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Twenty-Year Trajectories of Physical Activity Types from Midlife to Old Age

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Conflicts of interest: None to declare

Abstract

Purpose: Correlates of physical activity (PA) vary according to type. However, predictors of long-term patterns of PA types into old age are unknown. This study aimed to identify 20-year trajectories of PA types into old age and their predictors. **Methods:** 7735 men (aged 40-59 years) recruited from UK towns in 1978–80 were followed up after 12, 16 and 20 years. Men reported participation in sport/exercise, recreational activity and walking, health status, lifestyle behaviours and socio-demographic characteristics. Group-based trajectory modelling (GBTM) identified the trajectories of PA types and associations with time-stable and time-varying covariates. **Results:** Men with ≥3 measures of sport/exercise (n=5116), recreational activity (n=5085) and walking (n=5106) respectively were included in analyses. Three trajectory groups were identified for sport/exercise, four for recreational activity and three for walking. Poor health, obesity and smoking were associated with reduced odds of following a more favourable trajectory for all PA types. A range of socioeconomic, regional and lifestyle factors were also associated with PA trajectories but the magnitude and direction were specific to PA type. For example, men with manual occupations were less likely to follow a favourable sport/exercise trajectory but more likely to follow an increasing walking trajectory compared to men with non-manual occupations. Retirement was associated with increased PA but this was largely due to increased sport/exercise participation. **Conclusion:** PA trajectories from middle to old age vary by activity type. The predictors of these trajectories and effects of major life events, such as retirement, are also specific to the type of PA. **Keywords:** Ageing, retirement, cardiovascular disease, sport, walking, exercise

INTRODUCTION

Identifying correlates of long-term patterns of physical activity (PA) may help interventions promote lifelong PA. Although there is an extensive body of research on the correlates of PA (1), few studies have examined the correlates of specific types of PA, such as sport, walking and domestic. The emerging evidence suggests that the correlates of PA may vary according to type (2-5). For example, a study in older adults aged 60-95 years found that older age and lower education were associated with reduced odds of sport participation but these characteristics were not associated with gardening/yard work (5). The majority of the current evidence is based on cross-sectional data and so it remains unclear whether the correlates of long-term PA are also specific to type.

Using group-based trajectory modelling (GBTM), we previously identified three distinct 20-year trajectories of overall PA between midlife and old age (6). We also found that a number of sociodemographic characteristics, family and health and lifestyle variables were associated with these trajectories. Chronic conditions and other age-related health problems were among the strongest predictors of long-term inactivity. Markers of social isolation (i.e. no children, never married) also predicted long-term inactivity. In addition, there was a tendency for more active trajectories to be associated with engagement in other healthy behaviours, such as healthy eating habits and not smoking, although this was not the case for alcohol consumption. However, as we analysed overall PA, the underlying trajectories of specific types of PA may have been masked and so it was not possible to identify the types of PA that drive these associations. Identifying trajectories of specific physical activities may help us better understand the patterns of overall PA and aid in the development of interventions aiming to promote specific types of PA. We hypothesised that associations between a range of sociodemographic and health and lifestyle factors with PA trajectories would be specific to PA types. The aim of this study was to identify trajectories of specific types of PA between midlife and old age and their predictors.

METHODS

Participants were men drawn from the British Regional Heart Study, an ongoing prospective cohort study including 7735 men recruited between 1978-80 when aged 40-59 years. Men completed a lifestyle and medical history questionnaire at baseline and at 12, 16 and 20 year follow ups. Participants provided informed written consent to the investigation. Ethical approval was obtained from the National Research Ethics Service Committee London.

Self-reported Physical Activities

At all waves, participants reported their usual PA levels. The questionnaire comprised of items on specific types of leisure time activity, including time spent travelling by foot per day (herein referred to as walking), time spent on recreational activities (such as recreational walking, gardening, chores, do-it-yourself activities) and level of engagement in sport/exercise (herein referred to as sport). The full questionnaire and scoring system for calculating the total PA score has been reported in detail elsewhere (7). The total PA score has previously been validated against heart rate and forced expiratory volume in 1 second (7) and more recently against objectively measured PA (8). For sport and recreational activity, the questions and response options at each wave were almost identical. However, for the first three waves, the question for walking asked men to report how many minutes they spend walking for transport or other purposes per day (mins.) during weekdays only whereas at the final wave walking time per day was derived from reported walking time across the whole week (hours), which included weekend days. For sport and exercise participation, men were asked "do you take physical exercise such as running, swimming, dancing, golf, tennis, squash, bowls, cycling, hiking etc.?" Response options were none, occasional (less than once a month) and frequent (once a month or more). Men who reported frequent sport participation were also asked to state what type of sport they engaged in. Men reporting activities not deemed to be sports (e.g. snooker) or activities that were included elsewhere in the questionnaire (e.g. walking) were reclassified as non-sport participants. For recreational activity, men were asked "compared to a man who spends four hours on most weekends on activities such as walking, gardening, household chores, DIY projects, how physically active would you consider yourself?". Response options were much more active, more active, similar, less active and much less active. For the purposes of consistency across all measures, men were classified into three groups for each PA type. The original categories for sport/exercise (none, occasional and frequent) were retained for analyses. Recreational activity was categorised as low (<4 hours at the weekend), moderate (similar to 4 hours at the weekend) and high (>4 hours at the weekend). Walking was categorised as low (<20 minutes/day), moderate (21-60 minutes/day) and high (>60 minutes/day).

Other measures

Time-stable

At baseline men reported a number of sociodemographic characteristics, health conditions and lifestyle behaviours; as they were not all measured at each follow up they were therefore treated as time-stable variables for the current analyses. These included current occupation or longest held occupation (manual or non-manual); marital status (single, married or widowed/divorced);

number of children (none or ≥1); doctor-diagnosed health conditions including arthritis, bronchitis and high blood pressure; other health problems including breathlessness and chest pain on exertion; body mass index (BMI) (normal weight: BMI <25.0 Kg/m^2 or overweight/obese: BMI ≥25.0 Kg/m^2); smoking status (current/ex-smoker or non-smokers); alcohol consumption (none, occasional [<1 drink/week], light [1-15 drinks/week], moderate [16-42 drinks/week] or heavy [>42 drinks/week]); region of residence (Scotland, North, Midlands and South); and weekly breakfast cereal consumption (none, occasional [1-2 times/week] or regular [>3 times/week]). Breakfast cereal consumption was used as an indicator of breakfast habits. Age at baseline was determined from date of birth.

The number of cardiovascular disease (CVD) diagnoses and employment status were treated as time-varying variables. The number of doctor-diagnosed CVD-related conditions (stroke, heart attack, myocardial infarction, coronary thrombosis or angina) was totalled at each time point. Men also reported employment status at each wave (employed [0] or not employed [1]). Years of follow up were derived from the date of survey completion. All predictor variables were selected a priori based on evidence in the current literature and were hypothesised to be associated with activity levels.

Data analysis

Group-based trajectory modelling (GBTM) was used to identify latent homogenous groups of study members with similar trajectories of sport participation, recreational activity and walking over 20 years via the Stata TRAJ plugin (9). The same process and criteria described previously (6) was followed to identify the trajectories of each PA type (see Table, Supplemental Digital

Content 1, Model search process for physical activity domain trajectories, http://links.lww.com/MSS/B404; see Table, Supplemental Digital Content 2, Determining the highest model function of the physical activity domain trajectory groups, http://links.lww.com/MSS/B405). In brief, models with 2 to 5 groups were tested for each PA type and compared using goodness of fit criteria. The best fitting model was selected based on highest (i.e. least negative) Bayesian information criterion, the log Bayes Factor (2*Δ Bayesian information criterion), sufficient trajectory group sizes (i.e. at least 5% of participants in each trajectory group), close agreement between the estimated probability of group membership and actual the proportion of the sample assigned to that group, posterior probabilities of >0.70 and odds of correct classification based on posterior probabilities exceeding 5 (10). Each subject is assigned to the trajectory group that they have the highest probability of belonging to. To determine the shape of each trajectory, the level of the polynomial function for each group was reduced, starting with quadratic, until each growth parameter estimate was statistically significant ($p < 0.05$). Time-stable and time-varying predictors were included in the class selection process, which simultaneously estimates the odds of trajectory group membership according to time-stable predictors and the effects of time-varying predictors on the trajectory shapes for each trajectory group. Wald tests were used to compare the effects of time-varying covariates between trajectory groups.

Supplementary analyses

To determine the concordance between PA type trajectories we also cross tabulated membership of trajectory group types. For example, we were interested to see whether men in the most favourable trajectories for sport were also in the most favourable groups for walking and recreational activity. Men who reported frequent sport participation were also asked what types of sport they engage in. In supplementary analyses, we explored what types of sport that were engaged in throughout the 20-year follow up. Finally, as the question on walking changed at the fourth wave (as described above), we performed a sensitivity analysis excluding the fourth time point from the trajectories.

RESULTS

Out of 7735 men who were originally invited at baseline, men with at least three measures of sport (n=5116), recreational activity (n=5085) and walking (n=5106) accompanied by complete covariate data were included in respective analyses. Compared to men included in analyses, men who did not have sufficient data for any of the PA types (n=2461) and therefore not included in any analyses were older (49.3 vs. 52.2 years), less active (>light activity: 63.8% vs. 52.6%), less likely to have children (≥1 child: 69.9% vs. 64.5%), less likely to be married (92.3% vs. 86.2%), more likely to suffer from a range of health conditions (e.g. breathlessness: 4.0% vs. 12.1%) at baseline and were more likely to come from manual occupations (55.4% vs. 70.9%).

Trajectories of Sport Participation

In total, three trajectory groups were identified for sport participation (see Figure 1a): consistently none (45.8%, n=2342), consistently occasional (30.4%, n=1555) and consistently frequent (23.8%, n=1219). Men in the consistently none trajectory group had low sport participation from baseline to follow up. The consistently occasional group comprised of men who had a fairly stable occasional level of sports participation, and the consistently frequent group had essentially frequent sports participation throughout the study period (Figure 1a). As shown in table 1, leaving employment was associated with an increase in sport participation in the consistently occasional group (β 1.179, $p<0.001$) and the consistently frequent group (β1.718, $p<0.05$), but was associated with a decrease in sport participation in the consistently none group (β-0.940, <0.001). Wald tests revealed significant differences in the effects of leaving employment for the consistently none group compared with the consistently occasional ($p<0.001$) and frequent groups ($p<0.05$). A supplementary analysis showed that a higher proportion of men in the consistently none group (22%) retired due to health issues compared to the consistently occasional (19%) and consistently frequent group (11%) ($p<0.001$). Developing cardiovascular conditions was associated with a decline in sport participation in the consistently frequent group (β -1.307, $p<0.05$) and the consistently none group (β -1.283, $p<0.05$) but not the consistently occasional group (β -0.045, $p=0.833$). Being older, coming from a manual occupation, being overweight or obese, suffering from breathlessness and being a current or recent ex-smoker was associated with reduced odds of belonging to the consistently frequent group compared to the consistently none group (see Table 2). Being married or previously married, having children, living in Scotland, consuming at least light amounts of alcohol and consuming breakfast cereal was associated with increased odds of belonging to the consistently frequent group compared to the consistently none group. Many of these associations were also found when comparing the men in the consistently occasional group to men in the consistently none group, although the magnitude of these associations were smaller. In a supplementary analysis, we explored the types of sport that were engaged in throughout the 20-year follow up in the consistently frequent trajectory group. The most prevalent sport at baseline was golf (29.9%, n=365), followed by racquet sports (18.5%, n=226), swimming (10.4%, n=127), and cycling (8.4%, n=102). At the 20-year follow up, golf (33.4%, n=407) remained the most common sport.

Cycling and swimming increased to 12.6% (n=154) and 19.9% (n=243), respectively. Racquet sport participation declined to 6.2% (n=76). Bowling increased from 5.7% (n=70) at baseline to 23.5% (n=286) at 20-year follow up. Dancing also increased from 1.9% (n=23) at baseline to 8.9% (n=108) at the 20-year follow up.

Trajectories of Recreational Activity

For recreational activity, four trajectory groups were identified (see Figure 1b): moderate, decreasing (14.6%, n=744), consistently moderate (30.5%, n=1550), high, decreasing (33.2%, n=1688) and consistently high (21.7%, n=1103). The moderate, decreasing group had moderate levels of recreational activity at baseline, which steadily decreased after 12 years and rapidly declined thereafter. The consistently moderate group had moderate levels of recreational activity at baseline, which remained fairly constant through the ensuing years. The high, decreasing group had high levels of recreational activity at baseline, which decreased to moderate levels by 20-years of follow up. The consistently high group had consistently high levels of recreational activity throughout the duration of the study. Leaving employment was associated with a decrease in recreational activity in the moderate, decreasing group (β -0.342, <0.05). No significant associations were observed in the remaining groups. Supplementary analysis showed that a significantly higher proportion of men in the moderate, decreasing group (38%) retired due to health issues compared to the other groups (9-16%, p<0.001). Developing cardiovascular-related conditions was associated with a decline in recreational activity in the moderate, decreasing (β -0.325, <0.001), consistently moderate (β -0.118, <0.05), high, decreasing (β -0.718, <0.001) and consistently high groups (β-1.192, <0.001). Wald tests showed that the effects of developing cardiovascular-related conditions was significantly larger in the consistently high group compared to the other groups ($p<0.05$).

Being older, working in a manual occupation, residing outside of the South of England, being overweight or obese, being diagnosed with a range of health conditions and being a current or recent smoker was associated with reduced odds of belonging to the consistently high group compared to the moderate, decreasing group (see Table 3). In addition, being married or previously married was associated with increased odds of belonging to the consistently high group compared to the moderate, decreasing group. Many of the same associations were found when comparing the other trajectory groups to the moderate, decreasing group, although they were typically of smaller magnitude.

Trajectories of Walking

For walking, three trajectory groups were identified (see Figure 1c): consistently low (27.2%, n=1388), low, increasing (64.6%, n=3297) and moderate, increasing (8.3%, n=421). The consistently low group is characterised by low levels of walking from baseline to 20-year follow up. The low, increasing group had low levels of walking at baseline but increased to moderate levels over the duration of the study. The moderate, increasing group had moderate levels of walking at baseline, which increased towards high levels by the 20-year follow up. Similar trajectory groups were observed when the fourth time point was excluded (data not shown). Leaving employment was associated with an increase in walking in the low, increasing group (β 0.439, $p<0.001$) but no associations were observed in the other groups. Development of cardiovascular-related conditions was not significantly associated with change in walking in any trajectory group. Being married, overweight, suffering from breathlessness and being a current or recent smoker was associated with reduced odds of belonging to the moderate, increasing group compared to the consistently low walking group (see Table 4). Working in a non-manual occupation, residing in Scotland and occasionally eating breakfast cereal was associated with increased odds of belonging to the moderate, increasing group compared to the consistently low group. Most of these associations were also observed when comparing the low, increasing group to the consistently low group. In addition, having arthritis was associated with reduced odds of belonging to the low, increasing group and having children was associated with increased odds when compared to the consistently low group. No significant associations were found with age and alcohol consumption.

In supplementary analyses, we found some evidence of concordance between PA type trajectories (see Table, Supplemental Digital Content 3, Cross tabulation showing concordance between PA type trajectories, http://links.lww.com/MSS/B406). Generally members of the least favourable trajectory in one PA type were also in the least favourable trajectory for other PA types. However, almost half of men who demonstrated an increasing walking pattern were members of the consistently none sport trajectory group.

DISCUSSION

Our results highlight significant variation in the patterns and predictors of participation in specific types of PA during the transition to old age. Three trajectory groups were identified for walking, two of which demonstrated increasing levels of walking over 20 years. By contrast, four trajectory groups were identified for recreational activity, two of which, comprising nearly half of the sample, demonstrated decreasing levels of recreational activity. For sport, three largely stable trajectory groups were identified, suggesting that sport participation in old age is largely determined by participation in midlife.

Working in a non-manual occupation was an important predictor for membership of a more favourable sport trajectory. This is consistent with other studies suggesting that higher social classes are more likely to participate in sport (11, 12). By contrast, manual occupations were associated with a more favourable walking trajectory. Other research with similar findings suggests that this may be due to manual workers having jobs that require more walking (13). Our results suggest this relationship extends past typical retirement age when occupational activities are less likely to contribute. We also observed that a higher proportion of men who increased their walking came from groups who participated in less sport. One possible explanation for these observations is that men from lower social classes may have less opportunity to engage in sport throughout life making walking the most feasible option in old age. Sport providers should seek to promote the most commonly practiced sports in old age (e.g. golf, swimming, cycling and bowls) across the lifecourse and increase opportunities in lower socio-economic groups.

Baseline age was an important predictor of sport and recreational activity trajectories but was not associated with walking trajectories. Older age may not be a barrier to walking in fact it might be an opportunity to increase walking. This is important as we know that walking is the predominant type of activity in older adults (14). Being married was associated with more favourable sport and recreational activity trajectories. Similarly, parenthood was also associated with more favourable sport and walking trajectories. Marriage, having children and potentially grandchildren may prevent social isolation, which may be important for preserving PA in old age (15). Presence of health conditions were associated with reduced odds of following more favourable trajectories of all PA types. Breathlessness was the most strongly and consistently associated health complaint, which is consistent with another study in community-dwelling older adults also highlighting breathlessness as one of the most important health-related barriers to PA (16). Further, higher alcohol consumption was associated with more favourable sport trajectories but was not associated with other PA types consistently. Region of residence was also differentially associated with trajectories of specific types of PA. Living in the south of England was associated with more favourable recreational activity trajectories when compared to other regions. However, living in Scotland was associated with increased odds of more favourable sport and walking trajectories when compared to the south of England. Environmental factors related to walkability, such as greater access to green spaces (17), larger open spaces (18), leisure facilities and greater social cohesion (19, 20) may explain these associations. Consuming breakfast cereal was associated with more favourable sport and walking trajectories but was not as consistently associated with recreational activity. Breakfast consumption may be a response to views about energy requirements for these types of activities. Similar findings have been reported in younger populations comparing sporty to non-sporty adolescents (21, 22), but the present study is the first to our knowledge to reproduce these findings in older adults.

The effects of time-varying covariates were also context specific. Diagnosis of CVD-related conditions was associated with reductions in recreational activity and sport, particularly in the most active trajectory groups; however, no significant associations were observed with walking. Development of CVD conditions may not limit activities of a lower intensity, such as walking.

For example, it has been reported that stroke survivors may be able to perform activities at around 50% of the peak oxygen consumption achieved by matched individuals without stroke (23). Our results suggest that retirement (i.e. leaving employment) is associated with an increase in sport participation in men who already play sports but a decrease in those who rarely participate. Equally, retirement may also be associated with increased walking, but also a decrease in levels of recreational activity in those with lower levels of recreational activity in midlife. Potentially, retirement is an important transition that may provide increased time for activities that are enjoyable in healthy older men, such as sport and walking. Notably, retirement had a negative effect in those who consistently did not play sport, possibly because more men in these groups are retiring due to health issues and are unable to engage in sport at all. Our study is in line with previous studies with shorter follow ups suggesting that changes in PA following retirement are specific to the type of PA (24).

The present findings suggest that tailored approaches may be needed to promote long-term participation in specific types of activity during the transition to old age. Retirement may be an important window to promote PA, but the cause of retirement and previous engagement in specific types of PA should be considered when planning appropriate interventions. Walking might be a particularly effective target for promotion in individuals who do not engage in sport as almost half of the men who increased their levels of walking consistently did not play sport.

To our knowledge this is the first study to apply the GBT approach to identify trajectories of specific types of activity and to estimate the effects of time-dependent variables on each type of PA. One of the main limitations of this study is that we were unable to quantify the exact amount of time spent in each type of PA, which would have provided a more accurate estimate. Nevertheless, our PA score has previously been validated against device-measured PA(8) and questionnaire items also correlate well with objective measures. In addition, changes to the wording of the walking question at the final follow up may have biased walking estimates. However, sensitivity analyses removing this time point revealed similar trajectories. In addition, it is possible that walking may have been underestimated in those men who reported walking/hiking as a frequent sport/exercise as this was not included as a sport nor was it possible to add to the walking estimate. Further, men dropping out of the study were generally less active. Thus, activity levels may have been overestimated. Finally, our sample is only in men, predominantly of white ethnicity, meaning that our findings may not be generalizable to women and non-white ethnic groups.

CONCLUSION

Trajectories of PA from midlife to old age are specific to type. Predictors of these trajectories and the effects of major life events, such as retirement, also vary according to the type of PA. Interventions targeting specific components of PA in older adults need to consider their distinct predictors of long-term engagement.

Acknowledgments

The results of this study do not constitute endorsement by the American College of Sports Medicine, and the results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

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Conflicts of interest:

None to declare

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Figure Caption

Figure 1. Trajectories and 95% CIs for (a) sport participation (b) recreational activity (c) walking from midlife to old age

Supplemental Digital Content

Supplementary Table 1. Model search process for physical activity domain trajectories

Supplementary Table 2. Determining the highest model function of the physical activity domain trajectory groups[a,b]

Supplementary Table 3. Cross tabulation showing concordance between PA type trajectories, % (n) (n=491)

Figure 1

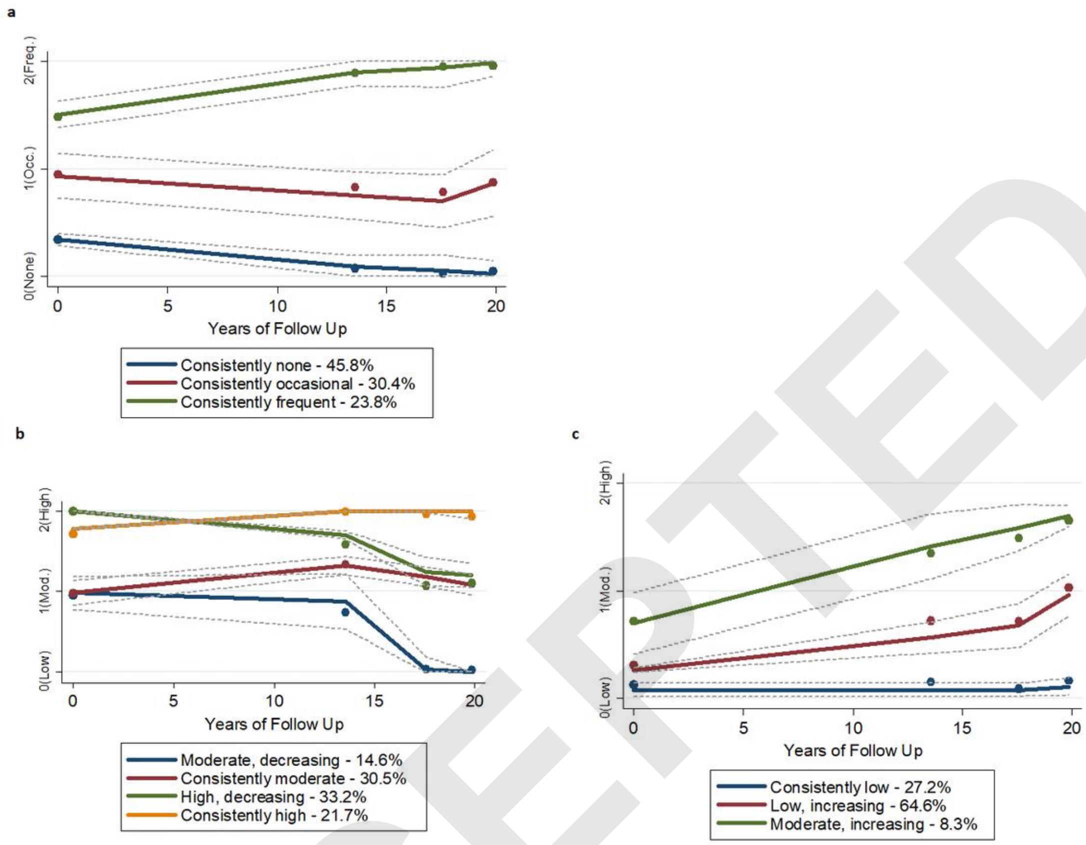
a
2(Freq.)
1(Occ.)
0(None)
0
5
10
15
20
Years of Follow Up
Consistently none - 45.8%
Consistently occasional - 30.4%
Consistently frequent - 23.8%
b
2(High)
1(Mod.)
0(Low)
0
5
10
15
20
Years of Follow Up
Moderate, decreasing - 14.6%
Consistently moderate - 30.5%
High, decreasing - 33.2%
Consistently high - 21.7%
c
2(High)
1(Mod.)
0(Low)
0
5
10
15
20
Years of Follow Up
Consistently low - 27.2%
Low, increasing - 64.6%
Moderate, increasing - 8.3%

Table 1. Trajectories of physical activity types across age and the effects of time-varying predictors on trajectory shapes, by trajectory group[a]

Parameter[b]	Sports trajectories (n=5116)			Recreational activity trajectories (n=5085)			Walking trajectories (n=5106)		
	Estimate	SE	p	Estimate	SE	p	Estimate	SE	p
	Consistently none			**Moderate, decreasing**			**Consistently low**		
Intercept	-3.306	0.208	<0.001	0.967	0.069	<0.001	-1.802	0.107	<0.001
Linear	-0.251	0.033	<0.001	0.488	0.050	<0.001	-	-	-
Quadratic	-	-	-	-0.037	0.004	<0.001	-	-	-
Time-varying covariates									
Leaving employment	**-0.940**	0.465	<0.05	**-0.342**	0.130	<0.05	0.234	0.148	0.115
N. of CVD diagnoses	**-1.283**	0.544	<0.05	**-0.325**	0.093	<0.001	0.007	0.101	0.946
	Consistently occasional			**Consistently moderate**			**Low, increasing**		
Intercept	0.645	0.205	0.002	0.972	0.051	<0.001	-0.767	0.060	<0.001
Linear	-0.079	0.016	<0.001	0.125	0.012	<0.001	0.063	0.005	<0.001
Quadratic	-	-	-	-0.006	0.001	<0.001	-	-	-
Time-varying covariates									
Leaving employment	**1.179**	0.245	<0.001	0.047	0.050	0.350	**0.439**	0.058	<0.001
N. of CVD diagnoses	-0.045	0.213	0.833	**-0.118**	0.047	<0.05	-0.017	0.043	0.683
	Consistently frequent			**High, decreasing**			**Moderate, increasing**		
Intercept	4.125	0.220	<0.001	14.802	1.474	<0.001	0.386	0.1127	<0.05
Linear	0.318	0.044	<0.001	-1.427	0.178	<0.001	0.109	0.011	<0.001
Quadratic	-	-	-	0.038	0.005	<0.001	-	-	-
Time-varying covariates									
Leaving employment	**1.718**	0.692	<0.05	-0.057	0.072	0.430	0.085	0.160	0.597

N. of CVD diagnoses	**-1.307**	0.477	<0.05	**-0.718**	0.078	<0.001	-0.237	0.137	0.083
				Consistently high					
Intercept	-	-	-	2.658	0.069	<0.001	-	-	-
Linear	-	-	-	0.674	0.166	<0.001	-	-	-
Quadratic	-	-	-	-0.029	0.008	<0.001	-	-	-
Time-varying covariates									
Leaving employment	-	-	-	-0.079	0.373	0.833	-	-	-
N. of CVD diagnoses	-	-	-	**-1.192**	0.168	<0.001	-	-	-

[a]Estimates for time-varying covariates represent the shift in physical activity trajectory per unit change in exposure variable.

[b]Models adjusted for employment status and number of CVD diagnoses as time-varying covariates, and occupational class, marital status, number of children, region, BMI, arthritis, bronchitis, blood pressure, breathlessness, chest pain, smoking status, alcohol consumption and breakfast consumption at baseline

Table 2. Time-stable predictors of sport participation trajectory classes

	Consistently occasional vs Consistently none[a]	**Consistently frequent vs. Consistently none**[a]
	OR (95% CI)[b]	OR (95% CI)[b]
Sociodemographics		
Baseline age (per year increase)	**0.92 (0.90, 0.94)**	**0.94 (0.92, 0.95)**
Occupational class		
Manual (ref. non-manual)	**0.64 (0.53, 0.77)**	**0.48 (0.41, 0.57)**
Marital status		
Married (ref. single)	**2.18 (1.32, 3.60)**	**2.37 (1.42, 3.96)**
Widowed/Divorced (ref. single)	**3.58 (1.86, 6.89)**	**2.40 (1.20, 4.82)**
Number of children		
≥1 child (ref. no children)	1.15 (0.94, 1.40)	**1.24 (1.03, 1.51)**
Region		
Midlands (ref. south)	**0.67 (0.51, 0.89)**	0.78 (0.60, 1.01)
North (ref. south)	0.84 (0.65, 1.03)	0.84 (0.69, 1.02)
Scotland (ref. south)	1.06 (0.77, 1.46)	**1.64 (1.24, 2.18)**
Health and Lifestyle Factors		
Overweight/Obese (ref. healthy	1.11 (0.93, 1.33)	**0.80 (0.67, 0.94)**

BMI)		
Arthritis (ref. no arthritis)	1.05 (0.78, 1.42)	0.77 (0.56, 1.06)
Bronchitis (ref. no bronchitis)	0.84 (0.65, 1.07)	0.82 (0.64, 1.04)
High blood pressure (ref. normal blood pressure)	**0.71 (0.52, 0.96)**	0.83 (0.64, 1.04)
Suffers breathlessness (ref. no breathlessness)	**0.58 (0.36, 0.94)**	**0.24 (0.12, 0.48)**
Suffers chest pain (ref. no chest pain)	0.81 (0.53, 1.23)	0.82 (0.54, 1.25)
Current/ex-smoker (ref. non-smoker)	**0.59 (0.49, 0.72)**	**0.46 (0.38, 0.55)**
Alcohol consumption		
Occasional (ref. none)	1.36 (0.90, 2.04)	1.51 (0.95, 2.40)
Light (ref. none)	**1.53 (1.02, 2.28)**	**3.03 (1.94, 4.73)**
Moderate (ref. none)	1.38 (0.91, 2.08)	**2.61 (1.66, 4.12)**
Heavy (ref. none)	1.49 (0.93, 2.38)	**2.50 (1.50, 4.17)**
Dietary habits		
Occasional breakfast cereal (ref. none)	**1.42 (1.07, 1.88)**	**1.62 (1.25, 2.09)**
Regular breakfast cereal (ref. none)	**1.43 (1.17, 1.75)**	**1.55 (1.29, 1.88)**

[a] Consistently none (reference group)

[b] Models adjusted for employment status and number of CVD diagnoses as time-varying covariates, and occupational class, marital status, number of children, region, BMI, arthritis, bronchitis, blood pressure, breathlessness, chest pain, smoking status, alcohol consumption and breakfast consumption at baseline.

Table 3. Time-stable predictors of recreational activity trajectory classes

	Consistently moderate vs Moderate, decreasing[a]	High, decreasing vs. Moderate, decreasing[a]	Consistently high vs Moderate, decreasing[a]
	OR (95% CI)[b]	OR (95% CI)[b]	OR (95% CI)[b]
Sociodemographics			
Baseline age (per year increase)	**0.95 (0.93, 0.97)**	0.98 (0.96, 1.00)	**0.95 (0.92, 0.97)**
Occupational class			
Manual (ref. non-manual)	0.94 (0.75, 1.19)	0.97 (0.76, 1.24)	**0.76 (0.59, 0.97)**
Marital status			
Married (ref. single)	**2.23 (1.30, 3.82)**	1.66 (0.96, 2.86)	**2.94 (1.55, 5.56)**
Widowed/Divorced (ref. single)	1.76 (0.83, 3.71)	1.44 (0.67, 3.10)	**2.95 (1.27, 6.83)**
Number of children			
≥1 child (ref. no children)	1.01 (0.79, 1.29)	1.28 (0.98, 1.66)	1.09 (0.84, 1.43)
Region			
Midlands (ref. south)	**0.76 (0.53, 1.08)**	**0.68 (0.48, 0.98)**	**0.60 (0.42, 0.87)**
North (ref. south)	0.88 (0.67, 1.17)	**0.64 (0.49, 0.85)**	**0.52 (0.39, 0.70)**
Scotland (ref. south)	0.80 (0.55, 1.16)	**0.53 (0.35, 0.79)**	**0.47 (0.31, 0.71)**
Health and Lifestyle Factors			
Overweight/Obese (ref. healthy	0.92 (0.74, 1.16)	**0.78 (0.62, 0.99)**	**0.70 (0.55, 0.89)**

BMI)			
Arthritis (ref. no arthritis)	**0.65 (0.46, 0.92)**	0.81 (0.57, 1.16)	**0.55 (0.36, 0.83)**
Bronchitis (ref. no bronchitis)	**0.61 (0.46, 0.80)**	**0.62 (0.46, 0.83)**	**0.58 (0.42, 0.79)**
High blood pressure (ref. normal blood pressure)	0.75 (0.54, 1.04)	0.71 (0.49, 1.01)	**0.67 (0.46, 0.98)**
Suffers breathlessness (ref. no breathlessness)	**0.45 (0.29, 0.70)**	**0.14 (0.07, 0.31)**	**0.17 (0.08, 0.36)**
Suffers chest pain (ref. no chest pain)	0.88 (0.57, 1.36)	**0.53 (0.31, 0.90)**	0.63 (0.37, 1.06)
Current/ex-smoker (ref. non-smoker)	**0.43 (0.34, 0.54)**	**0.44 (0.34, 0.56)**	**0.29 (0.22, 0.38)**
Alcohol consumption			
Occasional (ref. none)	1.60 (0.94, 2.70)	1.22 (0.73, 2.05)	1.50 (0.86, 2.61)
Light (ref. none)	**1.79 (1.07, 3.00)**	1.35 (0.81, 2.23)	1.54 (0.89, 2.65)
Moderate (ref. none)	1.58 (0.94, 2.65)	1.05 (0.63, 1.76)	1.22 (0.70, 2.12)
Heavy (ref. none)	1.27 (0.72, 2.24)	0.80 (0.45, 1.43)	1.12 (0.61, 2.08)
Dietary habits			
Occasional breakfast cereal (ref. none)	1.06 (0.73, 1.52)	**1.45 (1.01, 2.09)**	1.16 (0.79, 1.70)
Regular breakfast cereal (ref. none)	1.18 (0.92, 1.52)	1.21 (0.93, 1.57)	1.22 (0.93, 1.60)

[a] Moderate, decreasing (reference group)

[b] Models adjusted for employment status and number of CVD diagnoses as time-varying covariates, and occupational class, marital status, number of children, region, BMI, arthritis, bronchitis, blood pressure, breathlessness, chest pain, smoking status, alcohol consumption and breakfast consumption at baseline.

Table 4. Time-stable predictors of walking trajectory classes

	Low, increasing vs Consistently low[a]	Moderate, increasing vs Consistently low[a]
	OR (95% CI)[b]	OR (95% CI)[b]
Sociodemographics		
Baseline age (per year increase)	1.01 (0.99, 1.03)	1.02 (0.99, 1.05)
Occupational class		
Manual (ref. non-manual)	**1.24 (1.02, 1.51)**	**1.90 (1.38, 2.60)**
Marital status		
Married (ref. single)	1.36 (0.75, 2.49)	**0.38 (0.22, 0.67)**
Widowed/Divorced (ref. single)	1.21 (0.57, 2.60)	0.67 (0.32, 1.42)
Number of children		
≥1 child (ref. no children)	**1.28 (1.04, 1.58)**	0.95 (0.69, 1.32)
Region		
Midlands (ref. south)	**0.72 (0.54, 0.95)**	0.94 (0.59, 1.48)
North (ref. south)	0.92 (0.73, 1.14)	1.00 (0.70, 1.44)
Scotland (ref. south)	1.12 (0.78, 1.62)	**2.25 (1.41, 3.57)**
Health and Lifestyle Factors		
Overweight/Obese (ref. healthy BMI)	**0.80 (0.66, 0.97)**	**0.58 (0.43, 0.78)**
Arthritis (ref. no arthritis)	**0.61 (0.44, 0.84)**	0.79 (0.49, 1.27)
Bronchitis (ref. no bronchitis)	1.03 (0.79, 1.35)	1.08 (0.73, 1.61)
High blood pressure (ref. normal blood pressure)	0.88 (0.65, 1.20)	0.78 (0.47, 1.30)
Suffers breathlessness (ref. no breathlessness)	**0.48 (0.30, 0.76)**	**0.25 (0.09, 0.67)**

Suffers chest pain (ref. no chest pain)	1.00 (0.65, 1.54)	1.06 (0.54, 2.09)
Current/ex-smoker (ref. non-smoker)	**0.65 (0.53, 0.80)**	**0.65 (0.48, 0.89)**
Alcohol consumption		
Occasional (ref. none)	0.86 (0.55, 1.35)	1.13 (0.56, 2.30)
Light (ref. none)	1.13 (0.73, 1.75)	0.91 (0.45, 1.86)
Moderate (ref. none)	1.07 (0.68, 1.68)	1.41 (0.70, 2.86)
Heavy (ref. none)	1.37 (0.81, 2.33)	2.03 (0.93, 4.40)
Dietary habits		
Occasional breakfast cereal (ref. none)	1.22 (0.89, 1.67)	**2.01 (1.36, 2.97)**
Regular breakfast cereal (ref. none)	**1.26 (1.02, 1.55)**	0.95 (0.67, 1.34)

[a] Consistently low (reference group)

[b] Models adjusted for employment status and number of CVD diagnoses as time-varying covariates, and occupational class, marital status, number of children, region, BMI, arthritis, bronchitis, blood pressure, breathlessness, chest pain, smoking status, alcohol consumption and breakfast consumption at baseline.

Supplementary Table 1. Model search process for physical activity domain trajectories

Number of groups	BIC	Log Bayes Factor (2*ΔBIC)	Estimated group %	Actual group %	Posterior probability
Sport/exercise (n=5116)					
			62.4	62.8	0.96
2	-15241.0		37.6	37.2	0.94
			36.0	41.2	0.83
			38.7	33.2	0.88
3	-15145.8	190.4	25.4	25.6	0.91
			36.9	42.3	0.84
			38.9	32.6	0.92
			12.4	12.7	0.73
4	-15214.0	-68.2	11.8	12.3	0.74
Recreational activity (n=5085)					
			50.0	49.3	0.88
2	-21538.8		50.0	50.7	0.87
			20.9	19.6	0.81
			63.2	61.9	0.90
3	-21446.8	184.0	16.0	18.6	0.78

			13.7	14.6	0.82
			38.5	30.5	0.94
			29.1	33.2	0.77
4	-21275.2	343.2	18.7	21.7	0.82
5	–[a]	–[a]	–[a]	–[a]	–[a]
Walking (n=5106)					
			66.6	67.2	0.95
2	-20386.3		33.4	32.8	0.92
			22.7	27.2	0.76
			59.4	59.1	0.84
3	-20347.1	78.4	17.9	13.7	0.76
			23.4	29.0	0.73
			60.9	59.1	0.91
			13.1	9.2	0.66
4	-20418.8	-143.4	2.6	2.6	0.77

BIC, Bayesian information criterion.

Models adjusted for employment status and number of CVD diagnoses as time-varying covariates, and occupational class, marital status, number of children, region, BMI, arthritis, bronchitis, blood pressure, breathlessness, chest pain, smoking status, alcohol consumption and breakfast consumption at baseline.

[a] Failed to converge

Supplementary Table 2. Determining the highest model function of the physical activity domain trajectory groups [a,b]

	1st iteration		2nd iteration		3rd iteration		4th iteration		5th iteration			
Group	**Highest function**	***p***	**Highest function**	***p***	**Highest function**	***p***	**Highest function**	***p***	**Highest function**	***p***	**Final estimated group %**	**Final actual group %**
Sport/exercise (n=5116)												
Group 1	Quadratic	–[c]	Linear	<0.001							43.1	45.8
Group 2	Quadratic	–[c]	Linear	<0.001							33.9	30.4
Group 3	Quadratic	–[c]	Linear	<0.001							23.0	23.8
Recreational activity (n=5085)												
Group 1	Quadratic	<0.001									13.7	14.6
Gro	Quadr	<0.0									38.5	30.5

up 2	atic	01										
Group 3	Quadratic	<0.001									29.1	33.2
Group 4	Quadratic	<0.001									18.7	21.7
Walking (n=5106)												
Group 1	Quadratic	<0.001	Quadratic	<0.001	Quadratic	0.999	Linear	–[c]	Intercept	<0.001	28.1	27.2
Group 2	Quadratic	<0.005	Quadratic	0.193	Linear	<0.001	Linear	–[c]	Linear	<0.001	60.4	64.6
Group 3	Quadratic	0.813	Linear	<0.001	Linear	<0.001	Linear	–[c]	Linear	<0.001	11.5	8.3

[a]Starting with quadratic, the level of the polynomial function for each group was reduced at each iteration until each parameter estimate was statistically significant (p<0.05). [b]Models adjusted for employment status and number of CVD diagnoses as time-varying covariates, and occupational class, marital status, number of children, region, BMI, arthritis, bronchitis, blood pressure, breathlessness, chest pain, smoking status, alcohol consumption and breakfast consumption at baseline. [c]Models failed to converge.

Supplementary Table 3. Cross tabulation showing concordance between PA type trajectories, %(n) (n=4917)

	Walking			Sport/exercise			Recreational activity			
	Consistently low (n=1321)	Low, increasing (n=3186)	Moderate, increasing (n=410)	Consistently none (n=2213)	Consistently occasional (n=1512)	Consistently frequent (n=1192)	Moderate, decreasing (n=705)	Consistently moderate (n=1496)	High, decreasing (n=1634)	Consistently high (n=1082)
Walking										
Consistently low	–	–	–	32.0 (708)	25.3 (382)	19.4 (231)	47.9 (338)	25.2 (377)	24.4 (399)	19.1 (207)
Low, increasing	–	–	–	59.1 (1308)	66.3 (1,003)	73.4 (875)	47.8 (337)	67.5 (1109)	67.4 (1102)	68.2 (738)
Moderate, increasing	–	–	–	8.9 (197)	8.4 (127)	7.2 (86)	4.3 (30)	7.4 (110)	8.1 (133)	12.7 (137)
Sport/exercise										
Consistently none	53.6 (708)	41.1 (1,308)	48.1 (197)	–	–	–	71.1 (501)	45.3 (677)	44.0 (719)	29.2 (316)
Consistently occasional	28.9 (382)	31.5 (1,003)	31.0 (127)	–	–	–	21.7 (153)	32.4 (484)	32.8 (536)	31.3 (339)
Consistently frequent	17.5 (231)	27.5 (875)	21.0 (86)	–	–	–	7.2 (51)	22.4 (335)	23.2 (379)	39.5 (427)
Recreational activity										
Moderate, decreasing	25.6 (338)	10.6 (337)	7.3 (30)	22.6 (501)	10.1 (153)	4.3 (51)	–	–	–	–
Consistently moderate	28.5 (377)	31.7 (1,009)	26.8 (110)	30.6 (677)	32.0 (484)	28.1 (335)	–	–	–	–
High, decreasing	30.2 (399)	34.6 (1,102)	32.4 (133)	32.5 (719)	35.5 (536)	31.8 (379)	–	–	–	–

Consistently high	15.7 (207)	23.2 (738)	33.4 (137)	14.3 (316)	22.4 (339)	35.8 (427)	–	–	–	–

Data are shown as % (n)

Sample size is smaller as men had to have trajectory data in all three PA types to be included