environments closer to home than local green space environments. South Asian children spent more time indoors but less of this time in moderate to vigorous physical activity than White children. It is apparent that increasing time spent in outdoor environments was important for health enhancing physical activity and reduced body fat %.

4.1 Environment and fatness

The results show that spending more time in indoor environments was associated with greater fatness. In addition, spending more time outdoors and specifically in non-green environments was associated with lower fatness. However, the associations were weak and the cross sectional nature of the study limits the ability to infer cause, thus it is not known whether there was reverse causality also. When moderate to vigorous physical activity time in environmental conditions was considered no relationship was evident with measures of fatness. The lack of relationship between moderate to vigorous physical activity in different environments and fatness could be due to a number of reasons. Firstly, fatness differences exist between white and South Asian children (Deurenberg, Chew & Deurenberg, 2002; Nightingale, Rudnicka, Owen, Cook & Whincup, 2011; Saxena, Ambler, Cole & Majeed, 2004) and the existing criteria for determining adiposity is validated in white populations, providing mean bias in ethnic populations (Haroun et al., 2010). The lack of ethnic specific cut-offs thus might make this challenging (Jebb, Cole, Doman, Murgatroyd & Prentice, 2000; Frisard et al., 2005; Sun et al., 2003). The majority of the study sample was South Asian which may limit associations. In addition, factors leading to obesity and ‘obesogenic environments’ are complex, which might not have been captured during this analysis. Finally, the measurement of activity came from heart rate which is the response to activity; energy expenditure might be more important. In future studies using global positioning system, heart rate monitoring and accelerometry, could provide detailed information regarding physical behaviour and the built environment.

4.2 Environmental differences

The findings show that females spent more time in outdoor environments on weekends than weekdays, which was attributed to increased time in non-green environments. For males, there were no differences in time spent in outdoor environments even though males spent less time in non-green space on weekend days than weekdays. Given that the children have the same exposure to non-green space at school; the sex differences observed appears to relate to engagement with the environment outside of school hours. The social, cultural and environmental influences might explain some of these differences. In a qualitative study conducted on the same children as the present study, parental constraints, weather, religious practice and safety were identified as the main barriers for physical activity engagement with the environment (Eyre, Duncan Birch & Cox, 2013b). The notion that young children are not autonomous in their decision making and so parental constraints limit their activity behaviour are supported by prior research (Brockman, Jago & Fox, 2011; Veitch, Salmon & Ball, 2010). However, these constraints might be experienced differently amongst sexes. Previous research suggests males had greater independent mobility than females and that increased independent mobility is associated with increased play, physical activity and active commuting in children (Page, Cooper, Griew & Jago, 2010). Another large study using global positioning system monitoring and accelerometer was able to explore this is more depth and found that males were more likely to roam outside of neighbourhoods whereas females used the garden and street spaces for physical activity (Jones et al., 2009b). In winter months, the hours of sunlight are reduced which may limit time available for physical activity in females for whom parents might exert more constraints due to safety concerns. This is supported by Pabayo et al. (2011) who found increased moderate to vigorous physical activity with greater deprivation in males when measured objectively but that greater deprivation in females was associated with lower moderate to vigorous physical activity.

In addition, cultural factors may inhibit time spent in environments and also affect parental constraints. A large proportion of the sample was made up of South Asian children and parental restrictions on activities might be experienced differently for South Asian females and males. Moreover, socio-economic and environmental issues must be considered. For both males and females a large proportion of their outdoors physical activity is made up of non-green which suggests that children spent most of their time in street. This agrees with prior research on this topic (Wheeler et al., 2010) and highlights the importance of understanding non-green space activity. It is not known whether living in a deprived area might affect parent's safety concerns and result in the children playing closer to home (i.e. street) instead of green space. The consensus data for these two Coventry wards suggest that 33% and 41% of the community perceive their neighbourhood as unsafe at night (Coventry City Council, 2010). Secondly, the green space provision in these wards is described as deficient across all areas (i.e. park, green space, outdoor sport, pitches, provision for young children and allotments) (Coventry City Council, 2008). In addition, the wards have the highest population density (56.8 per hectare and 51.8 per hectare vs mean 39.8 per hectare), resulting in high numbers of flats in blocks, flats/apartments, shared dwellings and the lowest percentage of owned houses (Coventry City Council, 2011). The availability of recreational space or public open spaces (e.g. park, playgrounds, playing fields or courts) and proximity to these sites is also associated with increased activity (Chomitz, Aske, McDonald, Cabral & Hacker, 2011; Grow, Saelens, Durant, Norman & Sallis, 2008; Loureiro, Matos, Santos, Mota & Diniz, 2010; Nielsen, Taylor, Williams & Mann, 2010; Timperio et al., 2008; Vietch et al., 2010).

Therefore, it is clear that both provision and accessibility of green space is low and safety concern high within the environments examined in the present study. These are likely to be a main cause of increased engagement in non-green environments (which from observation were close to home) in the autumn for physical activity. It is also apparent that outdoors physical activity is important for health enhancing physical activity but that environmental and socio-economic factors are key determinants of behaviour. Future research needs to assess how patterns of behaviour are affected by hours of sunlight (i.e. changes in greenery with seasons). In addition, understanding the proximity in which children play from the home with seasonality, environment and socio-economic status may enhance understanding.

The results of the current study indicate that less than half of the children from low socio-economic status and ethnic backgrounds meet the current physical activity guidelines. Low levels of adherence to physical activity in South Asian children are already described previously (Eyre & Duncan, 2013; Eyre et al., 2012a; Owens et al., 2009). However, in this current study the adherence is lower, this could be due to the specific socio-economic groups assessed i.e. the two most deprived wards and monitoring by heart rate not accelerometry. Secondly, of this time spent in moderate to vigorous to physical activity, physical activity in school contributed to nearly half of this (43%), followed by playing outside (23% in street/garden), home (20%) and from active travel (14% walking one journey). Previous literature has highlighted the significant positive impact that school (Ridgers, Timperio, Crawford & Salmon, 2011; Fairclough, Beighle, Erwin & Ridgers, 2012, Stratton & Mullen, 2005), spending time in outdoors environments (Dunton, Ligo, Instule, Wolch & Pentz, 2011; Perry, Saelens & Thompson., 2011; Cleland et al., 2008; Jones et al., 2009a; McCurdy, Winterbottom, Mehta & Roberts, 2010) and active commuting (Lubans, Boreham, Kelly & Foster, 2011; Lee, Orenstein & Richardson, 2008) has on daily moderate to vigorous to physical activity levels. Therefore, it is clear that physical activity policies focused on school and active commuting are important for increasing physical activity in children from deprived and ethnic environments.

The present findings also suggest that these children were most active, spending more time in health enhancing physical activity in outdoor environments irrespective of week or weekend days. Previous research is supportive of these findings (Dunton et al., 2011; Perry et al., 2011; Cleland et al., 2008; McCurdy et al., 2010), with some research yielding a positive relationship between and time spent in moderate to vigorous to physical activity in outdoors environments (Jones et al., 2009b; Cooper et al., 2010). However, when examining the association between the variables in this present study, no significant relationship (not presented) was found for moderate to vigorous to physical activity and time spent outdoors. This might be due to population differences (ethnicity and low socio-economic status) between the present study and previous studies (Jones et al., 2009b; Cooper et al., 2010) or due to a smaller subsample of heart rate analysis undertaken in the present study.

For indoor time, time spent in moderate to vigorous to physical activity was increased during weekdays, which may be attributable to physical education lessons conducted in the school hall during autumn and media engagement indoors at home on weekends moderated by weather constraints (Eyre et al., 2013b). In addition, the children in this study spent a significantly greater percentage of time on weekdays in outdoor environments. This is surprising and is likely to reflect an under representation of indoor time spent at school due to spatial error (Elgethun, Fenske, Yost & Palcisko, 2003), unworn monitors when inactive at home and is supportive of the lower contribution of school recording time. Secondly, ethnic differences were found, with South Asian children spending more time indoors on weekends than White, but when indoors, South Asian children engaged in less moderate to vigorous to physical activity than White children. This is the first study to explore ethnic differences using global positioning system and suggests that low physical activity previously described (Eyre et al., 2013a; Owens et al., 2009) in South Asian children may in part relate to cultural differences (indoors activity) and socio-demographic factors (i.e. deprivation).

Previous studies have found that children are more active on weekdays (Duncan, Schofield & Duncan, 2006; Duncan, Al-Nakeeb, Woodfield & Lyons 2007; McGall, McGuigan & Nottle, 2011; Oliver, Schofield & Kilt, 2007; Owens et al., 2009; Riddoch, Mattocks et al., 2007). Research suggests that highly active children spend more time in physical activity before school, during class, lunch and after school (Rowlands, Pilgrim & Eston, 2008). However, it is not apparent what the school to after-school contribution plays on these patterns. Other research suggests that greater physical activity engagement occurs school time (Fairclough et al., 2012; Ridgers, Timperio et al., 2011) because school provides specific physical activity opportunities within the school day (physical education, recess), contributing to overall physical activity (Stratton & Mullen, 2005). However, other research suggests that children are most active after school and that it is the differences in after school activity accounts for differences in overweight/obese vs. normal children and inactive vs. active children (Deforche et al., 2009; Riddoch, Mattocks et al., 2007; Olds, Maher & Ridley, 2011). Eyre et al. (2013a) is the only study to consider within day patterns of PA in SA children. The study concluded that South Asian children are less active because they engage in less activity and expend less energy after school than

White children. Further research needs to clarify these differences to better focus future interventions.

This study shows the feasibility of global positioning monitors and heart rate monitoring in young children from low SES and ethnic groups to explore differences in their engagement with environmental features. This study also used a protocol requiring participants to wear the heart rate and global positioning system monitors throughout 4 whole days unlike other work where smaller windows of wear time have been presented (Collins et al., 2012). Adherence to the monitoring period is also good, indicated by high response rate and an average monitoring compliance time of 6.5 hours (ranging to 9.5 hours). For a weekday, on average 63% of this time was worn for free living and 37% at school, thus confirming that weekday contributions were in both school and out of school environments. However, it is acknowledged that there could be some inflation in the findings between outdoors vs. indoors due to increased spatial error indoors (Elgethun et al., 2003). The current sample size, although small, is consistent with other published studies utilising global positioning systems to assess young people's physical activity (Duncan, Badland et al., 2009; Fjortoft, Kristoffersen et al., 2009; Fjortoft, Lofman et al., 2010; Maddison et al., 2010; Collins et al., 2012). It is acknowledged that in future studies, a larger sample size would enable more sophisticated statistical analyses in future research. This would also enable subgroups analysis of South Asian children in order to account for heterogeneity in the ethnic sample and to establish if the limited ethnic findings relate to grouped effect.

CONCLUSION

Outdoor non-green environments are important for health enhancing physical activity in children from low socio-economic status and ethnic groups, but complex and interrelated factors, environmental and socio-economic status challenges within the neighbourhood, limit engagement in physical activity. Interventions aimed at increasing physical activity in these environments may need to consider a holistic social, environment and cultural approach to challenging both the physical environment and perceptions associated with the environment for ethnic groups. A school based approach to increasing physical activity in people from ethnic, low socio-economic status and living within challenging environments may be beneficial for policy makers.

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******TABLE 1 here**

Table 1 descriptive variable by sex and ethnicity

	All n = 64	Males n = 30	Females n = 34	*p* (95% CI)	South Asian n = 46	*d*	White n = 18	*p* (95% CI)	*d*
Height (cm)	130 ± 7	130 ± 8	131 ± 7	0.60 (-3, 4)	130 ± 7	0.13	133 ± 8	0.21 (-7, 2)	0.41
weight (kg)	31 ± 9	31 ± 10	30 ± 7	0.53 (-3, 6)	29 ± 8	0.00	33 ± 11	0.40 (-7, 3)	0.45
BMI (kg/m2)	17 ± 3	18 ± 4	17 ± 3	0.65 (-1, 2)	17 ± 3	0.29	19 ± 4	0.62 (-3, 2)	0.61
BMI centile	60 ± 31	61 ± 33	59 ± 30	0.68 (-12, 18)	57 ± 31	0.06	70 ± 31	0.55 (-24, 13)	0.42
Body Fat%	23 ± 9	22 ± 10	22 ± 9	0.73 (-6, 4)	22 ± 9	0.00	23 ± 9	0.73 (-11, 1)	0.11
Waist Circumference (cm)	57 ± 25	57 ± 29	57 ± 21	0.23 (-3, 12)	57 ± 24	0.00	57 ± 21	0.67 (-14, 1)	0.00
Waist circumference centile	57 ± 43	46 ± 46	65 ± 37	0.70 (-24, 16)	57 ± 42	0.46	52 ± 45	0.35 (-32, 12)	0.12

Mean ± SD

Table 2 The percentage of time spent in environments.

	Indoor	Outdoor	*d*	Green space	Non green space	*d*
	% of total time spent					
All days	20 ± 2 (25, 34)	45 ± 4 (38, 52)*	8.22	13 ± 1 (10, 16)	30 ± 2 (26, 35)#	10.75
Weekdays	18 ± 4 (10, 26)	52 ± 5 (42, 63)*	7.51	15 ± 2 (11, 18)	36 ± 4 (29, 43)#	6.64
Weekend	47 ± 3 (39, 54)	54 ± 3 (45, 61)	2.33	16 ± 2 (11, 21)	33 ± 3 (27, 39)#	6.67

Mean ± SE (CI)

* >indoors (P<0.01), # >green space (P<0.01)

**** **FIGURE 1 HERE**

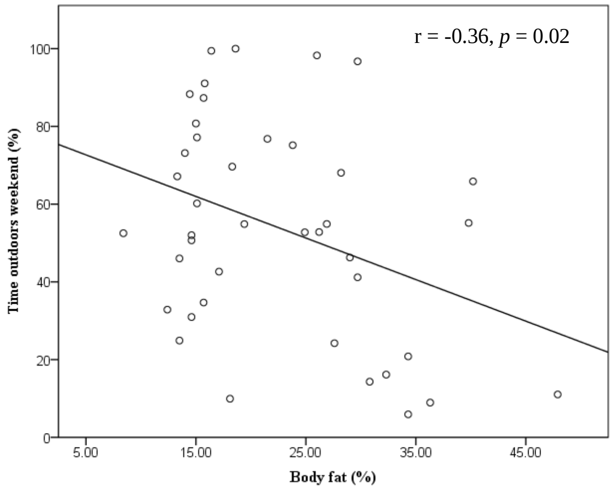
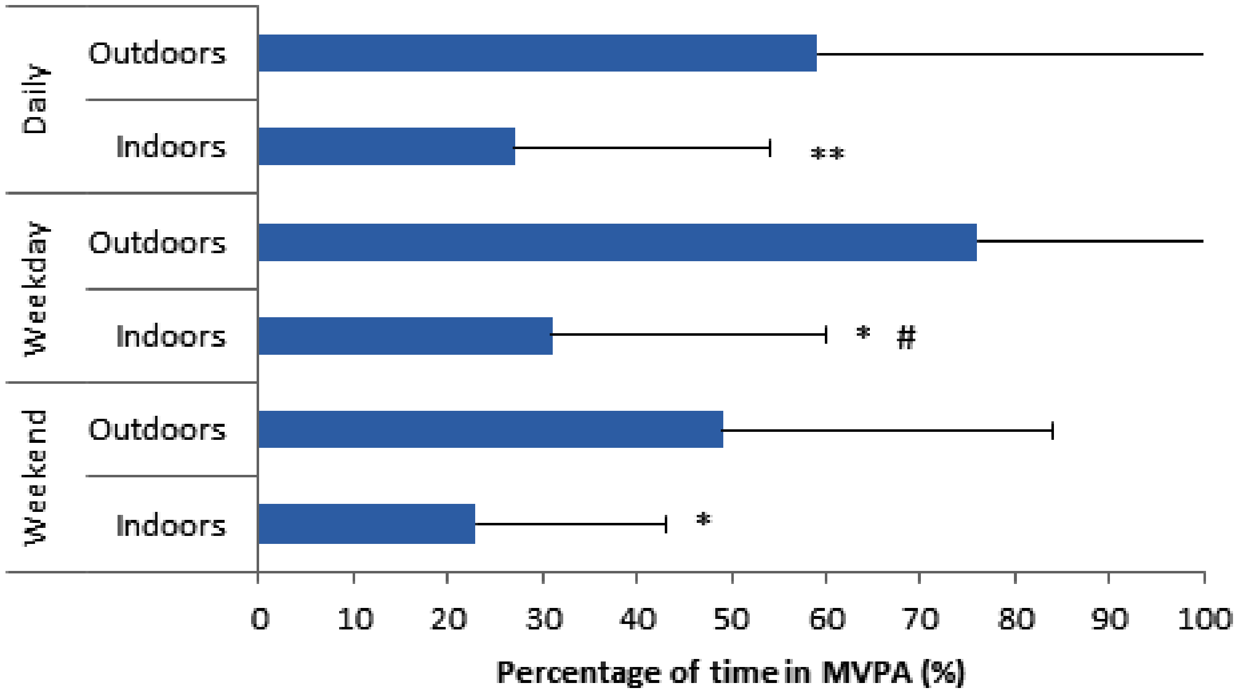


Figure 1 Relationship between time spent outdoors on weekends with body fat (%).

****** FIGURE 2 HERE**

(See attached file)

Figure 2 Percentage of time in MVPA for daily, week and weekend activity.



** Sig < outdoors *P* =<0.001, * Sig < outdoors *P* = <0.01, # Sig > indoors weekend *P* = 0.01