9 Perez-Escamilla R, Pollitt E, Lonnerdal B, Dewey KG. Infant feeding policies in maternity wards and their effect on breast-feeding success: an analytical overview. *Am J Public Health* 1994;84:89–97.

10 Sewell WH, Mussen PH. The effects of feeding, weaning, and scheduling procedures on childhood adjustment and the formation of oral symptoms. *Child Dev* 1952;23:185–91.

11 Anderson JW, Johnstone B, Remley DT. Breast-feeding and cognitive development: a meta-analysis. *Am J Clin Nutr* 1999;70:525–35.

12 Der G, Batty GD, Deary IJ. Effect of breast feeding on intelligence in children: Prospective study, sibling pairs analysis, and meta-analysis. *Br Med J* 2006;333:945.

13 Ip S, Chung M, Raman G, et al. *Breastfeeding and Maternal and Infant Health Outcomes in Developed Countries*. Evidence Report/Technology Assessment No. 153. AHRQ Publication No. 07-E007. Rockville, MD: Agency for Healthcare Research and Quality, 2007.

14 Kramer MS, Aboud F, Mironova E, et al. Promotion of Breastfeeding Intervention Trial (PROBIT) Study Group. Breastfeeding and child cognitive development: new evidence from a large randomized trial. *Arch Gen Psychiatry* 2008;65:578–84.

15 Oddy W H, Li J, Whitehouse AJO, Zubrick SR, Malacova E. Breastfeeding duration and academic achievement at 10 years. *Pediatrics* 2011;127:e137–e145.

16 Golding J. Children of the nineties. A longitudinal study of pregnancy and childhood based on the population of Avon (ALSPAC). *West Engl Med J* 1990;105:80–2.

17 Golding J, Pembrey M, Jones R, ALSPAC Study Team. ALSPAC-The Avon longitudinal study of parents and children. I. Study methodology. *Paediatr Perinatal Epidemiol* 2001;15:74–87.

18 ALSPAC. Data collection on the child from birth to seven years. Available at: http://www.bristol.ac.uk/alspac/documents/children-in-focus.pdf (23 February 2010, last accessed).

19 ALSPAC. Data collections on the child aged 7+ to 17+. Available at: http://www.bristol.ac.uk/alspac/documents/focus-collections.pdf (23 February 2010, last accessed).

20 Rubin DB. Multiple imputation after 18+ years. *J Am Stat Assoc* 1996;91:473–89.

21 Schafer JL. *Analysis of Incomplete Multivariate Data*. Boca Raton, FL: Chapman & Hall/CRC, 1997.

22 WHO/UNICEF. *Protecting, Promoting and Supporting Breastfeeding: The Special Role of Maternity Services: A Joint WHO/UNICEF Statement*. Geneva, Switzerland: World Health Organization, UNICEP, 1989.

23 Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. *Biometrika* 1983;70:41–55.

24 Rosenbaum PR, Rubin DB. Reducing bias in observational studies using subclassification on the propensity score. *J Am Stat Assoc* 1984;125:305–53.

25 Quandt SA. Nutritional thriftiness and human reproduction: beyond the critical body composition hypothesis. *Soc Sci Med* 1984;19:117–82.

26 Dettwyler KA, Fishman C. Infant feeding practices and growth. *Annu Rev Anthropol* 1992;21:171–204.

27 De Carvalho M, Robertson S, Friedman A, Klaus M. Effect of frequent breast-feeding on early milk production and infant weight gain. *Pediatrics* 1983;72:307–11.

European Journal of Public Health, Vol. 23, No. 1, 19–24
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doi:10.1093/eurpub/cks040 Advance Access published on 2 May 2012

Low vigorous physical activity at ages 15, 19 and 27: childhood socio-economic position modifies the tracking pattern

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Background: The present study examines (i) if the level of vigorous physical activity (VPA) at age 15 predicts low VPA at ages 19 and 27 and (ii) whether the observed prediction pattern differs by childhood socio-economic position (SEP). In this way, prediction analyses are applied to study tracking behaviour. **Methods:** Data are from The Danish Longitudinal Health Behaviour Study. The baseline survey was conducted in 1990 at age 15, the first follow-up in 1994 at age 19, and the second follow-up in 2002 at age 27, $n = 561$. The study population was a random sample of the Danish population selected from the National Civic Registration System, and data were collected by anonymous postal questionnaires. The indicator of childhood SEP was family occupational social class. Prediction analyses are conducted by stratified logistic regression analyses. **Results:** There was a significant and marked predictive power of low levels of VPA in mid adolescence (aged 15) for low VPA in late adolescence (age 19) [odds ratio (OR)=4.95 (2.83−8.66)], from late adolescence (age 19) into early adulthood (age 27) [OR = 2.71 (1.61−4.55)] and also over the full study period from age 15 to age 27 [2.91 (1.72−4.94)]. Analyses stratified by SEP revealed that the predictive power of VPA at age 19 for low VPA at age 27 was only significant among participants from low SEP. **Conclusion:** These findings suggest that low VPA tracks through adolescence while tracking into adulthood only occurs among individuals with low childhood SEP.

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Introduction

Low physical activity in adulthood is associated with increased risk of morbidity and mortality.[1,2] In childhood, the absence of physical activity may have immediate health consequences[3] and adult health may be compromised directly (e.g. by deterioration of adult bone health)[4] or indirectly by instigating habits of low levels of physical activity. Therefore, a special emphasis on low levels of physical activity – including breaking the tracking patterns – is a key public health focus area.[5,6]

In epidemiology, 'tracking' describes that an individual's level of a given behaviour at a given time in life predicts the same level of behaviour later in life.[7] Tracking is also defined by the maintenance of relative rank or position within a given group over time when considering the full range of the behaviour of interest.[7] Telama (2009) summarizes explanations of tracking of physical activity by four potential approaches.[5] First, the carry-over value hypothesis suggests that people simply continue activities they engaged in at a younger age. Second, the ability and readiness hypothesis suggests that early experiences with physical activities and the skills thereby acquired make it easier to maintain being physical active. Third, tracking results from physical activity being a habit which is maintained automatically without much awareness or intended behaviour. Finally, a hereditary disposition to fitness and motor performance may result in maintaining high levels of physical activity over time.[5]

Two comprehensive reviews show low to moderate tracking of physical activity during all life phases.[5,8] Some studies document weaker tracking patterns in early childhood and in transitional phases from childhood into adolescence and from adolescence into adulthood compared with adulthood. Some studies indicate lower levels of tracking across longer intervals, whereas more recent studies document similar levels of tracking in long-term studies. Several studies show lower levels of tracking among women compared with men.[5,8]

Low physical activity is prevalent among adolescents,[9] so from a public health perspective it may be even more relevant to study tracking patterns of low levels of physical activity.[6] Also, physical activity and physical inactivity may have different determinants which indicate the relevance of studying different levels of physical activity separately.[10] The scientific literature on tracking of low physical activity is limited. Studies of preschool children show inconsistent findings,[11,12] whereas studies on older age groups indicate that inactivity and low activity tends to track more strongly than high activity.[13,14]

Also, little research has examined whether tracking of physical activity varies across socio-economic groups. Social differential tracking patterns of physical activity from adolescence into adulthood may be one of several mechanisms which results in social inequality in physical activity in adulthood.[15]

Kimm *et al.*[16] reported larger decreases in self-reported leisure time physical activity from ages 9–10 to 18–19 among US girls of lower educated parents compared with girls of higher educated parents. Another US study by Walters *et al.*[17] found that boys of less-educated parents showed a steeper decline in self-reported moderate to vigorous physical activity (VPA) from mean age 15.9 to mean age 20.4. A Norwegian study showed that from age 15–16 to 18 self-reported physical activity levels declined more in girls of mothers with compulsory education than in girls of mothers with tertiary education and declined more among boys with fathers with low income than among boys with fathers with high income.[18] A study from Australia by Cleland *et al.*[19] analysed the social patterns of tracking of self-reported physical activity from age 7–15 to 26–36 years. No relationship between parental education and tracking of physical activity was observed.

We have not been able to identify studies of socially differentiated tracking which specifically focus on low physical activity, and only limited documentation exists for transitions from mid adolescence into late adolescence and from late adolescence into adulthood, two distinct life periods of great behavioural transitions.[20] Also, no studies with two or more follow-up surveys covering a long follow-up time have been identified.

The present study used data from a Danish cohort study of men and women to examine (i) if the level of VPA at age 15 predicts low VPA at ages 19 and 27 and (ii) whether the observed prediction pattern differs by childhood socio-economic position (SEP). In this way, we use prediction analyses to study tracking behaviour.

Methods

We used data from the youngest of the five cohorts in The Danish Longitudinal Health Behaviour Study. The baseline survey was conducted in 1990 at age 15, the first follow-up was in 1994 at age 19 and the second follow-up was in 2002 at age 27. The study population was a random sample of 15 year olds selected from the National Civic Registration System. The questionnaires included items concerning demographic factors, social background, living conditions, psychosocial factors, self-reported health, illness and health behaviours.

Data were collected by postal questionnaires. As the participants were underaged at baseline, parents were informed about the possibility to withdraw their child from the study. Of all the invited adolescents ($n = 1100$), 104 were left out due to parental request, leaving a potential study population of 996 adolescents. Response rates were 85.0% in 1990, 86.9% in 1994 and 81.3% in 2002. Only participants completing questionnaires in all three surveys were included in the present analyses (n_{total}= 561, n_{boys}= 215, n_{girls}= 346), corresponding to 56.3% of the baseline population.

Table 1 describes the applied measures of VPA and the re-coded categories applied in the analysis. The outcome measure in the statistical analyses was 0 hours of VPA outside school/work. Participants with 0 hours of VPA may conduct VPA during school or work time, so we characterize this behaviour as low VPA.

Childhood SEP was estimated by retrospective data measured at age 27 using two items about the father's and mother's occupation. Respondents reported their parents' occupation at the age of 50. Data were coded according to the standards of the Danish National Institute of Social Research[21] into SEP I (high) to V (low) and VI (living on social welfare benefits). Two criteria guided the coding of occupation: required educational qualifications and control over people or capital, e.g. size of the company or number of subordinates. This standard is almost identical to the UK Registrar General's classification.[22] Due to the relatively low power of the study for stratified analyses, we categorized participants in two groups, according to the highest ranking parent: high childhood SEP (I+II) and low childhood SEP (III+IV+V+VI). Sensitivity analyses showed that change of cut-point did not influence the direction of the associations. In analyses of loss to follow-up, we used similar data on parental occupation collected by students' reports at age 15.

Based on the assumption that 27 year olds are able to provide more reliable data on parental occupation compared with 15 year olds, we decided to use the data collected at age 27 for prediction analyses. Prediction analyses with both sets of information on parental occupation revealed identical conclusions (data not shown).

Ethics

Ethical approval of questionnaire-based survey studies in the general population is not required in Denmark. The study complies with the formal rule to request parents' acceptance of inclusion of their children in a prospective study. The participants were informed in writing that participation was voluntary and anonymous. The study complies with the Helsinki II declaration.

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Table 1 Description of items measuring vigorous physical activity outside school at ages 15, 19 and 27 and categorizations applied for analysis

Item description	Response categories	Categorization when included in analysis as independent variable	Dichotomization when included in analysis as dependent variable
Age 15:			
''Outside school: How many hours a week do you exercise or participate in sports that make you sweat or out of breath?	None 0.5 h per week 1 h per week 2–3 h per week 4–6 h per week ≥7 h per week	0–0.5 h per week 1 h per week 2–3 h per week ≥4 h per week	–
Age 19:			
''Outside work or school: How many hours a week do you exercise or participate in sports that make you sweat or out of breath?	None 0.5 h per week 1 h per week 2–3 h per week 4–6 h per week ≥7 h per week	0–0.5 h per week 1 h per week 2–3 h per week ≥4 h per week	0 h per week ≥0.5 h per week
Age 27:			
''How many hours a week do you exercise or participate in sports that make you sweat or out of breath?''	None 0.5 h per week 1 h per week 2–3 h per week 4–6 h per week ≥7 h per week	–	0 h per week ≥0.5 h per week

Statistical analyses

We used logistic regression analyses to estimate odds ratios (OR) for the prediction of low VPA at ages 19 and 27 by level of VPA at age 15 (reference group: ≥4 hours/week). Thereby we were able to keep several levels of the independent variables. We also estimated the association between level of VPA at age 19 and low VPA at age 27. Preliminary stratified analyses showed similar patterns for males and females, and consequently we show analyses for men and women combined. The overall tracking analyses were adjusted by sex and childhood SEP. Finally, analyses were stratified by childhood SEP to evaluate the modifying effect of childhood SEP. Additionally, the modifying effect of childhood SEP was tested by inclusion of an interaction term in the regression model of SEP and level of VPA at ages 15 and 19, respectively.

Analyses of loss to follow-up from baseline to second follow-up ($n = 282$) regarding sex, VPA at age 15 and parental occupational class reported at age 15 were conducted by chi-squared tests. Analyses were conducted using SAS software (version 9.1, SAS institute, Cary, NC).

Results

The prevalence of low VPA increased from 12.7% at age 15 to 26.2% at age 19 and 29.2% at age 27. Generally, females were less physically active than males (Table 2).

Table 3 presents the results of the prospective analyses of the association between level of VPA at age 15 and low VPA at age 19 and 27 and the association between level of VPA at age 19 and low VPA at age 27. All analyses showed gradually increasing OR with decreasing level of VPA. The OR for low VPA at age 19 was 4.95 (2.83–8.66) among those with 0–½ hours of VPA per week at age 15. The corresponding OR for ages 19 to 27 was 2.71 (1.61–4.55) and 2.91 (1.72–4.94) for ages 15 to 27.

Table 3 also shows the results of the analyses stratified by childhood SEP. In both SEP strata, there was a strong association between level of VPA at age 15 and low VPA at age 19. A significant association was seen between level of VPA at age 15 and low VPA at age 27 in the low SEP stratum [OR = 4.03 (2.11–7.68) for 0–½ hour/week] whereas no corresponding association was found in the high SEP stratum. Correspondingly, the association between VPA at age 19 and low VPA at age 27 was significant in the low SEP stratum [3.79 (2.00–7.20) for 0–½ hour/week] and insignificant in the stratum of high childhood SEP. No statistical interactions were identified.

Analyses of loss to follow-up revealed no differences between those who did and did not participate in the follow-up surveys regarding VPA at age 15 ($P = 0.5965$) and SEP measured at age 15 ($P = 0.2787$). For sex, the loss to follow-up was selected towards men ($P < 0.0001$).

Discussion

This study of a Danish cohort documents a significant and marked predictive power of low levels of VPA in mid-adolescence for low VPA in late adolescence, from late adolescence into adulthood and for the full study period from mid-adolescence into early adulthood. However, analyses stratified by childhood SEP revealed that the predictive power of VPA at age 15 and 19 for low VPA at age 27 was only significant among participants from low childhood SEP. These findings suggest socially differential tracking of low VPA from late adolescence into early adulthood, whereas tracking of low VPA between mid and late adolescence seems to be independent of socio-economic background. Despite insignificant statistical tests for interaction, the observed differences in OR estimates in stratified analyses suggest the existence of a modifying effect of childhood SEP. It is likely that the observed insignificant tests for interaction are due to limited statistical power.

The US study by Kimm *et al.*[16] covering the period from childhood to late adolescence and the US study by Walters *et al.*[17] and the Norwegian study by Sagatun *et al.*,[18] which both analyse the period from mid-adolescence to late adolescence (age 15.9 to 20.4 and age15–16 to 18, respectively), all found that tracking of physical activity was modified by childhood SEP. In our study, there was no modifying effect of childhood SEP from age 15 to 19. The study by Cleland *et al.*[19] studied the tracking pattern of physical activity from adolescence into adulthood and found no modifying effect of

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Table 2 Characteristics of study population

	Total population ($n = 561$)[a] % (n)	Males ($n = 215$) % (n)	Females ($n = 346$) % (n)
Baseline, age 15			
Weekly hours of vigorous physical activity			
0	12.7 (71)	10.2 (22)	14.2 (49)
0.5	7.0 (39)	2.8 (6)	9.5 (33)
1	13.0 (73)	7.9 (17)	16.2 (56)
2–3	32.4 (182)	30.7 (66)	33.5 (116)
4–6	23.2 (130)	29.8 (64)	19.1 (66)
≥7	11.6 (65)	18.1 (39)	7.5 (26)
Missing	0.2 (1)	0.5 (1)	0.0 (0)
Childhood SEP[b]			
Social class I	10.2 (57)	11.2 (24)	9.5 (33)
Social class II	21.9 (123)	21.9 (47)	22.0 (76)
Social class III	25.3 (142)	24.2 (52)	26.0 (90)
Social class IV	24.8 (139)	22.3 (48)	26.3 (91)
Social class V	14.6 (82)	15.4 (33)	14.2 (49)
On social welfare benefits	0.7 (4)	0.5 (1)	0.9 (3)
Unclassifiable	0.0 (0)	0.0 (0)	0.0 (0)
Missing	2.5 (14)	4.7 (10)	1.2 (4)
First follow-up, age 19			
Weekly hours of vigorous physical activity			
0	26.2 (147)	23.3 (50)	28.0 (97)
0.5	9.5 (53)	9.3 (20)	9.5 (33)
1	16.2 (91)	10.7 (23)	19.7 (68)
2–3	21.4 (120)	20.5 (44)	22.0 (76)
4–6	16.6 (93)	19.1 (41)	15.0 (52)
≥7	9.6 (54)	16.7 (36)	5.2 (18)
Missing	0.5 (3)	0.5 (1)	0.6 (2)
Second follow-up, age 27			
Weekly hours of vigorous physical activity			
0	29.2 (164)	24.7 (53)	32.1 (111)
0.5	9.3 (52)	7.4 (16)	10.4 (36)
1	14.8 (83)	14.0 (30)	15.3 (53)
2–3	25.3 (142)	20.9 (45)	28.0 (97)
4–6	16.2 (91)	25.6 (55)	10.4 (36)
≥7	3.6 (20)	5.12 (11)	2.6 (9)
Missing	1.6 (9)	2.3 (5)	1.2 (4)
Childhood SEP[c]			
Social class I	7.0 (39)	7.4 (16)	6.7 (23)
Social class II	26.0 (146)	29.3 (63)	24.0 (83)
Social class III	28.2 (158)	26.5 (57)	29.2 (101)
Social class IV	26.7 (149)	24.2 (52)	28.0 (97)
Social class V	10.9 (61)	10.7 (23)	11.0 (38)
On social welfare benefits	0.2 (1)	0.0 (0)	0.3 (1)
Unclassifiable	0.2 (1)	0.0 (0)	0.3 (1)
Missing	1.1 (6)	1.9 (4)	0.6 (2)

a: Individuals participating in all three data collections
b: Data on family occupational social class collected by students' reports in 1990 are used in analyses of non-respondents
c: Retrospective data on family occupational social class collected at age 27

childhood SEP. We observed stronger tracking of low VPA among adolescents with low childhood SEP compared with high childhood SEP from age 19 to 27.

The inconsistent findings of socio-economic patterning of physical activity among young people[23,24] suggest that the role of SEP for young people's habits of physical activity may vary by cultural setting and by birth cohorts. This may also explain the differences in findings from the previous studies of social differential tracking of physical activity and the presented results from analyses of a Danish cohort. Methodological differences may also partly explain the different findings. First, the present study specifically analyses the prediction of low levels of physical activity whereas the focus of the previous literature has been higher levels of physical activity. Second, the applied measure of childhood SEP varies across studies. Finally, the present study has two follow-up data collections which gave the opportunity to analyse prediction patterns in two study periods. In the present study, we did not find different tracking patterns for men and women. This does not correspond with the existing literature which generally finds stronger tracking among men.[5,8] These inconsistent findings may also be due to differences in cultural setting and methodology.

A life-course perspective is crucial for understanding social inequalities in health and health behaviours in adult population,[25,26] and the distinct relevance of adolescence is increasingly being recognized.[15] The Adolescent Pathway Model by Due *et al.*[15] outlines pathways which may work during adolescence to create and strengthen adult health inequalities. One relates to socially differential tracking of health behaviours from adolescence into adulthood. The literature on social inequalities in physical activity in adolescence is inconclusive[23,24], whereas studies on adult populations are generally more consistent in finding social inequality in physical activity.[27] One way of understanding the change in social patterning of physical activity over time is therefore to disentangle the patterns of social differential tracking of physical activity and thereby understand the timing of changes. The present study from a Danish cohort contributes to this yet limited research by suggesting that low VPA mainly tracks from late adolescence into adulthood in populations with low childhood SEP but not in populations with high childhood SEP. Tracking of low VPA from mid- into late adolescence occurs independent of socio-economic background. Understanding such timing and the underlying mechanisms will contribute to the planning and designing of health promotion initiatives. The mechanisms leading to socially differential tracking of low physical activity are yet unknown.

When interpreting the presented results, a number of limitations should be considered. Analyses of loss to follow-up revealed that dropouts were more often male than female. No selected loss to follow-up was seen for VPA or SEP. However, a selected uptake of

Table 3 Sex-adjusted odds ratios (OR, 95% CI) for low vigorous physical activity (low VPA) at ages 19 and 27 by level of vigorous physical activity (VPA) at ages 15 and 19 stratified by childhood SEP ($n = 561$)

	Full study population[a] ($n = 561$)		High SEP[b] (I+II, $n = 185$)		Low SEP[b] (III+IV+V+VI, $n = 368$)	
	Low VPA at age 19	Low VPA at age 27	Low VPA at age 19	Low VPA at age 27	Low VPA at age 19	Low VPA at age 27
VPA at age 15						
0–0.5 h/week	4.95 (2.83–8.66)	2.91 (1.72–4.94)	6.50 (2.40–17.59)	1.49 (0.57–3.91)	4.31 (2.19–8.49)	4.03 (2.11–7.68)
1 h/week	2.29 (1.19–4.41)	2.06 (1.13–3.77)	1.83 (0.53–6.26)	1.05 (0.33–3.38)	2.45 (1.12–5.36)	2.70 (1.31–5.55)
2–3 h/week	1.81 (1.07–3.06)	1.15 (0.70–1.89)	1.94 (0.79–4.78)	0.71 (0.30–1.69)	1.71 (0.89–3.27)	1.50 (0.82–2.75)
≥4 h/week	1.0	1.0	1.0	1.0	1.0	1.0
VPA at age 19						
0–0.5 h/week	–	2.71 (1.61–4.55)	–	1.28 (0.52–3.17)	–	3.79 (2.00–7.20)
1 h/week	–	2.14 (1.15–4.01)	–	0.87 (0.29–2.62)	–	3.03 (1.41–6.52)
2–3 h/week	–	1.35 (0.73–2.48)	–	0.67 (0.24–1.91)	–	1.79 (0.84–3.79)
≥4 h/week	–	1.0	–	1.0	–	1.0

a: Adjusted by childhood SEP
b: Adjusted by sex

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individuals into the study at baseline may have occurred as almost no participants had parents who received social welfare benefits. The conclusions of the present study therefore only apply for children with economically active parents. Also, a selection bias into the study at baseline may have reduced the variation in SEP, which may have caused an underestimation of the modifying effect of SEP.

Data on physical activity were collected from self-reports. Former validation studies suggest that the applied measurements have reasonably good reliability and validity[28,29]. Still, the use of self-reports increase the risk of recall bias and social desirability bias.[30] The applied analytical model may reduce the effect of such bias as we model against low levels of VPA. Social desirability may lead to an overestimation whereby individuals with low or no physical activity are categorized in high levels of physical activity. Therefore, the issues of over-reporting physical activity may be less serious in analyses focusing on low physical activity. Also, it should be kept in mind that the measure of physical activity solely relates to VPA outside school/work. Conclusions are therefore valid only for VPA conducted during leisure time.

A validation study of retrospectively reported childhood parental education showed that such data are valid and that validity did not vary by SEP.[31]. We used parental occupation as the indicator of SEP and assume acceptable validity also of recalls of parental occupation. Validity studies have shown that adolescents can report their parents' occupational activity in sufficient details to be used for studies of socio-economic differences.[32,33]

Personal SEP at age 27 may influence VPA at age 27, and its role as an unmeasured confounder should be considered. However, as personal SEP at age 27 cannot be a determinant of VPA at age 15, it does not fulfil the criteria for being a confounder between levels of VPA at age 15 and low VPA at age 27. Rather, it may potentially be a mediating factor. As Cleland *et al.*[19] argue, high physical activity may improve physical or emotional health which may lead to improved SEP through improved educational and occupational opportunities. Further, initial analyses showed that personal SEP at age 27 was not significantly associated with low VPA at age 27 (data not shown). Finally, for many individuals, the measure of personal SEP at age 27 will characterize a short period of life in which one holds a temporary low SEP, e.g. as a student. There may be other issues of unmeasured confounding, e.g. availability of physical activity resources in the environment, but we have no available data on such variables.

The random sample, the long period of follow-up and the inclusion of two follow-up data collections are important merits of the study. Thereby, two distinct life stages of high importance to physical activity were explored separately. Throughout the study period, the response rates were fairly high and the measurement of physical activity was similar. Finally, very few studies specifically focus on low physical activity. The present study adds to this upcoming area of socio-epidemiological behavioural research.

The present study suggests social differential tracking of low VPA as a potential pathway that may lead to social inequality in low VPA among adults. We propose further analyses based on larger and less selected data sets and analyses including moderate levels of physical activity. Still, in a life-course perspective, the presented findings highlight the importance of considering socio-economic circumstances in adolescence for long-term development of healthy habits.

Key points

- Existing studies on socio-economic modification of tracking of physical activity over time are limited in numbers and inconclusive.
- The present study shows that the less vigorous the physical activity (VPA) at age 15, the higher the risk of low VPA at age 19.
- The study also shows that the less the VPA at age 15, the higher the risk of low VPA at age 27, but only among participants from families of lower SEP.
- In a life-course perspective, these findings highlight the importance – in both research and practice – of considering socio-economic circumstances of early life for the long-term development of healthy habits.

Funding

The Danish Cancer Society (grant no. 93-504); the National Board of Health (grant no. 407-19-1999); the Nordea Foundation.

Conflicts of interest: None declared.

References

1 US Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta, Georgia: US Department of Health and Human Services, Public Health Service, CDC, National Center for Chronic Disease Prevention and Health Promotion, 1996.

2 Woodcock J, Franco OH, Orsini N, Roberts I. Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. *Int J Epidemiol* 2011;40:121–38.

3 Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act* 2004;7:40.

4 Hallal PC, Victora CG, Azevedo MR, Wells JCK. Adolescent physical activity and health. *Sports Med* 2006;36:1019–30.

5 Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obes Facts* 2009;3:187–95.

6 Corbin CB. The 'un-tracking' of sedentary living: a call for action. *Pediatr Exerc Sci* 2001;13:347–56.

7 Foulkes MA, Davis CE. An index of tracking for longitudinal data. *Biometrics* 1981;37:439–46.

8 Malina RM. Tracking of physical activity and physical fitness across the lifespan. *Res Q Exerc Sport* 1996;67:48–57.

9 Currie C, Nic Gabhainn S, Godeau E, et al. (eds) (2008). Inequalities in young people's health: HBSC international report from the 2005/06 survey. Copenhagen: WHO Regional Office for 5 Europe, (Health Policy for Children and Adolescents, No. 5).

10 Gordon-Larsen P, McMurray RG, Popkin BM. Determinants of adolescent physical activity and inactivity patterns. *Pediatrics* 2000;105:E83.

11 Kelly LA, Reilly JJ, Jackson DM, et al. Tracking physical activity and sedentary behavior in young children. *Pediatr Exerc Sci* 2007;19:51–60.

12 Baggett CD, Stevens J, McMurray RG, et al. Tracking of physical activity and inactivity in middle school girls. *Med Sci Sports Exerc* 2008;40:1916–22.

13 Raustorp A, Svensson K, Perlinger T. Tracking of pedometer-determined physical activity: a 5-year follow-up study of adolescents in Sweden. *Pediatr Exerc Sci* 2007;19:228–38.

14 Kjønniksen L, Torsheim T, Wold B. Tracking of leisure-time physical activity during adolescence and young adulthood: a 10-year longitudinal study. *Int J Behav Nutr Phys Act* 2008;5:69.

15 Due P, Krølner R, Rasmussen M, et al. Pathways and mechanisms in adolescence contribute to adult health inequalities. *Scand J Public Health* 2011;39(6 Suppl):62–78.

16 Kimm SYS, Glynn NW, Kriska AM, et al. Decline in physical activity in black girls and white girls during adolescence. *N Engl J Med* 2002;347:709–15.

17 Walters S, Barr-Anderson DJ, Wall M, Neumark-Sztainer D. Does participation in organized sports predict future physical activity for adolescents form diverse economic backgrounds? *J Adolesc Health* 2009;44:268–74.

18 Sagatun Å, Kolle E, Anderssen SA, et al. Three-year follow-up of physical activity in Norwegian youth from two ethnic groups: associations with socio-demographic factors. *BMC Public Health* 2008;8:419.

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19 Cleland VJ, Ball K, Magnussen C, Dwyer T, Venn A. Socioeconomic position and the tracking of physical activity and cardiorespiratory fitness from childhood to adulthood. *Am J Epidemiol* 2009;170:1069–77.

20 Patton GC, Viner R. Pubertal transition in health. *Lancet* 2007;31:1130–9.

21 Hansen EJ.Distribution of living conditions. Vol 1 [Fordelingen af levekårene. Bind 1, in Danish] Danish National Institute of Social Research, 1978.

22 Galobardes B, Shaw M, Lawlor DA, et al. Indicators of socioeconomic position (part 2). *J Epidemiol Community Health* 2006;60:95–101.

23 Stalsberg R, Pedersen AV. Effects of socioeconomic status on the physical activity in adolescents: a systematic review of evidence. *Scan J Med Sci Sports* 2010;20:368–83.

24 Brodersen NH, Steptoe A, Boniface DR, Wardle J. Trends in physical activity and sedentary behaviour in adolescence: ethnic and socioeconomic differences. *Br J Sports Med* 2007;41:140–4.

25 Kuh D, Power C, Blane D, Bartley M. Social pathways between childhood and adult health. In: Kuh D, Ben-Shlomo Y, editors. *A Life Course Approach to Chronic Disease Epidemiology*. Oxford: Oxford University Press, 1997: 169–78.

26 Graham H, Power C. Childhood disadvantage and health inequalities: a framework for policy based on life course research. *Child Care Health Dev* 2004;30:671–8.

27 Trost SG, Owen N, Bauman AE, et al. Correlates of adults' participation in physical activity: review and update. *Med Sci Sports Exer* 2002;34:1996–2001.

28 Booth ML, Okely AD, Chey T, Bauman A. The reliability and validity of the physical activity questions in the WHO health behaviour in schoolchildren (HBSC) survey: a population study. *Br J Sports Med* 2001;35:263–7.

29 Rangul V, Holmen TL, Kurtze N, et al. Reliability and validity of two frequently used self-administered physical activity questionnaires in adolescents. *BMC Med Res Methodol* 2008;8:47.

30 Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med* 2003;37:197–206.

31 Krieger N, Okamoto A, Selby JV. Adult female twins' recall of childhood social class and father's education: a validation study for public health research. *Am J Epidemiol* 1998;147:704–8.

32 Lien N, Friedstad C, Klepp K-I. Adolescents' proxy reports of parents' socioeconomic status: How valid are they? *J Epidemiol Community Health* 2001;55:731–7.

33 Vereecken CA, Vandegehuchte A. Measurement of parental occupation: agreement between parents and their children. *Arch Public Health* 2003;61:141–9.

European Journal of Public Health, Vol. 23, No. 1, 24–29
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doi:10.1093/eurpub/cks038 Advance Access published on 28 April 2012

The family's economic resources and adolescents' health complaints—do adolescents' own economic resources matter?

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Background: The present study focuses on the relevance of economic resources to psychological and psychosomatic health complaints during adolescence. It explores the link between the family's and the adolescent's economic resources and investigates whether or not differences in health complaints by the family's financial situation can be explained by adolescents' own economic resources. **Methods:** Drawing on data from two Swedish surveys on living conditions during adolescence (in the age group 10–18 years) conducted in 2002–03, logistic regressions were used to assess the associations between adolescents' own and household economic resources on two measures of health complaints. **Results:** The association between family economic hardship (i.e. lack of cash margin) and adolescents' health complaints largely disappeared when controlling for adolescents' own economic resources. Three measures of own absolute and relative economic resources were used. Out of these, the ability (or not) to buy things that others have was connected with both psychological [Odds ratio (OR) 2.16, 95% confidence interval (95% CI) 1.6–2.9] and psychosomatic complaints (OR 1.67, 95% CI 1.3–2.1), irrespective of age and gender. The importance of lacking a personal cash margin or not being able to join friends seemed to differ between age groups and genders. **Conclusions:** The importance of different aspects of economic resources seems to vary across age groups and gender. However, not being able to buy things that others have was clearly associated with health complaints irrespective of age and gender. Family economic hardship was associated with adolescents' health complaints, and this association was largely explained by adolescents' own economic resources.

Introduction

In the adult population, the relation between income, or economic resources, and health has been studied extensively and the importance of income discussed in both absolute and relative terms.[1,2] Needs and necessities are relative to the society and to the groups we belong to, and lacking these necessities makes it difficult to fully participate in society or to be part of these groups.[3] For young people, inclusion is sometimes linked to having 'what all the other kids have', leading to increased stress among both parents and children if these needs cannot be met.[1] The influence of family economy in the peer group setting may have many components, including young persons' own economic resources in both absolute and relative terms.

The concept of relative deprivation has long been used in social research.[4–6] The general idea is that having less resources than others

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