CHANGE IN PHYSICAL ACTIVITY AND WEIGHT IN RELATION TO RETIREMENT: THE FRENCH GAZEL COHORT STUDY

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ARTICLE SUMMARY

Article focus

•The main focus of this article was to examine whether statutory retirement is associated with changes in physical activity.

•Especially, we wanted to clarify what happens during the actual retirement transition (i.e. the year of retirement +/- 1 years).

•Further, we examined whether there were changes in body weight as a function of pre- and post-retirement physical activity level.

Key messages

•We able to show that during a 9-year follow-up physical activity increased most during the retirement transition, both in men and women.

•Beneficial changes were noticed also among those usually considered as low physical activity groups, such as smokers.

•Physically inactive persons were most prone to gain weight during the follow-up.

Strengths and limitations of this study

•The main strength of this study was yearly measurements of the outcome, which enabled us to get accurate estimates of physical activity during the actual retirement transition phase.

•Large and stable occupational cohort, prospective study design, accurate register-based data on retirement and long follow-up both pre- and post-retirement were other strengths of this study.

•The main limitation was the use of self-report data of the outcome.

ABSTRACT

Background Retirement is an important life phase in older age, during which changes in a person's lifestyle behaviour may occur. Previous studies have produced contradictory findings with regard to changes in physical activity and body weight after statutory retirement.

Methods In two analyses using data from employees of the French national gas- and electricity company (the GAZEL Cohort Study) we examined changes in physical activity and body weight (kg) after statutory retirement.

Results In the Analysis 1 (n=2,711), prevalence estimates for four years before and four years after retirement showed that high leisure-time physical activity (walking at least 5 km/week) increased by 36% in men and 61% in women during the transition to retirement. This increase was also observed among people at a higher risk of physical inactivity, such as smokers and those with elevated depressive symptoms. In a separate sample, (Analysis 2, n=3,812), change in weight as a function of pre- and post-retirement physical activity were analyzed. Weight gain pre- to post-retirement was 0.85 (95% CI 0.48, 1.21) to 1.35 (0.79, 1.90) kg greater among physically inactive persons (decrease in activity or inactive) compared to those physically active ($p < 0.001$).

Conclusions Retirement may be accompanied by an increase in physical activity in various groups of individuals, and may help with weight control post-retirement.

Keywords: Body weight changes, Exercise, Longitudinal studies, Retirement

Introduction

Physical activity is one of the major components of a healthy life-style (1) and even moderate-intensity physical activity is associated with reduced risk of several chronic diseases (including cardiovascular disease, type 2 diabetes, breast and colon cancer, osteoporosis, depression) and increased longevity (2). Physical inactivity, in turn, contributes to the (global) obesity epidemic (3) and has been estimated to cause 6% of all deaths (1). Despite this evidence, only one third of Europeans meet the recommended levels of physical activity (4).

Level of physical activity varies across the life span depending on individual, socio-cultural and environmental factors (5). A growing body of evidence suggests that different life transitions (e.g. retirement, parenthood) may also significantly change peoples' engagement in physical activity in either direction (6-10). Retirement is an important life transition (11), which has been shown to associate with peoples' health behaviors. Some studies have reported beneficial changes in health behaviors, such as smoking cessation (12), decreased alcohol consumption (13) and increased leisure-time physical activity (7-9, 14) following retirement. However, prevalence of obesity has been shown to peak around retirement age (15), and retirement itself has been associated with modest weight gain (16-18). Contradictory results with regard to leisure-time physical activity have also been reported; some studies report only minor or no increase in leisure-time physical activities after retirement (18-20). To the best of our knowledge, only one previous study has linked changes in physical activity after retirement with simultaneous changes in weight (18). In that study, retirement was associated with an increase in weight and decreases in several leisure-time physical activities, but the findings were not consistent across occupational groups.

A major drawback of previous studies has been the use of self-reported data on retirement status (e.g. 7-9, 18). Typically, the exact date of the retirement is not known and only a few pre- and post-retirement measurements have been available. This implies that estimations of the changes in physical activity during the retirement transition may have been imprecise. The aim of

this study was to examine long-term trajectories of physical activity over a 9-year follow-up covering pre-, peri- and post-retirement phases. We also studied the extent to which these changes were associated with change in weight.

Methods

Study population

The GAZEL Cohort Study, established in 1989, is comprised of employees from the French national gas and electricity company: Electricité de France-Gaz de France (EDF-GDF) (21). EDF-GDF employees have a civil servant-like status that guarantees job security and opportunities for occupational mobility. Typically, employees are hired in their 20s and stay with the company until retirement, so losses to follow-up are small. At baseline (1989), 20,625 employees (73% men), aged 35-50, agreed to participate, and have been followed since that annually by postal questionnaires requesting data on health, lifestyle, individual, familial, social and occupational factors. These data are linked to valid occupational and health data collected by the company, including retirement, long-standing work disability, and sickness absence. The management, unions and medical department of EDF-GDF gave consent to the usage of all personal and health data files (22).

Since our two research questions require different samples, we describe the analytic samples and procedures in two parts.

Analysis 1 prospectively examined self-reported physical activity (walking distance per week) trajectories over a time window from four years before to four years after retirement. Of GAZEL participants retiring between 2003 and 2008 on a statutory basis (n=3,601), we included only those who had completed the annual questionnaire at least once before and once after their year of retirement, a final sample of 2,711 employees (63% men).

Analysis 2 examined changes in physical activity pre-to post-retirement in greater detail. These analyses included associations with weight change but were based on data from two surveys only (administered 2000 and 2007). To allow at least one pre- and one post-retirement assessment, only

participants who retired on a statutory basis between 2001 and 2006 and provided responses to more detailed physical actitvity questions administered both in 2000 and 2007 were taken into account (n=3,812 employees; 75% men).

Ascertainment of retirement

All pensions are paid by the employer, EDF-GDF, ensuring high quality comprehensive retirement data. Statutory age of retirement is between 55 and 60 years, depending on type of job. We only included persons retiring on a statutory basis (96% of the whole cohort) and excluded those retiring on health grounds. Year of statutory retirement was determined by receipt of an official retirement pension.

Measurement of physical activity and weight

Data on physical activity were drawn from questionnaires. Walking distance (Analysis 1) per week was measured annually (2002−09) using one question: "At the moment, how long a distance do you walk in the town or on the road?" Answers were categorised as follows: 1) less than 500 metres/week, 2) between 500 metres and 5 km/week, 3) between 5 and 10 km/week, 4) between 10 and 20 km/week and 5) more than 20 km/week. This measure was dichotomised into 1) high activity (≥5 km per week) and 2) low activity (<5 km per week).

For Analysis 2 physical activity measurement was based on responses to three questions on leisure-time sport administered in 2000 (time 1, T1) and 2007 (Time 2, T2). The questions covered three different aspects of habitual physical activity; 1) engaging in leisure-time sport (yes/no), 2) frequency of leisure-time sport (once a week/once a month/sometimes) and 3) manner of the leisure-time sport (group/alone). Using responses to the first question at T1 and T2, participants were categorised as 1) inactive (no sport at T1 or T2), 2) increasingly active (no sport at T1, but sport at T2), 3) decreasingly active (sport at T1, but not at T2) and 4) active (sport at T1 and T2).

Self-reported weight was also drawn from the 2000 and 2007 questionnaires and used to calculate weight change between these years ($weight_{2007} - weight_{2000}$).

Covariates

Socio-demographic chracteristics included sex, age at retirement, marital status, and occupational position (a measure of socioeconomic status, SES). Marital status (married or cohabiting vs. single, divorced, or widowed), and SES were defined using the last measurement before retirement. SES was derived from the employer's records and classified into three groups: high SES (managers), intermediate SES (technical), and low SES (clerical and manual), based on categorisations of the French National Statistics Institute.

Work-related factors included night work (never vs. occasionally or regularly) and work demands, assessed annually on an 8-point scale. For each participant we calculated mean scores of physical and psychological work demands over the pre-retirement period (years -4 to -1) (Analysis 1), or used the baseline (T1) value (Analysis 2). Answers were dichotomized using the upper quartile as the cut-off point.

Health and health behavior were assessed annually over the pre-retirement period (years -4 to -1) (Analysis 1), and one affirmative response during this period was considered to indicate the presence of the particular health problem, medical condition or health behavior. In Analysis 2 we used the baseline value (T1) of the variables. Presence of chronic diseases (cancer, diabetes, chronic bronchitis, asthma, angina, myocardial infarction, stroke, osteoarthritis, and rheumatoid arthritis) (no chronic disease vs. at least one chronic disease) and depression (no depression vs. depression) were derived from a checklist of over 50 medical conditions experienced during the past 12 months (24). Questionnaire data on the amount of beer, wine, and spirits consumed were transformed into units of alcohol per day. The average number of units per day over the pre-retirement period was classified as 0-3 units or more than 3 units (24). Reports of height and weight were used to calculate average body mass index (BMI) over the pre-retirement period

(Analysis 1) or at baseline (T1, Analysis 2) to identify obese (≥30.0) individuals. Current smoking was ascertained using one question "Are you a current smoker?", dichotomized as smoker vs. non-smoker or occasional smoker. Mental and physical fatigue were assessed on an 8-point scale (1=not at all... 8=very/extremely fatigued). The mean for the pre-retirement responses (Analysis 1) or the baseline value (T1, Analysis 2) for both items were dichotomized as 1) low fatigue and 2) high fatigue, using the upper quartile as the cut-off point.

Statistical analyses

Associations between the pre-retirement covariates and physical activity prior to retirement, expressed as prevalence ratios (PRs), were examined using logistic regression adjusted for sex and age at retirement.

Analysis 1. Prevalence of high physical activtity around retirement was estimated using a repeated-measures logistic regression analysis with the generalized estimating equations (GEE) method (25). This method was chosen since it takes into account the within-subject correlation between physical activity measurements, and is not sensitive to missing measurements. All analyses were conducted separately for men and women.

First, we calculated the annual prevalence estimates of high physical activity and their 95% confidence intervals (CI) adjusting for age at retirement to illustrate the overall physical activity trajectory in relation to statutory retirement for the 9-year study period. Next, the whole study period was divided into 3 different phases: Period 1 refers to the pre-retirement (years -4 through -2), Period 2 to the retirement transition (years -1 through +1), and Period 3 to the post-retirement (years +2 through +4). We calculated the prevalence ratios (PR) and their 95% CIs for the physical activity trend within each period, treating time as a continuous variable. The risk ratios were expressed as PRs per three years within all periods. In order to find factors shaping the trajectory we also examined multiplicative interactions (i.e. the differences in physical activity trends within the periods by the level of each potential effect modifier) by testing the significance of

an interaction term 'covariate *x* time *x* period' in a model including the main effect and all first level interactions. Only demographic factors (age and SES) and variables significantly ($P < 0.10$) associated with high physical activity at baseline were tested as potential effect modifiers. We calculated the PRs (95% CI) for high physical activity by contrasting the trend of physical activity within each period for each level of the potential effect modifier. Finally, in order to examine differences in the maintenance of physical activity from pre- to post-retirement in each subgroup, we calculated the overall PRs (95% CI) for post-retirement physical activity by contrasting the prevalence of physical activity in Period 3 with the prevalence of physical activity in Period 1 for each level of the potential effect modifier.

As a sensitivity analysis, we replicated the main analyses in a subgroup of participants who provided data on physical activity in year +4, in addition to one year both pre- and post-retirement, to assess the role of healthy survival effect.

Analysis 2. First, we calculated the likelihood of engaging in leisure-time sport (vs. not engaging), of doing sport at a high frequency (vs. low frequency) and of participating in group sports (vs. alone) during the post-retirement period compared to the pre-retirement, and expressed results as PRs and their 95% CIs. Then we analyzed the association between the changes in physical activity from pre- to post-retirement (inactive, increasingly active, decreasingly active, active) and simultaneous weight change (kg) by using the repeated measures analysis of variance, adjusting for age and sex. We calculated the contrast estimates by using active at T1 and T2 as the reference category.

Results

Table 1 shows baseline characteristics of the two samples and the association between covariates and high physical activity. Before retirement high physical activity was more common among men than women in both samples. Low levels of mental and physical fatigue as well as being non-obese were also associated with high physical activity at pre-retirement.

Analysis 1

The mean age of retirement in this sample (N=2,711) was 58 years (SD 2.4, range 50−66), and most of the employees (94%) had retired by the age of 60. The analyses were based on 19 673 observation years (on average 7.3 observations per person). Before retirement 58% of the participants reported walking at least five kilometres per week, 25% between 5 and 10 kilometres, and 17% more than 10 kilometres.

Figure 1 shows the age-adjusted prevalence estimates (95% CIs) for high physical activity (i.e. walking ≥5 km per week) within the 9-year time window. Before retirement, the annual prevalence of men and women walking at least 5 km per week was around 40%. There was a significant difference in the prevalence of physical activity between the pre-, peri- and post-retirement periods in both men and women (P-value for interaction time *x* period <0.001 in both sexes) (Table 2a/b). The proportion of men walking at least five kilometers increased by 36% during Period 2. A lesser, 18%, increase was noticed during Period 1 and a non-significant 8% decrease in Period 3. In women, the sharpest increase (61%) in physical activity also occured during the retirement transition, in contrast to 14%−19% decreases in physical activity during the pre- and post-retirement phases. Importantly, a similar pattern of significant increases in physical activity, especially during Period 2, was noticed across all subgroups. Of the covariates, only depression significantly shaped the physical activity trajectory pattern among male respondents. Interestingly, during Period 2 the likelihood of high physical activity increased more in men with elevated depressive symptoms compared to men with lower levels of depressive symptoms (PR 2.17 95% CI 1.45, 3.24 vs. PR 1.32 95% CI 1.21, 1.44, P-value (two-sided) for interaction covariate *x* time *x* period <0.05).

Table 3 shows the comparisons between the overall prevalences of high physical activity in Period 3 compared to Period 1. Both men and women maintained higher prevalence of physical activity over the whole post-retirement period compared to the pre-retirement period (PR

1.13 95% CI 1.06, 1.19; PR 1.14 95% CI 1.05, 1.24, respectively). However, in some subgroups beneficial changes were not maintained into Period 3. For example, men and women belonging to the lowest SES category or with elevated depressive symptoms, as well as female smokers and women with high levels of mental or physical fatigue did not maintain the increased level of physical activity post-retirement.

Sensitivity analyses

In a sensivity analysis, conducted among 1,492 participants who, in addition to one pre- and one post-retirement measurement, also provided data at the end of follow-up (year +4), the main result was replicated. In both men and women the biggest increase (48% and 85%, respectively) in physical activity occured over the retirement transition (Period 2). The beneficial changes were maintained post-retirement in both sexes (PR for the difference between Period 3 and Period 1 1.22 95% CI 1.11, 1.33 in men; 1.30 95% CI 1.09, 1.54 in women).

Analysis 2

The mean age of retirement was 56 (SD 2.4, Range 48−63), and 99% of individuals had retired by the age of 60. As shown in Table 4, the likelihood of engaging in sport activities increased pre- to post-retirement both in men and women (PR 1.15 95% CI 1.11, 1.20; PR 1.31 95% CI 1.23, 1.40, respectively). The frequency of sport activities increased to almost three-fold (PR 2.77 95% CI 1.94, 3.96) in women and to 1.6-fold in men. After retirement, male and female participants were also more likely to engage in sport activities in groups than alone, group activities being more frequent among men.

Repeated measures analysis of variance showed a significant difference in weight change pre- to post-retirement between different physical activity classes (P-value for physical activity change main effect <0.001), when adjusted for age and sex. Participants who either stopped taking part in leisure-time sports after retirement or who maintained an inactive lifestyle during the

entire follow-up gained on average 0.85−1.35 kg more weight compared to those engaging in leisure-time sports both before and after retirement (Table 5).

Discussion

In this large cohort of French national gas- and electricity company employees, statutory retirement was associated with a substantial increase in leisure-time physical activity. During the retirement transition, the prevalence of those walking at least 5 kilometres per week increased by 36% in men and 61% in women. In addition, the likelihood of engaging in sport activities, as well as sport frequency significantly increased in both sexes, the latter being especially pronounced in women. Importantly, the increase in physical activity over the retirement transition was observable even among those belonging to risk groups for low physical activity (e.g. smokers). Weight changes pre- to post-retirement appeared to be limited to a gain in weight among participants with low or decreasing levels of leisure-time physical activity, with no significant changes observable among those with increasing leisure-time physical activity. The reasons behind the retirement related increase in physical activity remain unknown, but multiple factors may be involved, such as social factors (7, 9), sense of purpose (26), more time availability and flexibility (7, 9), and increasing concerns about health and well-being post-retirement (7).

In contrast to previous studies mostly relying on self-reported retirement data, we were able to use records including the exact year of retirement, which were collected by a single employer. Other strenghts include a large sample size and annually repeated measurements over an extended time window of 9 years. Even though observational evidence cannot be used to infer causality, alternative explanations of our results appear implausible. These data suggest that retirement is associated with benefits in terms of increasing physical activity.

The main limitation of this study was the reliance on self-reported physical activity and weight, as these data can be subject to recall and self-report bias (27). Previous studies suggest that the level of both moderate intensity physical activity and weight tends to be underestimated by

responders (28-29). Also various characterictics of the respondents, such as age and education level, have been shown to affect self-reports of physical activity (28). A further limitation is that we measured only leisure-time physical activity, rendering estimations of the net changes in total physical activity impossible. It may be that people at work are actually more likely to achieve the recommended overall levels of physical activity compared to those already retired because work for some people involves a substantial amount of physical activity which is lost upon retirement (20). However, only a minority of the study participants retired from manual occupations (10%−12%) suggesting that net gains in physical activity after retirement are likely.

In large cohort studies, where the participants are followed by surveys for a long time, persons with severe illnesses or functional impairments tend to drop out (30) creating a healthy-survivor effect. Since physical inactivity is associated with many chronic diseases (2), it is likely that persons with the most severe conditions were lost to follow-up. The fact that the results remained essentially the same when the analysis was restricted to participants also providing data for year +4 following retirement suggests that any healthy-survivor effect is likely to be small. It is also noteworthy that the particularities of this cohort (e.g. stable job status, low statutory retirement age, and high pensions) may limit the generalizability to other working cohorts.

The observed increase in physical activity after retirement is in agreement with previous studies with shorter follow-up times (7-9). However, contradictory results have also been reported (18-20). Berger et al. 2005 (20) reported only marginal increases in physical activity after retirement, and Slingerland et al. (2007) (19) reported no association between retirement and any increase in sport participation or non-sport physical activity (including walking, cycling and gardening). However, these longitudinal studies had only 1 measure of physical activity at follow-up, preventing precise detection of changes in physical activity in relation to retirement. Nooyens et al. (2005) (18) also showed retirement to be associated with increases in weight and waist circumference, which in turn, were said to be related to decreases in several physical activities.

However, these results were based on a small sample of 288 men. The results of the present study are also in agreement with, and may partly explain, the earlier findings from the same cohort that retirement was associated with improved self-rated health (31) and decreased prevalence of sleep problems (32).

One intriguing findings was leisure-time physical activity increased significantly in men with higher levels of depression. However, they appeared to be unable to maintain these levels of activity beyond the actual retirement transition period. A similar phenomenon was seen among women; smokers, women with higher levels of depression, high mental or physical fatigue, and those with high physical work demands increased their physical activity levels substantially during the retirement transition, but were unable to sustain these benefits post-retirement. These finfings show that individuals belonging to "risk groups" for low physical activity actually have the potential to improve their habits, when faceing a major change in the life course. This is promising in terms of health promotion, although interventions aimed at maintenaining high physical activity levels are crucial to gain ensure long-term improvement in physical activity.

In this occupational cohort of French employees, a clear increase in leisure-time physical activity, walking and sport activities, was found in both men and women. These results highlight the importance of retirement as a life transition during which considerable changes in health habits are likely. Our findings should be taken into account by policymakers and those involved in planning and developing health promotion strategies for older employees.

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COMPETING INTERESTS

None.

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CONTRIBUTORSHIP STATEMENT

All authors participated in writing of the manuscript, have seen the latest version of the manuscript and will take the full responsibility for the entire manuscript. In more detail: Authors Noora Sjösten and Jussi Vahtera designed the original hypothesis. Noora Sjösten analyzed the data, and drafted the first version of the manuscript, in close collaboration with Jussi Vahtera, who is a supervisor of this study. Jaana Pentti provided statistical advice and helped planning and conducting the statistical analyses. Marie Zins and Marcel Goldberg are the founders of GAZEL cohort and manage all the data. They also helped revising the intellectual content of the manuscript. All other authors (MK, AS-M, JF, HW) contributed to subsequent drafts, revised the text, and approved the final draft of the report.

DATA SHARING STATEMENT

No additional data available.

Table 1. Baseline Characteristics of the Two Samples and Likelihood of High Physical Activity† by Different Covariates Expressed as Prevalence Ratios (PRs) and Their 95% Confidence Intervals (CIs), in EDF-GDF Employees, France.

	Analysis 1 N=2,711				Analysis 2 N=3,812			
	N	%	PR	95% CI	N	%	PR	95% CI
Demographics								
*Sex**								
Men	1703	62.8	1.00	ref.	2872	75.3	1.00	ref.
Women	1008	37.2	0.79	0.71, 0.88	940	24.7	0.84	0.74, 0.96
Age at retirement								
≤53	98	3.6	1.00	ref.	516	13.5	1.00	ref.
54−56	933	34.4	1.08	0.76, 1.54	1925	50.5	0.99	0.86, 1.06
≥57	1680	62.0	1.19	0.84, 1.68	1371	36.0	0.99	0.87, 1.13
Employment grade								
Higher	1104	40.8	1.00	ref.	1574	41.3	1.00	ref.
Intermediate	1281	47.3	1.01	0.91, 1.12	1855	48.7	0.90	0.82, 1.00
Lower	324	12.0	0.89	0.74, 1.07	380	10.0	0.90	0.75, 1.07
Marital status								
Married	2276	84.0	1.00	ref.	3325	87.2	1.00	ref.
Single, divorced or widowed	435	16.1	0.96	0.76, 1.22	487	12.8	1.04	0.90, 1.21
Work characteristics								
Night work								
No	2029	75.0	1.00	ref.	2572	67.5	1.00	ref.
Yes	679	25.1	0.92	0.82, 1.02	1236	32.5	1.07	0.97, 1.19
*Psychological work demands**								
Low	2090	77.7	1.00	ref.	2841	74.7	1.00	ref.
High	601	22.3	0.90	0.79, 1.01	960	25.3	0.95	0.86, 1.06
Physical work demands								
Low	2079	77.3	1.00	ref.	2817	74.1	1.00	ref.
High	612	22.7	1.04	0.93, 1.16	984	25.9	0.90	0.81, 1.01
Health								
*Mental fatigue**								

Low	2041	75.4	1.00	ref.	2848	74.7	1.00	ref.
High	667	24.6	0.84	0.75, 0.96	964	25.3	0.94	0.84, 1.04
*Physical fatigue**								
Low	1992	73.5	1.00	ref.	2833	74.3	1.00	ref.
High	718	26.5	0.85	0.75, 0.96	979	25.7	0.83	0.73, 0.93
Chronic diseases†								
No	1390	52.3	1.00	ref.	1941	50.9	1.00	ref.
Yes	1321	48.7	0.93	0.84, 1.02	1871	49.1	0.95	0.86, 1.04
*Depression**								
No	2381	87.8	1.00	ref.	3279	86.0	1.00	ref.
Yes	330	12.2	0.87	0.74, 1.03	533	14.0	0.93	0.81, 1.08
*Smoking**								
No	2209	81.6	1.00	ref.	3061	87.6	1.00	ref.
Yes	498	18.4	0.89	0.78, 1.02	433	12.4	0.84	0.74, 0.96
Alcohol consumption								
≤3	1816	77.3	1.00	ref.	2857	79.2	1.00	ref.
>3	532	22.7	0.99	0.89, 1.10	750	20.8	1.00	0.91, 1.11
BMI*								
<30	2111	90.6	1.00	ref.	3215	89.4	1.00	ref.
>=30	218	9.4	0.63	0.50, 0.80	381	10.6	0.59	0.45, 0.77

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, Prevalence ratio.

* P−value <0.100 for the difference between covariate classes in Analysis 1.

†High physical activity ≥5 km walking distance/week (Analysis 1); Likelihood of engaging in leisure-time sport (Analysis 2).

†† Chronic diseases = cancer, diabetes, chronic bronchitis, asthma, angina, myocardial infarction, stroke, osteoarthritis, and rheumatoid arthritis.

Models were adjusted for age and sex.

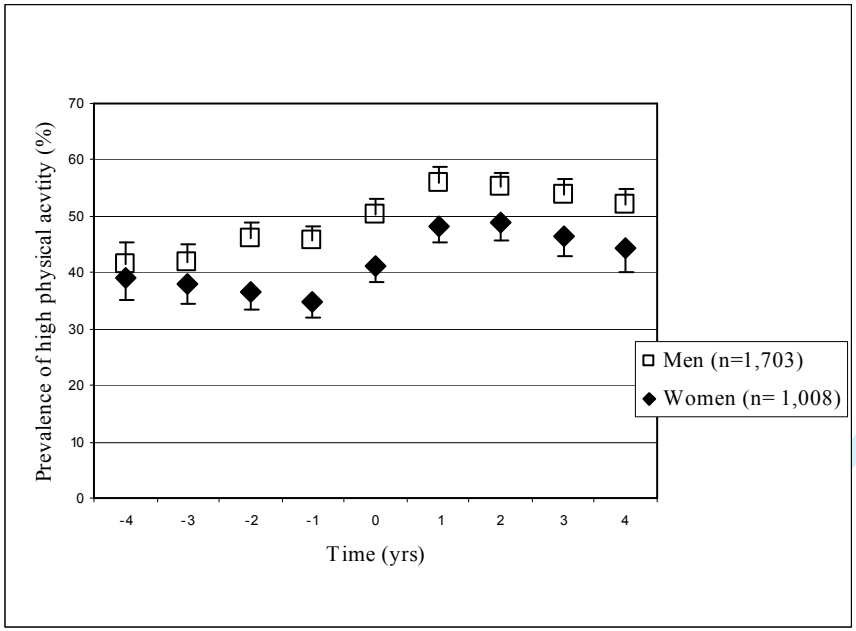

Figure 1. Proportion of Men and Women Walking at Least 5 Kilometres per Week in Relation to the Year of Retirement (Year 0) Among Eléctricité de France-Gaz de France (EDF-GDF) Employees, France, 2002-2009.
Adjusted for age.
Number of Responders During the Follow-Up.

Year	−4	−3	−2	−1	0	+1	+2	+3	+4
Men	480	625	875	1,474	1,506	1,546	1,424	1,223	1,030
Women	423	508	593	847	856	876	712	584	457

Table 2a. Age-Adjusted Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) of High Physical Activity in Pre-, Peri- and Post-Retirement Among Male EDF-GDF Employees, France, 2002−2009.

	MEN						
	Period 1		Period 2		Period 3		
	PR	95% CI	PR	95% CI	PR	95% CI	P−value*
All	1.18	1.03, 1.37	1.36	1.25, 1.48	0.92	0.85, 1.00	<0.001
SES							0.35
Higher	1.16	0.97, 1.39	1.46	1.31, 1.63	0.93	0.83, 1.03	
Intermediate	1.12	0.87, 1.44	1.17	1.01, 1.35	0.90	0.79, 1.02	
Lower	1.92	0.99, 3.72	1.78	1.21, 2.61	0.99	0.71, 1.37	
Age at retirement							0.27
>57	0.70	0.35, 1.41	1.44	1.25, 1.65	0.92	0.83, 1.02	
≥57	1.21	1.04, 1.40	1.31	1.18, 1.46	0.90	0.79, 1.02	
Psychological work demands							0.86
Low	1.20	1.03, 1.41	1.34	1.22, 1.48	0.91	0.83, 1.00	
High	1.14	0.81, 1.61	1.44	1.18, 1.75	0.97	0.82, 1.14	
Mental fatigue							
Low	1.16	1.00, 1.35	1.30	1.18, 1.42	0.92	0.84, 1.00	0.33
High	1.36	0.89, 2.09	1.68	1.34, 2.11	0.94	0.78, 1.13	
Physical fatigue							
Low	1.20	1.03, 1.40	1.34	1.22, 1.47	0.92	0.84, 1.00	0.86
High	1.16	0.79, 1.72	1.47	1.19, 1.81	0.94	0.78, 1.14	
BMI							0.61
<30	1.19	1.03, 1.38	1.34	1.23, 1.46	0.91	0.84, 0.99	
>=30	1.02	0.52, 1.98	1.73	1.17, 2.55	1.02	0.73, 1.43	
Smoking							0.23
No	1.22	1.05, 1.43	1.34	1.22, 1.46	0.94	0.86, 1.03	
Yes	1.00	0.70, 1.44	1.49	1.20, 1.85	0.82	0.69, 0.99	
Depression							0.05
No	1.21	1.05, 1.40	1.32	1.21, 1.44	0.92	0.85, 1.00	
Yes	0.80	0.38, 1.70	2.17	1.45, 3.24	0.90	0.64, 1.26	

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.

* P−values (two-sided) refer to interaction time *x* period *x* covariate (except for All, where P-value refers to period main effect).

Period 1= years −4 to −2 (pre-retirement); Period 2 = years 1− to +1 (peri-retirement); Period 3 = years +2 to +4 (post-retirement).

Models were adjusted for age at retirement.

Table 2b. Age-Adjusted Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) of High Physical Activity in Pre-, Peri- and Post-Retirement Among Male EDF-GDF Employees, France, 2002−2009.

	WOMEN						
	Period 1		Period 2		Period 3		
	PR	95% CI	PR	95% CI	PR	95% CI	P−value*
All	0.91	0.75, 1.09	1.61	1.40, 1.86	0.86	0.74, 0.99	<0.001
SES							0.99
Higher	1.05	0.69, 1.58	1.69	1.22, 2.35	0.88	0.61, 1.28	
Intermediate	0.88	0.69, 1.12	1.63	1.37, 1.94	0.87	0.73, 1.03	
Lower	0.86	0.55, 1.34	1.46	1.03, 2.06	0.78	0.51, 1.19	
Age at retirement							0.10
>57	0.86	0.66, 1.12	1.86	1.55, 2.23	0.86	0.73, 1.02	
≥57	0.98	0.75, 1.29	1.28	1.03, 1.58	0.84	0.63, 1.12	
Psychological work demands							0.69
Low	0.90	0.73, 1.11	1.54	1.32, 1.80	0.85	0.71, 1.00	
High	0.92	0.58, 1.45	2.04	1.43, 2.90	0.93	0.67, 1.25	
Mental fatigue							
Low	0.96	0.78, 1.18	1.54	1.31, 1.82	0.91	0.77, 1.08	0.23
High	0.76	0.50, 1.17	1.85	1.40, 2.44	0.75	0.56, 1.00	
Physical fatigue							
Low	0.94	0.76, 1.16	1.58	1.34, 1.85	0.85	0.72, 1.01	0.77
High	0.84	0.56, 1.25	1.71	1.29, 2.27	0.90	0.67, 1.19	
BMI							0.84
<30	0.91	0.75, 1.10	1.63	1.42, 1.88	0.85	0.73, 0.98	
>=30	0.95	0.41, 2.20	1.37	0.53, 3.52	1.12	0.41, 3.11	
Smoking							0.48
No	0.92	0.76, 1.12	1.53	1.32, 1.78	0.83	0.71, 0.97	
Yes	0.83	0.47, 1.46	2.20	1.46, 3.33	1.05	0.67, 1.63	
Depression							0.12
No	0.98	0.80, 1.20	1.54	1.31, 1.81	0.86	0.73, 1.03	
Yes	0.60	0.36, 1.00	1.88	1.42, 2.49	0.83	0.64, 1.09	

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.

* P−values (two-sided) refer to interaction time *x* period *x* covariate (except for All, where P-value refers to period main effect).

Period 1= years −4 to −2 (pre-retirement); Period 2 = years 1− to +1 (peri-retirement); Period 3 = years +2 to +4 (post-retirement).

Models were adjusted for age at retirement.

Table 3. Differences in Physical Activity Between Period 3 and Period 1, Expressed as Prevalence Ratios (PRs) and their 95% Confidence Intervals (CIs), Among EDF-GDF Employees, France, 2002−2009.

	MEN			WOMEN		
	Period 3 vs. period 1			Period 3 vs. period 1		
	PR	95% CI	P−value	PR (95% CI)		P−value
All	1.13	1.06, 1.19	<0.001	1.14	1.05, 1.24	0.006
Employment grade			0.03			0.37
Higher	1.31	1.13, 1.52		1.20	0.83, 1.73	
Intermediate	1.24	1.02, 1.50		1.34	1.11, 1.61	
Lower	0.83	0.53, 1.33		1.07	0.77, 1.48	
Age at retirement			0.55			0.63
>57	1.13	0.99, 1.29		1.17	1.05, 1.31	
≥57	1.10	1.02, 1.18		1.10	0.96, 1.26	
Psychological work demands			0.85			0.30
Low	1.12	1.05, 1.19		1.15	1.04, 1.26	
High	1.16	1.02, 1.33		1.17	0.96, 1.43	
Mental fatigue			0.77			0.05
Low	1.11	1.04, 1.18		1.19	1.08, 1.31	
High	1.16	1.00, 1.35		1.05	0.87, 1.27	
Physical fatigue			0.42			0.06
Low	1.12	1.05, 1.19		1.19	1.08, 1.31	
High	1.16	1.00, 1.36		1.06	0.89, 1.27	
BMI			0.19			0.03
<30	1.09	1.00, 1.20		1.23	1.11, 1.36	
≥30	1.14	1.05, 1.22		0.95	0.80, 1.12	
Smoking			0.77			0.05
No	1.12	1.05, 1.19		1.18	1.08, 1.30	
Yes	1.17	1.01, 1.36		0.91	0.72, 1.15	
Depression			0.18			0.13
No	1.14	1.07, 1.21		1.16	1.06, 1.28	
Yes	0.95	0.73, 1.22		1.07	0.88, 1.31	

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.

*P−values (two-sided) refer to interaction covariate *x* period (except for **All**, where P−value refers to period main effect).

Period 1= years −4 to −2 (pre−retirement); Period 2 = years 1− to +1 (peri−retirement); Period 3=years +2 to +4 (post−retirement).

Models were adjusted for age at retirement.

Table 4. Likelihood of Sports Activities During Post-retirement Compared to Pre-retirement Years, Expressed as Prevalence Ratios (PRs) and Their 95% Confidence Intervals (CIs), Among EDF-GDF Employees, France, 2000−2007.

	All		Men		Women		
	PR	95% CI	PR	95% CI	PR	95% CI	P−value*
Sport activity (active vs. inactive)	1.19	1.15, 1.23	1.15	1.11, 1.20	1.31	1.23, 1.40	<0.001
Sport frequency (low vs. high)	1.77	1.56, 2.00	1.62	1.42, 1.85	2.77	1.94, 3.96	0.02
Sport manner (group vs. alone)	1.68	1.48, 1.91	1.28	1.19, 1.38	1.11	1.04, 1.19	<0.001

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.
*P-values (two-sided) refer to interaction sex *x* year.
Adjusted for age at retirement.

Table 5. Changes in Weight by Categories of Physical Activity Among EDF-GDF Employees, France, 2000−2007, Expressed as Least Square Means (LS-means) and Their 95% Confidence Intervals (CIs).

	Weight change (kg) pre- to post-retirement								
	All			Men			Women		
	LS-means	95% CI	P−value*	LS-means	95% CI	P−value*	LS-means	95% CI	P−value*
Inactive vs. active	0.85	0.48, 1.21	<0.001	0.65	0.24, 1.06	<0.01	1.52	0.75, 2.28	<0.001
Increasing vs. active	−0.15	−0.53, 0.24	0.45	−0.38	−0.83, 0.07	0.10	0.48	−0.23, 1.19	0.19
Decreasing vs. active	1.35	0.79, 1.90	<0.001	1.36	0.74, 1.99	<0.001	1.22	0.01, 2.44	0.05

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; LS-means, least square means.
*P-values (two-sided) refer to differences between the two classes in repeated measures ANOVA contrast estimates.
Adjusted for age at retirement.
Active both in 2000 and 2007 used as a reference.

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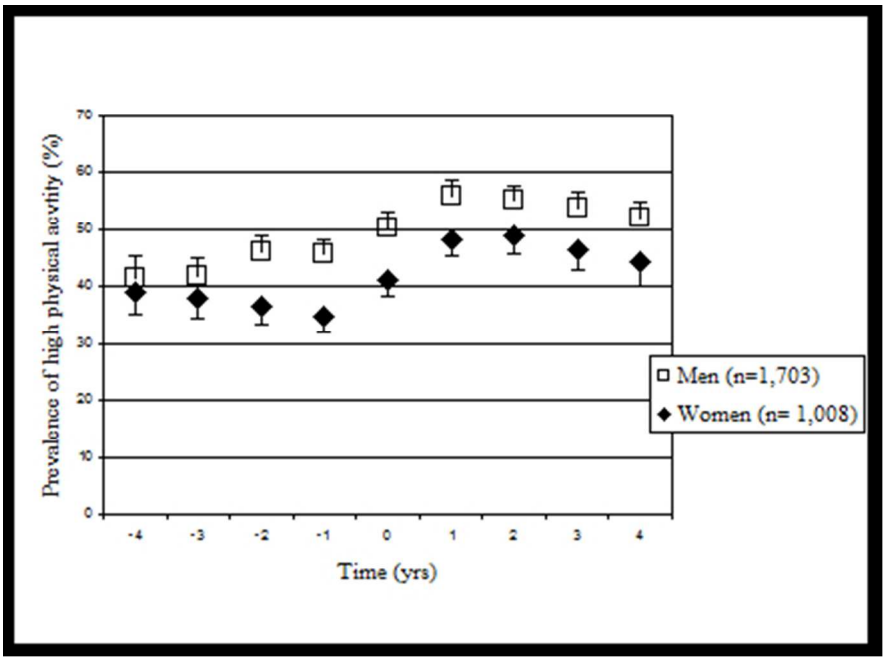

Proportion of Men and Women Walking at Least 5 Kilometres per Week in Relation to the Year of Retirement (Year 0) Among Eléctricité de France-Gaz de France (EDF-GDF) Employees, France, 2002-2009. Adjusted for age.

116x85mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract. Yes. Front page+abstract.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Yes.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Yes, page 4.
Objectives	3	State specific objectives, including any prespecified hypotheses. Yes, page 4.
Methods		
Study design	4	Present key elements of study design early in the paper Yes, page 5.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Yes, pages 5-7.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Yes, page 5.
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed -
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Yes, pages 6-8.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Yes, pages 6-8.
Bias	9	Describe any efforts to address potential sources of bias Yes, page 11, 13.
Study size	10	Explain how the study size was arrived at Yes, pages 5-6.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Yes, pages 6-8
Statistical methods	12	Describe all statistical methods, including those used to control for confounding Yes, pp. 8-9
		(*b*) Describe any methods used to examine subgroups and interactions Yes, pp. 8-9
		(*c*) Explain how missing data were addressed -
		(*d*) If applicable, explain how loss to follow-up was addressed See, pages 5, 11.
		(*e*) Describe any sensitivity analyses Yes, page 11.
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Yes, pages 5-6.
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Table 1.
		(b) Indicate number of participants with missing data for each variable of interest Table 1.
		(c) Summarise follow-up time (eg, average and total amount) Yes, page 10.
Outcome data	15*	Report numbers of outcome events or summary measures over time Yes, figure 1.
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and

		their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Yes, Table 2.
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Yes, pp. 9, 11-12.
Discussion		
Key results	18	Summarise key results with reference to study objectives Yes, p. 12.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Yes, pp. 12-13.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Yes, pp.13-14.
Generalisability	21	Discuss the generalisability (external validity) of the study results Yes, p. 13.
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Yes, p.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

CHANGE IN PHYSICAL ACTIVITY AND WEIGHT IN RELATION TO RETIREMENT: THE FRENCH GAZEL COHORT STUDY

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Secondary Subject Heading:	Epidemiology, Geriatric medicine
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, PREVENTIVE MEDICINE

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Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Yes, pages 6-8.
Bias	9	Describe any efforts to address potential sources of bias Yes, page 11, 13.
Study size	10	Explain how the study size was arrived at Yes, pages 5-6.
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Statistical methods	12	Describe all statistical methods, including those used to control for confounding Yes, pp. 8-9
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Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Yes, pp.13-14.
Generalisability	21	Discuss the generalisability (external validity) of the study results Yes, p. 13.
Other information		
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Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

CHANGE IN PHYSICAL ACTIVITY AND WEIGHT IN RELATION TO RETIREMENT: THE FRENCH GAZEL COHORT STUDY

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ABSTRACT

Objectives To examine the trajectories of physical activity from pre- to post-retirement, and to further clarify whether the changes in physical activity are associated with changes in body weight.

Design Prospective.

Setting French national gas- and electricity company (GAZEL cohort).

Participants From the original sample of 20,625 employees, only those retiring between 2001 and 2008 on a statutory basis were selected for the analyses (Analysis 1: n=2,711, 63% men; Analysis 2: n=3,812, 75% men). Persons with data on at least one pre- and post-retirement measurement of the outcome were selected.

Primary and secondary outcome measures: All outcome data were gathered by questionnaires. In Analysis 1 the annual prevalence of higher physical activity (walking ≥ 5 kilometres/week) four years before and after retirement was analysed. In Analysis 2 changes in leisure-time sport activities (engagement, frequency, manner) from pre- to post-retirement were analysed with simultaneous changes in body weight (kg).

Results In Analysis 1 (n=2,711), prevalence estimates for four years before and four years after retirement showed that high leisure-time physical activity (walking at least 5 km/week) increased by 36% in men and 61% in women during the transition to retirement. This increase was also observed among people at a higher risk of physical inactivity, such as smokers and those with elevated depressive symptoms. In a separate sample, (Analysis 2, n=3,812), change in weight as a function of pre- and post-retirement physical activity were analysed. Weight gain pre- to post-retirement was 0.85 (95% CI 0.48, 1.21) to 1.35 (0.79, 1.90) kg greater among physically inactive persons (decrease in activity or inactive) compared to those physically active ($p < 0.001$).

Conclusions Retirement transition may be associated with beneficial changes in lifestyle, and may

thus be a good starting point to preventive interventions in various groups of individuals in order to maintain long-term changes.

Keywords: Body weight changes, Exercise, Longitudinal studies, Retirement

Summary

Article focus

•The main focus of this article was to examine whether statutory retirement is associated with changes in physical activity.

•Especially, we wanted to clarify what happens during the actual retirement transition (i.e. the year of retirement +/- 1 years).

•Further, we examined whether there were changes in body weight as a function of pre- and post-retirement physical activity level.

Key messages

•We able to show that during a 9-year follow-up physical activity increased most during the retirement transition, both in men and women.

•Beneficial changes were noticed also among those usually considered as low physical activity groups, such as smokers.

•Physically inactive persons were most prone to gain weight during the follow-up.

Strengths and limitations of this study

- The main strength of this study was yearly measurements of the outcome, which enabled us to get accurate estimates of physical activity during the actual retirement transition phase.
- Large and stable occupational cohort, prospective study design, accurate register-based data on retirement and long follow-up both pre- and post-retirement were other strengths of this study.
- The main limitation was the use of self-report data of the outcome.

Introduction

Physical activity is one of the major components of a healthy life-style (1). Despite a clear dose-response relationship between physical activity and disease risk, even moderate-intensity physical activity is associated with reduced risk of several chronic diseases (including cardiovascular disease, stroke, type 2 diabetes, breast and colon cancer, osteoporosis, depression) and increased longevity (2, 3). Physical inactivity, in turn, contributes to the (global) obesity epidemic (4) and has been estimated to cause 6% of all deaths (1). Despite this evidence, only one third of Europeans meet the recommended levels of physical activity (5).

Level of physical activity varies across the life span depending on individual, socio-cultural and environmental factors (6). A growing body of evidence suggests that different life transitions (e.g. retirement, parenthood) may also significantly change peoples' engagement in physical activity in either direction (7-11). Retirement is an important life transition (12), which has been shown to associate with peoples' health behaviors. Some studies have reported beneficial changes in health behaviors, such as smoking cessation (13), decreased alcohol consumption (14) and increased leisure-time physical activity (8-10, 15-16) following retirement. However, prevalence of obesity has been shown to peak around retirement age (17), and retirement itself has been associated with modest weight gain (18-20). Contradictory results with regard to leisure-time physical activity have also been reported; some studies report only minor or no increase in leisure-time physical activities after retirement (20-22). To the best of our knowledge, only one previous study has linked changes in physical activity after retirement with simultaneous changes in weight (20). In that study, retirement was associated with an increase in weight and decreases in several leisure-time physical activities, but the findings were not consistent across occupational groups.

A major drawback of previous studies has been the use of self-reported data on retirement status (e.g. 8-10, 20). Typically, the exact date of the retirement is not known and only a few pre- and post-retirement measurements have been available. This implies that estimations of the

changes in physical activity during the retirement transition may have been imprecise. The aim of this study was to examine long-term trajectories of physical activity over a 9-year follow-up covering pre-, peri- and post-retirement phases. We also studied the extent to which these changes were associated with change in weight.

Methods

Study population

The GAZEL Cohort Study, established in 1989, is comprised of employees from the French national gas and electricity company: Electricité de France-Gaz de France (EDF-GDF) (23). EDF-GDF employees have a civil servant-like status that guarantees job security and opportunities for occupational mobility. Typically, employees are hired in their 20s and stay with the company until retirement, so losses to follow-up are small. At baseline (1989), 20,625 employees (73% men), aged 35-50, agreed to participate, and have been followed since that annually by postal questionnaires requesting data on health, lifestyle, individual, familial, social and occupational factors. These data are linked to valid occupational and health data collected by the company, including retirement, long-standing work disability, and sickness absence. The management, unions and medical department of EDF-GDF gave consent to the usage of all personal and health data files (24).

Since our two research questions require different samples, we describe the analytic samples and procedures in two parts.

Analysis 1 prospectively examined self-reported physical activity (walking distance per week) trajectories over a time window from four years before to four years after retirement. Of GAZEL participants retiring between 2003 and 2008 on a statutory basis (n=3,601), we included only those who had completed the annual questionnaire at least once before and once after their year of retirement, a final sample of 2,711 employees (63% men).

Analysis 2 examined changes in physical activity pre-to post-retirement in greater detail. These analyses included associations with weight change but were based on data from two surveys only

(administered 2000 and 2007). To allow at least one pre- and one post-retirement assessment, only participants who retired on a statutory basis between 2001 and 2006 and provided responses to more detailed physical actitvity questions administered both in 2000 and 2007 were taken into account (n=3,812 employees; 75% men).

Ascertainment of retirement

All pensions are paid by the employer, EDF-GDF, ensuring high quality comprehensive retirement data. Statutory age of retirement is between 55 and 60 years, depending on type of job. We only included persons retiring on a statutory basis (96% of the whole cohort) and excluded those retiring on health grounds. Year of statutory retirement was determined by receipt of an official retirement pension.

Measurement of physical activity and weight

Data on physical activity were drawn from questionnaires. Walking distance (Analysis 1) per week was measured annually (2002−09) using one question: "At the moment, how long a distance do you walk in the town or on the road?" Answers were categorised as follows: 1) less than 500 metres/week, 2) between 500 metres and 5 km/week, 3) between 5 and 10 km/week, 4) between 10 and 20 km/week and 5) more than 20 km/week. This measure was dichotomised into 1) higher activity (≥5 km per week) and 2) lower activity (<5 km per week).

For Analysis 2 physical activity measurement was based on responses to three questions on leisure-time sport administered in 2000 (time 1, T1) and 2007 (Time 2, T2). The questions covered three different aspects of habitual physical activity; 1) engaging in leisure-time sport (yes/no), 2) frequency of leisure-time sport (moderate frequency: once a week / low frequency: once a month or sometimes) and 3) manner of the leisure-time sport (group/alone). Using responses to the first question at T1 and T2, participants were categorised as 1) inactive (no sport at T1 or T2), 2) increasingly active (no sport at T1, but sport at T2), 3) decreasingly active (sport at T1, but not at T2) and 4) active (sport at T1 and T2). Self-reported weight was also drawn from the 2000 and

2007 questionnaires and used to calculate weight change between these years ($weight_{2007}$– $weight_{2000}$).

Covariates

Socio-demographic chracteristics included sex, age at retirement, marital status, and occupational position (a measure of socioeconomic status, SES). Marital status (married or cohabiting vs. single, divorced, or widowed), and SES were defined using the last measurement before retirement. SES was derived from the employer's records and classified into three groups: high SES (managers), intermediate SES (technical), and low SES (clerical and manual), based on categorisations of the French National Statistics Institute.

Work-related factors included night work (never vs. occasionally or regularly) and work demands, assessed annually on an 8-point scale. For each participant we calculated mean scores of physical and psychological work demands over the pre-retirement period (years -4 to -1) (Analysis 1), or used the baseline (T1) value (Analysis 2). Answers were dichotomized using the upper quartile as the cut-off point.

Health and health behavior were assessed annually over the pre-retirement period (years -4 to -1) (Analysis 1), and one affirmative response during this period was considered to indicate the presence of the particular health problem, medical condition or health behavior. In Analysis 2 we used the baseline value (T1) of the variables. Presence of chronic diseases (cancer, diabetes, chronic bronchitis, asthma, angina, myocardial infarction, stroke, osteoarthritis, and rheumatoid arthritis) (no chronic disease vs. at least one chronic disease) and depression (no depression vs. depression) were derived from a checklist of over 50 medical conditions experienced during the past 12 months (25). Questionnaire data on the amount of beer, wine, and spirits consumed were transformed into units of alcohol per day. The average number of units per day over the pre-retirement period was classified as 0-3 units or more than 3 units (26). Reports of height and weight were used to calculate average body mass index (BMI) over the pre-retirement period

(Analysis 1) or at baseline (T1, Analysis 2) to identify obese (≥30.0) individuals. Current smoking was ascertained using one question "Are you a current smoker?", dichotomized as smoker vs. non-smoker or occasional smoker. Mental and physical fatigue were assessed on an 8-point scale (1=not at all... 8=very/extremely fatigued). The mean for the pre-retirement responses (Analysis 1) or the baseline value (T1, Analysis 2) for both items were dichotomized as 1) low fatigue and 2) high fatigue, using the upper quartile as the cut-off point.

Statistical analyses

Associations between the pre-retirement covariates and physical activity prior to retirement, expressed as prevalence ratios (PRs), were examined using logistic regression adjusted for sex and age at retirement.

Analysis 1. Prevalence of higher physical activity (i.e. walking ≥5 km per week) around retirement was estimated using a repeated-measures logistic regression analysis with the generalized estimating equations (GEE) method (27). This method was chosen since it takes into account the within-subject correlation between physical activity measurements, and is not sensitive to missing measurements. All analyses were conducted separately for men and women.

First, we calculated the annual prevalence estimates of higher physical activity and their 95% confidence intervals (CI) adjusting for age at retirement to illustrate the overall physical activity trajectory in relation to statutory retirement for the 9-year study period. Next, the whole study period was divided into 3 different phases: Period 1 refers to the pre-retirement (years -4 through -2), Period 2 to the retirement transition (years -1 through +1), and Period 3 to the post-retirement (years +2 through +4). We calculated the prevalence ratios (PR) and their 95% CIs for the physical activity trend within each period, treating time as a continuous variable. The risk ratios were expressed as PRs per three years within all periods. In order to find factors shaping the trajectory we also examined multiplicative interactions (i.e. the differences in physical activity trends within the periods by the level of each potential effect modifier) by testing the significance of

an interaction term 'covariate *x* time *x* period' in a model including the main effect and all first level interactions. Only demographic factors (age and SES) and variables significantly ($P < 0.10$) associated with high physical activity at baseline were tested as potential effect modifiers. We calculated the PRs (95% CI) for higher physical activity by contrasting the trend of physical activity within each period for each level of the potential effect modifier. Finally, in order to examine differences in the maintenance of physical activity from pre- to post-retirement in each subgroup, we calculated the overall PRs (95% CI) for post-retirement physical activity by contrasting the prevalence of physical activity in Period 3 with the prevalence of physical activity in Period 1 for each level of the potential effect modifier.

We conducted two sensitity analyses to further test our results. Firstly, in order to take into account the full variety of the physical activity measure (i.e. all five classes of walking), we applied cumulative logistic regression and caluculated CORs (Cumulative Odds Ratios) for each period. As another sensitivity analysis, we replicated the main analyses in a subgroup of participants who provided data on physical activity in year +4, in addition to one year both pre- and post-retirement, to assess the role of healthy survival effect.

Analysis 2. First, we calculated the likelihood of engaging in leisure-time sport (vs. not engaging), of doing sport at a moderate frequency (vs. low frequency) and of participating in group sports (vs. alone) during the post-retirement period compared to the pre-retirement, and expressed results as PRs and their 95% CIs. Then we analyzed the association between the changes in physical activity from pre- to post-retirement (inactive, increasingly active, decreasingly active, active) and simultaneous weight change (absolute and relative) by using the repeated measures analysis of variance, adjusting for age and sex. We calculated the contrast estimates by using active at T1 and T2 as reference category.

Results

Table 1 shows baseline characteristics of the two samples and the association between covariates and higher physical activity. Before retirement higher physical activity was more common among men than women in both samples. Low levels of mental and physical fatigue as well as being non-obese were also associated with higher physical activity at pre-retirement.

Analysis 1

The mean age of retirement in this sample (N=2,711) was 58 years (SD 2.4, range 50−66), and most of the employees (94%) had retired by the age of 60. The analyses were based on 19 673 observation years (on average 7.3 observations per person). Before retirement 58% of the participants reported walking at least five kilometres per week, 25% between 5 and 10 kilometres, and 17% more than 10 kilometres.

Figure 1 shows the age-adjusted prevalence estimates (95% CIs) for higher physical activity (i.e. walking ≥5 km per week) within the 9-year time window. Before retirement, the annual prevalence of men and women walking at least 5 km per week was around 40%. There was a significant difference in the prevalence of physical activity between the pre-, peri- and post-retirement periods in both men and women (P-value for interaction time *x* period <0.001 in both sexes) (Table 2a/b). The proportion of men walking at least five kilometers increased by 36% during Period 2. A lesser, 18%, increase was noticed during Period 1 and a non-significant 8% decrease in Period 3. In women, the sharpest increase (61%) in physical activity also occured during the retirement transition, in contrast to 14%−19% decreases in physical activity during the pre- and post-retirement phases. Importantly, a similar pattern of significant increases in physical activity, especially during Period 2, was noticed across all subgroups. Of the covariates, only depression significantly shaped the physical activity trajectory pattern among male respondents. Interestingly, during Period 2 the likelihood of higher physical activity increased more in men with elevated depressive symptoms compared to men with lower levels of depressive symptoms (PR

2.17 95% CI 1.45, 3.24 vs. PR 1.32 95% CI 1.21, 1.44, P-value (two-sided) for interaction covariate *x* time *x* period <0.05).

Table 3 shows the comparisons between the overall prevalences of higher physical activity in Period 3 compared to Period 1. Both men and women maintained higher prevalence of physical activity over the whole post-retirement period compared to the pre-retirement period (PR 1.13 95% CI 1.06, 1.19; PR 1.14 95% CI 1.05, 1.24, respectively). However, in some subgroups beneficial changes were no more maintained in Period 3. For example, men and women belonging to the lowest SES category or with elevated depressive symptoms, as well as female smokers and women with high levels of mental or physical fatigue were not able to maintain the increased level of physical activity post-retirement.

Sensitivity analyses

Sensitivity analysis with cumulative logistic regression replicated the main results by showing a significant difference in physical activity between the periods (interaction year*period p<0.001 in both sexes). In both men and women the sharpest increase in physical activity occurred during retirement transition (COR 1.99 95% CI 1.71, 2.31 in men; 2.23 95% CI 1.81, 2.74 in women), while slighter changes were noticed in pre- and post-retirement periods. In men, the proportion of those in higher physical activity groups increased significantly already in Period 1 i.e. during pre-retirement years (COR 1.32 95% CI 1.04, 1.67), while in women no trend was observed (COR 0.97 95% CI 0.75, 1.25). In Period 3, a decreasing trend was noticed in both sexes, even though statistically significant only in women (COR 0.86 95% CI 0.74, 1.01 in men; 0.74 95% CI 0.57, 0.95 in women). Despite the decreasing trend in Period 3, both men and women maintained a significantly higher level of physical activity over the whole post-retirement period compared to pre-retirement period (COR for the difference between Period 3 and Period 1 1.58 95% CI 1.40, 1.78 in men; COR 1.54 95% CI 1.32, 1.79 in women).

In another sensivity analysis, conducted among 1,492 participants who, in addition to one pre- and one post-retirement measurement, also provided data at the end of follow-up (year +4), the main result was replicated. In both men and women the biggest increase (48% and 85%, respectively) in physical activity occured during retirement transition (Period 2). The beneficial changes were also maintained post-retirement in both sexes (PR for the difference between Period 3 and Period 1 1.22 95% CI 1.11, 1.33 in men; 1.30 95% CI 1.09, 1.54 in women).

Analysis 2

The mean age of retirement was 56 (SD 2.4, Range 48−63), and 99% of individuals had retired by the age of 60. As shown in Table 4, the likelihood of engaging in sport activities increased pre- to post-retirement both in men and women (PR 1.15 95% CI 1.11, 1.20; PR 1.31 95% CI 1.23, 1.40, respectively). The frequency of sport activities increased to almost three-fold (PR 2.77 95% CI 1.94, 3.96) in women and to 1.6-fold in men. After retirement, male and female participants were also more likely to engage in sport activities in groups than alone, group activities being more frequent among men.

Repeated measures analysis of variance showed a significant difference in weight change pre- to post-retirement between different physical activity classes (P-value for physical activity change main effect <0.001), when adjusted for age and sex. Participants who either stopped taking part in leisure-time sports after retirement or who maintained an inactive lifestyle during the entire follow-up gained on average 0.85−1.35 kg more weight (corresponding 1.2−1.7% of participants' initial weight) compared to those engaging in leisure-time sports both before and after retirement (Table 5).

Discussion

In this large cohort of French national gas- and electricity company employees, statutory retirement was associated with a substantial increase in leisure-time physical activity. During the retirement transition, the prevalence of those walking at least 5 kilometers per week increased by 36% in men

and 61% in women. Since the main results were further confirmed by cumulative logistic regression, they hardly arise from an artbitrarily chosen cut-off point. In addition, the likelihood of engaging in sport activities, as well as sport frequency significantly increased in both sexes, the latter being especially pronounced in women. Importantly, the increase in physical activity over the retirement transition was observable even among those belonging to risk groups for low physical activity (e.g. smokers). Weight changes pre- to post-retirement appeared to be limited to a gain in weight among participants with low or decreasing levels of leisure-time physical activity, with no significant changes observable among those with increasing leisure-time physical activity. The reasons behind the retirement related increase in physical activity remain unknown, but multiple factors may be involved, such as social factors (8, 10), sense of purpose (28), more time availability and flexibility (8, 10), and increasing concerns about health and well-being post-retirement (8). Since the manner of exercise also changed (i.e. participants engaged more in group activities compared to exercising alone after retirement), social factors may have played a significant role as a motivating factor in this particular cohort.

In contrast to previous studies mostly relying on self-reported retirement data, we were able to use records including the exact year of retirement, which were collected by a single employer. Other strenghts include a large sample size and annually repeated measurements over an extended time window of 9 years. Even though observational evidence cannot be used to infer causality, alternative explanations of our results appear implausible. These data suggest that retirement is associated with benefits in terms of increasing physical activity.

The main limitation of this study was the reliance on self-reported physical activity and weight, as these data can be subject to recall and self-report bias (29). Previous studies suggest that the level of both moderate intensity physical activity and weight tends to be underestimated by responders (30-31). Also various characterictics of the respondents, such as age and education level, have been shown to affect self-reports of physical activity (30). A further limitation is that we

measured only leisure-time physical activity, rendering the estimations of the net changes in total physical activity impossible. It may be that people at work are actually more likely to achieve the recommended overall levels of physical activity compared to those already retired because for some people work involves a substantial amount of physical activity which is lost upon retirement (20). However, only a minority of the study participants retired from manual occupations (10%−12%) suggesting that net gains in physical activity after retirement are likely. Further, we were not able to define intensity of exercise, nor single session duration. These variables would be necessary when estimating energy consumption and net health effects of physical activity. With regard to weight changes, the main limitation was that we did not consider simultaneous changes in diet including alcohol consumption, which has been shown to increase in GAZEL cohort around retirement (32). Both the decrease in physical activities as well as unhealthier eating or drinking habits may contribute to weight changes at retirement as shown e.g. in the study of Nooyens et al. (2005) (20).

In large cohort studies, where the participants are followed by surveys for a long time, persons with severe illnesses or functional impairments tend to drop out (33) creating a healthy-survivor effect. Since physical inactivity is associated with many chronic diseases (2-3), it is likely that persons with the most severe conditions were lost to follow-up. The fact that the results remained essentially the same when the analysis was restricted to participants also providing data for year +4 following retirement suggests that any healthy-survivor effect is likely to be small. It is also noteworthy that the particularities of this cohort (e.g. stable job status, low statutory retirement age, and high pensions) may limit the generalizability to other working cohorts.

The observed increase in physical activity after retirement is in agreement with previous studies with shorter follow-up times (8-10). Supportive of our findings are also the results by Lahti et al. (2010) (16) stating that time spent in moderate intensity exercise (walking or alike) increased among retirees. However, contradictory results have also been reported (20-22). Berger et al. 2005 (22) reported only marginal increases in physical activity after retirement, and Slingerland

et al. (2007) (21) reported no association between retirement and any increase in sport participation or non-sport physical activity (including walking, cycling and gardening). However, these longitudinal studies had only 1 measure of physical activity at follow-up, preventing precise detection of changes in physical activity in relation to retirement. Nooyens et al. (2005) (20) also showed retirement to be associated with increases in weight and waist circumference, which in turn, were found to be related to decreases in several physical activities. However, these results were based on a small sample of 288 men. The results of the present study are also in agreement with, and may partly explain, the earlier findings from the same cohort that retirement is associated with improved self-rated health (34) and decreased prevalence of sleep problems (35).

One intriguing finding was that leisure-time physical activity increased significantly in men with higher levels of depression prior to retirement. However, retirement has been associated with a substantial reduction in mental and physical fatigue as well as depressive symptoms in this and other cohorts (36-38). Among older workers who feel tired of their work, the decrease in fatigue during retirement transition could increase energy resulting in a higher probability to spend time in stimulating and restorative activities, such as physical exercise. (39) Unfortunately, men who were depressed before retirement were not able to maintain the increased levels of physical activity beyond retirement transition. A similar phenomenon was noticed among women; female smokers, women with high levels of depression, high mental or physical fatigue, and those with high physical work demands increased their physical activity substantially during retirement transition, but were unable to maintain the benefits post-retirement. These findings show that also individuals belonging to "risk groups" of low physical activity have potential to improve their habits, when encountering a major life event. This is promising with regard to health promotion even though interventions aimed at maintaining high physical activity levels are crucial to ensure long-term improvements.

In this occupational cohort of French employees, a clear increase in leisure-time physical activity, walking and sport activities, was found in both men and women. These results highlight the importance of retirement as a life transition during which considerable changes in health habits are likely. Our findings should be taken into account by policymakers and those involved in planning and developing health promotion strategies for older employees.

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COMPETING INTERESTS

None.

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DATA SHARING

No data available.

CONTRIBUTORSHIP

All authors participated in writing of the manuscript, have seen the latest version of the manuscript and will take the full responsibility for the entire manuscript. In more detail: Authors Noora Sjösten and Jussi Vahtera designed the original hypothesis. Noora Sjösten analyzed the data, and drafted the first version of the manuscript, in close collaboration with Jussi Vahtera, who is a supervisor of this study. Jaana Pentti provided statistical advice and helped planning and conducting the statistical analyses. Marie Zins and Marcel Goldberg are the founders of GAZEL cohort and manage all the data. They also) made a significant contribution to the conception and design of this study. All other authors (MK, AS-M, JF, HW) significantly contributed to subsequent drafts, helped in interpretation of the results and revision of the text. All authors approved the final draft of the report.

Table 1. Baseline Characteristics of the Two Samples and Likelihood of High Physical Activity† by Different Covariates Expressed as Prevalence Ratios (PRs) and Their 95% Confidence Intervals (CIs), in EDF-GDF Employees, France.

	Analysis 1 N=2,711				Analysis 2 N=3,812			
	N	%	PR	95% CI	N	%	PR	95% CI
Demographics								
*Sex**								
Men	1703	62.8	1.00	ref.	2872	75.3	1.00	ref.
Women	1008	37.2	0.79	0.71, 0.88	940	24.7	0.84	0.74, 0.96
Age at retirement								
≤53	98	3.6	1.00	ref.	516	13.5	1.00	ref.
54−56	933	34.4	1.08	0.76, 1.54	1925	50.5	0.99	0.86, 1.06
≥57	1680	62.0	1.19	0.84, 1.68	1371	36.0	0.99	0.87, 1.13
Employment grade								
Higher	1104	40.8	1.00	ref.	1574	41.3	1.00	ref.
Intermediate	1281	47.3	1.01	0.91, 1.12	1855	48.7	0.90	0.82, 1.00
Lower	324	12.0	0.89	0.74, 1.07	380	10.0	0.90	0.75, 1.07
Marital status								
Married	2276	84.0	1.00	ref.	3325	87.2	1.00	ref.
Single, divorced or widowed	435	16.1	0.96	0.76, 1.22	487	12.8	1.04	0.90, 1.21
Work characteristics								
Night work								
No	2029	75.0	1.00	ref.	2572	67.5	1.00	ref.
Yes	679	25.1	0.92	0.82, 1.02	1236	32.5	1.07	0.97, 1.19
*Psychological work demands**								
Low	2090	77.7	1.00	ref.	2841	74.7	1.00	ref.
High	601	22.3	0.90	0.79, 1.01	960	25.3	0.95	0.86, 1.06
Physical work demands								
Low	2079	77.3	1.00	ref.	2817	74.1	1.00	ref.
High	612	22.7	1.04	0.93, 1.16	984	25.9	0.90	0.81, 1.01
Health								
*Mental fatigue**								

Low	2041	75.4	1.00	ref.	2848	74.7	1.00	ref.
High	667	24.6	0.84	0.75, 0.96	964	25.3	0.94	0.84, 1.04
*Physical fatigue**								
Low	1992	73.5	1.00	ref.	2833	74.3	1.00	ref.
High	718	26.5	0.85	0.75, 0.96	979	25.7	0.83	0.73, 0.93
Chronic diseases†								
No	1390	52.3	1.00	ref.	1941	50.9	1.00	ref.
Yes	1321	48.7	0.93	0.84, 1.02	1871	49.1	0.95	0.86, 1.04
*Depression**								
No	2381	87.8	1.00	ref.	3279	86.0	1.00	ref.
Yes	330	12.2	0.87	0.74, 1.03	533	14.0	0.93	0.81, 1.08
*Smoking**								
No	2209	81.6	1.00	ref.	3061	87.6	1.00	ref.
Yes	498	18.4	0.89	0.78, 1.02	433	12.4	0.84	0.74, 0.96
Alcohol consumption								
≤3	1816	77.3	1.00	ref.	2857	79.2	1.00	ref.
>3	532	22.7	0.99	0.89, 1.10	750	20.8	1.00	0.91, 1.11
BMI*								
<30	2111	90.6	1.00	ref.	3215	89.4	1.00	ref.
>=30	218	9.4	0.63	0.50, 0.80	381	10.6	0.59	0.45, 0.77

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, Prevalence ratio.

* P−value <0.100 for the difference between covariate classes in Analysis 1.

†High physical activity ≥5 km walking distance/week (Analysis 1); Likelihood of engaging in leisure-time sport (Analysis 2).

†† Chronic diseases = cancer, diabetes, chronic bronchitis, asthma, angina, myocardial infarction, stroke, osteoarthritis, and rheumatoid arthritis.

Models were adjusted for age and sex.

Table 2a. Age-Adjusted Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) of Higher Physical Activity in Pre-, Peri- and Post-Retirement Among Male EDF-GDF Employees, France, 2002−2009.

	MEN						
	Period 1		Period 2		Period 3		
	PR	95% CI	PR	95% CI	PR	95% CI	P−value*
All	1.18	1.03, 1.37	1.36	1.25, 1.48	0.92	0.85, 1.00	<0.001
SES							0.35
Higher	1.16	0.97, 1.39	1.46	1.31, 1.63	0.93	0.83, 1.03	
Intermediate	1.12	0.87, 1.44	1.17	1.01, 1.35	0.90	0.79, 1.02	
Lower	1.92	0.99, 3.72	1.78	1.21, 2.61	0.99	0.71, 1.37	
Age at retirement							0.27
□57	0.70	0.35, 1.41	1.44	1.25, 1.65	0.92	0.83, 1.02	
≥57	1.21	1.04, 1.40	1.31	1.18, 1.46	0.90	0.79, 1.02	
Psychological work demands							0.86
Low	1.20	1.03, 1.41	1.34	1.22, 1.48	0.91	0.83, 1.00	
High	1.14	0.81, 1.61	1.44	1.18, 1.75	0.97	0.82, 1.14	
Mental fatigue							
Low	1.16	1.00, 1.35	1.30	1.18, 1.42	0.92	0.84, 1.00	0.33
High	1.36	0.89, 2.09	1.68	1.34, 2.11	0.94	0.78, 1.13	
Physical fatigue							
Low	1.20	1.03, 1.40	1.34	1.22, 1.47	0.92	0.84, 1.00	0.86
High	1.16	0.79, 1.72	1.47	1.19, 1.81	0.94	0.78, 1.14	
BMI							0.61
<30	1.19	1.03, 1.38	1.34	1.23, 1.46	0.91	0.84, 0.99	
>=30	1.02	0.52, 1.98	1.73	1.17, 2.55	1.02	0.73, 1.43	
Smoking							0.23
No	1.22	1.05, 1.43	1.34	1.22, 1.46	0.94	0.86, 1.03	
Yes	1.00	0.70, 1.44	1.49	1.20, 1.85	0.82	0.69, 0.99	
Depression							0.05
No	1.21	1.05, 1.40	1.32	1.21, 1.44	0.92	0.85, 1.00	
Yes	0.80	0.38, 1.70	2.17	1.45, 3.24	0.90	0.64, 1.26	

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.

* P−values (two-sided) refer to interaction time *x* period *x* covariate (except for All, where P-value refers to period main effect).

Period 1= years −4 to −2 (pre-retirement); Period 2 = years 1− to +1 (peri-retirement); Period 3 = years +2 to +4 (post-retirement).

Models were adjusted for age at retirement.

Table 2b. Age-Adjusted Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) of Higher Physical Activity in Pre-, Peri- and Post-Retirement Among Female EDF-GDF Employees, France, 2002−2009.

	WOMEN						
	Period 1		Period 2		Period 3		
	PR	95% CI	PR	95% CI	PR	95% CI	P−value*
All	0.91	0.75, 1.09	1.61	1.40, 1.86	0.86	0.74, 0.99	<0.001
SES							0.99
Higher	1.05	0.69, 1.58	1.69	1.22, 2.35	0.88	0.61, 1.28	
Intermediate	0.88	0.69, 1.12	1.63	1.37, 1.94	0.87	0.73, 1.03	
Lower	0.86	0.55, 1.34	1.46	1.03, 2.06	0.78	0.51, 1.19	
Age at retirement							0.10
<57	0.86	0.66, 1.12	1.86	1.55, 2.23	0.86	0.73, 1.02	
≥57	0.98	0.75, 1.29	1.28	1.03, 1.58	0.84	0.63, 1.12	
Psychological work demands							0.69
Low	0.90	0.73, 1.11	1.54	1.32, 1.80	0.85	0.71, 1.00	
High	0.92	0.58, 1.45	2.04	1.43, 2.90	0.93	0.67, 1.25	
Mental fatigue							
Low	0.96	0.78, 1.18	1.54	1.31, 1.82	0.91	0.77, 1.08	0.23
High	0.76	0.50, 1.17	1.85	1.40, 2.44	0.75	0.56, 1.00	
Physical fatigue							
Low	0.94	0.76, 1.16	1.58	1.34, 1.85	0.85	0.72, 1.01	0.77
High	0.84	0.56, 1.25	1.71	1.29, 2.27	0.90	0.67, 1.19	
BMI							0.84
<30	0.91	0.75, 1.10	1.63	1.42, 1.88	0.85	0.73, 0.98	
>=30	0.95	0.41, 2.20	1.37	0.53, 3.52	1.12	0.41, 3.11	
Smoking							0.48
No	0.92	0.76, 1.12	1.53	1.32, 1.78	0.83	0.71, 0.97	
Yes	0.83	0.47, 1.46	2.20	1.46, 3.33	1.05	0.67, 1.63	
Depression							0.12
No	0.98	0.80, 1.20	1.54	1.31, 1.81	0.86	0.73, 1.03	
Yes	0.60	0.36, 1.00	1.88	1.42, 2.49	0.83	0.64, 1.09	

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.

* P−values (two-sided) refer to interaction time *x* period *x* covariate (except for All, where P-value refers to period main effect).

Period 1= years −4 to −2 (pre-retirement); Period 2 = years 1− to +1 (peri-retirement); Period 3 = years +2 to +4 (post-retirement).

Models were adjusted for age at retirement.

Table 3. Differences in Physical Activity Between Period 3 and Period 1, Expressed as Prevalence Ratios (PRs) and their 95% Confidence Intervals (CIs), Among EDF-GDF Employees, France, 2002−2009.

	MEN			WOMEN		
	Period 3 vs. period 1			Period 3 vs. period 1		
	PR	95% CI	P−value	PR (95% CI)		P−value
All	1.13	1.06, 1.19	<0.001	1.14	1.05, 1.24	0.006
Employment grade			0.03			0.37
Higher	1.31	1.13, 1.52		1.20	0.83, 1.73	
Intermediate	1.24	1.02, 1.50		1.34	1.11, 1.61	
Lower	0.83	0.53, 1.33		1.07	0.77, 1.48	
Age at retirement			0.55			0.63
>57	1.13	0.99, 1.29		1.17	1.05, 1.31	
≥57	1.10	1.02, 1.18		1.10	0.96, 1.26	
Psychological work demands			0.85			0.30
Low	1.12	1.05, 1.19		1.15	1.04, 1.26	
High	1.16	1.02, 1.33		1.17	0.96, 1.43	
Mental fatigue			0.77			0.05
Low	1.11	1.04, 1.18		1.19	1.08, 1.31	
High	1.16	1.00, 1.35		1.05	0.87, 1.27	
Physical fatigue			0.42			0.06
Low	1.12	1.05, 1.19		1.19	1.08, 1.31	
High	1.16	1.00, 1.36		1.06	0.89, 1.27	
BMI			0.19			0.03
<30	1.09	1.00, 1.20		1.23	1.11, 1.36	
≥30	1.14	1.05, 1.22		0.95	0.80, 1.12	
Smoking			0.77			0.05
No	1.12	1.05, 1.19		1.18	1.08, 1.30	
Yes	1.17	1.01, 1.36		0.91	0.72, 1.15	
Depression			0.18			0.13
No	1.14	1.07, 1.21		1.16	1.06, 1.28	
Yes	0.95	0.73, 1.22		1.07	0.88, 1.31	

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.

*P−values (two-sided) refer to interaction covariate *x* period (except for **All**, where P−value refers to period main effect).

Period 1= years −4 to −2 (pre−retirement); Period 2 = years 1− to +1 (peri−retirement); Period 3=years +2 to +4 (post−retirement).

Models were adjusted for age at retirement.

Table 4. Likelihood of Sports Activities During Post-retirement Compared to Pre-retirement Years, Expressed as Prevalence Ratios (PRs) and Their 95% Confidence Intervals (CIs), Among EDF-GDF Employees, France, 2000−2007.

	All		Men		Women		
	PR	95% CI	PR	95% CI	PR	95% CI	P−value*
Sport activity (active vs. inactive)	1.19	1.15, 1.23	1.15	1.11, 1.20	1.31	1.23, 1.40	<0.001
Sport frequency (moderate vs. high)	1.77	1.56, 2.00	1.62	1.42, 1.85	2.77	1.94, 3.96	0.02
Sport manner (group vs. alone)	1.68	1.48, 1.91	1.28	1.19, 1.38	1.11	1.04, 1.19	<0.001

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; PR, prevalence ratio.
*P-values (two-sided) refer to interaction sex *x* year.
Adjusted for age at retirement.

Table 5b. Differences in Weight Changes in different Categories of Physical Activity compared to Participants who were Physically Active during whole Study Period, Expressed as Least Square Means (LS-means) and their 95% Confidence Intervals (CIs), and as Procentual Changes from Initial Pre-retirement Weight.

	Between group differences in weight changes (kg/% of initial weight) from pre- to post-retirement								
	All			Men			Women		
	LS-means kg (%)	95% CI	P−value*	LS-means kg (%)	95% CI	P−value*	LS-means kg (%)	95% CI	P−value*
Inactive vs. active	0.85 (1.2)	0.48, 1.21	<0.001	0.65 (0.8)	0.24, 1.06	<0.01	1.52 (2.3)	0.75, 2.28	<0.001
Increasing vs. active	−0.15 (-0.1)	−0.53, 0.24	0.45	−0.38 (-0.4)	−0.83, 0.07	0.10	0.48 (0.7)	−0.23, 1.19	0.19
Decreasing vs. active	1.35 (1.7)	0.79, 1.90	<0.001	1.36 (1.6)	0.74, 1.99	<0.001	1.22 (1.8)	0.01, 2.44	0.05

Abbreviations: CI, confidence interval; EDF-GDF, Eléctricité de France-Gaz de France; LS-means, least square means.
*P-values (two-sided) refer to differences between the two classes in repeated measures ANOVA contrast estimates.
Adjusted for age at retirement. Active both in 2000 and 2007 used as a reference.

Number of Responders During the Follow-Up.

Year	−4	−3	−2	−1	0	+1	+2	+3	+4
Men	480	625	875	1,474	1,506	1,546	1,424	1,223	1,030
Women	423	508	593	847	856	876	712	584	457

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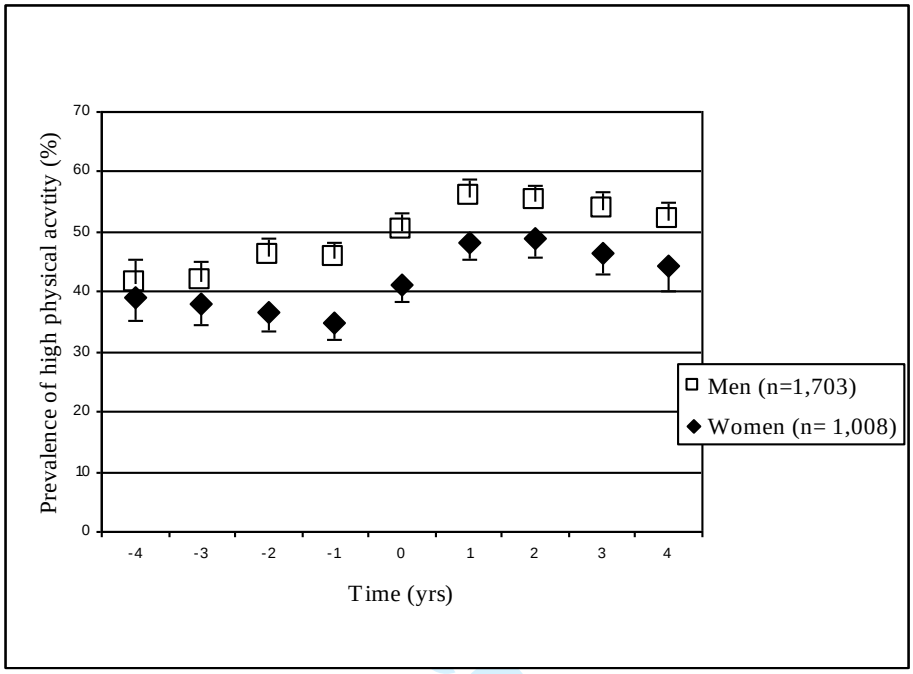

Figure 1. Proportion of Men and Women Walking at Least 5 Kilometres per Week in Relation to the Year of Retirement (Year 0) Among Eléctricité de France-Gaz de France (EDF-GDF) Employees, France, 2002-2009. Adjusted for age.