Title page

Full title: Physical education and leisure time physical activity in youth are both important for adulthood activity, physical performance and health.

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Abstract

Background The importance of youth physical activity (PA) for adulthood PA, performance and health was retrospectively evaluated.

Methods A total of 258,146 participants (49% women), 19-70 years, with a first time health profile assessment between 1982-2015, provided self-reported current perceived health, PA, lifestyle, and physical education (PE) class participation and PA outside school hours before age 20. Anthropometrics, blood pressure and estimated VO_2max were obtained.

Results Women participating in PE class, compared to those who did not, had significantly lower OR (range 0.81-0.87) for perceiving poor overall health, general obesity and high diastolic blood pressure after adjustment for potential confounders, and increased OR (range 1.17-1.23) for exercise regularly and a normal/high VO_2max in adulthood. For men, the ORs were significant lower (range 0.66-0.86) for poor perceived overall health, general and abdominal obesity. These associations were seen for participants up to 70 years. Increased PA outside school hours revealed even stronger beneficial associations. In joint analyses, both youth and current PA were important for lower OR of poor health and being obese in adulthood.

Conclusions PE class participation and additional PA after school hours were both important for perceived health, PA, VO_2max and metabolic health in adulthood up to 70 years.

Introduction

Despite the well-established knowledge that physical activity (PA) is important for health and longevity, the majority of the adult population does not meet current national guidelines.[1,2] Even if current PA level is known to have the greatest effect on health and physical performance in general,[3,4] childhood and adolescence PA might also have important beneficial effects in different domains, for example bone density.[5] With the alarming reports of increasing childhood/adolescent obesity and declining fitness levels,[6,7] studies on the immediate effects on health and disease in youth, as well as tracking into adulthood and effects on lifestyle, activity habits and health later in life, are highly relevant. Previous tracking studies report in general low to moderate correlation between childhood and adult PA and fitness, with some equivocal results between different domains of youth PA.[8-11] This might be due to methodological issues as well as small sample sizes. Follow-ups are mainly performed over the early parts of the adult life-span, up to 26-39 years,[9,10,12,13] with limited long-term follow-ups from childhood to late adulthood. Also, little is known about the effects of youth PA and cardiovascular risk later in life.[14] Moreover, although physical education (PE) class at least once a week has been and is provided to all Swedish children/adolescents from first grade (7 years) until leaving high school at the age of 16 years, there is a paucity of research that specifically studies the importance of school based PE class participation.

Health Profile Assessment (HPA) is an interdisciplinary method combining medicine, physiology and behavioral science to promote health. This method has been used in occupational health services in Sweden for almost 40 years, with several thousand participants carrying out a HPA every year in different places around Sweden. It is comprised of a person-centred dialogue, and includes self-reported lifestyle and perceived health, previous and current PA habits, metabolic and physiological measurements. All data are subsequently registered and stored in a database. The combination of the large amount of HPA performed

each year and the long-term usage of well-established and standardized methods in occupational health promotion generates a unique database, which enables analyses of youth PA habits in relation to adulthood PA habits, performance and health in the Swedish working population. The large amount of data also enables sex and age stratified analyses.

The primary aim of this study was to retrospectively analyze the importance of PA before 20 years of age, specified as participation in PE class or not, together with additional PA outside school hours, on adult PA level, VO_2max, and perceived and metabolic health later in life in a large sample of Swedish men and women of a broad age span.

Methods

From October 1982 until September 2015, a total of 363,746 men and women, aged 19 to 70 years, performed a first-time HPA, which were registered and stored in the database. Health Profile Institute (Stockholm, Sweden) is the institute that is responsible for the database, standardization of methods used and education of the HPA coaches since the start of the administration of HPAs in the late 1970s. In October 2015, a withdrawal of participants from the database was made and available for the present analyses. The protocols used were approved by the institutional review boards of the institutions involved in this study and all participants provided informed consent prior to data collection. The study was approved by the ethics board at Karolinska University, Dnr 2015/1864-31/2 and adhered to the Declaration of Helsinki.

Health Profile Assessment

The HPA method comprises three components which have been scientifically evaluated;[15,16] current perceived health, self-assessment of life style habits and some medical and physiological measurements. Participation is optional and free of charge for the individual,

and is offered to all employees working for a company or organisation connected to occupational or other health service. The participant answers an extensive questionnaire including current lifestyle, PA habits, and perceived overall stress and health. During a following dialogue with a HPA coach, the participant provides information regarding age, marital status, occupation and PA level prior to the age of 20 years, the latter including participation or not in PE class and additional PA outside school hours. Subsequently, weight, height, waist circumference and blood pressure (BP) are obtained. Finally, the participant performs a submaximal exercise test on a cycle ergometer for estimation of maximal oxygen consumption (VO_2max). All data are recorded in the Health Profile Institute database.

Physical activity habits

PA level prior to the age of 20 years was self- reported by selecting one of the following five given alternatives through the statement; *Prior to the age of 20, I… Did not participate in physical education (PE) class*, *Participate only in PE class*, *Participate in PE class + 1-2 times/week of PA outside school hours*, *Participate in PE class + 3-5 times/week of PA outside school hours* or *Participate in PE class + At least 6 times/week of PA outside school hours*. Current exercise and commuting habits were self-reported through the statement; *I exercise for the purpose of maintaining/improving my physical fitness, health and well-being...*with the alternatives *Never*, *Sometimes*, *1-2 times/week*, *3-5 times/week* or *At least 6 times/week*. For current commuting, the statement *I walk or cycle to and/or from work...* was used with the alternatives *Less than 5 min/day*, *5-9 min/day*, *10-19 min/day*, *20-29 min/day* or *At least 30 min/day*.

Perceived health and covariates

Perceived overall health and overall stress, as well as diet, smoking and alcohol habits were obtained from the questionnaire responses. Perceived overall health was assessed using the statement *I perceive my physical and mental health as…* with the alternatives *Very poor*, *Poor*, *Neither good or bad*, *Good* or *Very good*. Perceived overall stress was assessed using the statement *I perceive stress in my life, both personally and at work…* with the alternatives *Very often*, *Often*, *Sometimes*, *Rarely* or *Never*. Diet habits were obtained using the statement *I consider my diet, regarding both meal frequency and nutritional content to be...* with the alternatives *Very poor*, *Poor*, *Neither good nor bad*, *Good* or *Very good*. Smoking habits were obtained using the statement *I smoke...* with the alternatives *At least 20 cig/day*, *11-19 cig/day*, *1-10 cig/day*, *Occasionally* or *Never*. The statement regarding alcohol use was since year 1982 *I drink alcohol…* with the alternatives *Very often*, *Often*, *Sometimes*, *Rarely* or *Never*, but was changed in 2011 to *I consider my alcohol habits, from a health perspective, to be...* with the alternatives *Very poor*, *Poor*, *Neither good nor bad*, *Good* or *Very good*. Although the alcohol use statement and alternatives have been changed throughout the years, the variable is kept in the analyses as a proxy for alcohol use as the answer alternatives in both occasions are on a five-point ordinal scale and the variable is only used as a covariate in the analyses with small variation between the different subgroups of the main exposure PA prior to the age of 20 years, see Table 1a and b.

In the dialogue, marital status was reported as either *Living together*, *Living together with children*, *Living alone* or *Living alone with children*. Occupation was reported according to the Swedish Standard Classification of Occupations 1996 (SSYK96) until June 2014 and according to the SSYK 2012 after that. SSYK is a system for classifying and aggregating data about occupations in administrative registers or statistical surveys. Occupations reported according to both SSYK96 or SSYK 2012 can be further grouped into four broad skill levels defined by level of education for the particular occupation; *Level 1* covers elementary

education at primary school level, meaning no or a low formal education requirements, *Level 2* covers education programs at upper secondary and tertiary level of no more than 2 years in length, *Level 3* covers practical or vocational tertiary education programs of 2-3 years in length, and *Level 4* covers theoretical or research-oriented tertiary education programs and third-cycle programs of at least 3 years, normally 4 years or longer in length.

Measured health and performance

Body mass was obtained with a calibrated scale in light-weight clothing to the nearest 0.5 kg. Body height was measured to the nearest 0.5 cm using a stadiometer. Body mass index (BMI) was computed as body mass divided by body height in meters squared ($kg \cdot m^{-2}$). Waist circumference was measured with a tape measure to the nearest 0.5 cm at the midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid axillary line after normal exhalation. Systolic and diastolic BP (mmHg) was measured manually in the right arm using the standard auscultatory method after 20 minutes of seated resting. Maximal oxygen uptake (VO_2max), expressed as ml $oxygen \cdot min^{-1} \cdot kg^{-1}$, was estimated from heart rate response after 6 minutes submaximal exercise on a cycle ergometer according to Åstrand and Rhyming.[17]

Statistical analysis

Continuous data displayed non-normality according to the Kolmogorov-Smirnov test, and was summarized as medians with quartile 1 and quartile 3 in Table 1. Significant differences between the levels of PA prior to age of 20 years for the continuous data were tested for by Kruskal-Wallis ANOVA with pairwise comparison (adjusting for multiple comparisons). The nominal and ordinal data obtained during the dialogue and through questionnaire responses was further dichotomized according to the definition in Table 1. Significant differences

between the levels of PA prior to age of 20 years for the proportions was tested by comparing proportions with the 99% confidence interval (CI) to compensate for multiple testing. In Table 2 and 3, logistic regression models were used to assess the odds ratio (OR) and 95% CI associated with higher levels of PA prior to the age of 20 years for the dichotomized variables of overall health, current exercise habits and intake of heart medicine (as a proxy of underlying disease). VO_2max, BMI, waist circumference, systolic and diastolic BP were all dichotomized according to conventional cut-offs points for increased health risks (VO_2max < 32 ml·min^{-1}·kg^{-1} in women and < 35 in men; BMI ≥ 30 kg·m^{-2}; waist circumference ≥ 88 cm in women and ≥ 102 cm in men; systolic BP ≥ 140 mmHg; diastolic BP ≥ 90 mmHg). Nagelkerk R^2 was reported as regression model fit diagnostics. All analyses were performed using IBM SPSS (version 21.0, SPSS Inc., Chicago IL) and Confidence Interval Analysis (version 2.2.0).

Results

A total of 258,146 participants (49% women) provided data on PA prior to the age of 20 years and the other covariates were included in the analyses. A small number of the participants (1%) had performed the HPA before 1994, with a subsequent annual participation rate of ≥2000 HPAs. For men and women in the database not included in the analyses, the majority (83%) was due to missing data for occupation. However, comparisons of important variables between participants with missing data vs. those included in the analyses showed significant ($p<0.001$), however, small variations (except for sex); men (59% vs. 51%), age (43.0 vs. 43.3 years), BMI (25.8 vs. 25.7), systolic BP (126.3 vs. 126.1 mmHg), diastolic BP (78.0 vs. 77.7 mmHg), VO_2max (36.9 vs. 36.3 ml·min^{-1}·kg^{-1}), self-reported very poor/poor overall health (6.4% vs. 5.9%), very poor/poor alcohol habits (4.9% vs. 4.6%), regular exercise (64.3% vs. 64.9%), very poor/poor diet habits (6.4% vs. 8.0%) and daily smokers (11.1% vs. 11.4%).

Thus, the analysed data can be regarded as representative for the whole HPI database population.

Characteristics of the study population are presented in Table 1a and b. Internal missing data is seen for VO_2max (103,553 women, 81.9%, and 107,040 men, 81.3%, provided data on VO_2max), mainly due to participants with medication affecting heart rate response, and waist circumference (18,747 women, 14.8%, and 29,005 men, 22.0%, provided data on waist circumference), as it was an optional part of the HPA.

Importance of youth PA on adulthood PA, performance and health

Women who participated in PE class (but with no additional PA outside school) had significantly lower OR (range 0.66 to 0.84) for perceiving very poor/poor overall health, being generally and abdominal obese and having a high diastolic BP after adjusting for age and performed year of the health assessment. Also, they had increased OR for being current regular exercisers (OR=1.27) and having a normal or high VO_2max (OR=1.26) compared to those who did not attend school PE class. These associations remained significant after adjusting for lifestyle related covariates, albeit with a somewhat lower magnitude of ORs (range 0.74 to 0.87 and 1.17 to 1.23, respectively). With more frequent participation in PA outside school hours (1-2 times/week, 3-5 times/week and ≥6 times/week), even stronger beneficial associations were seen for the above mentioned outcome variables, and additionally for systolic BP and the odds of not taking heart medicine.

Men participating in PE class had a significant lower OR (range 0.64 to 0.85) for perceiving their overall health to be very poor/poor and being both generally and abdominal obese compared to those who did not participate in PE class (Table 2b). Moreover, a more beneficial profile was seen for all the outcome variables for those with additional PA outside school hours, compared to those not participating in PE class (OR range for additional PA 1-2

times/week 0.55 to 0.83 for perceived and metabolic health variables, and 1.47 to 1.54 for current exercise and normal/high VO_2max). All odds ratios, except for waist circumference, remained significant after adjusting for relevant lifestyle covariates.

In table 3, the variations with increasing age of the participants, and hence age since youth PA, were analysed for the importance of PA prior to the age of 20 years in three adulthood age-subgroups; 20-35, 36-50 and 51-70 years. Participation in PE class compared to not attending PE class was significantly important in all stages of adulthood up to 70 years for not perceiving very poor/poor overall health (range 0.73 to 0.80). Similar beneficial associations were seen for the odds of being a currently regular exerciser and not being obese in later adulthood, and for having a normal/high VO_2max in early adulthood. Participants reporting additional PA outside school hours were during all stages of adulthood more likely to exercise regularly (OR range 1.28 to 1.58), having a normal/high VO_2max (OR range 1.35 to 1.58) and not to be obese (OR range 0.73 to 0.77). Similar beneficial associations, although not always significant, were seen for high waist circumference, systolic and diastolic BP. For intake of heart medicine, beneficial associations were seen in middle- and older stages of adulthood among those participating in PE class compared to those who did not.

Joint associations of youth and adulthood PA on adulthood perceived health and obesity

Compared to the reference group, those reporting not being regular exercisers in adulthood had significantly higher OR for perceiving their overall health as very poor/poor as well as being obese regardless youth PA level (PE class + PA ≥ 1 times/week, PE class only or No PE class) (Figure 1a and b). However, those reporting only participating in PE class or no PE class prior to the age of 20 years had higher risk of perceiving their overall health as very poor/poor and being obese, regardless exercising or not in adulthood. Participants reporting

no PE class and not being currently regularly active experienced the highest risk (OR=2.6 for very poor/poor perceived overall health and OR=1.98 for being obese).

Discussion

The present results show that participation in school-based PE class, compared to not participating, was associated with more beneficial perceived health, a more active life, higher VO_2max and a better metabolic health in adulthood in a sample of over 250.000 working Swedish men and women. Additional PA outside school hours is associated with even stronger beneficial associations in both men and women for all studied outcome variables. These associations are maintained even after adjusting for important confounders. Further, in analyses of the impact of age (up to 70 years) and hence time since leaving school, the associations were similar, with some variations between stages of adulthood. To our knowledge, no previous study has included a population based sample of this size to retrospectively evaluate the associations between PE class participation and PA levels in childhood/adolescence to adulthood PA level, VO_2max and health up to 70 years of age.

The beneficial associations found for those participating in at minimum PE class compared to those not participating in PE class is highly important. In women, PE class participation was associated with better current perceived health, regular exercise habits, higher VO_2max, lower levels of overall and abdominal obesity and lower diastolic BP. In men, similar associations were seen for perceived health and overall and abdominal obesity. Although the goal and content of the education plan for the PE class has been reformed and revised throughout the years, one of the most common aims of PE in many countries (including Sweden) is to promote a life-long physically active life style.[18] Also, skill development and habits in childhood is of great importance for higher exercise habits in adult life.[19] Hence, the present results indicating that PE class participation alone increase the

possibility to be active in adulthood is especially important for those individuals who are not engaged in additional PA outside of school hours, as school PE classes are thought to present a diversity of activities for the child/adolescent to try and perform.

PE class participation (in women) and, in a dose response manner, increasing PA outside school hours increases significantly the odds of exercise regularly as well as having a higher VO_2max later in life for both men and women. This is an important finding, and in line with previous research. Cleland et al. reported significant associations with total weekly PA at follow up (mean age 26 to 36 years) in boys aged 9-12 years and girls aged 13-15 years at baseline,[9] however they reported school compulsory PE (min/week) in the same population showed no relationships.[10] In a retrospective study, Kraut et al. report that those participating in organized school sports had a more than three-fold increased odds of being weekly regularly active after 40 years of age.[20] Hirvensalo et al. reported a more than two-fold increased odds for being regularly weekly active on at least moderate intensity at 70 year of age, if reporting participation in competitive sport prior to 20 years of age.[21] In general, tracking of PA from adolescence to older adulthood is in general reported to be low to medium with more non-significant associations (indicating poorer stability) in women compared to men.[22] This might be due to a low number of participants in some studies, shorter follow up period, or both.

The finding of 30% lower OR for poor/very poor perceived overall health among men and women reporting at minimum PE class participation, compared to non-participants, is highly interesting. Poor perceived health, assessed through a simple question as the present study, has in large population-based samples been identified as a single, strong predictor of all-cause mortality.[23,24] Importantly, the present associations remained even after adjustments for other factors associated with poor health such as low level of education, bad diet habits and smoking, and is strong and evident in all stages of adulthood (table 3). Interestingly, the

further reduced risk of poor overall health with additional PA outside school hours in the fully adjusted analyses is small. This may point out that non-participants in school PE classes belong to a risk group for adult impaired health and other outcomes, but it might also indicate that even low levels of PA engagement prior to the age of 20 years is important for future overall health.

We found strong associations with lower overall and abdominal obesity in both men and women in those with only PE class participation and increasingly with additional PA hours outside school. A similar association was seen for diastolic BP in women. For both systolic BP and heart medicine intake, significant associations were present in those reporting at least one hour of PA outside school. Previous research on the effects of youth PA on CVD risk in adulthood is limited. Rangul et al. presented data from the HUNT study, which aimed at investigate differences in PA patterns between adolescence (13-19 year old boys and girls) to young adulthood (23-31 years) on cardio-metabolic risk factors.[14] They found that those who maintained their PA from adolescence to adulthood had a significantly lower CVD risk and better mental health, compared to those who remained inactive. This may be comparable to the results in Figure 1a and b in the present study. Those who did not attend PE class and did not exercise regularly in adulthood, had a two-fold increased OR for overall obesity and 2.6-fold increased OR for poor health compared to those who had maintained an active lifestyle from adolescence to adulthood. Importantly, participants in the present study who adopted an active life style from adolescence to adulthood had a significantly lower OR for both for poor perceived health and overall obesity (Figure 1a and b). This is evident in those with no PE class as well as only PE class during adolescence, and indicates the importance of present activity levels for metabolic health and well-being. On the contrary, participants who adopted an inactive lifestyle (participating in only PE class or PE class plus additional PA hours outside school during adolescence, but with no regular exercise in adulthood) had

significantly lower OR for both for poor perceived health and overall obesity compared to those being inactive maintainers from adolescence to adulthood. This illustrates the possible importance of PA habits in early life, although not continuing being active, which evidently influences health and well-being through other pathways.

It should be noted that it is not possible to draw any definite conclusions regarding causality in these associations between youth PA and different adult outcomes, since many transitions and life-changing events occur during the course of life. Moreover, we lack information regarding the reasons for not participating in PE class for the participants. Although being a compulsory subject in the Swedish school system since the 19th century, there are students that choose to not participate. In a study of 1000 high school students in southern Sweden, one out of four did not attend at least one third of PE class opportunities.[25] Few students had medical reasons for not participating, with psychological (PE class perceived as boring/meaningless, bad self-confidence, less satisfied with own athletic ability, physical appearance and health) and social (peer pressure to not participate, bullying) being more frequently reported. Also, the PE class having a competitive approach where students need to perform well and achieve sporting results, together with being directed at and including mainly interested students,[26,27] may serve as unmotivating factors for students equivocal to the subject and increase the risk of dropping out. Swedish junior high school and high school students identified as frequent drop-outs from PE class were found to smoke and drink alcohol more often, skip other compulsory classes, have a higher BMI, enjoy school less and have less interest in school work, compared to other students attending PE class on regular basis.[28] Girls dropping out from PE class were also more often bullied. Only fourteen percent reported some physical or psychological hinder that could have influenced participation. External risk factors for PE class drop-out were mandatory showering after PE class, grades depending on physical performance, far off located sports facilities and PE class

taking place in the early morning or at lunch time. Girls more often than boys have been reported to experience unease and discomfort for PE class,[26] which may influence participation. In the present study more women than men reported not participating in PE class. However, it is important to emphasize that those participants reporting not attending school PE classes, regardless reason, must be considered as belonging to a risk group for adult physical inactivity, low VO_2max and poor perceived overall health as well as measured impaired metabolic health later in life.

Strength and limitations

A strength of this study is the large number of men and women studied with standardized methods. Another strength is also the duration during which current data were obtained making variations in perceived health and other factors not depending on variations in changes in the society. A novelty is the long positive tracking effects of childhood/adolescence PA on adult health up to 70 years, hence providing a possibility to study the associations at different stages of adulthood. A limitation is that we have no information on why participants did not participate in PE class. Also, there is no information regarding level and amount of PA in school PE class, but modern research regarding non-intentional physical exercise have shown that even walking and other low-intensity non-sport activities have positive effects on health and longevity.[29] Health problems in youth may influence adult VO_2max and PA. Moreover, we do not have any information regarding intensity and amount of PA outside school hours, or information if PE was taught by PE specialists, at what dosage and at which level of education. Another limitation could be that retrospective information on PE class participation and PA outside school hours may suffer from recall bias. However, PE class participation might be a more definite decision which may be easier to recall than hours per week of PA. However, any uncertainty of additional PA

hours outside school should be equal in all PA classes. Although the data collection was not initially intended for research purposes, the standardization of procedures and quality control is well suited for such analyses.

Conclusions

PE class participation, compared to not participating, was associated with more beneficial perceived health, a more active life, higher VO_2max and a better metabolic health in adulthood in a sample of over 250.000 working Swedish men and women. Additional PA outside school hours induced even stronger associations. When analysing the impact of age up to 70 years, and hence time since leaving school, the associations were similar, with some small variations between stages of adulthood. Joint analyses revealed that both youth PA and current PA were important for reducing the probability of having poor health and being obesity in adulthood. For those not participating in leisure time PA, PE class may provide an important opportunity to engage in and try a diversity of activities which may promote a life-long active and healthy life style. Though, it also seems essential to encourage previously inactive individuals to engage in PA, as adulthood PA level regardless youth PA, decreased probability of poor health and obesity.

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Table 1a Characteristics of women in the study population (n=126,438).

	No PE Class n=1793	Only PE Class n=32449	PE Class+PA 1-2 t/w n=51680	PE Class+PA 3-5 t/w n=34134	PE Class+PA ≥6t/w n=6382
Age (years)	47 (37-54)[a,b,c,d]	49 (40-56)[b,c,d]	45 (36-54)[c,d]	40 (33-49)[d]	39 (31-47)
Relationship (Live together)	72%[a,b,c,d]	77%	77%	77%	76%
Level of education (Level 4)	22%[b,c,d]	22%[b,c,d]	29%[c,d]	32%[d]	38%
Overall health (Very poor/Poor)	11%[a,b,c,d]	8%[b,c,d]	6%	6%	6%
Overall stress (Very often/Often)	23%[a,b,c,d]	19%	19%	19%	18%
Diet habits (Very poor/Poor)	9%[a,b,c,d]	6%[b,c,d]	5%	5%	4%
Smoking habits (≥1 cig/day)	19%[a,b,c,d]	15%[b,c,d]	13%[c,d]	12%[d]	10%
Alcohol habits (Very poor/Poor)[#]	4%	3%	3%	3%	3%
Current exercise (≥1 time/week)	58%[a,b,c,d]	63%[b,c,d]	71%[c,d]	74%[d]	78%
Current commuting (≥10 min/day)	30%	29%[b,d]	31%	30%[d]	32%
VO_2max ($ml \cdot min^{-1} \cdot kg^{-1}$)	32 (26-38)[b,c,d]	32 (27-38)[b,c,d]	34 (29-41)[c,d]	37 (31-44)[d]	39 (32-47)
BMI ($kg \cdot m^{-2}$)	25.1 (22.5-28.7)[a,b,c,d]	24.8 (22.4-27.9)[b,c,d]	24.2 (22.0-27.2)[c,d]	23.9 (21.7-26.7)[d]	23.6 (21.5-26.4)

Waist circumference (cm)	88.0 (79.0-99.3)[b,c,d]	86.0 (78.5-95.0)[b,c,d]	84.0 (77.0-92.0)[c,d]	82.0 (76.0-91.0)	81.0 (75.0-91.0)
Systolic BP (mmHg)	123 (112-135)[b,c,d]	125 (115-136)[b,c,d]	120 (110-132)[c,d]	120 (110-130)[d]	120 (110-129)
Diastolic BP (mmHg)	79 (70-85)[b,c,d]	80 (70-85)[b,c,d]	76 (70-82)[c,d]	75 (70-80)[d]	75 (70-80)
Taking heart medicine (Yes)	8% [b,c,d]	8% [b,c,d]	6% [c,d]	4%	4%

Data is presented as median (Q1-Q3) or %

[a]Significant difference vs. Only PE class

[b]Significant difference vs. PE class + PA 1-2 t/w

[c]Significant difference vs. PE class + PA 3-5 t/w

[d]Significant difference vs. PE class + PA ≥ 6 t/w

[#]The question was changed in 2011, see method section

PE class; Physical education class, BP; Blood pressure

Table 1b Characteristics of men in the study population (n=131,708).

	No PE Class n=1289	Only PE Class n=18628	PE Class+PA 1-2 t/w n=39925	PE Class+PA 3-5 t/w n=56491	PE Class+PA ≥6t/w n=15375
Age	44 (34-53)[a,c,d]	46 (36-54)[b,c,d]	44 (35-53)[c,d]	42 (33-51)[d]	40 (32-48)
Relationship (Live together)	72%[c,d]	71%[b,c,d]	74%[c,d]	77%[d]	79%
Level of education (Level 4)	24%[b,c,d]	27%[b,c,d]	30%[d]	30%[d]	35%
Overall health (Very poor/Poor)	10%[a,b,c,d]	6%[b,c,d]	6%[c,d]	5%	5%
Overall stress (Very often/Often)	11%	11%[c]	10%[c]	10%[d]	11%
Diet habits(Very poor/Poor)	15%[a,b,c,d]	15%[b,c,d]	11%[c,d]	10%[d]	9%
Smoking habits (≥1 cig/day)	18%[a,b,c,d]	13%[b,c,d]	11%[c,d]	9%[d]	7%
Alcohol habits (Very poor/Poor)[#]	8%[a,b,c,d]	7%[c,d]	6%	6%	6%
Current exercise (≥1 time/week)	46%[b,c,d]	46%[b,c,d]	56%[c,d]	65%[d]	72%
Current commuting (≥10 min/day)	21%	22%	23%	22%	23%
VO_2max ($ml \cdot min^{-1} \cdot kg^{-1}$)	33 (27-40)[b,c,d]	33 (28-39)[b,c,d]	35 (29-41)[c,d]	37 (30-44)[d]	39 (32-47)
BMI ($kg \cdot m^{-2}$)	26.1 (23.9-29.0)[b,c]	25.9 (23.7-28.6)[b,c]	25.7 (23.6-28.2)[c,d]	25.8 (23.8-28.1)[d]	25.9 (23.9-28.2)

Waist circumference (cm)	98.0 (90.8-107.0)[b,c,d]	97.0 (90.0-105.0)[b,c,d]	96.0 (89.0-103.0)[c,d]	94.0 (88.0-102.0)	94.0 (88.0-101.0)
Systolic BP (mmHg)	130 (120-140)[b,c,d]	130 (120-140)[b,c,d]	130 (120-139)[c,d]	126 (120-136)[d]	125 (120-135)
Diastolic BP (mmHg)	80 (70-87)[c,d]	80 (74-85)[b,c,d]	80 (70-85)[c,d]	80 (70-85)[d]	80 (70-85)
Taking heart medicine (Yes)	9% [b,c,d]	8% [b,c,d]	7% [c,d]	6% [d]	5%

Data is presented as median (Q1-Q3) or %

[a]Significant difference vs. Only PE class

[b]Significant difference vs. PE class + PA 1-2 t/w

[c]Significant difference vs. PE class + PA 3-5 t/w

[d]Significant difference vs. PE class + PA ≥ 6 t/w

[#]The question was changed in 2011, see method section

PE class; Physical education class, BP; Blood pressure

Table 2a Odds ratio (95% CI) for different levels of physical activity prior to the age of 20 years of age in relation to dichotomized variables of perceived health, exercise habits, VO_2max and metabolic health in women.

		No PE Class	Only PE Class	PE Class + PA 1-2 t/w	PE Class + PA 3-5 t/w	PE Class + PA ≥6t/w	R^2
Overall health *(Very poor/Poor)*	Age-adjusted	1	0.68 (0.58-0.79)	0.57 (0.49-0.66)	0.53 (0.45-0.62)	0.53 (0.44-0.63)	0.002
	Lifestyle-adjusted	1	0.84 (0.71-0.99)	0.81 (0.68-0.96)	0.81 (0.69-0.97)	0.89 (0.73-1.09)	0.19
Current exercise *(≥1 time/w)*	Age-adjusted	1	1.27 (1.16-1.40)	1.82 (1.65-2.00)	2.21 (2.00-2.43)	2.71 (2.42-3.02)	0.02
	Lifestyle-adjusted	1	1.17 (1.06-1.30)	1.58 (1.42-1.74)	1.87 (1.69-2.07)	2.21 (1.97-2.49)	0.11
Normal/High VO_2max *(≥32 ml·kg^{-1}·min^{-1})*	Age-adjusted	1	1.26 (1.12-1.41)	1.72 (1.53-1.94)	2.13 (1.89-2.40)	2.52 (2.20-2.88)	0.19
	Lifestyle-adjusted	1	1.23 (1.09-1.39)	1.50 (1.33-1.70)	1.78 (1.58-2.01)	1.98 (1.83-2.27)	0.26
BMI *(≥30)*	Age-adjusted	1	0.74 (0.65-0.83)	0.60 (0.53-0.67)	0.55 (0.49-0.62)	0.48 (0.41-0.55)	0.02
	Lifestyle-adjusted	1	0.81 (0.71-0.91)	0.76 (0.67-0.86)	0.74 (0.65-0.85)	0.70 (0.60-0.81)	0.10
Waist circumference *(≥88 cm)*	Age-adjusted	1	0.66 (0.50-0.87)	0.51 (0.39-0.67)	0.48 (0.37-0.63)	0.46 (0.35-0.61)	0.08
	Lifestyle-adjusted	1	0.74 (0.55-0.98)	0.64 (0.48-0.85)	0.65 (0.49-0.86)	0.67 (0.50-0.96)	0.18
Systolic BP *(≥140 mmHg)*	Age-adjusted	1	0.93 (0.82-1.06)	0.83 (0.73-0.94)	0.75 (0.66-0.85)	0.71 (0.61-0.83)	0.21
	Lifestyle-adjusted	1	0.95 (0.83-1.08)	0.89 (0.79-1.01)	0.83 (0.73-0.94)	0.82 (0.70-0.95)	0.22

Diastolic BP *(≥90 mmHg)*	Age-adjusted	1	0.84 (0.74-0.97)	0.74 (0.65-0.85)	0.68 (0.59-0.79)	0.67 (0.57-0.79)	0.09
	Lifestyle-adjusted	1	0.87 (0.76-0.99)	0.80 (0.70-0.92)	0.76 (0.66-0.87)	0.77 (0.65-0.91)	0.10
Heart Medicine *(yes)*	Age-adjusted	1	0.94 (0.78-1.13)	0.81 (0.67-0.97)	0.71 (0.59-0.86)	0.66 (0.52-0.82)	0.14
	Lifestyle-adjusted	1	0.96 (0.80-1.15)	0.87 (0.73-1.15)	0.79 (0.66-0.96)	0.76 (0.60-0.95)	0.15

Age-adjusted model; Adjusted for age and year performed

Lifestyle adjusted model; Additionally adjusted for overall stress, diet habits, smoking habits, alcohol habits, level of education, relationship, current commuting and current exercise (when not evaluated as dependent variable).

PE class; Physical education class

Table 2b Odds ratio (95% CI) for different levels of physical activity prior to the age of 20 years of age in relation to dichotomized variables of perceived health, exercise habits, VO_2max and metabolic health in men.

		No PE Class	Only PE Class	PE Class + PA 1-2 t/w	PE Class + PA 3-5 t/w	PE Class + PA ≥6t/w	R^2
Overall health *(Very poor/Poor)*	Age-adjusted	1	0.64 (0.53-0.78)	0.55 (0.45-0.67)	0.46 (0.38-0.55)	0.47 (0.38-0.57)	0.003
	Lifestyle-adjusted	1	0.66 (0.54-0.82)	0.66 (0.54-0.81)	0.61 (0.50-0.75)	0.70 (0.56-0.86)	0.16
Current exercise *(≥1 time/w)*	Age-adjusted	1	1.00 (0.89-1.12)	1.47 (1.32-1.65)	2.10 (1.88-2.35)	2.87 (2.56-3.23)	0.04
	Lifestyle-adjusted	1	0.94 (0.83-1.06)	1.31 (1.17-1.47)	1.87 (1.66-2.10)	2.43 (2.15-2.74)	0.13
Normal/High VO_2max *(≥35 ml·kg^{-1}·min^{-1})*	Age-adjusted	1	1.10 (0.96-1.26)	1.54 (1.34-1.76)	1.97 (1.72-2.25)	2.47 (2.15-2.84)	0.18
	Lifestyle-adjusted	1	1.09 (0.95-1.26)	1.34 (1.16-1.54)	1.59 (1.38-1.83)	1.80 (1.56-2.08)	0.27
BMI *(≥30)*	Age-adjusted	1	0.85 (0.74-0.98)	0.70 (0.61-0.81)	0.67 (0.58-0.78)	0.65 (0.56-0.76)	0.02
	Lifestyle-adjusted	1	0.86 (0.74-0.99)	0.79 (0.68-0.91)	0.79 (0.68-0.92)	0.84 (0.72-0.97)	0.08
Waist circumference *(≥102 cm men)*	Age-adjusted	1	0.74 (0.57-0.98)	0.68 (0.52-0.88)	0.58 (0.44-0.75)	0.58 (0.44-0.76)	0.07
	Lifestyle-adjusted	1	0.79 (0.59-1.05)	0.79 (0.60-1.05)	0.71 (0.54-0.94)	0.78 (0.58-1.04)	0.17
Systolic BP *(≥140 mmHg)*	Age-adjusted	1	0.91 (0.80-1.04)	0.83 (0.73-0.95)	0.77 (0.67-0.87)	0.75 (0.65-0.86)	0.14
	Lifestyle-adjusted	1	0.93 (0.81-1.06)	0.87 (0.76-0.99)	0.81 (0.71-0.92)	0.82 (0.71-0.94)	0.15

Diastolic BP *(≥90 mmHg)*	Age-adjusted	1	0.89 (0.77-1.02)	0.78 (0.68-0.90)	0.74 (0.65-0.86)	0.76 (0.65-0.88)	0.10
	Lifestyle-adjusted	1	0.90 (0.78-1.04)	0.83 (0.72-0.96)	0.81 (0.70-0.93)	0.86 (0.74-0.99)	0.11
Heart Medicine *(yes)*	Age-adjusted	1	0.83 (0.67-1.02)	0.74 (0.60-0.92)	0.72 (0.59-0.89)	0.65 (0.52-0.81)	0.18
	Lifestyle-adjusted	1	0.83 (0.67-1.02)	0.76 (0.62-0.94)	0.75 (0.61-0.92)	0.68 (0.55-0.85)	0.18

Age-adjusted model; Adjusted for age and year performed

Lifestyle adjusted model; Additionally adjusted for overall stress, diet habits, smoking habits, alcohol habits, level of education, relationship, current commuting and current exercise (when not evaluated as dependent variable).

PE class; Physical education class

Table 3 Odds ratio (95% CI) for different levels of physical activity prior to the age of 20 years of age in relation to dichotomized variables of perceived health, exercise habits, VO_2max and metabolic health in different age-groups.

	Age	No PE Class	Only PE Class	PE Class + PA 1-2 t/w	PE Class + PA 3-5 t/w	PE Class + PA ≥6t/w	R^2
Overall health *(Very poor/Poor)*	20-35	1	0.75 (0.57-0.99)	0.73 (0.56-0.96)	0.70 (0.54-0.92)	0.70 (0.52-0.93)	0.21
	36-50	1	0.80 (0.65-0.98)	0.79 (0.65-0.97)	0.77 (0.63-0.94)	0.96 (0.77-1.19)	0.19
	51-70	1	0.73 (0.58-0.92)	0.70 (0.56-0.87)	0.68 (0.54-0.86)	0.70 (0.54-0.91)	0.14
Current exercise *(≥1 time/w)*	20-35	1	0.86 (0.74-1.01)	1.28 (1.10-1.49)	1.92 (1.65-2.24)	2.74 (2.33-3.22)	0.14
	36-50	1	1.11 (0.99-1.25)	1.49 (1.32-1.67)	1.90 (1.69-2.14)	2.38 (2.10-2.71)	0.13
	51-70	1	1.17 (1.03-1.33)	1.58 (1.39-1.80)	1.93 (1.70-2.20)	2.17 (1.88-2.51)	0.12
VO_2max *(Women >32 and Men >35 ml·kg^{-1}·min^{-1})*	20-35	1	1.26 (1.05-1.52)	1.58 (1.32-1.89)	2.05 (1.71-2.45)	2.32 (1.92-2.80)	0.15
	36-50	1	1.09 (0.95-1.25)	1.35 (1.18-1.54)	1.60 (1.40-1.83)	1.83 (1.58-2.10)	0.16
	51-70	1	1.13 (0.95-1.34)	1.37 (1.15-1.63)	1.52 (1.28-1.81)	1.64 (1.36-1.97)	0.12
BMI *(≥30)*	20-35	1	0.87 (0.71-1.07)	0.73 (0.59-0.89)	0.64 (0.52-0.78)	0.59 (0.47-0.73)	0.11
	36-50	1	0.86 (0.74-1.00)	0.78 (0.68-0.91)	0.79 (0.68-0.92)	0.83 (0.71-0.97)	0.17
	51-70	1	0.79 (0.68-0.93)	0.77 (0.66-0.90)	0.80 (0.68-0.94)	0.87 (0.73-1.04)	0.19

Waist circumference *(Women ≥88 and Men ≥102 cm)*	20-35	1	0.91 (0.60-1.38)	0.81 (0.54-1.22)	0.71 (0.47-1.06)	0.69 (0.46-1.05)	0.05
	36-50	1	0.71 (0.52-0.98)	0.66 (0.48-0.91)	0.64 (0.47-0.87)	0.70 (0.50-0.96)	0.01
	51-70	1	0.75 (0.53-1.06)	0.69 (0.49-0.97)	0.66 (0.47-0.92)	0.73 (0.51-1.04)	0.57
Systolic BP *(≥140 mmHg)*	20-35	1	0.82 (0.62-1.07)	0.76 (0.58-0.99)	0.64 (0.49-0.86)	0.65 (0.49-0.86)	0.08
	36-50	1	0.88 (0.76-1.02)	0.78 (0.68-0.90)	0.73 (0.63-0.85)	0.76 (0.65-0.89)	0.08
	51-70	1	1.03 (0.91-1.17)	0.99 (0.87-1.12)	0.94 (0.83-1.07)	0.94 (0.81-1.08)	0.05
Diastolic BP *(≥90 mmHg)*	20-35	1	0.75 (0.55-1.03)	0.65 (0.48-0.88)	0.64 (0.47-0.87)	0.64 (0.47-0.88)	0.06
	36-50	1	0.90 (0.77-1.05)	0.77 (0.66-0.90)	0.75 (0.65-0.88)	0.80 (0.68-0.94)	0.07
	51-70	1	0.91 (0.78-1.05)	0.89 (0.77-1.03)	0.85 (0.73-0.98)	0.90 (0.77-1.06)	0.03
Heart Medicine *(Yes)*	20-35	1	1.52 (0.61-3.75)	1.49 (0.61-3.65)	1.23 (0.50-3.00)	1.36 (0.54-3.41)	0.02
	36-50	1	0.68 (0.54-0.86)	0.60 (0.48-0.75)	0.58 (0.46-0.73)	0.50 (0.39-0.65)	0.05
	51-70	1	1.01 (0.85-1.21)	0.93 (0.79-1.11)	0.90 (0.76-1.07)	0.87 (0.72-1.05)	0.04

Adjusted for sex, age, performed year, overall stress, diet habits, smoking habits, alcohol habits, level of education, relationship,

current commuting and current exercise (when not evaluated as dependent variable).

PE class; Physical education class, BP; Blood pressure