Leisure-time physical activity is associated with socio-economic status beyond income – Cross-sectional survey of the Northern Finland Birth Cohort 1966 study

Sanna Huikari*[a], Hanna Junttila[b], Leena Ala-Mursula[c], Timo Jämsä[d,e,f], Raija Korpelainen[c,d,g], Jouko Miettunen[c,d], Rauli Svento[a], Marko Korhonen[a]

[a] Department of Economics, Accounting and Finance, University of Oulu, P.O. Box 4600, FIN-90014 University of Oulu, Finland

[b] Department of Physical Medicine and Rehabilitation, University of Oulu, P.O. Box 4600, FIN-90014 University of Oulu, Finland

[c] Center for Life Course Health Research, P.O. Box 5000, FIN-90014 University of Oulu, Finland

[d] Medical Research Center, Oulu University Hospital and University of Oulu, P.O. Box 5000, 90014, Oulu, Finland

[e] Research Unit of Medical Imaging, Physics and Technology, University of Oulu, P.O. Box 5000, FIN-90014 University of Oulu, Finland

[f] Department of Diagnostic Radiology, Oulu University Hospital, Kajaanintie 50, FIN-90220 Oulu, Finland

[g] Department of Sport and Exercise Medicine, Oulu Deaconess Institute Foundation sr, Albertinkatu 18A, P.O. Box 365, 90100, Oulu, Finland

* Corresponding author. Department of Economics, Accounting and Finance, University of Oulu, P.O. Box 4600, FIN-90014 University of Oulu, Finland. Tel: +358 45 123 5860. Email: sanna.huikari@oulu.fi

Abstract

We apply neoclassical economic modelling augmented with behavioral aspects to provide a detailed empirical investigation into indicators of socio-economic status (SES) as determinants of leisure-time physical activity. We utilize the data from the Northern Finland Birth Cohort 1966 obtained at the most recent time point during 2012-2014 (response rate 67%), at which time the participants were approximately 46 years old. Our final study sample consists of 3,335employed participants (1,520 men, 1,815 women; 32.3% of the target population). We apply logistic regression methods for estimating how the probability of being physically active is related to various indicators of socio-economic status, taking into account physical activity at work and individual lifestyle, family- and health-related factors. Overall, our findings show that belonging to a higher socio-economic group, whether defined by income level, educational attainment, or occupational status, is associated with higher leisure-time physical activity. However, when we analyze different socio-economic groups, defined in terms of education, income and occupation, separately, we find that income is not a significant determinant of leisure-time physical activity within any of the particular SES groups. Further, we find that leisure-time physical activity is negatively associated with higher screen time (i.e., watching TV and sitting at a computer), and other aspects of unhealthy lifestyle, and positively associated with self-assessed health. In addition, we note that proxies for individual motivational factors and childhood physical activity, such as the grade point average and the grade achieved in physical education when leaving basic education, are strongly correlated with leisure-time physical activity in middle age among men, but not among women. Our results are in line with behavioral economics reasoning that social comparisons and environments affect behaviors. We emphasize the importance of considering behavioral economic factors when designing policies to promote physical activity.

Key words: *Physical activity; income; cohort study; logistic regression; health; socio-economic status*

JEL classifications: C25; I12; J3

1. Introduction

Globally, physical inactivity was estimated to be associated with US$53.8 billion in international health care costs in 2013; further, inactivity-related deaths was estimated to contribute to US$13.7 billion in productivity losses the same year (Ding et al. 2016). The factors related to low physical activity (PA) are only partly understood. The most commonly reported barriers to regular exercise are lack of time, low income and inability to exercise (see e.g., King et al. 2000; Sallis et al. 2006; Shuval et al. 2013; Charness and Gneezy 2009). Brown and Roberts (2011) explored how economic and demographic factors influence the frequency of physical activity participation for working individuals. Their results indicate that there is a time trade-off between non-market work, market work, and the frequency of physical activity participation. Colombo et al. (2018) analyze the effects of macroeconomic conditions on individuals' health outcomes. Their findings show that while, overall, higher unemployment is negatively related to health, physical activity seems to dampen this relationship, possibly indicating dominating time effect over income effect. In addition, it has been documented that the shift in modern society to non-manual work and sedentary life styles has resulted in decreased levels of physical activity, increased incidence of obesity, and declines in individuals' health (see e.g., Södergren et al. 2008; Galán et al. 2013).

The behavioral economics approach emphasizes the role of non-financial factors in explaining LTPA, such as the psychological foundations of consumer choice and social behavior (e.g., Downward and Riordan 2007; Downward and Rasciute 2016; and Downward 2007). This approach draws upon a wider literature with insights that individual preferences are shaped by social comparisons and class (e.g., Veblen 1925; and Lavoie 2004). Zimmerman (2009) notes that LTPA is highly dependent on habit and social context. In addition, many studies suggest that the intensity of LTPA varies with socio-economic status (SES) (see e.g., Cerin and Leslie 2008; Eime et al. 2015; So et al. 2016; and Kakinami et al. 2018). In contrast, Bauman et al. (2012) found that there is no evidence for the role of peers in influencing LTPA.

In addition, the social environment (including social networks, social cohesion, and social capital) affects individual health-related behavior, such as physical activity, e.g. by providing social support or by shaping norms (Lindström 2008; McNeill et al. 2006). Social capital has been associated with health status, obesity, and physical activity behaviors among adults (Kim et al. 2006). Lindström et al. (2001) found that among psychosocial variables, social participation was the strongest predictor of low physical activity, and a strong predictor for socioeconomic differences in low leisure-time physical activity. Social ties have been shown to be positively associated with frequency of exercise also among adolescents (Carroll-Scott et al. 2013).

In this study, we use Cawley's (2004) economic theoretical framework (SLOTH) of human behavior to better understand the insights of SES (income, occupation and education), lifestyle and self-reported health aspects in explaining LTPA. More specifically, we include the costs of alternative uses of leisure time rather than costing this time in a way that was similar to that of assigning costs to goods in a typical economic market.

We explore LTPA utilizing the Northern Finland Birth Cohort 1966 (www.oulu.fi/nfbc) general population based data (original N = 12,058 live-born individuals). Our data was obtained at the most recent time point during 2012-2014, at which time the participants were approximately 46 years old. Our study sample consists of 3,335 employed participants (1,520 men and 1,815 women). We explore how SES, as measured by income quartiles, education level and occupational status, is related to LTPA. The data allow us to distinguish the time used for different domains of leisure-time activities. More specifically, we are able to include the costs of alternative uses of leisure time rather than costing this time in a way that was similar to that of assigning costs to goods in a typical economic market. Further, we are able to provide robust identifications of income, life styles (e.g., smoking) and health as determinants of LTPA. We are also able to control work-related PA, a factor that has limited the scope of many other LTPA studies. The novelty of our data allows us to combine economic, time-constraint, socio-economic and health-related factors into the same model framework used to predict LTPA. Importantly, by using background proxy variables we are able to control for unobservable individual characteristics such as motivation, ambition, self-discipline, and target orientation, as reflected in the grade point average (GPA) at the time of leaving basic education at the age of 15-16 years, as well as childhood PA, reflected in the grade for physical education at the same time. These enable us to markedly alleviate the endogeneity problem related to the association between income and LTPA.

2. Theoretical framework

Our analysis is based on the SLOTH modelling framework described in Cawley (2004). The SLOTH model categorizes the ways in which individuals spend their time on: sleeping (S); leisure (L), including physical activity, watching television, playing computer games etc.; paid work (O); transportation (T); and on unpaid home production (H). The basic idea is that individuals' decisions reflect both their immediate and future marginal costs and benefits. These costs include foregone income, momentary discomfort (sweating, etc.) and an increase in morbidity, among others; and the benefits include momentary pleasure, enjoyment, health improvements and a prolonged life, among others.

An important feature of the SLOTH approach is that it employs a neoclassical view of economics as a rational decision framework with which to model individual LTPA. Individuals choose between consumption and leisure in order to maximize their utility function with respect to budget and time constraints. The role of physical activity for health and in maintaining a healthy weight is in the basic approach ignored by treating them as exogenous variables. More specifically, the basic SLOTH leisure-consumption model can be expressed as,

$$Max\ U = U(S, L, O, T, H; C)$$

with respect to income (*wage*) and time constraints (24 hours)

$$i)\ C = wage * O$$

$$ii)\ S + L + O + T + H = 24.$$

Consumption (C) presents the consumption of goods. SLOTH stands for time spent sleeping (S), time at leisure (L), time devoted to occupation (O), time in transportation (T) and time spent on home based activities (H) (Cawley 2004). The time allotted to leisure-time physical activity time is defined as LTPA = L – the time devoted to other leisure activities. Hence, the amount of LTPA depends on the opportunity cost of the time spent at work (*wage*), among other things.

3. Data and measures

3.1 Data Source

The Northern Finland Birth Cohort 1966 (NFBC1966) is an epidemiological and longitudinal prospective research program (www.oulu.fi/nfbc). It consists of 12,058 unselected live-born children (6,169 men and 5,889 women) in Finland's two northernmost provinces (Oulu and Lapland). The NFBC1966 was designed to study the population's health and well-being by collecting prospective data on genetic, biological, social and behavioral factors. Data collection began during the mothers' pregnancies and the live-born children were followed-up at the ages of 12 months, 14 years, 31 years, and 46 years, by using questionnaires and clinical examinations. This study utilizes the information obtained from the 46-year follow-up survey questionnaires, the accompanying clinical examinations, and by using unique personal identification codes, highly reliable national register-based information on personal income from the Finnish Tax Service as well as registered information from Statistics Finland on lifetime highest level of education as well as the grade points from the National Agency for Education when leaving basic education at the age of 15-16 years. Postal questionnaires were sent to all cohort members who were alive and living in Finland with known addresses in 2012–2014 (target population n=10,321, response rate 67%, n=6,851). The questionnaires included items on health, health behavior, and social background. Education, employment status, and prevalence of diagnosed diseases were addressed. Those who lived in Finland were invited to clinical examinations, and 57% attended (n=5,861).

The final sample, presented in Figure 1, includes employed 3,335 members (32.3% of the target population) of this cohort (1,520 men and 1,815 women) from whom the necessary information for the analyses were available. All participants provided written informed consent, and the overall study design has been approved by the Ethical Committee of the Northern Ostrobothnia Hospital District, Finland (94/2011) and has been performed in accordance with the Declaration of Helsinki.

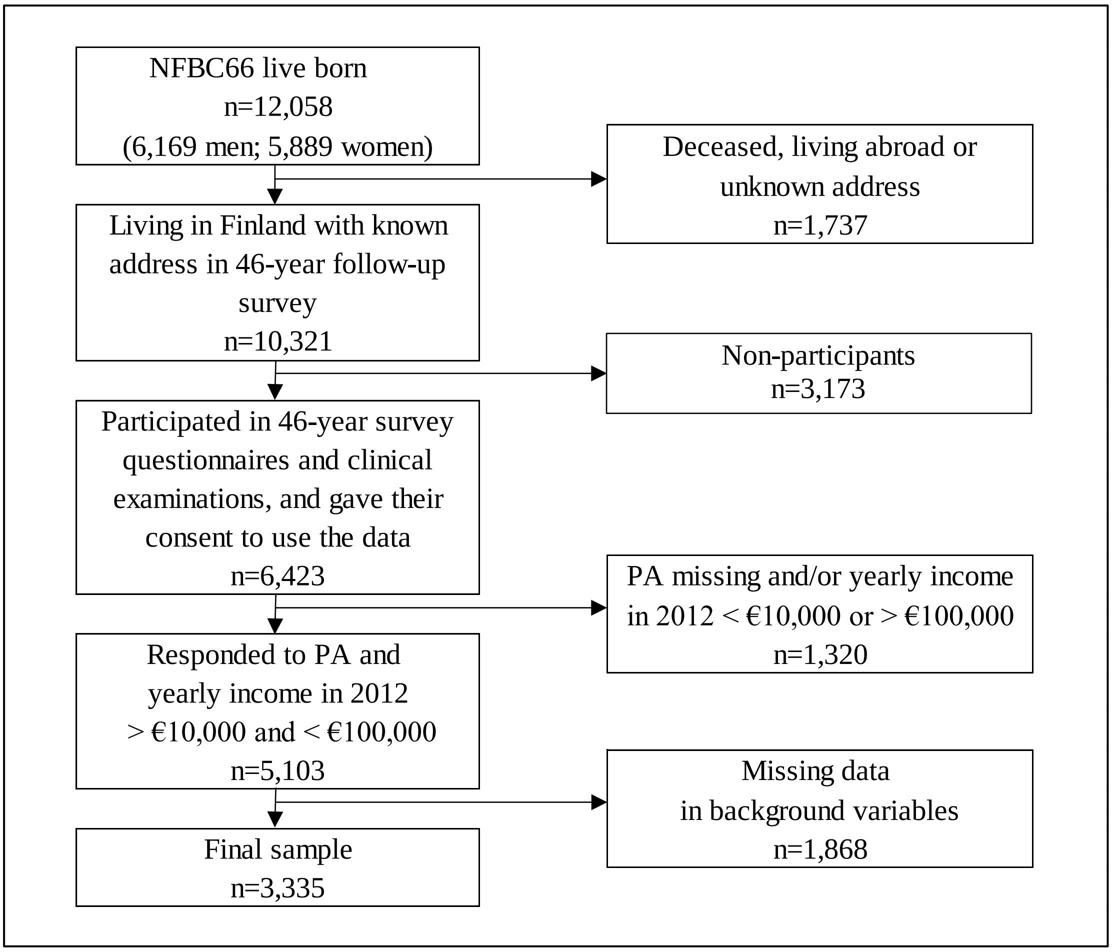

Figure 1. The participants of the 46-year follow-up survey in 2012 and construction of the study sample of Northern Finland Birth Cohort 1966 (NFBC66).

3.2 Measures of physical activity

The self-reported LTPA data were collected by asking subjects how often they participate in leisure-time physical activity that is a) light and b) brisk (at least some sweating and getting out of breath; corresponding to moderate-to-vigorous intensity), with the following alternatives: 1) once a month or less often; 2) 2 to 3 times a month; 3) once a week; 4) 2 to 3 times a week; 5) 4 to 6 times a week; and 6) more than 6 times a week. Subjects were also asked how much time they usually spent exercising in a) light and b) brisk leisure-time sports, with the following alternatives: 1) not at all; 2) less than 20 minutes; 3) 20-39 minutes; 4) 40-59 minutes; 5) 1-1.5 hours and, 6) over than 1.5 hours (see appendix, Table A1). These data were transferred into *total weekly volume of LTPA* by calculating metabolic equivalent (MET) minutes using an intensity value of 3 METs for light physical activity and 5 METs for brisk physical activity: (Frequency of light PA * Duration of light PA * 3) + (Frequency of brisk PA * Duration of brisk PA * 5) (Kaakinen et al. 2010).

For the purpose of the empirical analysis we transformed LTPA into a binary variable based on an individual's *self-reported leisure-time physical activity exceeding 500 MET minutes per week*, (yes: value 1; and no: value 0). It has been shown that the amount of physical activity necessary to produce health benefits ranges between 500 to 1,000 MET-minutes per week (U.S. Department of Health and Human Services, 2008).

We also obtained information related to individuals' physical activity in their daily work. Participants were asked if their daily work is mainly (over half of one's work time) mental, physical, or as much mental as physical.

3.2.Income

For the income variable, we use data from the Finnish Tax Administration in 2012 to obtain register-based information regarding the individuals' annual taxable earned income. In our study sample, we include individuals with annual incomes of between 10,000 and 100,000 euros.

3.3 Education

Information on the participants' level of educational attainment is obtained from the register of the Central Statistical Office of Finland. The educational categories used in the analysis are defined according to each participant's lifetime highest level of educational achievement until the age of 46 years. The categories used are upper-secondary education or basic education, short-cycle tertiary education or higher education. Higher education is defined as a bachelor or equivalent-level degree, or higher.

3. 4 Leisure time

The information regarding what we define as time allocated to sedentary leisure time is compiled from the survey questions; here, participants reported how many minutes per day they spent on leisure time, on average, sitting at the computer or watching television (i.e., screen time). Our measure of sedentary leisure time is derived by summing the minutes across the two contexts. Similar definition has been used previously e.g. in Larsson and Wolk (2019) and Burton et al. (2012).

3.5 Occupation

According to their reported occupational statuses in the 46-year survey, participants are categorized into four occupational groups: 1) skilled workers; 2) self-employed; 3) lower-level office workers; and 4) professional and managerial employees.

3.6 Transportation

Participants were also asked to report how many minutes per usual day they spent on leisure time sitting in transportation.

3.7 Home production

The time used in unpaid home production is approximated by the participants' marital status and number of children at home. Marital status is coded to equal 1 if the person reported being married, co-habiting, or in a registered relationship, and 0 otherwise. Participants were also asked to give their number of children under 18 years of age living at home.

3.8 Health-related and behavioral factors

We use self-assessed health as a proxy for health. The participants were asked to estimate their self-assessed health status with the following alternatives: 1) very good; 2) good; 3) fair; 4) poor; and 5) very poor. In the analyses, we use the health variable in the opposite direction, so that the higher the value, the better the self-assessed health. From the questionnaire, we also have information on whether or not the cohort member was current smoker at 46 years. The cohort members' clinical health examination (implemented from 2012 to 2014) included measuring their height and weight, among other things, which were used in calculating the body mass index (BMI, kg/m^2).

3.9 Individual background variables

Other background variables are the GPA for theoretical subjects and the grade obtained in physical education at the time of leaving basic education at the age of 15-16 years. These are obtained from the central application register of the Finnish National Agency for Education.

4. Methods

All of the analyses are conducted using the Stata statistical software package (version 15.1 for Windows, StataCorp LLC, College Station, TX.).

4.1 Attrition analyses

It has been previously described, that the nonparticipation in the whole cohort is related e.g. to SES (Haapea et al. 2008). We use nationwide income data to investigate attrition in our study sample with regard to the original cohort members (n=10,321), for whom the income data in 2012 are available (n=10,277). By using Student's t-test in comparing our study sample to all cohort members, we find that, in 2012, the annual income significantly ($p<0.001$) differed between participants (i.e. those who participated at the 46-year-old follow-up and the information on LTPA is available) and non-participants (i.e. those who did not participate at all, or who participated, but for whom the information on LTPA is not available) among both genders. For male participants, the average annual income in 2012 was 39,100 euros and for non-participants 31,813 euros. The corresponding figures for females were 29,662 and 24,706 euros.

To take attrition into account, we use inverse probability weighting in our multivariate analyses, following Haapea et al. (2011). The weights are obtained from a binary logistic regression model on non-participation at the 46-year-old follow-up, which included the annual incomes from 2012 for predicting the incidence of non-participation (see the appendix for further methodological details).

4.2 Statistical analyses

In the first step, Pearson's chi-square test of independence was used to investigate the possible relationship between LTPA and SES groups. This test can be used to evaluate the association between two categorical variables. In a second step, based on the theoretical consideration above, we formed the following weighted logit model to be used in our empirical analyses:

$$Pr(Pa_i = 1) = \alpha_0 + \alpha_1 ln(inc_i) + \delta LeisureTimeAll_i' + \theta covariates_i' + \lambda Z_i' + e_i \qquad (1)$$

where *i* refers to an individual, α_0 is a constant term, and e_i is the stochastic error term with a constant variance. The dependent variable $Pr(Pa_i = 1)$ is the probability that the individual's self-reported physical activity measured in MET minutes per week is above or equal to 500. The vector of the $LeisureTimeAll_i'$ variables includes time spent sitting at a computer and watching television (leisure time, L); time spent sitting in transportation (T); and marital status and number of children (as a proxy for time spent on unpaid home production, H). We assume that sleeping hours (S) are fixed for every participant. Since the final study sample consists of employed people, the natural logarithm of annual income $ln(inc_i)$ can be regarded as a proxy for the opportunity cost of the time spent at work (O).

We add health and lifestyle factors to our SLOTH model framework. The literature presents the lack of time, embarrassment of participating, inability to exercise due to poorer health and the lack of enjoyment as being important obstacles related to LTPA (e.g., Charness and Gneezy 2009). In the Western world, for many individuals, a sedentary lifestyle and obesity (an epidemic in the West) leads to less physical activity (Ekelund et al. 2008). Bauman et al. (2012) note that individual-level factors, such as increasing age, as well as poorer health status and self-efficacy, correlate markedly with lower physical activity. The vector $covariates_i'$ includes the following set of control variables: a measure for the physical/mental nature of the work, self-assessed health, smoking, and BMI.

In addition to the above-mentioned control variables, there are unobserved individual characteristics, such as motivation, ambition, self-discipline, and target orientation, that are likely to be correlated with both income level and level of physical activity (Humphreys and Ruseski, 2011). Some previous empirical analysis of the relationship between physical activity and income have addressed this endogeneity concern by using statistical techniques such as instrumental variable (IV) approach to alleviate possible omitted variable bias (Kari et al. 2015; Humphreys & Ruseski, 2011). However, income is not treated as exogenous variable in many previous empirical analysis of physical activity because of the challenge of finding plausible and valid IVs that have an effect on physical activity only through income.[1] Following Heckman et al. (2018) we address the possible endogeneity of income in our empirical analyses by using the GPA for theoretical subjects at the time of leaving basic education at the age of 15-16 years as a proxy for ability. Information on the grade scores in physical education at the same time is used as a proxy for childhood physical activity. These background variables are included in the vector Z_i'.

Apart from overall level analyses among men and women, we concentrate also on different SES sub-groups. As a reference group to which the individual is assigned, we use income quartiles, educational level and occupational status. Previous studies have shown a positive association between SES and LTPA (e.g., Cerin and Leslie 2008; Gidlow et al. 2006; and

[1] Because of the possible endogeneity between income and physical activity, we estimated our models also using IV-probit method, with municipality unemployment rate as instrument variable following Humphreys & Ruseski (2011), and with ninth-grade GPA as additional instrument. The results for males suggested that at least one of our two instruments were not exogenous. For females, exogeneity assumption of income could not be rejected, indicating that there is no sufficient evidence to consider income as an endogenous variable in the analyses. Given these results, we estimated regressions again using IV-probit technique, but only with sex-specific municipal unemployment rate as instrument. In these further estimations exogeneity assumption of income could not be rejected in any of regressions, nor for males, neither for females. The detailed results are available upon request.

Borodulin et al. 2008). For example, Eime et al. (2015) present a positive overall relationship between higher occupational statuses and LTPA, both for any participation in recreational PA and for regular participation in some form of LTPA. Yuanyuan et al. (2018) show that additional schooling increases physical activity. Kakinami et al. (2018) suggest a persistent association between lower SES and lower LTPA, especially for those with sedentary lifestyles. So et al. (2016) examined whether the frequency and intensity of LTPA is associated with occupational status in Korea. Their results show, in contrast to many other studies, that the higher the job intensity, the more frequent and intense the LTPA.

5. Results

5.1 Descriptive statistics

Table 1 shows the descriptive statistics of our study sample. We can see that for 65.5% of men and for 72.5% of women self-reported LTPA expressed in MET minutes ≥ 500 per week, i.e. they are defined physically active. The median annual income is €38,020 for men and €29,515 for women. The largest occupational group for both genders consists of skilled workers, the shares being 46.3% for men and 51.9% for women. There is relatively more self-employed among men than women (14.6% vs. 5.9%). It is notable that women are quite evenly distributed among the three education categories; i.e., upper-secondary education or basic education, short-cycle tertiary education, and higher education. For men, the most common education group is the upper-secondary education level or basic education (over 50%). About 20% of men and 10% of women report that over a half of their working time comprises physically demanding tasks.

For leisure time spent on sitting, the statistics show that men spend approximately two and three-quarter hours per day sitting at the computer or watching TV, and women spend around two and a half hours on this activity. Men spend, on average, over one hour and 20 minutes sitting during transport every day, while for women the time spent is much shorter, at around 45 minutes. The vast majority of individuals in the study sample (81.3% of men and 77.1% of women) are in a relationship. The average number of dependent children under 18 years old, for both men and women, is around 1.5. Over 25% of both genders self-report as having only fair or poor health statuses, and nearly 70% of men are categorized as being overweight or obese (BMI > 25). For women, the overweight/obese share is around 50%. The most common grade achieved in physical education at the time of leaving basic education at the age of 15-16 years, among both genders, is 7/10 or 8/10. The mean of the GPAs for theoretical subjects at the same time is 7.3 for men and 7.9 for women out of a possible score ranging between 4 and 10.

Table 1. Descriptive statistics of the study sample of 46-year old male and female in the Northern Finland Birth Cohort 1966 (NFBC66) in 2012.

Characteristics	Male (N = 1520) N (%)	Female (N = 1815) N (%)
Physical activity [a]	995 (65.5)	1316 (72.5)
Occupational		
Income - median (in euros)	38,020	29,515
Socio-economic status		
Workers	703 (46.3)	942 (51.9)
Self-employed	222 (14.6)	107 (5.9)
Lower-level office workers	252 (16.6)	420 (23.1)
Professional (managerial) employees	343 (22.6)	346 (19.1)
Educational status		
Upper- secondary education or lower-level education	827 (54.4)	692 (38.1)
Short-cycle tertiary education	284 (18.7)	517 (28.5)
Higher education	409 (26.9)	606 (33.9)
Daily working comprises mainly of (over half of working time):		
Mental tasks	740 (48.7)	1016 (56.0)
Equal amount of mental and physical tasks	467 (30.7)	602 (33.2)
Physical tasks	313 (20.6)	197 (10.9)
Leisure time		
Screen time, minutes per day - mean (SD)	167.9 (83.3)	145.7 (75.9)
Transportation		
Time spent sitting during transport, minutes per day - mean (SD)	83.0 (106.9)	44.5 (52.6)
Home production (unpaid work)		
Married, cohabiting, or in registered relationship	81.3 (1236)	77.1 (1400)
Number of children under 18 years at home - mean (SD)	1.5 (1.5)	1.3 (1.2)
Health-related		
Smoker	316 (20.8)	293 (16.1)
Self-assessed health status		
Very good	194 (12.8)	258 (14.2)
Good	849 (55.9)	1048 (57.7)
Fair	441 (29.0)	472 (26.0)
Poor or very poor	36 (2.4)	37 (2.0)
BMI (kg/m^2) - mean (SD)	27.1 (4.0)	25.8 (4.7)
BMI (kg/m^2) categories		
Underweight (<18.5)	2 (0.1)	16 (0.9)
Normal weight (18.5-24.9)	458 (30.1)	906 (49.9)
Overweight (25.0-29.9)	772 (50.8)	591 (32.6)
Obese (≥30)	288 (18.9)	302 (16.6)
Background controls at the time of leaving basic education at the age of 15-16 years		
Physical education grade (scale 4-10)		
4-6	96 (6.3)	77 (4.2)
7-8	895 (58.9)	1128 (62.2)
9-10	529 (34.8)	610 (33.6)
GPA in theoretical subjects (scale 4-10) - mean (SD)	7.25 (1.02)	7.87 (1.02)

SD – Standard deviation

[a] Physical activity is defined as individual's self-reported physical activity expressed in MET minutes ≥ 500 per week.

5.2 SES and LTPA

Figure 2 presents the proportions of physically active participants (defined as MET minutes ≥ 500 per week) among the different SES sub-groups for males (2a) and females (2b), respectively. In addition, we utilize chi-squared tests for exploring whether the probability that an individual's LTPA reaches the level of MET minutes ≥ 500 per week, Pr(PA), is independent on their SES. The reference group for income is the lowest income quartile among the participants (annual income of between €10,000 and €28,989 for males and €10,000 and €24,139 for females); for education, the measures are the achievement of upper-secondary education or basic education at highest; and for occupation, we use the self-employed.

Across all of SES indicators, a higher SES is associated with a higher level of LTPA. 76% of men and 79% of women within the highest income quartile self-report sufficient level of LTPA with respect to health benefits (defined as MET minutes ≥ 500 per week), while around 57% and 65%, respectively, of those within the lowest income quartile self-report sufficient level of LTPA. For education, these figures are 78% and 77% for higher educated men and women, respectively, and 58% and 68%, for lower educated men and women; and for occupations the figures are 76% and 78% among professional and managerial male and female employees and 57% and 70% for self-employed men and women, respectively. These numbers are in line with Hallal et al. (2012), who report that the proportion of physically active European adults in the 45 to 59 years age group for 2011 was approximately 65%.

We test the equality of the Pr(PA) with respect to a particular reference group for all sub-groups. The resulting p-values of the chi-squared tests are also shown on Figure 2. For men, we find that there is no statistically significant difference (p-value=0.238) in the probabilities that LTPA reaches the sufficient levels with respect to health benefits between the two lowest income quartiles. Indeed, below the threshold level €38,020 for men, an increase in income is not associated with the probability of being more active. For women, the probability of reaching the sufficient levels of LTPA with respect to health benefits is statistically significantly higher (p=0.032) in the second lowest income quartile (annual income in 2012 ranging between €24,139 and €29,515) than in the lowest income quartile (annual income in 2012 below €24,139). For both genders, earnings are significantly associated ($p<0.05$) with the amount of LTPA of those in the higher income quartiles, relative to the reference group. For those men and women who belong to the highest income quartile in 2012 (above €49,193 for men and €38,297 for women, respectively) the likelihood of reaching the sufficient levels of LTPA with respect to health benefits is approximately 33% and 22%, respectively, higher than for those men and women who belong to the lowest income quartile (below €28,989 for men and €24,139 for women, respectively).

We find qualitatively similar results when analyzing other SES indicators. For males, the Pr(PA) between individuals with the lowest educational status is significantly lower than among those with higher levels of educational attainment (p-values<0.001). For females, the difference in the Pr(PA) between the lowest level of educational attainment and short-cycle tertiary education is not statistically significant (p=0.100), but between the lowest and the highest levels of educational attainment, the difference is statistically significant (p<0.001). There is also a statistically significant difference (p-values<0.01) when the Pr(PA) of males who are lower-level office workers or who are professional and managerial employees are compared with the Pr(PA) of those who are self-employed. For female, there is no statistically significant difference (p-values>0.10) in Pr(PA)s between occupational groups.

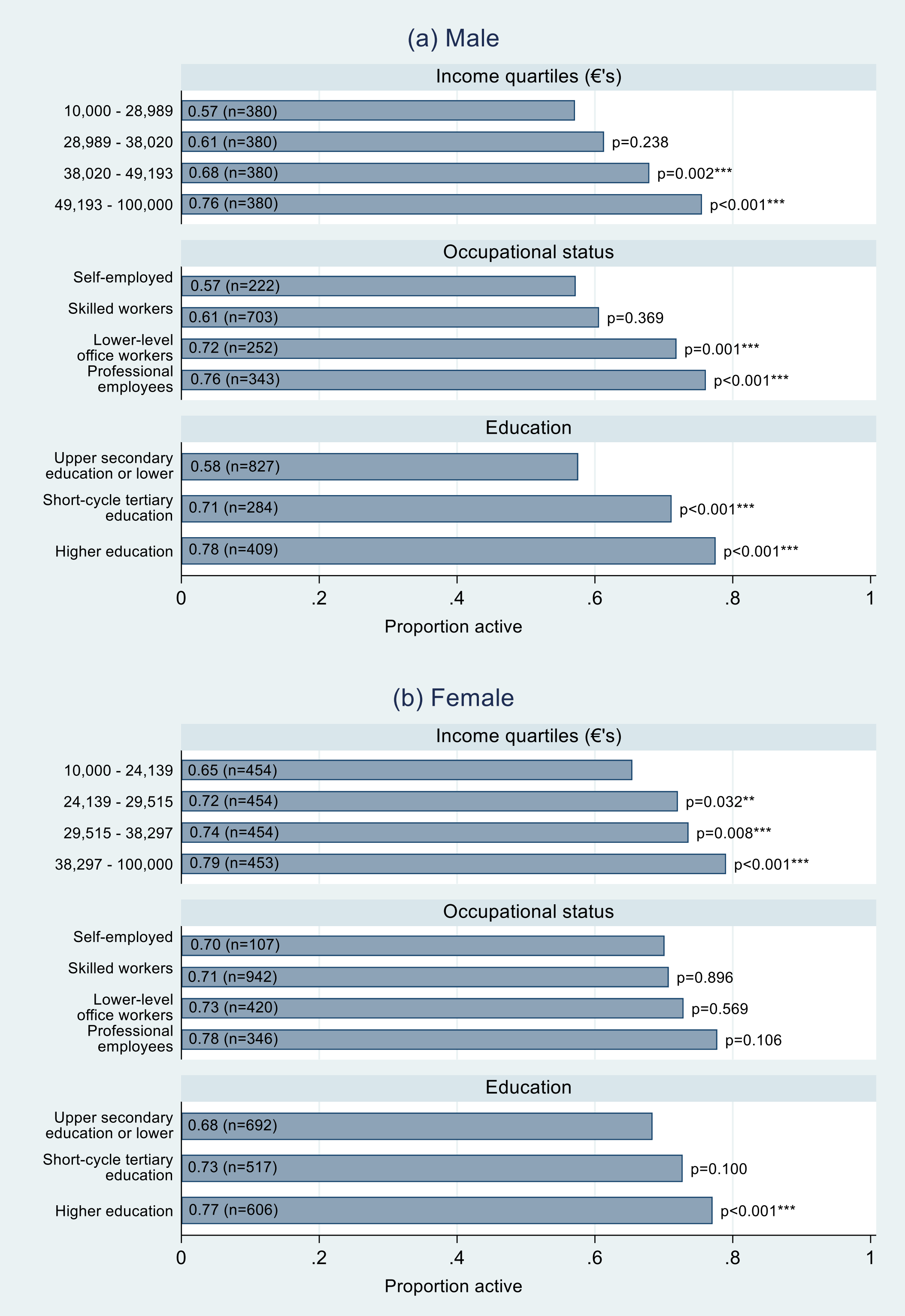

Figure 2. Proportion of physically active 46-year old male and female by annual income quartile, occupational status, and the highest attained education in the Northern Finland Birth Cohort 1966 (NFBC66) in 2012.[a]

[a] Physical activity is defined as individual's self-reported physical activity (PA) reaching the sufficient level with respect to health benefits, measured as MET minutes $\geq$ 500 per week. The p-values for the chi-squared tests testing whether the probability that individual reaches the sufficient level of physical activity, Pr(PA), is independent from the education level, income level, or occupational status are presented at the end of the bars. The reference group for income is the lowest income quartile, for education the upper secondary education or basic education, and for occupation the self-employed. *** Statistically significant at 1% significance level. ** Statistically significant at 5% significance level.

5.3 Multivariate analysis

The estimation results of eq. (1) are provided in Table 2. Columns 1 and 5 of Table 2 show the most basic specifications, where we only include in the regressions the annual incomes (of individuals) accompanied by the proxies for innate ability and childhood physical activity. Income is positively related with LTPA for both genders ($p=0.007$ for males and $p=0.002$ for females).

Columns 2 and 6 show that when including the work-related PA variable in the model, the association between income and LTPA still remains positive and statistically significant ($p=0.032$ for males and $p=0.004$ for females), although the magnitudes of the coefficients slightly decrease from the previous ones. Controlling for leisure screen time, time spent sitting in transportation, and time spent on unpaid home production (columns 3 and 7) do neither remarkably change the results for females. For males, the income effect is no longer statistically significant ($p=0.072$).

Regarding the effects of the other SLOTH variables, we see that the time spent sitting in transportation ($p<0.001$) and leisure screen time (i.e., sitting at the computer or watching television) ($p=0.002$) are significantly and negatively associated with the amount of LTPA for males. Also for women, the leisure screen time ($p<0.001$) have significant and negative association with the amount of LTPA.

We are aware of the potential endogeneity problem of including variables that measure the allocation of leisure time as explanatory variables in the regressions. However, we do not consider that to be a serious concern since the main coefficients of interest remain stable when we add controls for the use of time into the regressions.

Finally, columns 4 and 8 show that after adding the health-related control variables in the specifications, the magnitudes of the income coefficients decrease and the coefficients no longer remain statistically significant for males ($p=0.230$) or females ($p=0.159$). This is not surprising, since poor health determines markedly individuals LTPA, and is known to be associated with income. Thus, these results indicate the possibility that positive association between income and LTPA originates from health-related factors determining LTPA and correlating with income. The effect of the time spent sitting in transportation remains negatively statistically significant in relation to the LTPA of males ($p=0.004$), as well as the effect of screen time for females ($p<0.001$).

For the health-related variables, self-assessed health has a significant positive relationship ($p<0.001$), and smoking has a significant negative relationship ($p<0.001$) with LTPA for both genders. In addition, BMI is inversely associated with LTPA for females ($p<0.001$). The background variables, the GPA and the grade in physical education at the time of leaving basic education at the age of 15-16 years, are positively and statistically significantly ($p=0.002$ and $p<0.001$, respectively) related to LTPA for males.

Table 2. Weighted logit estimation results of income effect on leisure-time physical activity among 46-year old male and female in the Northern Finland Birth Cohort 1966 (NFBC66) in 2012 .

Explanatory variables	Dependent variable: *Pr(PA)*							
	Male				Female			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Work-related								
ln(income)	0.396***	0.330**	0.284*	0.198	0.483***	0.475***	0.449***	0.251
	(0.147)	(0.154)	(0.158)	(0.165)	(0.154)	(0.166)	(0.168)	(0.178)
physical strain of the work		-0.109	-0.097	-0.116		-0.011	0.008	-0.007
		(0.079)	(0.081)	(0.084)		(0.087)	(0.089)	(0.093)
Leisure time								
sitting at the computer or watching TV			-0.133***	-0.071			-0.248***	-0.203***
			(0.042)	(0.043)			(0.052)	(0.054)
Transportation								
time spent sitting during transport			-0.106***	-0.096***			-0.168*	-0.112
			(0.032)	(0.034)			(0.088)	(0.080)
Home production (unpaid work)								
married			0.034	-0.090			-0.145	-0.207
			(0.158)	(0.164)			(0.133)	(0.137)
number of children			-0.053	-0.040			-0.045	-0.064
			(0.043)	(0.043)			(0.047)	(0.049)
Health-related								
self-assessed health				0.697***				0.618***
				(0.093)				(0.088)
smoker				-0.471***				-0.606***
				(0.140)				(0.146)
BMI				-0.024				-0.059***
				(0.016)				(0.013)
Background controls								
GPA	0.351***	0.327***	0.308***	0.214***	0.095	0.093	0.045	-0.024
	(0.064)	(0.067)	(0.068)	(0.070)	(0.062)	(0.063)	(0.065)	(0.068)
Physical education grade	0.273***	0.272***	0.271***	0.259***	0.107*	0.107*	0.101	0.062
	(0.057)	(0.057)	(0.059)	(0.060)	(0.062)	(0.062)	(0.063)	(0.065)
constant	-8.221***	-7.163***	-5.973***	-2.039	-5.604***	-5.500***	-3.821**	1.975
	(1.493)	(1.667)	(1.715)	(1.886)	(1.512)	(1.738)	(1.778)	(1.976)
pseudo R^2	0.058	0.059	0.070	0.116	0.014	0.014	0.038	0.096
N	1520	1520	1520	1520	1815	1815	1815	1815

Dependent variable, Pr(PA), is the probability that physical activity reaches the sufficient level with respect to health benefits, measured as MET minutes ≥ 500 per week. Robust standard errors are in parentheses. *** Statistically significant at 1% significance level. ** Statistically significant at 5% significance level. * Statistically significant at 10% significance level.

5.4 SES sub-group analysis

We continue by examining whether the above established association between LTPA and income level is different for individuals with different SES statuses. We do this by running a set of sub-group analyses.

Figure 3 presents the estimates for income in eq. (1) by sub-group at the individual level. Here, we show findings for separate income quartiles, education levels, and by occupational statuses. All of the analyses are controlled with the same covariates as presented above. The estimates of the full models and further details of these results are available upon request from the authors.

Panel A shows the weighted results of the income effect on the LTPA among the income groups for males and females. We find that, within income quartiles, income is not statistically significantly associated with the amount/volume of LTPA of either gender.

Panels B and C give the results for the test on whether the association between income and LTPA is related to other SES indicators for these groups. The findings also show that, within these SES indicators, individuals' income seems not to be associated with LTPA. This evidence supports our general conclusion that while SES differences explain an individual's LTPA, income has no effect within a particular SES group. This may be interpreted that social comparisons seem to be an important factor in determining LTPA.

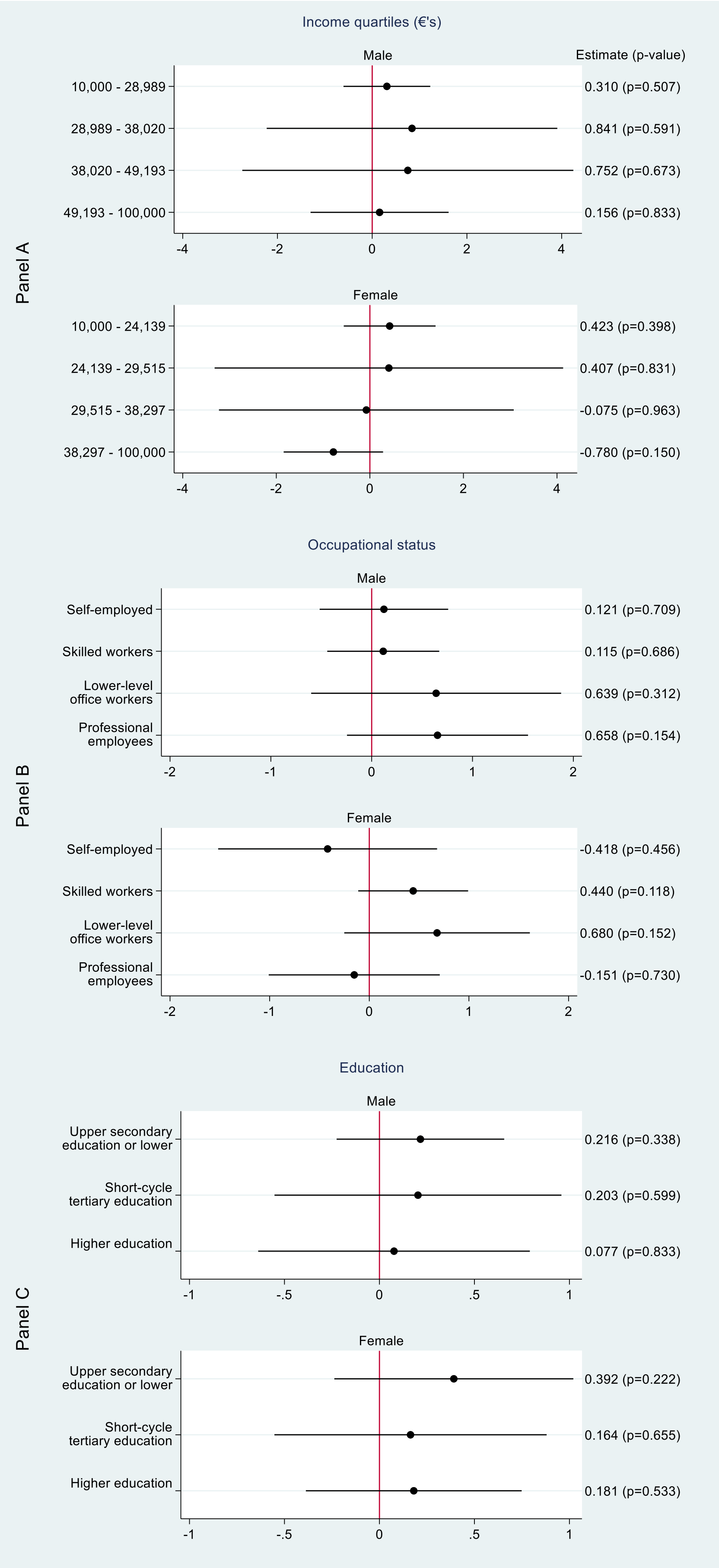
Income quartiles (€'s)
Male
Estimate (p-value)
10,000 - 28,989
0.310 (p=0.507)
28,989 - 38,020
0.841 (p=0.591)
38,020 - 49,193
0.752 (p=0.673)
49,193 - 100,000
0.156 (p=0.833)
-4
-2
0
2
4
Panel A
Female
10,000 - 24,139
0.423 (p=0.398)
24,139 - 29,515
0.407 (p=0.831)
29,515 - 38,297
-0.075 (p=0.963)
38,297 - 100,000
-0.780 (p=0.150)
-4
-2
0
2
4
Occupational status
Male
Self-employed
0.121 (p=0.709)
Skilled workers
0.115 (p=0.686)
Lower-level office workers
0.639 (p=0.312)
Professional employees
0.658 (p=0.154)
-2
-1
0
1
2
Panel B
Female
Self-employed
-0.418 (p=0.456)
Skilled workers
0.440 (p=0.118)
Lower-level office workers
0.680 (p=0.152)
Professional employees
-0.151 (p=0.730)
-2
-1
0
1
2
Education
Male
Upper secondary education or lower
0.216 (p=0.338)
Short-cycle tertiary education
0.203 (p=0.599)
Higher education
0.077 (p=0.833)
-1
-.5
0
.5
1
Panel C
Female
Upper secondary education or lower
0.392 (p=0.222)
Short-cycle tertiary education
0.164 (p=0.655)
Higher education
0.181 (p=0.533)
-1
-.5
0
.5
1

Figure 3. The estimated effects of income on LTPA from weighted logit estimations by SES sub-groups among 46-year old male and female in the Northern Finland Birth Cohort 1966 (NFBC66) in 2012.

6. Discussion

We make a contribution to the literature by showing that both standard (neoclassical) and behavioral economic views play important roles in determining factors that influence individuals' leisure-time physical activity. Evidence shows that the extent to which an individual participates in LTPA closely follows their SES. We show that individuals with a high SES have a higher level of LTPA than those of middle or low SES. Our finding is robust for evidence of all three SES indicators (income, education and occupation) as being predictors for LTPA.

The possible explanation for the positive relationship between income and LTPA is that higher personal economic success generates possibilities for participating in exercise, which is in line with the standard neoclassical economic reasoning. However, when we expanded the model to behavioral factors, we found that there was no relationship between income and LTPA. In addition, when we further analyzed for factors within SES, we found that income was not associated with LTPA. These findings suggest that LTPA behavior might be strongly influenced by the reference group's perception or social comparison, reflecting the proposition of Zimmerman (2009). Our results show that SES is an indicator for the amount of LTPA an individual participates in. This lends to behavioral economic insights on the relationship between income and LTPA, and is in line with the results of e.g. Cerin and Leslie (2008), and Kakinami et al. 2018).

For the specific SES indicators, we found that education was an especially powerful determinant of LTPA. With a high probability, this was not due to an association with greater access to resources but more likely because of the impact of education on healthy lifestyle behaviors. This is in line with the findings of Farrell et al. (2014) and Yuanyuan et al. (2018), among others, who show that education is strongly associated with PA.

Further, our results show that Cawley's SLOTH framework provides a good base framework for analyzing LTPA. Our contribution is in expanding the basic model by including behavioral and health-related factors. We show that all the added explanatory variables are relevant factors for the LTPA regressions. The expanded model is sufficient to explore LTPA in general with differing individual characteristics. Our model provides some relevant insights for policymakers wishing to promote LTPA, especially among different SES groups.

Our study also presents some important gender-specific outcomes. We show that in LTPA decision-making, individual-specific factors, such as motivation and history of PA, seem to be relevant only for men. This implies that men whose PA was lower during their youth will probably also be physically inactive in their older age. For women, PA during their youth does not appear as crucial factor in explaining later-life LTPA. These results are consistent with the results in review article by Telama (2009), who presents that only among men, the stability of physical activity from adolescence to adulthood seems to be significant.

In addition, leisure-time use markedly differs across genders. Screen time has a negative association with women's LTPA, whereas time spent sitting during transportation has a negative association with men's LTPA. These differences among genders reflect the importance of conducting further studies to analyze LTPA using gender-specific models.

In almost all SES indicators and for both genders we found that an unhealthy lifestyle and poor self-reported health are negatively associated with LTPA. While it is clear that these factors correlate with physical activity, our results give some policy-relevant insights that point to the fact that for the obese and/or those individuals with other indicators of poor health, starting physical activity might be especially difficult. These findings predict that large future health problems will be concentrated on people who already self-report poor health.

The major strength of this study is the large population-based birth cohort data. Most previous studies used data on only small samples and, regarding the time allocation, they did not consider a pure measure of the opportunity cost of time. For example, Kari et al.'s (2015) study consisted of only 753 individuals aged 34 to 49 in a random sample of men and women from six age cohorts from five university towns and a surrounding rural area with a medical school in Finland. Hence, the specific factors of the state of living related to climate, geography, variations in travel costs of the physical activity, and the supply of goods and services may have affected physical activity decisions and, thereby, the results of their study. The novelty of our data is that it provides us with information on both income and time allocation at the individual level. Further, relatively few studies included work-related physical activity in their analyses. The amount of physical work needed in manual jobs is likely to affect individuals' motivation to participate in LTPA. Further, work-related physical activity varies between genders. Men more often have jobs that include more physical activity, compared to women. We also clarified the determinants of LTPA, since taking into account work-related PA helps to lower the measurement bias in LTPA due to the fact that total PA accumulates throughout the day.

This study also comes with some limitations. First, using a questionnaire to collect data on physical activity and leisure sedentary time spent on sitting may lead to cognitive bias. The use of self-reported information on physical activity may lead individuals to overstate their true physical activity behaviors. In addition, the types of exercise were not taken into account, so the physical-activity variable of this study is not ideal. Second, there is also a possibility of omitting variable bias if some unobserved variables, for example self-discipline, affect both participation in regular exercise and personal economic success and, thus, distort the results of the study. To alleviate this possible bias in the estimated relationship between LTPA and income, in controlling for the unobserved heterogeneity in our empirical analyses, we used a proxy for an individual's innate ability. Despite that, our identification strategy cannot be regarded strong enough to provide causal interpretations. Third, the possibility of simultaneous causality cannot be ruled out. It is also possible that the level of physical activity affect income and its related factors. Longer-term follow-up is needed to shed light on questions of causality.

Finally, this study's approach to economic modelling has some limitations. While the SLOTH model is a useful framework for analyzing LTPA, economic theory offers no guidance on the origins of individuals' preferences or how easily they may be rationalized and changed in the real world.

This study gives some important policy implications. We show that the underlying factors (e.g. SES, screen time, time spent sitting during transportation and health) explain the individuals' exercise decisions, which helps to design more effective mechanisms, interventions and incentives to increase daily physical activity. Here we are in line with Humphreys and Ruseski (2011), who show that different strategies may motivate different individuals to increase exercising. We argue that effective physical activity promoting strategy should also include behavioral economic factors. Especially, we present that it is in people's interest to adhere their LTPA to reference group level. It is, hence, important for public policy to realize the role of reference group effects or social comparison in "incentives" to increase good lifestyle habits. This echoes Cawley (2004), who states that information of factors affecting PA as well as positive health and economic effects of physical activity should be perfectly accurate and objective so that policymakers may process it quickly and easily.

To further understand predictors of LTPA, longitudinal data to examine causal effects will be needed, also to further reveal the complexity behind social context in LTPA. Overall, more studies concerning individual physical activity decisions and affecting factors in dynamic set-up are needed. Especially interdisciplinary approach and new perspectives are required. In addition, using objective PA measurement in addition to self-reports would improve the reliability of the results.

7. Conclusions

There is an urgent need to increase physical activity in societies. Understanding the different underlying factors that affect individuals' exercise decisions will help policy makers develop programs that can effectively promote physical activity. The simultaneous role of the economic, behavioral and health aspects of the LTPA decision has not been presented in previous literature.

Our findings give only limited support for the standard economic determinants (income and time) of physical activity. We show that the factors that affect individuals' decisions concerning their level of physical activity may differ between income, educational and occupational groups. This implies that individuals with different socio-economic statuses respond markedly differently to strategies that promote physical activity.

Our findings also suggest that the same methods may not be effective for the whole population, instead it seems that there is need for different methods for different individuals. To successfully and effectively promote and manage physical activity, it is important to recognize the factors that affect individuals' decisions concerning their levels of physical activity.

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APPENDIX

Methodological details

Following Rosenbaum and Rubin (1983), the propensity score is defined as the conditional probability of responding given the basic background information:

$$Pr(R = 1|X') = E(R|X'),$$

where $R = \{0,1\}$ is the indicator of responding and X' is the vector of background information. We estimate the propensity score by fitting the following logit model:

$$Pr(R_i = 1|X_i) = F(\beta_0 + \beta_1 X_i),$$

where $Pr(R_i = 1|X_i)$ denotes the probability of responding of individual *i* given income level X_i, and *F* denotes the cumulative logistic distribution function. Probability of responding is estimated for each individual.

A sampling weight (w_i) for individual *i* is then obtained by

$$w_i = \frac{1}{Pr(R_i=1|X_i)} \times \overline{Pr}(R_i = 1|X_i),$$

where $\overline{Pr}(R_i = 1|X_i)$ is the average probability of responding for all individuals who responded.

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Table A1. Questions related to physical activity and corresponding levels of average frequency and duration in 46-year follow-up survey in the Northern Finland Birth Cohort 1966 (NFBC66) in 2012.

Items	Frequency /Duration
How often do you participate in light leisure-time physical activity?	
once a month or less often	0 times per week
2-3 times a month	0.5 times per week
once a week	once per week
2-3 times a week	2.5 times per week
4-6 times a week	5 times per week
more than 6 times a week	7 times per week
How often do you participate in brisk leisure-time physical activity?	
once a month or less often	0 times per week
2-3 times a month	0.5 times per week
once a week	once per week
2-3 times a week	2.5 times per week
4-6 times a week	5 times per week
more than 6 times a week	7 times per week
How much time do you spent in a light physical activity session?	
not at all	0 minutes
less than 20 minutes	10 minutes
20-39 minutes	30 minutes
40-59 minutes	45 minutes
1-1.5 hours	75 minutes
over than 1.5 hours	90 minutes
How much time do you spent in a brisk physical activity session?	
not at all	0 minutes
less than 20 minutes	10 minutes
20-39 minutes	30 minutes
40-59 minutes	45 minutes
1-1.5 hours	75 minutes
over than 1.5 hours	90 minutes