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Change in physical activity and health-related quality of life in old age – a 10-year follow-up study

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Abstract

The aim of the study was to examine the association between change in leisure-time physical activity (LTPA) and change in health-related quality of life (HRQoL) and symptoms of depression during a 10-year follow-up. This prospective study included 1036 men and women (mean age at baseline = 61.2 years) from the Helsinki Birth Cohort Study (HBCS). LTPA was measured with a questionnaire, HRQoL with SF36 and depression symptoms with Beck's depression inventory (BDI). The association between the change in LTPA, and change in HRQoL and BDI were investigated with sex stratified general linear models adjusted for age, smoking, educational attainment, comorbidity score and baseline value of outcomes. One standard deviation (SD) increase in LTPA was associated with increase in physical summary component of HRQoL in women (*B* = 0.7 unit, 95% CI = 0.1 to 1.3, *p*=0.032) and in men (*B* = 0.8 unit, 95% CI = 0.2 to 1.5, *p*=0.014). In women, the 1SD increase in LTPA was also associated with an increase in mental summary component score (*B* = 1.0, 95% CI = 0.3 to 1.7, *p*=0.005) and a reduction in depressive symptoms (*B* = -0.7, 95% CI = -1.1 to -0.2, *p*=0.003). In conclusion, increase in the volume of LTPA over a ten-year period in late adulthood was associated with improved HRQoL in both men and women, and also diminished depressive symptoms in women. The findings support the promotion of physical activity in later years to enhance HRQoL and mental wellbeing.

Introduction

Physical activity (PA) is a key component in healthy aging[1] and in preserving physical functioning and capability to prolong independent living among elderly.[2] WHO has also identified physical inactivity as the fourth leading risk factor globally for overall mortality.[3] PA is a fundamental modifiable health behavior that has a myriad of health benefits such as decreased risk of cardiovascular diseases, diabetes, colon and breast cancer, depression, dementia, hip or vertebral fractures and it also helps in weight management.[4-8]

Health-related quality of life (HRQoL) is an important aspect of health in the aging population. HRQoL is a multidimensional concept that incorporates physical, social, and mental dimensions. It is a subjective measure reflecting the persons' wellbeing, how they experience diseases or symptoms and limitations caused by illnesses.[9]. It has been shown to predict hospitalization[10] and short- and long-term mortality in older adults.[11] Thus, HRQoL may be considered an important tool in prevention for monitoring increased risk of adverse health events.

Many cross-sectional studies have shown that PA is positively associated with higher HRQoL and reduction in depressive symptoms in older people.[12-15] Adopting a more active lifestyle is also known to be associated with improved physical health.[16] Furthermore, a higher level of leisure-time physical activity (LTPA) has been positively linked with added years of self-reported healthy life and years without impairment in activities of daily living in older adults.[17] These studies have applied many different kind of self-reported measures of quality of life, such as EQ-5D-5L, SF-36 and 6-item physical self-worth scale. The SF36 is a much used and it has been shown to be reliable and valid also in older population.[18] Given that PA is an inexpensive and low-risk method to enhance older people's HRQoL and many other health related factors, regular PA is recommended for older people.[3]

Despite the apparent positive association between PA and HRQoL in older people, limited knowledge exists on how change in PA is associated with change in HRQoL during old age. There are only a few longitudinal studies on the relationship between PA and HRQoL and often the follow-up period has been rather short[19] and in some of the studies PA and HRQoL have been assessed at different time points.[14] Many cross-sectional and observational studies have also reported an inverse relationship between PA and depression or depressive symptoms in adults.[17, 20] Our aim was to examine prospectively how change in self-reported LTPA is associated with change in HRQoL and symptoms of depression in old age during a 10-year follow-up.

Methods

Study population and measures

This study utilizes data from the Helsinki Birth Cohort Study (HBCS). The original cohort includes 13,345 individuals who were born in Helsinki between 1934 and 1944, visited child welfare clinics in the city, and lived in Finland in 1971 when a unique personal identification number was assigned to all Finnish residents. In the year 2000, a random sample of 2003 subjects from HBCS were invited to participate in a clinical examination conducted between the years 2001 and 2004.[21] From this clinical study cohort (n=2003), 1404 people who were alive and living within 100 km distance from the study clinic in Helsinki were invited to participate in a new clinical follow-up in 2011.[22] A total of 1094 participants attended the clinical examination between 2011 and 2013. Of these, 1036 (mean age 61.2, 55 % women) had information on both LTPA and HRQoL at both clinical examinations (2001-2004 and 2011-2013) and

were included in the present study. In addition, of individuals who had information on LTPA, 892 participants also had information on depressive symptoms. The clinical study protocol was approved by the Ethics Committee of Epidemiology and Public Health of the Hospital District of Helsinki and Uusimaa. Written informed consent was obtained from each participant before any study procedure was initiated.

Assessment of LTPA

LTPA was assessed twice, the first time during the clinical examination in 2001-2004 and a second time during the follow-up examination in 2011-2013. LTPA was assessed by using a validated Kuopio Ischaemic Heart Disease Risk Factor (KIHD) Study 12-month LTPA history questionnaire.[23, 24] The KIHD questionnaire has been modified from the Minnesota leisure time activity questionnaire and the questionnaire presents a list of different PA types, including conditioning LTPA (e.g. running, skiing, swimming), non-conditioning LTPA (e.g. household work, gardening, shoveling snow), physical activity from commuting to work (walking or cycling) and an additional category for "other" physical activities specified by the participant. The subjects were asked to fill in frequency (occasions per month), average duration and intensity (0=recreational, 1=conditioning, 2=brisk conditioning and 3=competitive, strenuous exercise) of each activity performed during the previous 12 months. For each activity and intensity class a metabolic equivalent of task (MET, 1 MET = 3.5 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ or 1 $kcal \cdot kg^{-1} \cdot h^{-1}$) value was assigned based on the compendium of physical activities by Ainsworth et al.[25] To calculate the volume of LTPA in MET-hours (METh), MET values were multiplied with the average duration and frequency of activities. The total volume of LTPA is expressed in METh per week.

Health-related quality of life

Participants' HRQoL was assessed using the Finnish validated version of the SF -36 Short-Form Health Survey (SF-36) at the clinical examinations in 2001-2004 and 2011-2013.[26] The SF-36 has been found to be reliable and valid in assessing HRQoL also in older people.[18] It is divided into eight domains that measures physical functioning, role limitation due to physical problems, bodily pain, general health perception, vitality, social functioning, role limitation due to emotional problems and mental health. Each subscale includes 2-10 items, which were scored on a scale from 0 to 100, where 0 = a lot of problems or unable to perform, 50 = some problems and 100 = no problems. These eight domains were grouped in physical and mental components providing physical component summary (PCS) and mental component summary (MCS) scores by using a US reference population (1990) for standardization of the eight domains and for factor score coefficients.[27] As recommended previously, the mental and physical component scores were standardized using a mean of fifty and a standard deviation of ten to allow comparison between the participants and meaningful interpretation of the scores.[28]

Symptoms of depression

Symptoms of depression was assessed by using the Beck's Depression Inventory (BDI).[29] It contains 21 multiple-choice questions and totaling the numbers to each question gets the score. The score varies between 0-63 and depressive symptoms are regarded to be present when the score is ≥ 10.[30] BDI provides an indication of the severity of depressive symptoms, but it is not a diagnostic instrument for depression.

Covariates

The participants were measured for weight and height. Body mass index (BMI) was calculated as weight in kilograms divided by square of height in meters (kg/m^2). Data on educational attainment was obtained from a register data controlled by Statistics Finland. At the clinical examinations, also a variety of laboratory tests and physical measurements were performed and participants' chronic diseases, smoking habits and other health characteristics were assessed by questionnaires. All measurements were done by trained study nurses. We calculated a comorbidity score by totaling together the following disease/symptoms based on a questionnaire from the first clinical examination: myocardial infarction, angina pectoris, congestive heart failure, claudication, osteoporosis, stroke, depression, asthma or emphysema. The maximum score was nine. Because only 12 of the participants had 3 or 4 of these chronic illnesses, we divided the comorbidity score to three groups, 0,1 and ≥2 disease/symptoms.

Statistical analyses

Data is presented as means with standard deviations or 95% confidence intervals (CI). Statistical comparisons between men and women at baseline were made by Student's *t*-test. Multiple linear regression analyses were used to assess the association between LTPA at baseline and 10-year PCS, MCS and BDI. We also assessed the associations between the standardized (*B*) change in total volume of LTPA and the change in physical and mental components of SF-36 and BDI using multiple linear regression analyses. The standardized LTPA change was applied both as a continuous and categorical variable. The categories were based on the tertiles according to standardized LTPA change (<-0.5 SD, -0.5 to 0.5 SD and >0.5 SD). The crude models were adjusted for age and further adjustments were made for smoking (years of smoking), educational attainment (years of studying) and comorbidity score. Models with change in PCS, MCS and BDI were also additionally adjusted for baseline values of the outcome. The threshold for statistical significance was set at $p < 0.05$. The analyses were carried out with SPSS (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp) and Stata/SE 14.2 (StataCorp LP, College Station, TX, USA).

Results

The characteristics of the study population is shown in table 1. We examined 1036 subjects, whose mean age at the first clinical examination was 61.2 years (range 56.8-69.8 years). The mean follow-up time was 9.8 years (range 7.9-11.5 years). At baseline the total volume of LTPA did not differ statistically significantly between men and women (p=0.622), but at the follow-up clinical visit men had greater volume of LTPA than women (p<0.001). Also, men had statistically higher PCS and MCS at both examinations than women (p<0.001) and women had higher BDI scores at both examinations (p<0.001). At the first clinical examination, a majority (761/74 %) of the participants did not have any of the comorbidities included in the comorbidity score. 204 (20 %) of the participants had one and 68 (7 %) had two or more comorbidities. There was no statistical significant difference in the number of comorbidities between men and women (p=0.25).

The volume of LTPA at baseline was not significantly associated with 10-year PCS (fully adjusted β = 0.01, 95 % CI = -0.01 to 0.02, p=0.235), MCS (β = -0.01, 95 % CI = -0.02 to 0.004, p=0.150), or BDI (β = 0.006, 95 % CI = -0.004 to 0.02, p=0.213) ten years later.

Figure 1 describes the change in PCS, MCS and BDI according to standardized LTPA (METh) change tertiles during the 10-year follow-up. In women, there was a significant linear relationship between standardized LTPA change and positive change in both in PCS and MCS (p for linearity 0.02 and 0.025 respectively) and with negative change in BDI scores (p for linearity 0.036). In men, there was a significant linear relationship only between standardized LTPA change and PCS (p for linearity 0.01) while the relationship between standardized LTPA change and change in MCS and BDI scores between standardized LTPA change tertiles remained insignificant (p for linearity 0.47 and 0.75 respectively).

Figure 2 shows the associations between the standardized change of total volume of LTPA and the change in PCS, MCS and BDI. Both in women and in men there was a statistically significant association between the standardized LTPA change and the change in PCS showing that a 1SD increase in LTPA was associated with smaller decrease in PCS (B = 0.7, 95% CI = 0.1 to 1.3, p=0.032 and B = 0.8, 95% CI = 0.2 to 1.5, p=0.014 respectively). A 1SD increase in standardized LTPA change was also significantly associated with increased MCS in women (B = 1.0, 95% CI = 0.3 to 1.7, p=0.005), but in men there was not a significant association (B = 0.3, 95% CI = -0.2 to 0.9, p=0.253). In women, also 1SD increase in standardized LTPA change was significantly associated with lower BDI scores (B = -0.7, 95% CI = -1.1 to -0.2, p=0.003), but in men no significant association was observed (B = -0.1, 95% CI = -0.5 to 0.3, p=0.718).

Discussion

We explored how change in LTPA is associated with change in HRQoL and symptoms of depression in a cohort of older people. We found that more positive changes in LTPA was associated with positive change in the physical component summary score of HRQoL in both men and women. There was no

significant association between change in LTPA and change in the mental component summary score of HRQoL in men but we did find an association in women. In addition, in women more positive changes in LTPA were inversely associated with depressive scores but not in men.

Our finding of the impact of increasing LTPA on higher physical component score of HRQoL over ten years is in line with previous cross-sectional studies showing that PA is positively associated with physical health HRQoL subscales.[31, 32] This finding is also supported at least by many short (2-12 months) interventions that have shown the effect of promoting PA among elderly in improving HRQoL.[33, 34]

The fact that we found an association of LTPA on the mental component of HRQoL in women is in accordance with a longitudinal study in older Australian women that showed that those who were able to maintain or adopt PA were in somewhat improved emotional health three years later than were those who were sedentary or physically inactive.[19] A recent study[32] has also reported an association between PA with both the physical and mental component summary of SF-36, but the physical component was stronger.

In our study, only in women increasing LTPA was associated with less depressive symptoms. In support of our present findings, many cross-sectional studies have shown a positive association between PA and less depressive symptoms.[35, 36] A recent study has reported that high levels of PA is associated with a lower risk of future depression and that the type of PA also matters.[37] Our finding that more positive change in LTPA was associated with diminished depression symptoms in women but not in men is partly in line with a previous study showing that regular physical activity reduced depressive symptoms notably among women.[38] Zhang et al[38] has also shown that there are gender differences in sociodemographic factors affecting depressive symptoms. Also, depression symptoms are more common in women[39] and women can be more vulnerable to depressive symptoms because they are more likely to experience chronic negative circumstances.[40] Aforementioned factors may contribute to the gender dependence.

The mechanisms how an increase in LTPA leads to enhanced HRQoL may include the fact that PA decreases the incidence of many non-communicable diseases, obesity and prevents falls and thus promote improved physical functioning.[5, 7] PA also decreases mental disorders, cognitive decline and it can also directly influence self-efficacy.[6, 8] These effects can lead to enhanced HRQoL. PA can also affect positively HRQoL without improving the cardiorespiratory status.[41] In our study, however, adjustment for chronic conditions did not attenuate the findings, which is consistent with a study that reported significant associations between PA and components of HRQoL.[42] In that study, the frequency, duration and intensity of PA was related to HRQoL both in young (<65 years) and old (≥65 years) and in both genders. Adjusting for socioeconomic factors, presence of disease, body mass index, smoking habits, cohabitation and disablement did not change the results.

Our study has several strengths including a well-characterized birth cohort, a large sample size and a long follow-up time. We used validated questionnaires in assessing self-reported PA, HRQoL and depressive symptoms and we used the same questionnaires at the both time points. SF-36 is widely used in assessing HRQoL and it is a practical, reliable, and valid measure of physical and mental health.

KIHD includes LTPA over the whole year and it also provides information about the type, intensity and duration of activity.

The limitations of HBCS have been previously discussed.[43] The participants may not represent all older people in Finland, because they were both born and attended child-welfare clinics in the city of Helsinki. Also, there might be a survival effect and only those who were fitter might have attended the follow-up examination. In addition, the information of PA was obtained by self-reporting and especially in older cohorts the recall bias can be a problem. Although the setting of the study was longitudinal the direction of causality remains uncertain. Those with a higher health status may be able to engage more in PA. There may be mediating variables modifying the association between PA and HRQoL. A study has for example suggested that older women who were more physically active had greater self-efficacy, which was associated with more positive physical and mental health status.[44] Finally, even if we took notice of major confounders, there may be some unmeasured ones.

In conclusion, our findings suggest that an increase in PA even in late adulthood can have a positive influence on physical aspects of HRQoL in older adults, on mental aspects of HRQoL and on depressive symptoms in older women.

Perspectives

With increasing number of aging people there is a great demand for actions that promote health maintenance and physical independence. When it comes to healthy aging, the role of HRQoL cannot be overemphasized. Thus, our findings support the promotion of regular PA among older adults for its positive influence on HRQoL and depressive symptoms. In accordance with our results a recent study[45] has shown the importance of PA to encourage healthy aging. A training intervention among older adults improved psychological well-being, general quality of life, and HRQoL as well as decreased anxiety and depression levels.

Key points:

- Increasing LTPA over a 10-year follow-up was positively associated with higher of HRQoL in both men and women.
- There was also a significant association between positive changes in LTPA with change in the MCS of HRQoL in women.
- In women, change in LTPA was also associated with less depressive symptoms.

- Our findings support the importance of regular PA among older adults for its positive influence on HRQoL to promote health maintenance and physical independence.

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Table 1 Subjects' characteristics, questionnaire based leisure-time physical activity and PCS, MCS and BDI scores.

	Total (*N=1036*)		Men (*N=457*)		Women (*N=579*)		
Characteristics	Mean	SD	Mean	SD	Mean	SD	p^a
Age (years)	61.2	2.8	61.2	2.6	61.3	2.9	0.592
Weight (kg)	76.8	14.3	83.4	13.0	71.7	13.2	<0.001
Height (cm)	168.5	9.0	176.2	5.9	162.3	5.7	<0.001
Body mass index (kg/m^2)	27.1	4.2	27.2	3.5	27.1	4.6	0.770
Smoking (years)	11.0	14.8	15.1	15.6	7.7	13.3	<0.001
Years of fulltime studying (years)[b]	12.6	3.7	13.0	3.8	12.3	3.5	0.001
Comorbidity score, n /(%)[c]							0.254
No comorbidities	761	(74)	346	(76)	415	(72)	
1 comorbidity	204	(20)	84	(18)	120	(21)	
≥2 comorbidities	68	(7)	25	(5)	43	(7)	
At baseline							
Total Volume of LTPA (METh/wk)	46.3	37.3	46.9	37.5	45.8	37.1	0.622
Physical Component Summary	49.7	7.8	51.0	6.6	48.7	8.6	<0.001
Mental Component Summary	54.2	8.6	55.4	7.3	53.2	9.3	<0.001
BDI[d]	5.2	4.7	4.2	4.0	6.1	5.1	<0.001
Follow-up							
Total Volume of LTPA (METh/wk)	33.9	34.3	39.7	37.8	29.3	30.5	<0.001
Physical Component Summary	47.4	8.7	48.6	8.2	46.5	9.0	<0.001
Mental Component Summary	54.8	8.3	55.9	7.1	53.9	9.1	<0.001
BDI[d]	7.4	5.8	6.0	4.9	8.4	6.2	<0.001

[a]Difference between men and women

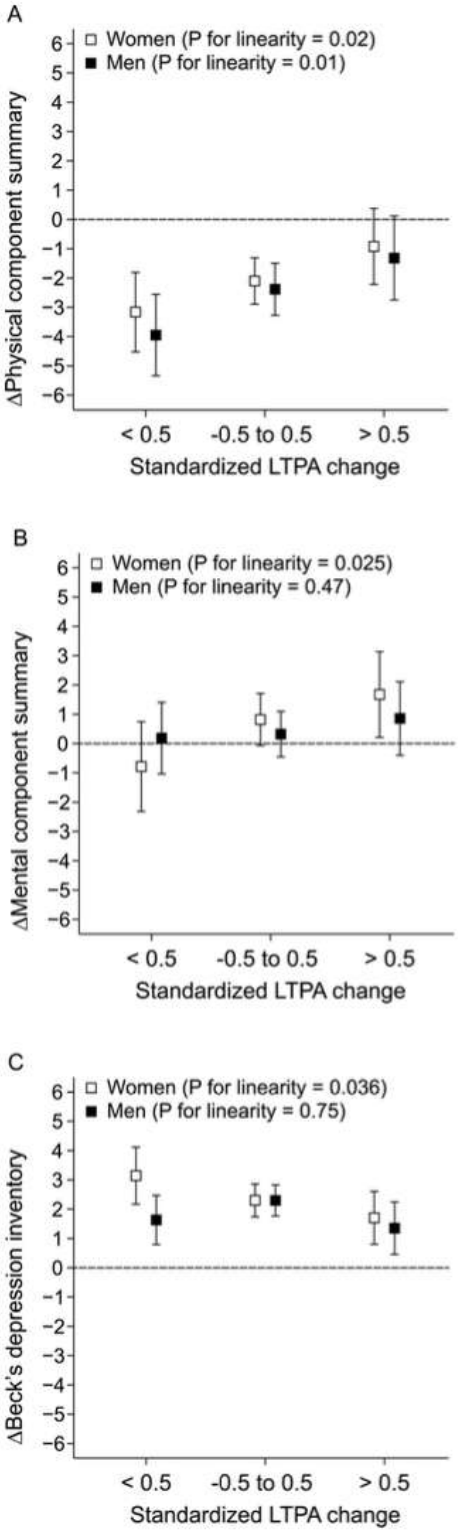
[b]Total *N*=1008; men *N*=442; women *N*=566

[c]Total *N*=1033; men *N*=455; women *N*=578

[d]Total *N*=892; men *N*=382; women *N*=510

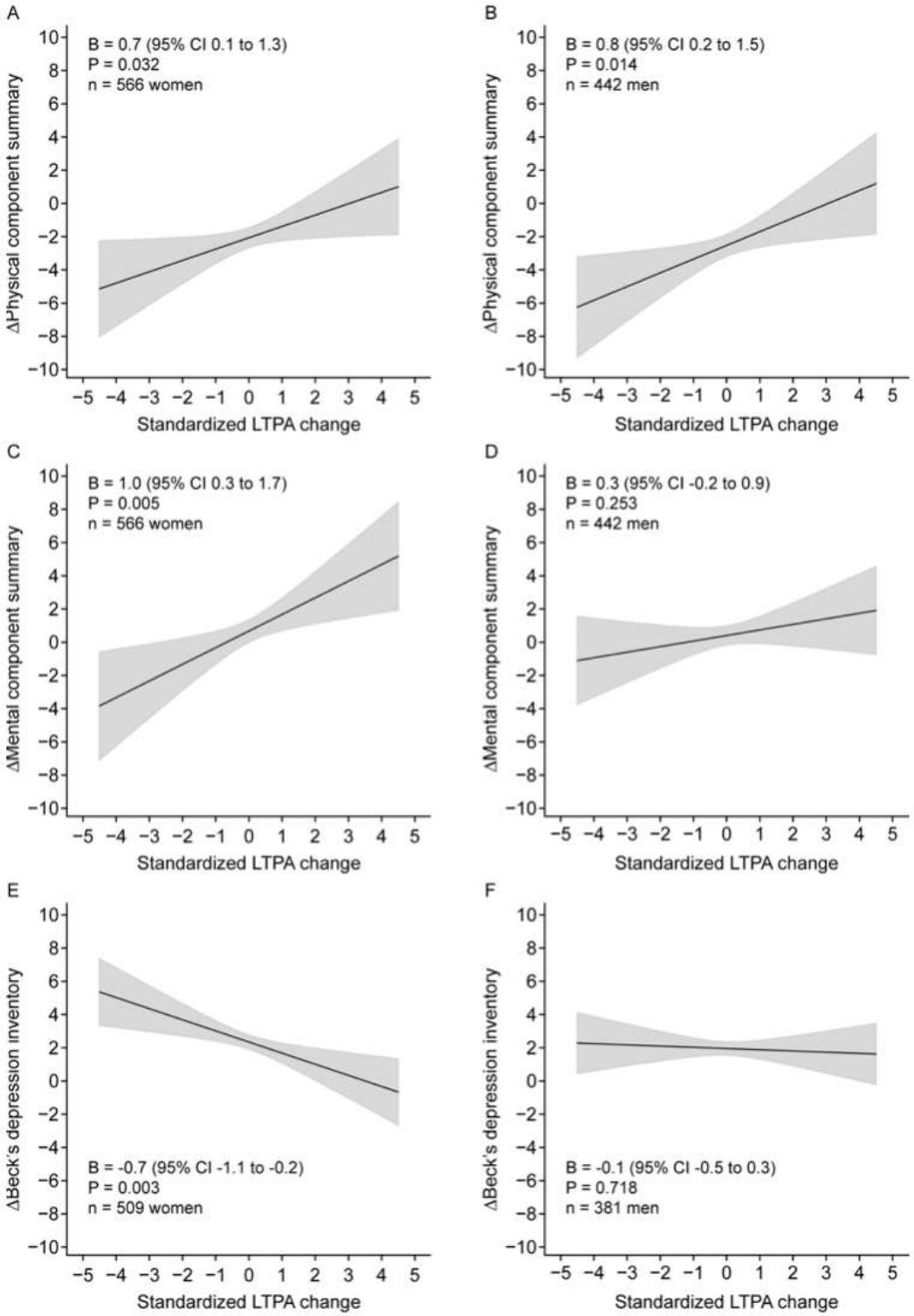
Abbreviations: BDI, Beck Depression Inventory; SD, standard deviation; LTPA, leisure-time physical activity; MET, metabolic equivalents of task

Figure 1 Change in the physical and mental component summary scores of HRQoL and Beck's Depression Inventory score according to standardized LTPA (METh) change tertiles during 10-years follow-up.



Adjusted for age at baseline, smoking, educational attainment, comorbidity score and baseline value of outcomes.

Figure 2 The association between standardized LTPA change (METh) and the change in physical and mental component summary scores of HRQoL and Beck's Depression Inventory score women (A, C and E) and men separately (B, D and F).



Adjusted for age at baseline, smoking, educational attainment, comorbidity score and baseline value of outcomes.