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ORIGINAL ARTICLE

Physical activity and retirement: original analysis of responses to the English Adult Active Lives Survey

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Abstract

Objectives Opportunities for older adults to do physical activity may depend on other commitments. We wanted to see if reported physical activity was higher or lower among older adults depending on work status: full-time, part-time work or retired.

Methods This is a secondary analysis of The Active Lives Survey 2016/17 in England. The dataset was used to see how active people were depending on employment or retirement status. Types of physical activity (PA) considered were: leisure, gardening, active travel and combined total, adjusted for age, sex, BMI, disability, rurality and deprivation in models using hurdle regression. Analysis was divided into mostly working age (under 65) or mostly retired (age 65 +) to have sensitivity to the likely transition point.

Results Total PA was significantly greater for retired persons compared to both full- and part-time workers age 55–64, while being retired or working part-time at age 65–74 meant more PA. People did more leisure or gardening with less work, but active travel decreased with fewer work hours, at all ages. Retirement meant more leisure and gardening PA but less active travel.

Conclusions Demand for opportunities to engage in leisure and gardening PA appears to be high among retired people. Greater promotion of active travel in this cohort may be possible.

Keywords Physical activity · Older people · Public health · Retirement · Gardening · Active travel

Introduction

Retirement is a complex process and a major life and employment transition that impacts all aspects of health and well-being, including physical activity. Staying physically active is widely promoted to ensure good health in later years of life, yet physical activity (PA) tends to decline following retirement, especially in lower socioeconomic groups (Lloyd 2011; Yorston et al. 2012). Loss of occupational and travel-linked PA contributes to net reductions in PA after retirement (Berger et al. 2005), even as recreational and household PA tends to increase, at least in early years after retirement (Barnett et al. 2014).

The process of transitioning to retirement in England has been estimated to take an average 10 years (Banks et al. 2016); this long period should offer many types of opportunities for interventions that can compensate for reduced occupational and active travel PA that was linked to work. Understanding the perspectives of older adults about PA could also inform interventions for them. Compared to younger adults, older adults may be more aware of potential health benefits from staying active (Caudroit et al. 2011). Equally, retired people have distinctive perceptions of their time and energy availability for doing physical activity (Devereux-Fitzgerald et al. 2018; McDonald et al. 2015). Self-efficacy (Caudroit et al. 2011) and identity issues are pertinent; older adults without a past history of being physically active may find it especially difficult to

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envision themselves as someone who could start to routinely undertake PA (Kosteli et al. 2016).

There are many potential "favourable and unfavourable lifestyle changes" at retirement that can influence total PA (Zantinge et al. 2013). These changes impact maintenance, sustainability of feasible forms of PA, motivations, financial resources, personal circumstances (such as caring responsibilities), personal mobility, perceived benefits of PA, resilience and social expectations. Some longitudinal studies found that retirees reported significantly greater PA, particularly in walking and moderate-intensity activities, compared with pre-retirement. However, Ding et al. (2016) observed that any "activity-promoting effect" of retirement is likely to most benefit those who retired at a younger age, who have better baseline physical function, and/or those who worked full time prior to retirement. Evidence on other populations also suggested that while leisure-time PA tends to increase among the retired and those transitioning to retirement, overall PA does not necessarily increase (Hobbs et al. 2013; McDonald et al. 2015) and net total PA may in fact decrease post-retirement (Holstila et al. 2017). In longitudinal analysis, Stenholm et al. (2016) observed an early sharp rise in physical activity in the first few years after retirement, followed by decline to pre-retirement levels typically within 5–10 years. Vigorous PA levels had a linear decline in older adults with increased age that was unaffected by retirement.

Increased age alone means increased risk of poor health or disability that can make PA more difficult (Büchs et al. 2018; Franco et al. 2015). Socioeconomic status and gender are important factors that can interact with quality and quantity of physical activity throughout the life course, including among older adults (Barnett et al. 2012, 2013). Participation barriers identified for older adults include lack of confidence, apathy, and lack of appropriate activities or activity leaders (Franco et al. 2015). Older adults are highly influenced by environmental features when deciding whether to engage in outdoor PA. Unpleasant neighbourhood features (such as litter or lack of pedestrian paths) are discouraging, while attractive environmental features (such as parks and cafes) seem to encourage greater PA (Cerin et al. 2017; Franco et al. 2015).

Separate from the effects of increased age, retirement affects PA in other ways. There may be more time for physical activity, but also new potential for competing activities that are higher priority, such as caring responsibilities (Franco et al. 2015; International Longevity Centre 2017). Reduced income is a possible barrier (Franco et al. 2015), as well as the loss of a daily structure which previously enabled and facilitated PA (Banks et al. 2016; Kosteli et al. 2016; McDonald et al. 2015).

As part of a wider study looking for intervention opportunities to support PA during the transition period to retirement, we were given unique access to a large and recent survey of physical activity for adults living in England. The data have not previously been subject to in-depth analysis. The survey included questions about many demographic traits, including employment status. Our primary objective was to explore if and how participation in or levels of physical activity seemed to be higher among those in work or who were retired.

Methods

Active Lives Survey

The Adult Active Lives Survey 2016/2017 (ALS1617) was conducted by the professional polling company Ipsos MORI on behalf of Sport England (Ipsos Mori 2018; Sport England 2015, 2018). Sport England is a semi-autonomous, publicly funded body tasked to promote and develop public sport and physical recreation in England, UK (Sport England 2009). A target of 500 returns was set from each local authority in England, with survey invitations sent to randomly selected addresses from a database for all UK residents maintained by the Royal Mail (encompassing all local government areas). Response rate for 2016–2017 is not published, but the response rate for the Active Lives Survey undertaken in 2015–2016 was 18.9% (Ipsos Mori 2017). Data were collected from November 2016 to November 2017 using both web survey forms (52%) and paper questionnaires (48%). Table 3 in the electronic supplementary material shows socio-demographic profile of respondents by model of response (paper or online). Females, persons without qualifications and in lower occupational groups were more likely to reply using paper. The sampling strategy is described in Ipsos Mori (2017) and was designed to be representative of the population across key demographic variables (such as age, geographic spread and levels of deprivation). Only households in England were eligible, and only persons age 16 + were considered in the sampling strategy. A maximum of two persons could respond from each household. The sampling frame and targets were intended to elicit responses from diverse demographic and geographic areas rather than calculated to satisfy any specific statistical query. Participants were informed that their replies would be used to help provide better services. Ethics approval for this secondary analysis was not required because consent was implied by submitting the completed questionnaire. Respondents were rewarded with a £5 shopping voucher. The final cleaned dataset described 198,911 individuals (age 16 +), of whom 93,509 were persons age 55 + years.

Although we had access to the ALS1617, we are not authorised by the data provider to share the original data onwards so only summary results are made available here.

The questions asked about specific physical activities people did in the preceding 28 days, duration, frequency, and whether the PA raised their breathing rate or made them sweaty. PA done for leisure or sport, gardening and active travel (cycling or walking for transport) was asked about. The questionnaire did not ask about physical activity connected to indoor domestic activity (such as home maintenance or housework) or occupation (except when occupational PA could also be categorised as active travel).

Reported PA was further categorised as moderate or vigorous by either (by respondents or assumed by questionnaire coding rules), as:

- *Moderate activity* Heart rate raised to put individual a little out of breath.
- *Vigorous activity* Breathing hard and fast and heart rate increased significantly.

Moderate and vigorous were the only two categories considered by the data provider. They were combined to come up with a single metric for each specific type of activity using methods described by Milton et al. (2017) and briefly summarised here. Automatic coding by the questionnaire for some types of activity into moderate or vigorous helped to reduce question burden on respondents and helped ensure consistency of categorisation across the respondent group for similar activities; for instance, all walking was assumed to be moderate and all running was assumed to be vigorous. "Moderate-intensity equivalent minutes" (MIEMs) were calculated for each respondent by the data provider. MIEMs have been validated as acceptably robust but not data-demanding indicators of total physical activity in population surveys (Milton et al. 2017). MIEMs in the ALS1617 were determined both by self-reported intensity (whether breathing rate was raised slightly or strongly) and type of activity. When calculating MIEMs, each ''moderate'' minute counted as 1 min, but a vigorous activity counted for double. For instance, a single 10-min walk was 10 MIEMs, while a vigorous 10-min run equalled 20 MIEMs. MIEMs were calculated from all PA sessions of at least 10-min duration, reported during the previous 28 days divided by four to produce a typical average over 7 days.

The ALS1617 also asked for gender, age, working status, disability, height and weight. Disability was defined as an individual reporting that they had a physical or mental condition that has lasted or will last at least 12 months, and that substantially affected their ability to do normal daily activities. Respondents' residence area was categorised by deprivation level by the data provider (Sport England) and (categorised by decile within the Index of Multiple Deprivation 2015; Department for Communities and Local Government 2015). Each decile categorises an exclusive 10% of the entire population in England according to weighted scoring in seven social domains: employment, health, income, education, crime, barriers to services and living environment. Different groupings of the deprivation indicators were tried (alternative results not fully elucidated here). A simple two-tier distinction: three highest deciles or seven lowest deciles had best fit in the final models. The survey was also provided with an indicator of relative urban density or rurality for each respondent, using a schema developed for the Office of National Statistics (Bibby and Brindley 2012). Retaining the full range of urban/rurality categories led to the best model fits.

Occupational category and the highest educational qualification obtained were also available in the dataset, but these variables were excluded from analysis for many reasons. Occupation and education were highly collinear with each other and fairly collinear with the deprivation indicator (IMD2015). The IMD2015 combines education and employment aspects. Unlike the IMD2015, education and occupation were prone to self-report biases including misclassification. Occupational group was selected by respondents using a short list of exemplars; people with job titles not listed had to guess at their closest match. The highest education level was generalised; people who had any qualifications after the age of 18 were in the same group (48% of respondents). This highest education level included any university degree as well as skilled technical trade apprenticeships. Occupation group and/or education level were missing for 22% of respondents, while IMD2015 decile was unknown for only two persons. Similarly, ethnicity was collected in the survey, but we excluded this variable because of lack of diversity: 91.1% of respondents identified as white British.

Analysis of the ALS1617

We focused on the period closest to retirement for most people. Although the timing is very individual, *most* people living in England retire close to the statutory pension age (SPA Hofaecker et al. 2016). 65 years and 62 years were the SPAs for men and women, respectively, in 2016–2017, with SPA rising to 65 years for women by November 2018. We wanted our modelling to be sensitive to seeing changes at the most likely transition point, when there may be unique opportunities for interventions that support retaining healthy PA habits into retirement years. We found that the percentages of persons in retirement significantly rose around age 63–65 years so we stratified the data into two age bands (55–64 and 65–74 years). Within these groups, we considered all persons in full-time work, part-time work or who were fully retired. Of the 93,509 respondents who

were age 55 + , 74,188 were age 55–74. We did not analyse persons in some work status categories (unemployed, students, keeping house or never worked) due to small numbers in each group so that we could focus on differences between working and retired persons. For PA indicators, we used four MIEMs measures derived from or provided with the ALS1617: leisure PA (defined as all PA done for fun, fitness or sport, but excluding gardening and active travel), gardening PA, active travel PA and totals of all three previous, which for brevity we call ''total PA''. We acknowledge that our label ''total PA'' is imperfect due to categories of PA (occupational and indoor domestic) not asked about in the original survey.

For all PA indicators, the distribution of MIEMs values was skewed: mostly relatively low values (including many zeros; 19% of people age 55–74 reported zero MIEMs) with a tiny percentage of extremely high values. We applied hurdle regression, which modelled PA participation in two separate models: one model for participation in PA or not (dichotomous outcome in a logit model) and a separate model (continuous response variable) to predict amount of MIEMs among those who reported any PA (using a zero-truncated negative binomial model). The models adjusted for age, sex, BMI group, disability, season, rurality and deprivation, looking at all four types of PA. The ALS1617 dataset had been cleaned but still retained any plausible answers. Relatively extreme reports for MIEM values (2.0% of total), which were defined as MIEMs $\geq$ 3360 (equivalent to $\geq$ 8 h of moderate activity, 7 days/week), were excluded to get better statistical model fit for the vast majority of observations. Tables 1 and 2 describe the independent variables used in the models and participant characteristics. Most data were available for most respondents.

The models treated full-time workers as the reference category. Differences between part-time workers and retired people were reported using odds ratios (any reported participation in PA model) or incidence risk ratios (MIEMs values among those who reported any PA). Data and statistical analysis were undertaken in SPSS (v. 25), MS-Excel 2016 and Stata (v. 15.1).

Results

Unadjusted models and full model specifications are in Supplementary Material (Tables 3–4 and Models 1–16), while this report focuses on work status in adjusted models. Table 3 in the main manuscript shows the results from first stage of each hurdle model that related participation in each type of PA with work status. In adjusted models for both age groups, people tend to be more likely to report doing some leisure PA or gardening when they report less employment. With respect to leisure PA and with full-time workers under 65 as referent, part-time workers had OR 1.23 (95% CI 1.13–1.33) for leisure PA and retired persons had OR 1.48 (95% CI 1.36–1.60). Similarly, with respect to gardening MIEMs and with full-time workers under 65 as referent, part-time workers had OR 1.17 (95% CI 1.10–1.25) while likelihood of retired persons engaging in gardening had OR 1.35 (95% CI 1.26–1.44).

Among the under-65 s, propensity to engage in active travel was similar for FT and PT workers. FT workers were the referent, and OR for part-timers was not significantly different with OR 1.04 (95% CI 0.98–1.11). However, retired persons under 65 were much less likely to engage in active travel, OR 0.91 (95% CI 0.85–0.97).

In contrast, any participation in active travel was more common for age 65–74 part-time workers (OR 1.34, 95% CI 1.16–1.56) than same age group full-time workers (referent) *or* retired persons (OR 0.94, 95% CI 0.82–1.07). Among respondents age 65–74, there was a non-significant difference in likelihood of participation in active travel between full-time workers and the retired. This last result could arise from the relatively small number of persons in full-time employment in the age 65–74 group (n = 1360). Among the age 65–74 respondents, both retired persons (OR 1.71, 95% CI 1.46–1.99) and part-timers (OR 1.61, 95% CI 1.41–1.83) reported significantly more propensity to undertake leisure PA than did the referent full time workers. Gardening was similarly more likely among the part-timers and retired than among people working full time.

Table 4 shows the relationship between work status and median MIEMs/week in each PA category, among those who engaged at all in each type of PA (age stratified). Differences are reported as incidence risk ratios (IRR) with 95% confidence intervals. IRR with 95% confidence intervals entirely below 1.0 strongly suggested *less* active travel PA for retired persons but IRR with 95% confidence intervals above 1.0 suggest *higher* leisure and gardening PA for retired persons.

Physical activity: total and leisure

Leisure was the main type of activity generating MIEMs for most people and dominates the aggregate results. Full-time workers age 55–64 reported significantly less total or leisure PA than people working part-time. For leisure PA, with full-time workers as referent, part-time workers had IRR 1.04 (95% CI 1.01–1.08) and the corresponding IRR for retired people was 1.21 (95% CI 1.17–1.25, $p < 0.001$). At age 65–74, the retired reported more leisure PA than workers. Retired and part-timer median reported MIEMs were, respectively, 407 and 420, which did not seem to be significantly different from each other (evidenced by

Table 1 Variables used in regression models, England, UK, 2016–2017

Attribute	Description, with reference category indicated, where relevant
Age	In complete years
Body mass index group (BMI group)	Calculated from self-reported height and weight
	Reduced by authors to 3 useable categories = healthy weight (reference); underweight or overweight (both one category away from being a healthy weight); obese or morbidly obese
Disability	2 useable categories = with or without limiting disability
Gender	2 useable categories = male or female
Index of multiple deprivation 2015	2 useable categories, least deprived 7 deciles as reference, variant = three most deprived deciles (ideally three deciles would have been 30% of total responses but in reality was $\sim$ 24.6% of responses)
Rural/urban classification of home address, from ONS RUCLAD data	6 useable categories available. Categories = urban major conurbation; urban minor conurbation
	Urban city and town; rural town; village; hamlet
Season (quarter) when survey was submitted	Winter (16 Nov–15 Feb) was used as reference category, others = spring (16 February–15 May), summer (16 May–15 August) and autumn (16 August–15 November)
Working status	Models only consider 3 categories: working full time (reference), working part-time or retired. Respondents were asked to select their ''main status'' and defined for selves what (how many hours) full-time or part-time meant

Participant age, dates used to assign season and the rural/urban categories were chosen and supplied by the data provider, and used in our models in these original categories

BMI, deprivation, disability and gender were available using many categories in the original supplied dataset but were simplified by the authors to fewer categories as described above

For the models, we only considered individuals with one of the three self-identified work status descriptions: working full time, working part-time or retired

ONS Office of National Statistics, *RUCLAD* rural–urban classification of local authority districts

overlapping IRR confidence intervals) for age 65–74. Both retired (IRR 1.18, 95% CI 1.10–1.26) and part-time workers (IRR 1.10, 95% CI 1.02–1.19) age 65–74 reported significantly more leisure MIEMs than full-time workers.

Gardening

People were much more likely to report doing any gardening if retired or part-time employed than if working full time. The median reported MIEMs spent gardening was relatively consistent, either 180 MIEMs (age 55–64 working PT or FT) or 240 MIEMs (retired persons age 55–64 and all persons age 65–74). Nevertheless, significantly more gardening MIEMs were done by age 55–64 part-timers (IRR 1.06, 95% CI 1.00–1.12), age 55–64 retired persons (IRR 1.27, 95% CI 1.21–1.34) and age 65–74 retired persons (IRR 1.19, 95% CI 1.07–1.32). It should be stated that gardening was still a minority past time; 67% of people age 55–74 reported no gardening in the preceding 4 weeks (so recorded zero MIEMs). Among those who did any gardening PA, gardening comprised (on average) about 45% of total reported MIEMs whether working or retired.

Active travel

For the age 55–64 group, reported levels of active travel in Table 4 were significantly lower in those who were part-time and retired, compared to those working full time (median 150 or 148 MIEMs vs. 180 MIEMs, approximate IRR 0.81, $p < 0.001$). At age 65–74 years, there was also significant difference in active travel participation between full-time workers and either part-timers or the retired (median 180 MIEMs vs. 150 MIEMs, approximate IRR 0.83). An alternative comparison for impacts of work status on active travel PA may provide better insight to whether more work seems to encourage active transport. Instead of comparing MIEMs for the PT or retired to FT workers, when we compare FT versus combined group of PT + retired at age 65–74, this yields OR = 0.82 (95% CI 0.71–0.93). 67% of people age 55–64 and 75% of those age 65–74 reported no active travel (walking or cycling) in the preceding 4 weeks. For those who did any active travel, active travel comprised (on average) approximately 37% of reported MIEMs, whether working or retired.

Table 2 Characteristics of survey respondents, England, UK, 2016–2017

Parameter	Age 55–64 $N = 37,124$	Age 65–74 $N = 37,064$	Missing or unuseable data
Age	59.6 years mean	69.2 years mean	None
	60 years median	69 years median	
% In each BMI group			
Healthy	37.4%	37.4%	2 out of plausible range; 7055 (9.5%) didn't know or couldn't say height/weight
Under or overweight	34.1%	37.4%	
Obese/morbidly obese	18.1%	16.8%	
Unuseable data	10.4%	8.6%	
% Reporting limiting disability			
Yes	18.1%	21.9%	3731 responses (5.03% of all those age 55–74 years)
% Female	55.3%	50.4%	2 respondents reported ''other''
% In 3 most deprived IMD2015 decile areas	26.47%	23.8%	2 responses had no data
Rural/urban classification (%) living in each area			
Major conurbation	25.4%	23.5%	2 responses had no data
Minor conurbation	3.6%	3.2%	
City and town	45.9%	46.4%	
Rural town	11.2%	12.3%	
Rural village	8.6%	9.5%	
Rural hamlets	5.2%	5.1%	
Season when questionnaires were returned			
Winter	23.4%	23.4%	No data missing
Spring	26.4%	26.2%	
Summer	21.4%	21.1%	
Autumn	28.9%	29.3%	
Working status			
Working full time	35.6%	3.7%	1862 (2.6%) records without data; 6436 (8.7%) in ineligible categories
Working part-time	22.2%	9.6%	
Retired	27.1%	79.4%	
Other	13.7%	3.6%	
Missing	1.4%	3.7%	

BMI body mass index, *IMD2015* index of multiple deprivation 2015 version

Discussion

Reported leisure- and gardening-related physical activity among persons age 55–74 was greatest when retired and much greater than reported by full-time workers. Reported leisure and gardening PA among retired persons age 55–64 was also greater than for part-time workers of the same age, but this difference for part-time workers and retired people was negligible for age 65–74. The reported increase in leisure and gardening PA was greater than implied decline in active travel for the same comparator groups. We found our stratification into the two age groups useful because it did indicate different preferences in physical activity patterns for persons who tended to be below or above typical retirement age (about 65). The distinctions between mostly still working and mostly early post-retirement age could help to inform intervention strategies targeted at persons in the transition period from working to retirement status. Similar to other cross-sectional surveys on older adults at about retirement age in Britain, we found that walking was the most popular leisure physical activity for persons age 55–74 (Bélanger et al. 2011; Martin et al. 2014).

Decline in active travel following retirement was reported in cohort analysis of residents in England (Barnett et al. 2014). Such decline is posited to relate to loss of

Table 3 Hurdle modelling, stage 1 (logit regression) odds ratios for participation or not in physical activity (in preceding 28 days), England, UK, 2016–2017

Work status	Max *N*	All PA	Leisure PA	Gardening only	Active travel only
Adults age 55–64					
Work FT	13,223	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Work PT	8239	1.26 (1.16–1.38)	1.23 (1.13–1.33)	1.17 (1.10–1.25)	1.04 (0.98–1.11)
Retired	10,073	1.54 (1.41–1.69)	1.48 (1.36–1.60)	1.35 (1.26–1.44)	0.91 (0.85–0.97)
Adults age 65–74					
Work FT	1360	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Work PT	3553	1.65 (1.40–1.95)	1.71 (1.46–1.99)	1.26 (1.09–1.45)	1.34 (1.16–1.56)
Retired	29,412	1.60 (1.39–1.85)	1.61 (1.41–1.83)	1.37 (1.20–1.55)	0.94 (0.82–1.07)

All models adjust for age, sex, presence of limiting disability, seasonal quarter, deprivation, BMI and urbanness/rurality of residence

95% confidence intervals for stated OR are in (). All OR reported in Table 3 are significant at $p \leq 0.05$

OR odds ratios (adjusted), *N* refers to maximum possible rather than actual number of observations for each model (missing data meant actual numbers were lower), *FT* full-time (working), *PT* part-time, *IRR* incidence risk ratio, *PA* physical activity, *ref* reference category

structure and routine that were provided by previous occupational duties. One way that structure (that facilitates PA) could be regained is via activities like dog walking, gardening and regular voluntary work activities. Voluntary work examples are conservation, leading walking groups or sports coaching, which have the potential to beneficially replace physical activity opportunities that arose due to employment activity. A policy in Britain known to successfully increase active travel (walking) is provision of free local bus passes for older persons (Coronini-Cronberg et al. 2012). Perhaps in contrast to active travel, gardening is a type of PA socially acceptable to older adults and that conforms with identity expectations about social position and advancing age (Bhatti 2006). Determinants and motivators for doing PA are often described as highly individual (McDonald et al. 2015), and the best theoretical framework for designing physical activity interventions that target older people or adults in transition to retirement remains unclear (Morgan and Tan 2018).

Because the ALS1617 data are cross-sectional, we cannot confirm *change* in activity after retirement or due to retirement. However, the implications are clear: retired people report more leisure and gardening PA, but less active travel PA, than working persons of the same age. A picture also emerges of a minority of very active older adults who several times over met the UK Chief Medical Officers' (CMO) guidelines to achieve at least 150 MIEMs/week (Chief Medical Officers 2011). Of those respondents (retired or still working) who engaged in any active travel, at least 50% met the CMO guidelines from active travel alone. The same is true of respondents who engaged in any gardening; at least 50% met the CMO guidelines from gardening alone. Many older adult respondents to the ALS1617 demonstrated ample appetite to undertake PA during retirement, at least within the leisure and gardening PA categories. We have also evidenced a widespread belief (but not often documented in scientific literature) that older adults like gardening; gardening was the second most popular physical activity in the previous year for ALS1617 respondents age 55 + (Supplementary Material, Tables 1–2). Combined indoor and outdoor domestic PA, a category which includes gardening, was shown in one cross-sectional survey to become a large proportion of all PA (about 35% of all PA on average) among adults over retirement age who achieved recommended total weekly targets for all PA (Bélanger et al. 2011).

Limitations

Our analysis could not address differences in indoor domestic or occupational PA (as this was a secondary data analysis and that information was not collected in the original survey), and hence, we could not evaluate subsequent potential impact on either total true PA or health outcomes. It merits mention that the health benefits of occupational PA are contested (Coenen et al. 2018; Holtermann et al. 2012). To focus on the specific possible effects of retirement, we excluded many work status categories: unemployed, students, having never worked or long term unable to work due to sickness/disability; we have no findings about these other populations, but neither would inclusion of these categories have informed the question about how retirement from paid work may be linked to preferences in physical activity patterns. Ethnicity was not part of our analysis due to data paucity; a larger or more targeted survey would have made comparisons between ethnic sub-groups appropriate. Whether respondents worked full time or part-time or were retired was self-reported, this response was a subjective perception rather than explicitly defined. We categorised and stratified

Table 4 Stage 2 hurdle models (zero-truncated negative binomial)

Adults age 55–64						Adults age 65–74				
Work status	Max *N*	Median MIEMs	Difference from working FT	Adjusted IRR	Adjusted IRR 95% CI	*N*	Median MIEMs	Difference from working FT	Adjusted IRR	Adjusted IRR 95% CI
All physical activity										
Work FT	10,594	510	–	1.0 (ref)	–	979	480	–	1.0 (ref)	–
Work PT	6798	530	+ 20	1.05	1.02–1.08	2833	500	+ 20	1.13	1.05–1.21
Retired	8329	645	+ 135	1.23	1.20–1.27	22,482	510	+ 30	1.21	1.13–1.28
Leisure only, which excludes gardening and active travel										
Work FT	10,127	435	–	1.0 (ref)	–	899	380	–	1.0 (ref)	–
Work PT	6556	450	+ 15	1.04	1.01–1.08	2700	407	+ 27	1.10	1.02–1.19
Retired	8056	540	+ 105	1.21	1.17–1.25	21,025	420	+ 40	1.18	1.10–1.26
Gardening only										
Work FT	4224	180	–	1.0 (ref)	–	426	240	–	1.0 (ref)	–
Work PT	2742	180	0	1.06	1.00–1.12	1240	240	0	1.08	0.96–1.21
Retired	3744	240	+ 60	1.27	1.21–1.34	10,436	240	0	1.19	1.07–1.32
Active travel only										
Work FT	4642	180	–	1.0 (ref)	–	379	180	–	1.0 (ref)	–
Work PT	2898	150	–30	0.81	0.77–0.86	1156	150	–30	0.83	0.72–0.95
Retired	3155	148	–32	0.82	0.77–0.87	7199	150	–30	0.80	0.71–0.90

Dependent variable = moderate-intensity minutes = amount of activity undertaken, for those who reported participating in physical activity at all

Incidence risk ratios (IRR) relative to working full time, for four categories of physical activity, adults age 55–74. England, UK, 2016–2017

MIEMs were calculated as described in text (minutes of moderate-intensity exercise, over 7 days), among only those who reported some physical activity

"Difference from working FT" refers to difference in median MIEMs

All models adjust for age, sex, presence of limiting disability, seasonal quarter, deprivation category, body mass index and urbanness/rurality of residence

MIEMs moderate-intensity minutes, *FT* full-time (working), *PT* part-time, *IRR* incidence risk ratio, *ref* reference category

Work status was significant at $p \leq 0.05$ in all models

the dataset to make interpretation more meaningful and associations more apparent; different categorisation schemas would have led to somewhat different raw incidence risk and odds ratios, but we don't believe those variations would substantially change the main conclusions or associations that we observed.

The ALS1617 data were self-reported and therefore prone to recall, subgrouping and engagement biases. Generalisability of our observations is also limited due to imperfect representativeness of English residents age 55 +. Within the ALS1617 data, the percentages of age 55–74 persons still in employment, living in not deprived areas, in administrative or managerial occupations or with healthy BMIs were greater than observed nationally (Baker 2018; Office for National Statistics 2016). ALS respondents also report more PA than the general population. In the 2016 Health Survey for England (NHS Digital 2017), about 55% of respondents age 55–74 reported obtaining ≥ 150 min of PA per week, compared to 66% of same-age ALS respondents who reported reaching this threshold.

Conclusions

Retired people reported doing more leisure and gardening PA but less active travel. Some older adults reported enough physical activity from either gardening or active

travel alone to meet official recommendations for best health outcomes. People working full time reported less leisure PA and less gardening PA than people with retired status, adjusted by age. There may be unique opportunities for interventions that try to cement in physical activity habits by targeting persons who are in the transition phase from mostly working to mostly retired. Policies to promote recommended amounts of regular physical activity for older adults need to acknowledge different opportunities and preferences that may be facilitated by working status.

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Compliance with ethical standards

Conflict of interest The authors declare that we have no conflict of interest.

Ethical approval Separate ethical approval to process these data was not required because this is secondary data analysis.

Informed consent Informed consent was implied with original survey data collection. Consent was given to use the information to improve services.

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