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Economic stress and low leisure-time physical activity: Two life course hypotheses

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ABSTRACT

The aim was to investigate associations between economic stress in childhood and adulthood, and low leisure-time physical activity (LTPA) in adulthood from two life course perspectives. The public health survey in Scania in the southernmost part of Sweden in 2012 is a cross-sectional study based on a stratified random sample with 28,029 respondents aged 18–80 (51.7% response rate). Associations between childhood and adult economic stress, and low LTPA were analyzed with logistic regressions. A 14.8% prevalence of men and 13.5% of women had low LTPA (sedentary lifestyle). Low LTPA was associated with higher age, being born abroad, low socio-economic status, low trust, smoking, poor self-rated health, and economic stress in childhood and adulthood. The odds ratios of low LTPA increased with more accumulated economic stress across the life course in a dose-response relationship. There was no specific critical period (childhood or adulthood), because economic stress in childhood and adulthood were both associated with low LTPA but the associations were attenuated after the introduction of smoking and self-rated health. The accumulation hypothesis was supported because the odds ratios of low LTPA indicated a graded response to life course economic stress. The critical period hypothesis was thus not supported. Economic stress across the life course seems to be associated with low LTPA in adulthood.

1. Introduction

Physical inactivity has been judged by the WHO to be the fourth strongest risk factor for mortality globally (World Health Organization, 2009). In many countries and populations, including Sweden and other economically developed countries, a sedentary life style and low levels of physical activity are prevalent in the population (Loyen et al., 2016). For a long time, the main recommendation has been to perform moderate physical activity (e.g. walking) for at least 30 min at least five days a week (O'Donovan et al., 2010), and the most important health improvement is achieved when moving from sedentary life style to moderate physical activity (Neuhaus et al., 2014; Prince, Saunders, Gresty, & Reid, 2014).

Determinants of low leisure-time physical activity (LTPA) and sedentary behavior include individual level factors such as biological, psychological and behavioral factors, but social, environmental and policy factors are also important (Owen et al., 2011; Rhodes, Mark, & Temmel, 2012; Carlin et al., 2017). A major pattern in economically developed countries such as Sweden is that sedentary life style and low levels of LTPA are not evenly distributed according to socioeconomic status (SES) (O'Donoghue et al., 2016). Lower SES groups, i.e. groups

with lower occupation, education or income, have consistently higher prevalence of sedentary life style and LTPA below the recommended level given above (Lindström, Hanson, & Östergren, 2001; Trost, Owen, Bauman, Sallis, & Brown, 2002; O'Donoghue et al., 2016). Typically, the associations between SES and low LTPA have been explored in cross-sectional or short-term longitudinal perspectives.

The longitudinal life-course connections between SES in childhood and low LTPA in adulthood have been investigated to a limited extent. Only one study investigating life course models in relation to low LTPA has been conducted to our knowledge (Juneau et al., 2014). The life course perspective has surged in epidemiological research in the two most recent decades following the “critical period” hypothesis proposed by Barker (Barker, 1998) that a well-defined period during the life course such as the growth impairment during the third trimester would lead to adverse health outcomes later in life such as decreased glucose tolerance, type 2 diabetes mellitus, hypertension, increased total cholesterol, increased LDL cholesterol, increased triglyceride levels and overweight/obesity, i.e. the metabolic syndrome. Previous studies have found that low SES in adolescence (measured as parents' SES) is associated with low LTPA and sedentary behavior during adolescence (Stalsberg and Pedersen, 2010; Stierlin et al., 2015), and that low SES in

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adulthood is associated with low LTPA in adulthood (Gidlow, Johnston, Crone, Ellis, & James, 2006; Lehto, Konttinen, Jousilahti, & Kaukka, 2013). The question whether there is an association between low (parents') SES in childhood/adolescence and low LTPA in adulthood has been investigated in a number of studies, and a review conducted by Juneau, Benmarhnia, Poulin, Coté, and Potvin (2015) found 42 studies with this research question that fulfilled at least one of the methodological quality criteria defined a priori by the reviewers. A 61.9% proportion of the studies (26 of 42 studies) in this review showed statistically significant associations between SES in early life and physical activity in adulthood. Most of the studies concerned parents' occupation and education. Only five studies concerned parent's economic situation during childhood and/or adolescence (Juneau et al., 2015). These studies show statistically significant associations to an even somewhat higher extent than studies investigating the association between other aspects of parents' SES in childhood and physical activity in adulthood (Sagatun, Kolle, Anderssen, Thoresen, & Sögaard, 2008; Azevedo, Horta, Gigante, Victora, & Barros, 2008; Svedenkrans, Henckel, Kowalski, Norman, & Bohlin, 2013; Popham and Mitchell, 2006; Elwell-Sutton et al., 2011). Finally, the few existing studies concerning economic stress and low LTPA do not further elaborate the plausible pathways such as pathways which include both SES in childhood and adulthood.

Economic stress in childhood may affect LTPA in adulthood through different life-course mechanisms. External and social barriers such as lack of money, lack of transport and lack of enjoyable scenery are mostly more common in SES groups with less economic resources. Internal barriers such as lack of motivation and poor psychosocial health may also be more common and socially inherited in economically less privileged population segments (Chinn, White, Harland, Drinkwater, & Raybould, 1999; King et al. 2000; for full reviews see Stierlin et al., 2015; O'Donoghue et al., 2016). Many of these barriers could permanently form health-related behaviors such as LTPA in early life, and cumulatively affect adult LTPA across the life course. With regard to economic stress in childhood/adolescence and LTPA in adulthood the critical period hypothesis would mean that childhood/adolescence would be a critical period for LTPA in adulthood because socially inherited adverse conditions (listed above) may shape behavior such as physical activity as opposed to sedentary behavior across the life course. In contrast, the accumulation hypothesis postulates that exposure to risk factors such as for instance economic stress in childhood and adulthood may have a cumulative effect across the life course on chronic disease (Hallqvist, Lynch, Bartley, Lang, & Blane, 2004; Wunsch, Duchene, Thiltges, & Salhi, 1996) as well as on health-related behaviors (Lindström, Modén, & Rosvall, 2013) later in life. The difference between the critical period hypothesis and the accumulation hypothesis is clear. According to the critical period hypothesis, economic stress during a specific time period over the life course such as childhood would affect LTPA in adulthood. In contrast, according to the accumulation hypothesis, economic stress in childhood and adulthood would cumulatively affect LTPA in adulthood. These two contrasting hypotheses will be tested.

LTPA has previously been shown to be associated with age, country of birth (Lindström & Sundquist, 2001; Langöien et al., 2017), generalized trust in other people (Lindström, 2011), SES (Lindström et al., 2001; O'Donoghue et al., 2016), smoking and self-rated health as an indicator of chronic diseases (O'Donoghue et al., 2016), which is the reason why these variables are included in the analyses. They are crucial factors associated with LTPA and available in the questionnaire. Generalized trust in other people is an aspect of social capital, i.e. the propensity for cooperation and trust between individuals, groups, organizations and institutions in society (Putnam, 2000).

The aim of this study is to investigate associations between economic stress in childhood and current (adult) economic stress, and low LTPA (sedentary) in relation to the life course accumulation and critical period hypotheses.

2. Methods

2.1. Study population

The public health survey in Scania, the southernmost part of Sweden, is a cross-sectional study based on a stratified random (weighted) sample of people in Scania drawn from the official residential population register conducted in the Autumn of 2012. A total of 28,029 respondents answered the questionnaire and returned it, which yielded a 51.7% response rate. Three letters of reminder containing new questionnaires were sent to the initial non-respondents. Ethical permission to conduct the present study was granted by the Ethical Committee at Lund University, southern Sweden.

2.2. Definitions

2.2.1. Dependent variable

Leisure-time physical activity (LTPA) was measured with a questionnaire item with four alternative answers. The alternatives are regular exercise (exercising at least three times per week for at least 30 min each time, leading to sweating), moderate and regular exercise (exercising at least once or twice per week for at least 30 min, leading to sweating), moderate exercise (walking, cycling or similar activity for at least 2 h per week without sweating) and sedentary leisure-time physical activity status (less than 2 h spent walking, cycling or similar activity each week). This item was dichotomized into high LTPA (the three first alternatives) and low LTPA (the fourth alternative).

2.2.2. Independent variables

Age was stratified in age groups 18–24, 25–34, 35–44, 45–54, 55–64 and 65–80 years of age.

Analyses in all tables were stratified by sex.

2.2.2.1. Country of birth. All participants born in countries other than Sweden were classified in one group and those born in Sweden in the other.

Socioeconomic status (SES) (by occupation and relation to labor market) included the employed categories non-manual employees in higher positions, non-manual employees in medium level positions, non-manual employees in lower positions, and skilled and unskilled manual workers as well as self-employed/farmers. The categories outside the workforce consist of unemployed, students, early retired (before age 65)/ long-term sick leave, pensioners aged 65 or above, and unclassified.

Generalized trust in other people is a variable that concerns the respondents' appraisal of generalized trust in others. This was assessed with the item "Generally, you can trust other people" with the four optional answers: "Do not agree at all", "Do not agree", "Agree", and "Completely agree". The alternatives were dichotomized with the two first options depicting low trust and the two following high.

Tobacco smoking was assessed with the question "Do you smoke?" with the options "daily smoker", "smoker, but not daily", "never smoker" and "non-smoker, stopped smoking". The item was dichotomized with the two first alternatives as "smoker" (yes) and the two latter as "non-smoker" (no).

Self-rated health was assessed with the question "How do you consider your general health status?", with the options "Very good", "Good", "Neither good nor poor", "Poor" and "Very Poor".

Economic stress in childhood was measured with the item "Did your family experience economic hardship during your childhood?" which entailed the alternatives "No, no significant problems" (category 1), "Yes, less severe problems and/or problems during short time periods" (category 2) and "Yes, severe problems and/or problems during long time periods" (category 3).

Economic stress in adulthood (current situation) was measured with the item "How often during the past twelve months have you had

problems paying your bills?” with the four alternative answers “never” (category 1), “occasionally” (category 2), “every second month” (category 3) and “every month” (category 3). The two alternatives “every second month” and “every month” were thus collapsed into category 3 in the statistical models in Tables 3 and 4.

Economic stress in childhood and *economic stress in adulthood* (current situation) were analyzed in combination in two differing ways to address the two life course hypotheses:

The accumulation hypothesis was analyzed by the combination of economic stress in childhood and adulthood: respondents with no problems in childhood as well as no problems in adulthood (current situation) being the first combination (category 1 + category 1, see above in description of separate economic stress in childhood and economic stress in adulthood variables, respectively), respondents with no problems in either childhood or adulthood combined with lesser (medium) problems in either childhood or adulthood being the second best combination (1 + 2 or 2 + 1). The third combination comprises the combination of categories (1 + 3), (3 + 1), (2 + 2), i.e. no economic problems in childhood + severe economic problems during the past year (every month or half the year) (1 + 3), moderate economic problems in both childhood and during the past year in adulthood (2 + 2) and severe economic problems in childhood + no economic problems during the past year in adulthood (3 + 1). The fourth combination consists of the (2 + 3) and (3 + 2) categories. The worst combination is severe economic stress in childhood as well as in adulthood (3 + 3). This yields a total of five combinations to analyze the accumulation hypothesis.

The critical period hypothesis was analyzed by the inclusion of both economic stress in childhood and economic stress in adulthood as two variables in the same model. The model also analyzed the interaction term between economic stress in childhood and age, and economic stress in adulthood and age.

2.3. Statistics

Sex-stratified and total distributions (%) of LTPA, age, country of birth, socioeconomic status, trust, smoking, self-rated health, economic stress in childhood and economic stress in adulthood were calculated (Table 1). Distributions (%) and odds ratios with 95% confidence intervals (OR:s, 95% CI:s) of low LTPA were estimated in multiple logistic regression analyses stratified by sex in relation to age, country of birth, SES, trust, smoking, self-rated health, economic stress in childhood and economic stress in adulthood, with odds ratios calculated with all variables calculated simultaneously in the same model (separate models for men and women) (Table 2). Age-adjusted and covariate-adjusted odds ratios with 95% confidence intervals of low LTPA according to the accumulation hypothesis were calculated in logistic regression analyses were calculated, stratified by sex (Table 3). Age- and covariate-adjusted odds ratios and 95% confidence intervals of low LTPA were calculated in logistic regression analyses according to the critical period hypothesis, including an assessment of interaction between economic stress in childhood and adulthood and age with the interaction terms, economic stress in childhood*age and economic stress in adulthood*age evaluated by the p-values of the interactions in the models, stratified by sex. Statistical calculations were conducted by the SPSS software, version 23.0.

3. Results

The prevalence of low LTPA was 14.8% among men and 13.5% among women. Table 1 also shows that 20.9% of the men and 22.2% of the women were born in other countries than Sweden, that 37.1% of the men and 37.3% of the women had low generalized trust in others, that 67.6% of the men and 67.2% of the women had experienced no significant economic stress in childhood according to their own self-report, that 75.9% of the men and 73.4% had never experienced economic

Table 1

Prevalence (%) of low LTPA, age, country of birth, socioeconomic status, generalized trust in other people, smoking, self-rated health, and economic stress in childhood and adulthood. Men (n = 12,828), women (n = 15,201), and total (n = 28,029). The public health survey in Scania 2012.

	Men (n = 12,828)	Women (n = 15,201)	Total (n = 28,029)
LTPA			
High	85.2	86.5	85.8
Low	14.8	13.5	14.2
(Missing)	(336)	(481)	(817)
Age			
18–24	11.2	13.7	12.5
25–34	17.1	18.0	17.5
35–44	17.5	17.9	17.7
45–54	17.7	16.9	17.3
55–64	16.2	15.3	15.7
65–80	20.3	18.1	19.2
(Missing)	(0)	(0)	(0)
Country of birth			
Sweden	79.1	77.8	78.4
Other country	20.9	22.2	21.6
(Missing)	(100)	(135)	(235)
Socioeconomic status			
Higher non-manual	11.7	9.6	10.6
Medium non-manual	9.8	12.9	11.3
Lower non-manual	5.7	10.2	7.9
Skilled manual	14.2	13.1	13.6
Unskilled manual	14.1	12.6	13.3
Self-employed/farmer	9.8	4.8	7.3
Early retired/long-term sick leave	2.5	4.0	3.2
Unemployed	5.7	4.7	5.2
Student	6.2	8.4	7.3
Old age pensioner	20.4	18.8	19.6
Unclassified	0.2	0.8	0.5
(Missing)	(134)	(172)	(306)
Trust			
High	62.9	62.7	62.8
Low	37.1	37.3	37.2
(Missing)	(371)	(400)	(771)
Smoking			
No	82.4	82.9	82.7
Yes	17.6	17.1	17.3
(Missing)	(157)	(303)	(460)
Self-rated health			
Very good	26.3	24.6	25.4
Good	49.2	47.9	48.5
Neither good nor poor	18.5	20.9	19.7
Poor	4.9	5.3	5.1
Very poor	1.1	1.3	1.2
(Missing)	(133)	(322)	(455)
Economic stress in childhood			
No significant problem	67.6	67.2	67.4
Less severe and/or shorter period	24.3	24.3	24.3
Severe and/or longer period	8.1	8.5	8.3
(Missing)	(161)	(212)	(373)
Economic stress in adulthood			
Never	75.9	73.4	74.6
Occasionally	15.3	16.8	16.1
Half the year	3.7	4.2	3.9
Every month	5.1	5.6	5.4
(Missing)	(375)	(442)	(817)

stress during the past year in adulthood (current), that 17.6% of men and 17.1% of women were smokers and that 75.5% of men and 72.5% of women had very good or good self-rated health. Table 1 also shows the distributions according to age and socioeconomic status.

Table 2 shows that the results of the multivariate analyses of low LTPA indicate that men in the age intervals 35–44 years had significantly higher odds ratios of low LTPA than men in the age interval 18–24 years. Women had significantly higher odds ratios of low leisure-

Table 2
Prevalence (%) and odds ratios (OR, 95% CI) in multivariate analyses of low LTPA according to age, country of birth, socioeconomic status, trust, smoking, self-rated health, and economic stress in childhood and adulthood. Men (n = 12,828) and women (n = 15,201). The public health survey in Scania 2012.

	Men (n = 12,828)		Women (n = 15,201)	
	%	OR(95%CI)	%	OR(95%CI)
Age				
18–24	10.7	1.00	10.5	1.00
25–34	13.1	0.95 (0.75–1.21)	11.9	1.39 (1.10–1.76)
35–44	16.2	1.29 (1.01–1.64)	13.8	1.70 (1.35–2.16)
45–54	16.8	1.19 (0.93–1.51)	13.9	1.47 (1.16–1.87)
55–64	16.1	0.96 (0.74–1.23)	14.0	1.43 (1.12–1.84)
65–80	14.6	1.36 (0.92–2.01)	16.2	2.30 (1.47–3.63)
Country of birth				
Sweden	13.1	1.00	11.4	1.00
Other country	21.7	1.28 (1.00–1.64)	21.1	1.48 (1.30–1.68)
Socioeconomic status				
Higher non-manual	9.9	1.00	7.4	1.00
Medium non-manual	13.2	1.28 (1.00–1.64)	9.1	1.12 (0.86–1.48)
Lower non-manual	13.0	1.38 (1.04–1.82)	11.9	1.38 (1.04–1.81)
Skilled manual	15.0	1.40 (1.12–1.75)	11.6	1.22 (0.93–1.59)
Unskilled manual	17.4	1.52 (1.22–1.91)	12.8	1.22 (0.94–1.61)
Self-employed/farmer	15.6	1.47 (1.16–1.87)	11.5	1.28 (0.91–1.78)
Early retired	35.0	1.54 (1.11–2.15)	28.5	1.35 (0.98–1.86)
Unemployed	19.3	1.14 (0.86–1.51)	23.9	2.19 (1.61–2.98)
Student	9.7	0.94 (0.67–1.31)	13.8	1.77 (1.30–2.41)
Old age pensioner	14.8	0.86 (0.59–1.25)	16.0	1.01 (0.64–1.59)
Unclassified	8.3	0.46 (0.08–2.77)	20.4	1.31 (0.69–2.48)
Trust				
High	12.6	1.00	10.8	1.00
Low	18.5	1.20 (1.07–1.33)	17.3	1.19 (1.06–1.34)
Smoking				
No	12.9	1.00	11.7	1.00
Yes	23.6	1.61 (1.42–1.83)	21.6	1.80 (1.58–2.04)
Self-rated health				
Very good	5.6	1.00	6.0	1.00
Good	13.5	2.40 (2.03–2.83)	10.7	1.76 (1.48–2.09)
Neither good nor poor	23.0	4.51 (3.75–5.42)	21.0	3.36 (2.78–4.05)
Poor	40.4	8.67 (6.81–11.03)	45.4	5.95 (4.67–7.59)
Very poor	51.2	12.84 (8.41–19.61)	53.8	11.16 (7.51–16.60)
Economic stress in childhood				
No significant problem	12.8	1.00	11.5	1.00
Less severe and/or shorter period	17.5	1.19 (1.06–1.35)	15.4	1.05 (0.92–1.19)
Severe and/or longer period	22.9	1.18 (0.99–1.42)	24.3	1.32 (1.11–1.58)
Economic stress in adulthood				
Never	12.9	1.00	11.4	1.00
Occasionally	16.0	0.86 (0.74–1.00)	15.4	1.15 (0.99–1.33)
Half the year	22.2	1.06 (0.82–1.36)	21.0	1.23 (0.96–1.56)
Every month	30.2	1.41 (1.14–1.75)	28.1	1.32 (1.07–1.62)

time physical activity in all age intervals compared to women aged 18–24. Men born in other countries than Sweden had a significantly higher odds ratio of low LTPA than men born in Sweden, and a higher odds ratio for women born abroad compared to women born in Sweden was also observed. Most SES groups had significantly higher odds ratios of low LTPA than the highest non-manual reference group among men, but only among **medium** non-manual employees, unemployed and student among women. Only the unemployed, the students, old age pensioners and unclassified among men did not significantly differ from the non-manual employee reference group. Men and women with low trust had higher odds ratios of low LTPA compared to the high trust group, respectively. Smokers had significantly higher odds ratios of low LTPA than non-smokers among both men and women. Among both men and women all the alternatives “good self-rated health”, “neither good nor poor”, “poor” and “very poor” had higher odds ratios of low LTPA

Table 3
Odds ratios (OR, 95% CI) in age-adjusted and covariate adjusted analyses of low LTPA according to economic stress risk accumulation (childhood + adulthood combined). Men (n = 12,828) and women (n = 15,201). The public health survey in Scania 2012.

Men			
Risk accumulation	OR(95% CI) ^a	OR(95% CI) ^b	OR(95% CI) ^c
Lowest (1 + 1)	1.00	1.00	1.00
(1 + 2) or (2 + 1)	1.31 (1.16–1.48)	1.24 (1.10–1.41)	1.12 (0.97–1.25)
(1 + 3), (2 + 2) or (3 + 1)	1.70 (1.48–1.96)	1.48 (1.28–1.72)	1.09 (0.94–1.28)
(2 + 3) or (3 + 2)	2.89 (2.38–3.51)	2.36 (1.92–2.91)	1.51 (1.21–1.88)
Highest (3 + 3)	3.96 (2.96–5.30)	2.89 (2.12–3.94)	1.37 (0.98–1.92)
Women			
Risk accumulation	OR(95% CI) ^a	OR(95% CI) ^b	OR(95% CI) ^c
Lowest (1 + 1)	1.00	1.00	1.00
(1 + 2) or (2 + 1)	1.34 (1.18–1.53)	1.20 (1.06–1.37)	1.07 (0.93–1.22)
(1 + 3), (2 + 2) or (3 + 1)	2.31 (2.01–2.65)	1.91 (1.65–2.21)	1.42 (1.22–1.66)
(2 + 3) or (3 + 2)	2.90 (2.38–3.53)	2.22 (1.80–2.74)	1.41 (1.13–1.76)
Highest (3 + 3)	4.38 (3.33–5.75)	2.76 (2.04–3.72)	1.51 (1.10–2.07)

28,029 respondents included in the analyses.

- ^a Adjusted for age.
- ^b Adjusted for age, country of birth, socioeconomic status and trust.
- ^c Adjusted for age, country of birth, socioeconomic status, trust, smoking and self-rated health.

than the “very good self-rated health” alternative, and the odds ratios of low LTPA increased strongly with increasingly poorer self-rated health. In the multivariate analyses in **Table 2** only the odds ratios of low LTPA for the less severe and/or shorter period of economic stress in childhood among men, and for the severe and/or longer period of economic stress in childhood among women significantly differed from the no economic stress in childhood reference group. The odds ratios of low LTPA were higher for the economic stress in adulthood every month categories for both men and women, compared to the never economic stress in adulthood category.

Table 3 shows that among men the odds ratios of low LTPA increased with more accumulation of combined childhood and adulthood economic stress in the multiple model adjusted for all covariates except smoking and self-rated health. In the final multiple model with all covariates including also smoking and self-rated health the odds ratios decreased to mostly statistically non-significant levels. Similar patterns were observed among women in the multiple model adjusted for the covariates except smoking and self-rated health, but although the odds ratios also decreased for women after final adjustment including smoking and self-rated health, the odds ratios mostly remained statistically significant for women.

Table 4 shows that the odds ratios of low LTPA for men in the categories with economic stress in childhood as well as adulthood remained statistically significant in the model a adjusted for age and in the multiple model b adjusted for age, country of birth, SES and trust. When smoking and self-rated health were added to model b in model c, the odds ratios for both economic stress in childhood and economic stress in adulthood were reduced to such an extent that only the odds ratio of less severe and/or shorter period of economic stress in childhood and the odds ratio of economic stress half the year/every month in adulthood remained statistically significant. In the final model d for men, all odds ratios of economic stress in childhood and adulthood were not significant. In this final model, the interaction term economic stress in adulthood*age was significant. For women, all odds ratios were significant in models a and b adjusted for age and age, country of birth, SES and trust, respectively. When smoking and self-rated health

Table 4

Odds ratios (OR, 95% CI) in age-adjusted and covariate adjusted analyses of low LTPA according to economic stress critical period. Interactions for economic stress in childhood and adulthood, respectively, in relation to age also calculated (p-value for interaction). Men (n = 12,828) and women (n = 15,201). The public health survey in Scania 2012.

Men Critical period	OR(95% CI) ^a	OR(95% CI) ^b	OR(95%CI) ^c	OR(95%CI) ^d
Economic stress in childhood				
No significant problem	1.00	1.00	1.00	1.00
Less severe and/or shorter period	1.32 (1.18–1.47)	1.26 (1.12–1.41)	1.19 (1.05–1.34)	1.08 (0.79–1.48)
Severe and/or longer period	1.72 (1.46–2.03)	1.46 (1.23–1.73)	1.17 (0.97–1.40)	0.73 (0.46–1.16)
Economic stress in adulthood				
Never	1.00	1.00	1.00	1.00
Occasionally	1.24 (1.08–1.42)	1.15 (1.00–1.32)	0.90 (0.77–1.04)	0.70 (0.49–1.01)
Half the year/every month	2.27 (1.95–2.63)	1.97 (1.68–2.31)	1.27 (1.07–1.51)	0.83 (0.55–1.26)
Economic stress childhood* age				0.090
p-value				
Economic stress adulthood* age				0.045
p-value				
<hr/>				
Women Critical period	OR(95% CI) ^a	OR(95% CI) ^b	OR(95%CI) ^c	OR(95%CI) ^d
Economic stress in childhood				
No significant problem	1.00	1.00	1.00	1.00
Less severe and/or shorter period	1.28 (1.14–1.45)	1.17 (1.03–1.32)	1.05 (0.92–1.19)	1.18 (0.86–1.61)
Severe and/or longer period	2.00 (1.71–2.35)	1.67 (1.41–1.97)	1.30 (1.09–1.56)	1.42 (0.93–2.19)
Economic stress in adulthood				
Never	1.00	1.00	1.00	1.00
Occasionally	1.44 (1.26–1.64)	1.33 (1.16–1.53)	1.16 (1.01–1.35)	0.62 (0.44–0.88)
Half the year/ Every month	2.44 (2.10–2.82)	1.95 (1.67–2.28)	1.34 (1.14–1.59)	1.62 (1.09–2.39)
Economic stress childhood*age				0.707
p-value				
Economic stress adulthood*age				0.000
p-value				

28,029 respondents included in the analyses.

^a Adjusted for age.

^b Adjusted for age, country of birth, socioeconomic status and trust.

^c Adjusted for age, country of birth, socioeconomic status, trust, smoking and self-rated health.

were added to model b in model c, the odds all odds ratios were reduced. The odds ratio of less severe and/or shorter period of economic stress in childhood was reduced to such an extent that it was not significant in model c. In the final model d for women, all odds ratios of economic stress in childhood and adulthood were not significant with the exception of economic stress half the year/every month in adulthood. In this final model for women, the interaction term economic stress in adulthood*age was significant.

4. Discussion

The accumulation hypothesis was supported, because the accumulation of economic stress across the life course was associated with low LTPA in a graded way in which the strength of association increased strongly with the accumulation of economic stress, although the odds ratios of low LTPA were importantly attenuated for both men and women to such an extent after adjustment for smoking and self-rated health in the final model that most odds ratios in the five stage accumulation model became statistically not significant for men (but still statistically significant for women). The support for the accumulation hypothesis is thus stronger for women than for men in this study. The critical period hypothesis was not supported, because economic stress in childhood and adulthood were independently associated with low LTPA, and the odds ratios of low LTPA were attenuated for both economic stress in childhood and adulthood among both men and women. Economic stress across the life course seems to be important for low LTPA in adulthood, particularly among women.

Several recent review articles have indicated the abundance of factors and determinants associated with low LTPA and sedentary

behavior. Such factors range from individual level factors such as biological, psychological and behavioral factors to social, environmental and policy factors (Owen et al., 2011; Rhodes et al., 2012; Carlin et al., 2017), which also often represent different stages in varying chains of causality. Although the associations between the economic stress in childhood and adulthood and low LTPA were strongly attenuated after the inclusion of smoking and self-rated health in the final models (and the interaction terms economic stress in childhood*age and economic stress in adulthood*age in the final models testing the critical period hypothesis), the study results suggest future full longitudinal studies regarding the accumulation and critical period hypotheses, and LTPA across the life course. Longitudinal studies with a panel data design should include at least three observation points in time (Singer & Willett, 2003) in different stages across the life course, including childhood and adolescence. The results also call for investigations including SES according to occupation, education and absolute income.

Given the study design, it may be that the associations between low LTPA and poor self-rated health are bi-directional, i.e. poor-self-rated health may lead to low LTPA, but low LTPA probably also causes poorer health. This bi-directional association may mask some of the strength of the associations in the two life course models derived from the two life course hypotheses. On the other hand, some confounders such as physical activity at work were not included in the questionnaire which means that some residual confounding may remain.

The strict interpretation of the critical period hypothesis is that there should be one well-defined critical period which would be crucial for health or health-related behaviors in later life (Hallqvist et al., 2004). An alternative interpretation is that there may be several “sensitive periods” which may affect health or health-related behaviors in

later life (Ben-Schlomo & Kuh, 2002). It may also be argued that the critical period hypothesis is investigated using very broad and rough intervals to depict both childhood and adulthood.

The accumulation hypothesis was confirmed due to the graded response to accumulated economic stress across the life course with pronounced increases in odds ratios of low LTPA with increased accumulation of economic stress, although the odds ratios were attenuated in the final model including smoking and self-rated health with most odds ratios even becoming not significant for men. Also a previous longitudinal study with five observation points over time has found support for the accumulation hypothesis, but this study lacked covariates such as trust, smoking and self-rated health (Juneau et al., 2014). There may be several mechanisms behind this cumulative pattern across the life course including the persistence of lack of money, lack of other resources which follow from lack of money, lack of motivation and poorer psychosocial health mentioned in the introduction. One plausible mechanism may be that economic stress in general and the persistent experience of economic stress across the life course in particular may increase the likelihood to believe that there is no or a very small possibility to influence one's own health, i.e. an external health locus of control. A learned helplessness may influence the perception of the personal ability to control one's own health by one's own actions (Lindström & Rosvall, 2014).

In the regression models investigating both the critical period and accumulation hypotheses the introduction of SES assessed as occupation and connection with the labor market did not attenuate the associations between economic stress across the life course and low LTPA. This result supports the notion that occupation (and connection with the labor market), education and income represent different dimensions of SES as suggested already several decades ago (Whitehead, 1992; Marmot, Adelstein, Robinson, & Rose, 1978).

The main implications of this study for policy and prevention are that economic and social conditions across the life course may be crucial for LTPA in adulthood.

4.1. Strengths and limitations

The fact that this is a large population-based study is a strength. The participation rate (51.7%) is on the same moderate level as in other studies in economically developed countries. The age range 18–80 was accounted for in the analyses by including age in the multiple regression analyses. Logistic regression analyses stratified for age intervals show similar results (not shown in tables). The sample is a stratified (weighted) random sample of the adult 18–80-year population in Scania, and the weighting has been taken into account throughout the analyses. There is an under-representation of the age interval 18–34 years (20.7% versus 30.0% in the 18–80-year general population), some under-representation of men (45.8% versus 49.9%), subjects with low education (20.8% versus 23.6%) and people born outside Europe (5.3% versus 8.2%). All details are included in a regional report in Swedish (Fridh, Modén, Lindström, Grahn, & Rosvall, 2013; see also Lindström & Rosvall, 2016). The risk of selection bias is still comparatively small due to the fact that the directions of the associations and the strengths of the associations (effect measures) are the same as in the 2008 survey (Lindström, Fridh, & Rosvall, 2014).

The four categories of the LTPA item each entail different levels of physical activity. The current recommendations are related to “heart rate” and “breathing” rather than “sweating” (Lindström, 2011). Still, the main recommendation to exercise at least 150 min per week remains, which implicates that the less than 2 h per week (less than 120 min per week) of moderate physical activity alternative which depicts sedentary life style and low LTPA is somewhat lower than the main recommendation (O'Donovan et al., 2010). The validity and repeatability of physical activity questionnaire items with four levels of activity are regarded as acceptable based on comparison with golden standards which assess four-day heart rate monitoring, which in its turn

had been validated against whole-body calorimetry and double-labelled water (Wareham et al., 2003). The cut-off between the three first alternatives and the last low LTPA alternative in this study thus seems highly relevant. Some previous studies have measured self-perceived economic stress. These studies have demonstrated statistically significant associations with health outcomes (Fritzell & Burström, 2006). The economic stress in childhood item may entail a risk of recall bias. Still, the most likely result of such hypothetical recall bias would be non-differential misclassification which would attenuate the associations between economic stress and low LTPA.

The analyses controlled for known and possible confounders by the inclusion of age, country of birth, socioeconomic status (SES), generalized trust in other people, smoking and self-rated health in the age-adjusted and multiple adjusted analyses, and by stratifying for sex.

The cross-sectional study design is a limitation. However, both economic stress in childhood and the accumulation of economic stress combinations precede LTPA.

5. Conclusions

The accumulation hypothesis was supported, because the accumulation of economic stress across the life course was associated with low LTPA in a graded way in which the strength of association increased strongly with the accumulation of economic stress, although the odds ratios were attenuated for men and women, and mostly reduced to not statistically significant levels among men after the introduction of smoking and self-rated health in the models. The critical period hypothesis was not supported, because economic stress in childhood and adulthood were independently associated with low LTPA. Economic stress across the life course may be important for low LTPA in adulthood.

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Conflicts of interest

None.

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