



Trends in physical activity and sedentary behaviour in adolescence: ethnic and socio-economic differences

Naomi Henning Brodersen, Andrew Steptoe, David R Boniface and Jane Wardle

Br. J. Sports Med. published online 18 Dec 2006;
doi:10.1136/bjism.2006.031138

Updated information and services can be found at:
<http://bjism.bmj.com/cgi/content/abstract/bjism.2006.031138v1>

These include:

Rapid responses

You can respond to this article at:
<http://bjism.bmj.com/cgi/eletter-submit/bjism.2006.031138v1>

Email alerting service

Receive free email alerts when new articles cite this article - sign up in the box at the top right corner of the article

Notes

Online First contains unedited articles in manuscript form that have been peer reviewed and accepted for publication but have not yet appeared in the paper journal (edited, typeset versions may be posted when available prior to final publication). Online First articles are citable and establish publication priority; they are indexed by PubMed from initial publication. Citations to Online First articles must include the digital object identifier (DOIs) and date of initial publication.

To order reprints of this article go to:
<http://www.bmjournals.com/cgi/reprintform>

To subscribe to *British Journal of Sports Medicine* go to:
<http://www.bmjournals.com/subscriptions/>

Trends in physical activity and sedentary behaviour in adolescence: ethnic and socio-economic differences

Naomi Henning Brodersen, Andrew Steptoe, David R. Boniface, Jane Wardle

Cancer Research UK Health Behaviour Unit, Department of Epidemiology and Public Health, University College London, London WC1E 6BT

Naomi Henning Brodersen, *research fellow*

David R Boniface, *Statistician*

Jane Wardle, *professor of clinical psychology*

Psychobiology Group, Department of Epidemiology and Public Health, University College London, London WC1E 6BT

Andrew Steptoe, *professor of psychology*

Correspondence to Jane Wardle, Cancer Research UK Health Behaviour Unit, Department of Epidemiology and Public Health, University College London, London WC1E 6BT

j.wardle@ucl.ac.uk

Key words: Physical activity, Sedentary behaviour, Adolescence, Ethnicity, Socioeconomic status

Abstract

Objective To assess developmental trends in physical activity and sedentary behaviour in British adolescents in relation to gender, ethnicity and socioeconomic status (SES).

Design Five year longitudinal study of a diverse cohort of students aged 11-12 years at baseline in 1999.

Setting 36 London schools sampled using a stratified random sampling procedure.

Participants 5863 students categorised as white, black or Asian, and stratified for SES using the Townsend Index.

Main outcome measures Number of days per week of vigorous activity leading to sweating and breathing hard. Hours of sedentary behaviour, including watching TV and video gaming. Data were analysed using multi-level, linear, mixed models.

Results There were marked reductions in physical activity and increases in sedentary behaviour between ages 11-12 and 15-16. Boys were more active than girls, and the decline in physical activity was greater in girls (46% reduction) than boys (23%). Asian students were less active than whites, and this was also true of black girls but not boys. Black students were more sedentary than white students. Levels of sedentary behaviour were greater in lower SES respondents. Most differences between ethnic and SES groups were present at age 11, and did not evolve over the teenage years.

Conclusions Physical activity declines and sedentary behaviours become more common during adolescence. There are ethnic and SES differences in physical activity and sedentary behaviour in British youth that anticipate adult variations in adiposity and cardiovascular disease risk. These are largely established by age 11-12, so reversing these patterns requires earlier intervention.

INTRODUCTION

There is widespread concern about the low levels of vigorous physical activity and high rates of sedentary behaviour in adolescents.^{1,2} Cross-sectional studies indicate that physical activity declines and sedentary behaviour becomes more common between ages 10-12 and later teenage years.³⁻⁵ Physical activity in youth is a predictor of subsequent adiposity,⁶ and decreases in physical activity over the teenage years are associated with increases in body mass index (BMI).⁷ Longitudinal studies have confirmed the decline in physical activity in samples in the USA,^{8,9} but there have been no large scale longitudinal studies of changes in physical activity and sedentary behaviour in British youth and only two in Europe.^{10,11} There are important differences in physical activity in adults related to ethnicity and socio-economic status (SES), but it is not known at what age these emerge.^{9,12} This analysis of the Health and Behaviour in Teenagers Study (HABITS) investigated trends in physical activity and sedentary behaviour between ages 11/12 and 15/16 years in an ethnically and socio-economically diverse sample of school students.

PARTICIPANTS AND METHODS

The HABITS study was carried out in 36 secondary schools randomly selected from all schools in 13 boroughs of South London, stratified by school type (inner London state schools, outer London state schools and independent schools; single sex or mixed) to obtain an ethnically and socio-economically diverse sample. The first wave of data was collected in 1999 from students in Year 7 (age 11-12, US grade 6) and continued annually until Year 11 (age 15-16). All students registered in the relevant year were eligible to take part in the study. We sent information about the study to parents, giving them the opportunity to exclude their child from participation, and all students gave written consent. The study was approved by the University College London/ University College London Hospital Medical Ethics Committee.

Trained researchers visited the schools every year and explained the purpose of the study. Students completed self-report questionnaires, with assistance available as required, and

anthropometric measures were taken as previously described.¹³ Ethnicity information was obtained by self-report, and classified into White, Black or mixed Black, Asian or mixed Asian, and Other. The 'other' ethnic group was too small to divide into specific subgroups, so was excluded from analyses. Socio-economic status (SES) was defined using an area-based measure, the Townsend Index, derived from postcode information. The Townsend index is standardised across England and Wales, with positive values indicating high socio-economic deprivation and negative values below-average deprivation. Townsend scores were divided into tertiles for analysis.

We assessed vigorous physical activity by asking students how many of the last seven days they had carried out vigorous exercise that made them sweat and breathe hard.¹⁴ Responses were coded from no days (0) to every day (7). We measured sedentary behaviour by asking students how many hours they watched TV, or played on the computer or video games on school days and weekends. Responses were added to generate an estimate of total hours of sedentary behaviour, as used in other investigations.¹⁵

Statistical analysis

We analysed changes in physical activity and sedentary behaviour using multi-level, linear, mixed-model analyses in MLwiN, with student, year of assessment and school at levels 1, 2 and 3 respectively. The dependent variables were days per week of vigorous physical activity, and hours per week of sedentary behaviour. The data were weighted at the school level according to the inverse sampling probability based on school type. The mixed-models analysis fits a linear trend line for each student and does not require data for every year, maximising the use of available data. Townsend index scores were divided into tertiles for analyses by SES.

RESULTS

We recruited 4320 (84%) of Year 7 students registered in the schools into the study. Their characteristics are summarised in Table 1. In later years, additional students participated either because they were new to the school or had previously been absent, so a total of 5863 students took part in one or more years. Response rates were above 80% in the first four years, with 1.5% to 5.6% of students declining to take part, and a further 10-16% being absent when their class was assessed. In the final year two schools were unable to continue and some students were on exam or placement leave, reducing the participation rate to 78%. Overall, 36% completed five years, 58% completed four or more years, 73% completed three or more and 88% completed at least two years. Ethnic information was not available for 159 students (2.7%), 113 (1.9%) had missing data on postcode, and 33 students (0.6%) did not provide data on physical activity and sedentary behaviour. The remaining 5287 students were included in the analyses.

Table 1 Age, ethnicity, and socioeconomic status of the sample by sex

Values are mean (SD) and N (%)

	Boys	Girls
Total sample (N)	2577	1742
Age (years)	11.81 (0.36)	11.84 (0.32)
BMI (kg/m ²)	19.03 (3.37)	19.98 (3.82)

	Boys	Girls
Ethnic group:		
White	1597 (65.7)	1010 (61.6)
Black and mixed black	582 (23.9)	454 (27.7)
Asian and mixed Asian	253 (10.4)	175 (10.7)
Townsend index:		
Higher	877 (34.4)	555 (32.1)
Intermediate	775 (30.4)	462 (26.8)
Lower	898 (35.2)	710 (41.1)

Physical activity trends over time

Boys consistently reported more physical activity than girls, so separate models were constructed, simultaneously evaluating associations with ethnicity and SES in the trends across the five time points. Levels of vigorous physical activity are shown separately by sex in Figure 1. We observed a fall in number of days of vigorous physical activity a week in boys (-1.06 days, SE=0.068) and girls (-1.82 days, SE=0.072) over the course of the study ($p<0.001$). On average, boys exercised 0.99 (SE=0.043) days a week more than girls ($p<0.001$). There was an interaction between sex and school year, with a steeper average decline in girls than boys (means 0.46 days (SE=0.018) and 0.25 days (SE=0.016) a week per year (SE=0.018), $p<0.001$). Asian students were less physically active than White students ($p<0.001$); Asian girls exercised on average 0.45 days a week less (SE=0.101) and Asian boys 0.46 days less (SE=0.018) than their White counterparts. The disparity between White and Asian girls diminished by 0.11 days a week per year (SE=0.046, $p<0.05$). Black girls averaged 0.39 days a week (SE=0.122, $p<0.001$) less physical activity than white students which did not change over time, while white and black boys did not differ in physical activity levels or trends.

There was no association between SES and physical activity in boys, but lower SES girls were less active ($p<0.001$). The mean difference between the highest and lowest SES tertiles averaged 0.47 days (SE=0.049), but SES effects did not vary across the five years of investigation.

Trends in sedentary behaviour

Boys reported more hours of sedentary behaviour than girls throughout the study (mean difference 0.63, SE=0.254, $p<0.01$), with no divergence in trends over time. Levels of sedentary behaviour are shown in Figure 2. Hours of sedentary behaviour increased in all groups over the five years, with an average increase of 2.52 hours (SE=0.066) per week in boys and 2.81 hours (SE=0.081) per week in girls ($p<0.001$). Black students of both sexes reported higher levels of sedentary behaviour than their white peers. The difference averaged 2.76 hours (SE=0.562) in boys, and 5.40 hours (SE=0.474) in girls. This difference did not vary over the five years of the study. Trends in sedentary behaviour also differed in white and Asian girls ($p<0.05$); there was no difference in Year 7, but the increase in sedentary behaviour was faster in Asian girls, with an average difference in rates of 0.41 (SE=0.197) hours each day.

Sedentary behaviour levels were greater in students from lower SES neighbourhoods ($p < 0.001$). The difference between the higher and lower SES groups averaged 2.29 hours ($SE = 0.318$) per week in boys and 4.09 hours ($SE = 0.490$) hours per week in girls. This difference did not change over the five years of the study.

DISCUSSION

This is the first study to track trends in physical activity and sedentary behaviour over early teenage years in a large sample of British adolescents. These years are crucial because they represent the emergence of more independent, adult patterns of behaviour after relatively stable levels in earlier childhood.¹⁶ Our data indicate that vigorous physical activity decreases and hours spent in sedentary behaviour increase between the ages of 11/12 and 15/16 years, with a larger decline in physical activity in girls than boys. Asian students are less physically active than white boys and girls, while sedentary behaviours are higher in black students. Students from lower SES neighbourhoods report higher levels of sedentary behaviour, and lower SES girls but not boys are less physically active than those from more affluent backgrounds.

Developmental trends in physical activity and sedentary behaviour

The decline in the number of days a week of vigorous physical activity was striking in all groups. In the white population, days of physical activity fell by 23% in boys and 46% in girls over the five years. Cross-sectional studies in the UK have shown inconsistent associations between age and physical activity in youth. A reduction in physical activity has been found in girls, but no decrease between ages 11 and 15 was recorded in boys in the Health Survey for England⁵ or the Scottish Health Behaviour of School-aged Children Study.¹⁷ Longitudinal studies have the advantage of avoiding selection factors influencing the participation of younger and older students, and eliminating secular trends in physical activity and leisure habits that might affect young people of different ages, while also permitting associations between physical activity and later health risk to be analysed.⁷ Other recent longitudinal studies have reported decreases in physical activity over early teenage years in both boys and girls.⁸⁻¹¹ We observed a far greater decline in vigorous physical activity in girls than boys, the opposite of the pattern found in samples from other countries.^{8,10,11} Differences in the measurement of physical activity make direct comparison impossible, but our findings are consistent with data from the Health Survey for England.⁵

Sedentary behaviour represents a distinct category, and is not simply the absence of vigorous exercise. Sedentary behaviour and physical activity are only modestly correlated, have separate sociodemographic determinants, and are associated differently with subsequent health risk.^{14,18} Slightly higher levels of sedentary behaviour were reported in boys than girls, as was found in the 1997 National Diet and Nutrition Survey,¹⁶ but the increase over adolescent years in girls was greater. Sedentary behaviours are thought to have a dual role in promoting obesity, since they not only involve low energy expenditure, but may also be associated with intake of high energy snacks.

Ethnic differences

There were pronounced differences in physical activity between white and Asian students throughout the study. In addition, Asian girls showed a faster increase in sedentary behaviour between ages 12/13 and 15/16 than white girls (Figure 3). Adults of Indian, Pakistani and Bangladeshi origin are less physically active than the white population, with particularly low participation rates in sports and exercise.¹² This difference is associated with higher levels of abdominal adiposity and increased risk of coronary heart disease and diabetes. Sedentary behaviour was also more common in black than white students, and black girls engaged in less physical activity than white girls. Obesity levels are substantially higher in Black African and Black Caribbean women than white women in the UK. Comparisons in the USA also indicate lower physical activity in black than white adolescents.^{9,19} The differences we observed in physical activity and sedentary behaviour may therefore contribute to later

morbidity and health risk. However, our finding that ethnic differences were present at age 11/12 indicates the need to study younger children in order to identify the emergence of these patterns.

Socioeconomic factors

There are some uncertainties surrounding SES differences in physical activity; higher SES men and women are involved in more sport and recreational activity, but they are less active at work.²⁰ Cross-sectional studies in the UK show less physical activity in adolescents from lower socio-economic backgrounds,^{12,17} and Kimm⁹ reported larger decreases over time in girls from lower SES backgrounds in the National Heart, Lung and Blood Institute Growth and Health study. We found SES differences in physical activity in girls but not boys, and differences in sedentary behaviour in both sexes. The latter may be important to future health in view of the associations that have been described between sedentary behaviours such as television viewing and adiposity.²¹ However, the nature of the sedentary activity may be important, and some adolescents combine activities like computer gaming with active pursuits.

Limitations

Physical activity was assessed with relatively simple questions about the number of days of activity in the past week, rather than activity duration or type. Sallis and Owen²² have argued that self-report measures in children aged 11/12 are more reliable when assessments are simple and involve recall over a short period, and we were concerned that recall of frequency and duration would be too challenging. The sedentary behaviour measure was similar to that used previously,^{15,18} but is likely to have led to under-estimation in comparison with diary and ecological sampling techniques.¹⁶

Conclusions

This study confirms the trend towards reduced physical activity and increased sedentary behaviour over early teenage years in a longitudinal analysis of English students. There are important ethnic and socioeconomic differences that anticipate adult variations of adiposity and cardiovascular disease risk. Social and cultural factors contribute to these patterns, though inequalities in the environment are also relevant.²³ Differences by ethnic group and SES were largely established in the first wave of data collection when participants were aged 11-12 years. Objective measures of physical activity do not show differences by SES in children aged around 4 years old,²⁴ suggesting that the primary school years may be critical for the development of disparities in physical activity and sedentary behaviour. Timetabled physical education makes a relatively minor contribution,²⁵ so more general society-wide changes in family recreational habits are required if ethnic minority and lower SES groups are not to be disadvantaged.

Acknowledgements

We gratefully acknowledge the participation of the 36 schools and the work of those involved in collecting the data.

Contributors

JW and NHB were involved in the conception and design of the study. Data were analysed by NHB, DRB and AS. AS and NHB wrote the manuscript, and JW and DRB were involved in revising the manuscript. JW is the guarantor. The corresponding author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence on a worldwide basis to the BMJ Publishing Group Ltd, and its Licensees to permit this article (if accepted) to be published in BMJ editions and any other BMJ PGL products and to exploit all subsidiary rights, as set out in the licence (bmj.com/advice/copyright.shtml).

Funding

This research was supported by Cancer Research UK, which had no involvement in the study itself or its interpretation. AS is supported by the British Heart Foundation.

Competing interests: None declared.

Ethical approval: University College London / University College London Hospital medical ethics committee.

What is already known on this topic

- Adolescence appears to be a phase during which physical activity decreases, though cross-sectional surveys in the UK show an inconsistent pattern.
- Sedentary behaviour is a distinct category of activity, and is not merely the absence of vigorous exercise.
- Physical activity in youth is a predictor of later adiposity.
- Variations in physical activity in UK adolescents in relation to ethnic background and socioeconomic status are poorly understood,

What this study adds

- There is a decrease in vigorous activity and increase in sedentary behaviour between ages 11-12 and 15-16 years.
- Lower SES adolescents engage in more sedentary behaviour, but physical activity differs by SES only in girls.
- Physical activity is lower in Asian than white adolescents, while black adolescents report higher levels of sedentary behaviour.
- Ethnic and SES differences are largely established by age 11-12 years, so remedial action requires earlier intervention.

“The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence (or non exclusive for government employees) on a worldwide basis to the BMJ Publishing Group Ltd and its Licensees to permit this article (if accepted) to be published in The British Journal of Sports Medicine editions and any other BMJ PGL products to exploit all subsidiary rights, as set out in our licence (<http://bjsm.bmjournals.com/misc/ifora/licenceform.shtml>).”

REFERENCES

1. **Chief Medical Officer.** *At least five a week: Evidence on the impact of physical activity and its relationship to health.* London: The Stationery Office, 2004.
2. **Department of Health and Human Services.** *Promoting Better Health for Young People through Physical Activity and Sports: A report to the President from the Secretary of Health and Human Services and the Secretary of Education.* Washington, D.C.: Department of Health and Human Services, 2000.
3. **Kristjansdottir G,** Vilhjalmsón R. Sociodemographic differences in patterns of sedentary and physically active behavior in older children and adolescents. *Acta Paediatr* 2001;**90**:429-35.
4. **Caspersen CJ,** Pereira MA, Curran KM. Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sports Exerc* 2000;**32**:1601-9.
5. **Sproston K,** Primatesta P, editors. *Health Survey for England 2002: The health of children and young people.* London: The Stationery Office, 2003.
6. **Must A,** Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *Int J Obes* 2005;**29 Suppl 2**:S84-96.

7. **Kimm SY**, Glynn NW, Obarzanek E, Kriska AM, Daniels SR, Barton BA, et al. Relation between the changes in physical activity and body-mass index during adolescence: a multicentre longitudinal study. *Lancet* 2005;**366**:301-7.
8. **Aaron DJ**, Storti KL, Robertson RJ, Kriska AM, LaPorte RE. Longitudinal study of the number and choice of leisure time physical activities from mid to late adolescence: implications for school curricula and community recreation programs. *Arch Pediatr Adolesc Med* 2002;**156**:1075-80.
9. **Kimm SY**, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, et al. Decline in physical activity in black girls and white girls during adolescence. *N Engl J Med* 2002;**347**:709-15.
10. **Telama R**, Yang X. Decline of physical activity from youth to young adulthood in Finland. *Med Sci Sports Exerc* 2000;**32**:1617-22.
11. **van Mechelen W**, Twisk JW, Post GB, Snel J, Kemper HC. Physical activity of young people: the Amsterdam Longitudinal Growth and Health Study. *Med Sci Sports Exerc* 2000;**32**:1610-6.
12. **Sproston K**, Mindell J, editors. *Health Survey for England 2004: The health of ethnic minority groups*. London: The Stationery Office, 2006.
13. **Wardle J**, Henning Brodersen N, Cole TJ, Jarvis MJ, Boniface DR. Development of adiposity in adolescence: five year longitudinal study of an ethnically and socioeconomically diverse sample of young people in Britain. *BMJ* 2006;**332**:1130-5.
14. **Henning Brodersen N**, Steptoe A, Williamson S, Wardle J. Sociodemographic, developmental, environmental, and psychological correlates of physical activity and sedentary behavior at age 11 to 12. *Ann Behav Med* 2005;**29**:2-11.
15. **Robinson TN**, Hammer LD, Killen JD, Kraemer HC, Wilson DM, Hayward C, et al. Does television viewing increase obesity and reduce physical activity? Cross-sectional and longitudinal analyses among adolescent girls. *Pediatrics* 1993;**91**:273-80.
16. **Gregory J**, Lowe S. *National Diet and Nutrition Survey: young people aged 4 to 18 years*. London: The Stationery Office, 2000.
17. **Inchley JC**, Currie DB, Todd JM, Akhtar PC, Currie CE. Persistent socio-demographic differences in physical activity among Scottish schoolchildren 1990-2002. *Eur J Public Health* 2005;**15**:386-8.
18. **Biddle SJ**, Gorely T, Marshall SJ, Murdey I, Cameron N. Physical activity and sedentary behaviours in youth: issues and controversies. *J R Soc Health* 2004;**124**:29-33.
19. **Bradley CB**, McMurray RG, Harrell JS, Deng S. Changes in common activities of 3rd through 10th graders: the CHIC study. *Med Sci Sports Exerc* 2000;**32**:2071-8.
20. **Macintyre S**, Mutrie N. Socio-economic differences in cardiovascular disease and physical activity: stereotypes and reality. *J R Soc Health* 2004;**124**:66-9.
21. **Marshall SJ**, Biddle SJ, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord* 2004;**28**:1238-46.
22. **Sallis JF**, Owen N. *Physical Activity and Behavioral Medicine*. Thousand Oaks, CA: Sage, 1999.
23. **Gordon-Larsen P**, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics* 2006;**117**:417-24.
24. **Kelly LA**, Reilly JJ, Fisher A, Montgomery C, Williamson A, McColl JH, et al. Effect of socioeconomic status on objectively measured physical activity. *Arch Dis Child* 2006;**91**:35-8.
25. **Mallam KM**, Metcalf BS, Kirkby J, Voss LD, Wilkin TJ. Contribution of timetabled physical education to total physical activity in primary school children: cross sectional study. *BMJ* 2003;**327**:592-3.

Figure legends

- Figure 1 Average number of days per week of vigorous physical activity over the 5 school years, divided on the basis of ethnicity (adjusted for SES, upper panel) and SES (adjusted for ethnicity, lower panel). Figures are also adjusted for school clustering and inverse sampling probability according to school type. Boys are shown in solid lines and girls in dashed lines.
- Figure 2 Average number of hours per week of sedentary behaviour over the 5 school years, divided on the basis of ethnicity (adjusted for SES, upper panel) and SES (adjusted for ethnicity, lower panel). Figures are also adjusted for school clustering and inverse sampling probability according to school type. Boys are shown in solid lines and girls in dashed lines.



