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Age, sex and other correlates with active travel walking and cycling in England: Analysis of responses to the Active Lives Survey 2016/17

Julii Brainard[a,*], Rachel Cooke[b], Kathleen Lane[a], Charlotte Salter[a]

[a] Norwich Medical School, University of East Anglia, Norwich NR4 7TJ, UK
[b] Active Norfolk, Easton & Otley College, Norwich NR9 5DX, UK

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ABSTRACT

Active travel (walking or cycling for transport) can generate personal and environmental benefits. We determined the frequency of participation in walking or cycling active travel by age and sex, as well as used multivariate analysis to find correlations with many other factors using a large cross-sectional 2016/17 survey of people living in England. Walking and cycling active travel were explored separately. Most respondents reported no active travel, but at least 25% of people under age 45 met activity recommendations only from active travel. Otherwise, (unlike other types of physical activity) active travel declined consistently with increased age. Men reported much more cycling active travel than women, who were more likely to do any active travel walking and therefore more likely to meet activity guidelines from just active travel walking. Lower levels of disability, fewer children in household, and working full time increased active travel. Season was sometimes relevant. BMI, personal-effectiveness, deprivation and rurality had mixed relationships with types of active travel. Understanding differences in correlates for cycling vs. walking active travel could help tailor local promotion programmes for each. The analysis suggests that motivators and barriers for active travel greatly by age.

1. Introduction

Physical activity undertaken while travelling for other purposes (such as to work, school or shops) is called 'active travel', and linked to many individual health and environmental benefits. Walking and cycling are the most common forms of active travel (AT). Higher rates of AT are linked to lower mortality (Mueller et al., 2015), reduced risk of diabetes, hypertension, being overweight (Flint et al., 2014; Laverty et al., 2013; Laverty et al., 2015), cancer and cardiovascular disease (Celis-Morales et al., 2017; Laverty et al., 2013). It was estimated that increased physical activity due to AT could save roughly UK £17 billion (2010 prices) for the National Health Service, via reductions in the prevalences of type 2 diabetes, dementia, ischaemic heart disease, cerebrovascular disease, and cancer (these savings adjusted for increased risk of road traffic injuries) (Jarrett et al., 2012). People who commute to work by active travel report considerably higher journey satisfaction than people who commute passively (Martin et al., 2014; Susilo and Cats, 2014). Environmental benefits from active travel include reduced vehicle traffic, less noise and reduced air pollution (Mueller et al., 2015).

National and local policy in Britain promotes active travel to try to obtain health, safety and environmental benefits (Department for Transport, 2017b; Public Health England, 2016; Transport Scotland, 2016). Government grants in England have been made available to directly fund "sustainable" (low carbon and environmental impact) transport schemes (Department for Transport, 2017a, 2018; Sustrans, 2015), while sustainable transport plans are part of the evaluation criteria for other types of development grants from government (Department for Communities and Local Government, 2017). Support for these policies and funding streams is long-standing from national charities and associations of public health professionals (Sustrans, 2012).

Previous studies linked higher participation in active travel with many traits, both personal and environmental, including lower age (Cole-Hunter et al., 2015; Fairnie et al., 2016; O'Hern and Oxley, 2015), not having children in the household (Perchoux et al., 2017), lower BMI (Flint et al., 2014; Panter et al., 2011) and less screen time (Barnett et al., 2014; Foley et al., 2018). Disability and/or poor health seems to reduce AT (Büchs et al., 2018). However, the impacts of non-white ethnicity (Freeman et al., 2013; Laverty et al., 2013) or socio-economic status seem inconsistent and may even be cohort-specific as well as heavily moderated by local environmental attributes. Propensity to engage in AT has been linked with more years of education (Cole-Hunter et al., 2015; Panter et al., 2011), higher income (Fairnie et al.,

* Corresponding author.
E-mail address: j.brainard@uea.ac.uk (J. Brainard).

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2016), higher socio-economic status (Zander et al., 2015) as well as greater deprivation (Falconer et al., 2017) and not owning a car (Zander et al., 2015). There is similarly mixed evidence about which sex is more or less likely to participate in active travel (Cole-Hunter et al., 2015; Fairnie et al., 2016; Panter et al., 2011). Many possible personal psychological or attitudinal correlates have been investigated for possible links with rates of participation in AT (such as confidence or self-efficacy (Cao, 2015; Humphreys et al., 2013; Martin et al., 2014; Panter and Jones, 2010; Van Holle et al., 2015). Determinants rather than correlates for active travel can be hard to distinguish (Panter and Jones, 2010). Important environmental determinants are thought to include higher residential density near home address (McDonald, 2008), 'walkable' neighbourhoods and safe routes, especially for cycling (Cerin et al., 2017; Freeman et al., 2013; Hansen et al., 2015; Ogilvie et al., 2008a), short travel distances (Freeman et al., 2013; Panter et al., 2011; Panter and Jones, 2010), dense residential neighbourhoods with sidewalks (Dalton et al., 2011), as well as clean and safe neighbourhoods (Cerin et al., 2017; Ogilvie et al., 2008a). AT tends to be greater in warmer and drier seasons (Dalton et al., 2011). Some people may select where to live partly to facilitate their active travel (Cao, 2015).

Life stages heavily interact with engagement in AT, including mode (walking or cycling). AT behaviour often reflects circumstances such as household income, number of children, employment, residence options and dozens of other factors (Barnes et al., 2016; Bonham and Wilson, 2012; Clark et al., 2014; Guell et al., 2012; Jones et al., 2015; Susilo et al., 2018; Waygood et al., 2015). Many of these factors highly correlate with sex and age, which suggests that best strategies to promote AT may link to age and sex of target participants. Retaining AT habits at key life transition points may also sustain more total physical activity for longer during the life course, and result in corresponding health benefits. Understanding how active travel participation varies with age and sex can be essential to inform policy development and practice. Therefore, although we also report on other correlates with AT, this analysis focused especially on age and sex, possible life course changes and opportunities for intervention points. Compared to other correlates, age and sex have the further advantages of being relatively unambiguous, very complete in many datasets, especially generalizable and subject to relatively low levels of reporting bias and inaccuracy.

Our objective was to use a recent and large survey of people living in England to estimate participation rates in active travel and examine how they varied with candidate correlates, especially age and sex. This is the largest such cross-sectional dataset available to date for describing AT among English residents; no in depth analysis has been done previously of these data for such purposes. The large survey size allowed separate analysis for walkers and cyclists; a distinction not made in many previous studies (Dalton et al., 2011; Fairnie et al., 2016; Foley et al., 2018; Freeman et al., 2013; Guell et al., 2012; Jarrett et al., 2012; Laverty et al., 2015; Ogilvie et al., 2008b; Sahlqvist et al., 2012). We interpret the results with respect to identification and better understanding of possible barriers or facilitators that might be addressed when trying to promote more active travel, especially with regard to age and sex.

2. Methods

2.1. Data

The Adult Active Lives Survey 2016/2017 (ALS1617) was conducted by Ipsos MORI on behalf of Sport England who commissioned the survey with additional funding from Public Health England, Arts Council England and the Department of Transport (Ipsos Mori, 2018; Sport England, 2015, 2018). Response rate for 2016–17 is not available but the response rate for the Active Lives Survey undertaken in 2015–16 was 18.9% (Ipsos Mori, 2017). Responses were obtained online (52%) or using a paper questionnaire (48%). 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). Completed questionnaires were rewarded with a £5 shopping voucher. Participants were informed that their replies would be used to help provide better services. Consent was implied by submitting the completed questionnaire. The data are anonymised, collected from November 2016 to November 2017, and supplied to the authors by Sport England. The dataset described 194,756 male or female individuals age 16+.

The questions asked about specific physical activities (PA) people did in the preceding 12 months, of minimum duration 10 min, on how many days they did each activity in the last 28 days and activity duration. The questionnaire allowed for answers about physical activity done for health, sport, fitness or leisure, gardening and any "walking (or cycling) primarily to get from place to place (e.g. walking to work), rather than for the purpose of health or recreation". For simplicity, in this report, we use the term 'leisure' PA, for all combined physical activity that does not also qualify as gardening or active travel PA.

Physical activity was categorised in the ALS1617 as:

- Moderate activity: Heart rate was raised leaving individual feeling a little out of breath.
- Vigorous activity: Breathing hard and fast and heart rate increased, unable to say more than a few words without pausing for breath

Using these descriptions, the data owner (Sport England) quantified the amounts of physical activity as "Moderate intensity equivalent minutes" (MIEMs; Milton et al., 2017). MIEMs are determined both by self-reported intensity (whether breathing rate was raised slightly or strongly) and type of activity (presumed intensity levels of some activities were preset). To calculate MIEMs, each 'moderate' minute counts as 1 min, and vigorous activity counts double. For instance, a single 10-minute walk is 10 MIEMs, while a vigorous 10-minute run equals 20 MIEMs. MIEMs were calculated from PA sessions undertaken during the previous 28 days and divided by four to produce an average per 7 days.

2.2. Analysis of the ALS1617

The ALS1617 gave separate weekly average totals for active travel by walking or cycling, as well as gardening and leisure/sport PA. The ALS1617 reported many attributes that we selected (from preceding literature summary) to be candidate correlates with active travel (see Table 1). Limiting 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 effects their ability to do normal daily activities. Deprivation was supplied by the data provider, based on respondent's residence, using the Index of Multiple Deprivation (IMD2015), which categorises deprivation in geographic areas according to seven domains. IMD2015 values were reported in deciles relative to all areas nationally (Dept. for Communities and Local Government, 2015). Almost equal response numbers were obtained (n = 19,424–19,523) from each IMD2015 geographic decile. Residences were described by their rurality into one of six categories, using a schema developed for the Office of National Statistics (Bibby and Brindley, 2012). A minority of respondents (about 51,780, 27%) also answered a set of specific questions about recent mood and outlook such as their levels of happiness, how satisfying or worthwhile they felt life was, and a question about personal effectiveness. Education level and occupational category were available but these variables were excluded from analysis for many reasons. Occupation and education were highly collinear with each other and the IMD2015, while also prone to self-report biases including misclassification, whereas the IMD2015 had been assigned using objective criteria. Occupational group was selected by respondents using a short list of exemplars; people with job titles not listed guessed at their closest match. The highest education level was generalised; people who had any qualifications after the age of 18 were

Table 1
Candidate correlates with active travel.

Attribute	Description
Age	In whole years, range 16–104 years (no missing data)
BMI group	Reduced to 3 categories = BMI 16–24.99 (reference, 42.4%) BMI 25–29.99 (29.8%) BMI ≥ 30 (14.7%) BMI missing (25,079) or BMI < 16 (n = 473) (combined total = 13.1%)
Impairment	2 categories. Impairment = reported limiting disability (16.8%) or not. 10,114 observations (5.2%) no data
Sex	2 categories used = female (reference, 55.8%) or male (none missing)
Index of multiple deprivation 2015 (IMD)	Reported in provided survey as IMD decile. Treated as numeric values in multivariate models; higher number = more deprived. Data missing for two respondents
Child#	Number of children in household (0, 1, 2, or 3+); missing for 5.7%
Rural/urban classification of home address, from ONS RUC2011 data	6 categories available. 2 responses were unclassified. Categories = Urban major conurbation (28.4%) Urban minor conurbation (3.6%) Urban city and town (46.5%) Rural town (10.4%), rural village (7.2%), rural hamlets (4.0%)
Working status	Adjusted models only consider 3 categories, which encompassed 83% of all respondents. FT working (46%), PT working (19%), or retired (35%). The other 7 work status categories (e.g., student, keeping house, unemployed) were each < 3.5% of total, and too heterogeneous to group together; potential collinearity in some categories with Impairment and Child# were also very likely.
Quarter	Quarter of year when the survey was taken (no missing data): (winter) 5 Nov16–5 Feb17, (spring) 6 Feb-6 May, (summer) 7 May-7 Aug, (autumn) 8 Aug-7 Nov
Happy (n = 51,783) Anxious (n = 51,769)	Answers to questions "On a scale of 0–10, where 0 is not at all happy (anxious) and 10 is completely happy (anxious), overall, how happy (anxious) did you feel yesterday?"
Worthwhile (n = 51,740)	Answers to question "On a scale of 0–10, where 0 is not at all worthwhile and 10 is completely worthwhile, overall, to what extent do you feel the things you do in your life are worthwhile?"
Life satisfaction (n = 51,800)	Answers to question "On a scale of 0–10, where 0 is not at all satisfied and 10 is completely satisfied, overall, how satisfied are you with your life nowadays?"
Can't achieve goals* (n = 51,770)	Personal effectiveness: Answers to the question: "To what extent do you agree with the statement: I can achieve most of the goals I set myself?" Scale was from (1) Strongly agree to (5) Strongly disagree.

Notes: n for mood and outlook traits refers to number of responses collected.

grouped together (48% of respondents). Occupation group and/or education level were missing for 17% of respondents (including all persons age 75+), while IMD2015 decile was unknown for only two persons.

In multivariate adjusted models, we used negative binomial regression because for all types of PA the distribution was very skewed: mostly relatively low values (including many zeros) with a small percentage of extremely high values. To clean the data we excluded very improbable values (MIEMs > 3360; equivalent to 8 h of moderate activity, 7 days/week). No one reported active travel cycling MIEMs > 3360, but four people reported > 3360 MIEMs for AT walking. BMI values < 16 (n = 473) were also excluded.

We looked for active travel correlation with age or sex, adjusted for other correlates as listed in Table 1, allowing for possible differences between AT walking and cycling.

1) Percentage of respondents who did different MIEMs categories of active travel and other types of PA (in age bands).
2) Percentage of people reporting any participation in AT in preceding four weeks (broken down by age, sex and type of AT)
3) Median MIEMs for AT cycling or walking (separated by age and sex, with chi-square calculations to test for differences)
4) Adjusted multivariate models linking correlates with MIEMs for AT cycling or walking.

The strategy to generate the final adjusted models was to put all candidate correlates in a single model; the correlate with the largest p value (if > 0.05) was individually removed and the model regenerated. This process continued until all correlates had p ≤ 0.05. To this near-final model all excluded correlates were trialled individually back in the model to see if a p-value ≤0.05 was recovered for previously excluded correlates. The analysis generated four separate models: for walking and cycling, with and without possible mood/outlook variables.

The final adjusted models have only correlates with 95% confidence intervals that do not cross 1.0. Coefficients are reported as incidence risk ratios (IRR). Data and statistical analysis were undertaken in SPSS (v. 25), MS-Excel 2016 and Stata (v. 15.1).

3. Results

Table 2 shows MIEMS for types of PA with percentages in each age band who reported < 30, 30–149 or 150+ MIEMs. Also shown for comparison are MIEMS for leisure and gardening PA, and percentage of people who obtained < 30 MIEMs in all non-AT PA. The percentage of people who reported < 30 MIEMs in non-AT types of PA was fairly constant until age 75 (at 22–27%); this contrasts with a very consistent decline in AT MIEMs with age. Mean leisure MEMS were somewhat constant until late middle age. Gardening MIEMs steadily rose with age. The apparent decline in AT was most apparent for MIEMs < 30 and 150+, although there was little variation in the percentages doing 30–149 AT MIEMs below 75 years. Median AT MIEMs was zero at all ages; most people reported no AT at all. Nevertheless, among people age 44 and below, ≥25% of people achieved recommended levels of physical activity (150 MIEMs/week; Chief Medical Officers, 2011) from active travel alone.

Fig. 1 shows participation in AT cycling and walking, in single year groups. Close to 50% of women ≤21 years old reported at least some active travel walking to the ALS1617. Women under 40 much more frequently reported AT walking then men. Past age 45, men and women reported similar amounts of AT walking in the preceding 28 days. AT cycling was much more commonly undertaken by men than women at all ages; frequency of participation in AT cycling was fairly stable among males or females until approximately age 50, older than which AT cycling became increasingly less likely with increased age (both sexes).

Not only was participation in AT lower at higher age, but the

Table 2
Age and participation (MIEMs) in active travel.

Age band	n	% < 30 MIEMs allotherPA	MIEMs mean, Gardening	MIEMs mean, Leisure*	MIEMs Mean, AT	% with these values of AT MIEMs < 30	30–149	150+
16–24	12,684	26.0%	21	591	233	54.6%	11.9%	33.6%
25–34	24,410	24.2%	40	461	168	59.6%	13.3%	27.2%
35–44	30,796	22.4%	58	444	145	60.5%	14.5%	25.0%
45–54	33,395	21.8%	84	468	122	65.9%	13.3%	20.8%
55–64	37,123	24.3%	123	437	104	69.8%	12.3%	17.9%
65–74	37,063	27.2%	155	382	72	77.3%	10.0%	12.7%
75+	19,285	46.8%	132	200	44	86.6%	6.0%	7.5%

Note: n was the maximum possible respondents, but actual denominator may be smaller if extreme MIEMs values (> 3360) were reported for that type of PA. *Leisure = all sport, recreation or fitness activity not otherwise counted as gardening or active travel; allotherPA = leisure + gardening (no active travel).

median MIEMs achieved were also lower with higher age for those who did any AT (Fig. 2). Fig. 2 shows the median reported MIEMs (walking or cycling) for individuals who reported any AT (either walking or cycling). The data in this plot were smoothed (rolling five-year averages). Of those who reported either type of AT, a majority got at least 150 MIEMs/week until age 30. Men who did any AT walking reported enough to meet or exceed the 150 MIEMs/week target until at least age 69. AT walking MIEMs appear to reduce most rapidly below the age of 30; cycling MIEMs appear to decline for both sexes most steeply around age 60–65 (near statutory retirement age) and also for women between the ages of 25 and 40 years. The depicted rise in AT cycling MIEMs for people age 70+ may be explained by a small number ($n \leq 40$) of especially keen active-travelling elders.

Although men who undertook any walking AT did more of it, there were fewer men doing any AT walking (just as there were fewer women engaging in any cycling AT). Table 3 shows the percentage of men and women engaging in levels of AT (walking or cycling). That women do more AT walking was confirmed by chi-square tests ($\chi^2 = 321.16$, $p \leq 0.001$). Similarly, men did more AT cycling ($\chi^2 > 2000$, $p \leq 0.001$). Men were more than twice as likely to report enough AT cycling to reach 150 MIEMS/week while the rate of female participation in any AT cycling was especially low (95.4% did none).

Table 4 shows multivariate models linking AT MIEMs (walking or cycling) with predictors that met inclusion criteria. Blank space means that a correlate was not in that final model. Models 1 considers walking AT without any mood or attitude correlates; Model 2 is the best fit model for walking AT including any mood or outlook trait. Only one mood or outlook attribute linked to AT walking: self-assessed inability to achieve self-set goals. This attribute appears to replace impairment that was in Model 1. Otherwise, Models 1 and 2 are very similar to each other.

Model 3 reports correlates with AT cycling. No attitude or mood attributes were associated with AT cycling MIEMs so a model for AT cycling with mood/attitude attributes is not shown. Similar to walking AT, participation was greater with lower age, male sex, fewer children in household, retirement and from survey answers in the warmer two quarters of the year (May–November). AT Cycling was much more strongly linked to male sex, retirement status and seasonality than AT walking. AT cycling and walking correlates substantially differed in other respects. Increased BMI was linked to less AT cycling, but BMI category lacked a strong relationship with AT walking. Deprivation decile was associated with AT walking but not AT cycling. The links varied between urban/rural classification of respondent's area and participation in AT walking and cycling. There was an apparent linear negative relationship between AT walking and increasing rurality in both Models 1 and 2. But for AT cycling, a linear relationship was not found. Instead, only one urban/rural category was distinct from the others: the relatively 'suburban' category of mixed city/town had much higher AT cycling participation than all other urban/rural classifications.

4. Discussion

Our results broadly agree with previous research on AT (Solomon et al., 2013). However, by separating AT walking from AT cycling our results indicate relatively different barriers to address. For instance, BMI category was not important for walking AT but did link to cycling AT. Perhaps people with higher BMIs have poorer balance that leads to

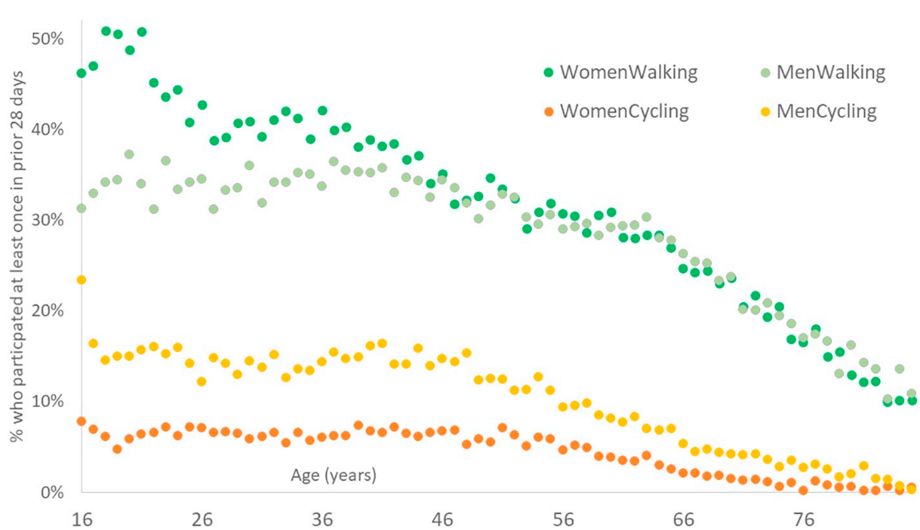

Fig. 1. Percentages who reported doing any active travel, in single year groups.

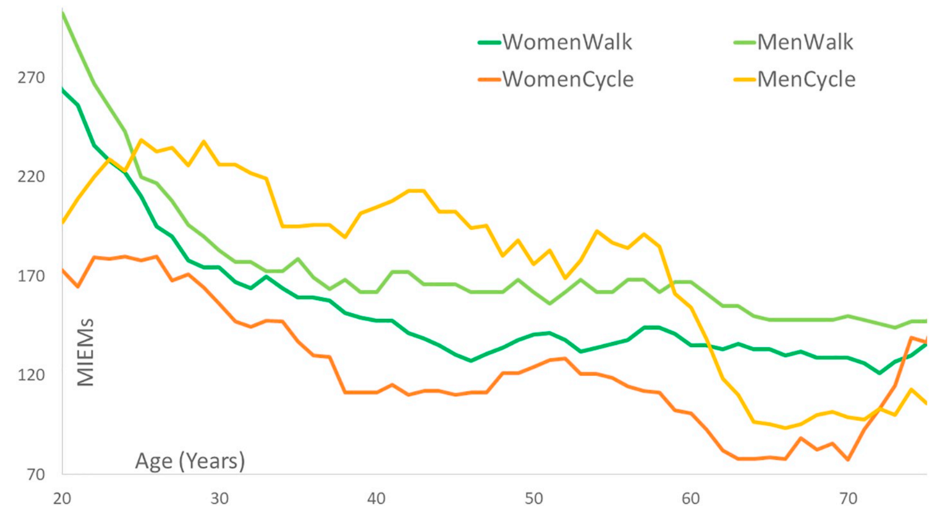

Fig. 2. Median reported AT cycling/walking MIEMs among individuals who reported any AT in respectively cycling or walking.
Notes: The data in Fig. 2 were smoothed (moving five year averages).

Table 3
Percentage of males and females engaging in each range of MIEMs (weekly) for respective types of active travel.

	MIEMs	Female	Male		MIEMs	Female	Male
Cycling	None	95.4%	90.3%	Walking	None	68.1%	71.6%
	1–29	0.6%	0.7%		1–29	2.5%	2.1%
	30–149	1.9%	3.3%		30–149	12.1%	10.1%
	150+	2.2%	5.6%		150+	17.3%	16.2%

lack of confidence in bike handling skills. Making cycling seem safe and familiar is an established strategy for increasing AT cycling in all demographic groups (Department for Transport, 2017b). As with other correlates described here, we lack evidence to suggest that more cycling itself led to lower BMI.

The expression of urban/rural classification was simpler in the cycling model than for walking, but not easier to interpret. Other analyses have found that the relationship between AT and types of built environments may be complicated (Hansen et al., 2015; Ogilvie et al., 2008b). Promotions of AT will probably be more successful in spring or summer than autumn/winter, especially cycling. Participation rate

Table 4
Correlates with active travel walking from the Active Lives Survey Nov 16–Nov 17, Models 1–3.

	Model 1. AT walking n = 145,249		Model 2. AT walking, with any mood or outlook traits n = 42,951		Model 3. AT cycling n = 130,748	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Age	0.985	0.983–0.987	0.986	0.982–0.989	0.973	0.968–0.979
Male	1.107	1.057–1.159	1.141	1.054–1.234	3.239	2.906–3.609
Impairment	0.893	0.836–0.953			0.600	0.516–0.699
Deprivation	1.037	1.029–1.045	1.031	1.017–1.045		
#Child	0.948	0.919–0.978	0.947	0.898–0.933	0.917	0.855–0.984
Working…						
Full time	1.0 (ref)	–	1.0 (ref)	–	1.0 (ref)	–
Part time	1.108	1.040–1.180	1.088	0.980–1.208	0.881	0.761–1.020
Retired	0.851	0.792–0.915	0.878	0.776–0.993	0.342	0.291–0.403
Home area =						
Major conurb.	1.0 (ref)	–	1.0 (ref)	–		
Minor conurb.	0.866	0.763–0.984	0.924	0.744–1.147		
City and town	0.893	0.846–0.943	0.903	0.824–0.989	1.307	1.180–1.447
Rural town	0.709	0.653–0.770	0.690	0.600–0.794		
Village	0.595	0.542–0.653	0.544	0.462–0.640		
Hamlet(s)	0.599	0.533–0.673	0.692	0.566–0.847		
Survey quarter =						
Nov 16–Feb 17	1.0 (ref)	–	1.0 (ref)	–	1.0 (ref)	–
Feb–May 2017	1.071	1.005–1.141	1.093	0.982–1.216	0.940	0.814–1.086
May–Aug 2017	1.182	1.106–1.264	1.237	1.108–1.381	1.478	1.269–1.722
Aug–Nov 2017	1.190	1.119–1.266	1.304	1.175–1.448	1.190	1.034–1.370
BMI =						
16–24.99					1.0 (ref)	–
25–29.99					0.631	0.562–0.707
≥30					0.424	0.365–0.492
Can'tAchieveGoals			0.924	0.882–0.969		

Notes: IRR = incident risk ratio (95% CI). See Table 1 for descriptions of correlates. Blank space means that correlate was not in that model. Goodness of fit measures (Akaike Information Criterion, adjusted for number of observations), Model 1: 5.563, Model 2: 6.124, Model 3: 1.612 [48].

differences by work status were expected and mirror findings for other cohorts. Addressing the needs of people with diverse work statuses probably means understanding differences in routine trip purpose and timing linked to employment or retirement. People making escort journeys (i.e., taking a child somewhere) probably have different barriers to people travelling alone. That deprivation was associated with AT walking but not AT cycling may not be meaningful, because the link was only just significant (95% CI just above 1.0) for walking and the number of AT cyclists was not huge which made it more difficult for some relationships to emerge in the final model.

There was steadily less AT with increased age, in contrast to more gardening with higher age (up to age 75), and fairly stable levels of leisure PA (until age 65). It is unclear why AT declines with age. Increased risk of poor health or disability may partly explain (Büchs et al., 2018), but impairment and age were separate predictors in our models. Retirement is not an explanation (also an independent predictor). Older people may be more dissuaded than younger adults from AT when urban environments are blighted by poor repair and litter or complicated by road obstacles and traffic (Mertens et al., 2017). The journey profiles for older adults undertaking active travel are different from younger people (less likely for work and more often at off-peak times, although journey times may be similar (O'Hern and Oxley, 2015)). Declining AT rates among women as they age has also been linked to concerns over personal safety and street harassment (Stop Street Harassment, undated), as well as more journeys that involve escorting someone (e.g., a child; Pucher and Buehler, 2012).

Under age 45, at least 25% of the ALS1617 respondents met PA guidelines (at least 150 MIEMs/week, (Chief Medical Officers, 2011) simply from active travel. Among those who did any AT, they usually reported ≥ 150 MIEMs/week (although this was less true of older people). Nevertheless, this reinforces the impression that AT (like many types of PA) is a habit. Therefore, a key to promoting active travel is to facilitate establishment of the habit as well as minimising loss of the habit. In research on other cohorts, among adults who use active travel to reach their workplace, such commuting AT comprised 47–52% of all their total PA, with average weekly minutes of AT alone tending to exceed 150 (Audrey et al., 2014; Sahlqvist et al., 2012).

Possibly, middle-aged people start to prefer other forms of PA. Declining participation rates in AT may therefore be of low concern for under-65s, at least with regard to health impacts, if other types of PA are high or even increase at this point in life. However, losing the habit of AT PA (Panter et al., 2011; Panter and Jones, 2010) may be very important if this habit does not return when/if participation in other types of PA reduces with older age. Engagement in active transport has also been positively linked to use of public transport (Coronini-Cronberg et al., 2012; Rissel et al., 2012); propensity to use of public transport is also partly habit-driven (Chen and Chao, 2011). Utilising social cues that encourage AT and related habitual behaviours, as well as viewing AT as a positive social norm (Perchoux et al., 2017) may be essential to address if it is deemed desirable to prevent decline in AT participation with age (Guell et al., 2012).

Previous research found that active travel commuters reported high levels of satisfaction with their work journey (Ye and Titheridge, 2017) and generally higher levels of life satisfaction (Martin et al., 2014). Our analysis linked only one mood or attitude indicator (for personal effectiveness) with AT walking while no mood/outlook attributes were linked to AT cycling.

4.1. Limitations

Persons of higher socio-economic status were over-represented in the ALS1617. As indicated by self-identified occupational grouping, 54% of respondents were in managerial or administrative jobs (highest SES), compared to 30% in the general population (2011 Census data; Office for National Statistics, 2018). Routine or semi-routine jobs (lowest SES occupational groups) are employment for about 26% of the general population, but just 11% of respondents in the ALS1617. The regression models further only considered three possible working statuses (to ensure sufficient variability in covariates) which meant exclusion of long term unemployed persons and most students. Our analysis addresses participation rates in AT linked to cohorts of specific ages rather than changes in the habits of the same individuals over time, so we do not describe influence of correlates on change over time. Levels of participation in AT cycling were very low among women ($< 5\%$) which makes generalisation for correlates related to sex and AT cycling less reliable. The ALS1617 questionnaire relies on self-reported data, which are prone to many errors and biases (miscalculation, memory error, responses from only engaged individuals, misinterpretation of questions, inclination to report socially desirable characteristics, etc. (Bowling, 2005; Grimes and Schulz, 2002; Keeter et al., 2017; Van de Mortel, 2008)). These many biases are why we focused on trends and comparisons, especially with respect to simple demographic traits (age and sex) rather than analyse raw values or elaborate on other correlates. Our analysis also could not consider associations of AT with health outcomes or local environmental attributes, journey routes and travel distances, because those data were not collected.

5. Conclusion

Consistent with similar research, higher rates of active travel (walking or cycling) linked to and had similar strength of associations with lower age, fewer children in household, lack of disability and higher deprivation. Female sex, retirement and colder weather seasons had more impacts (negative) on AT cycling than walking. Lower BMI was linked to more AT cycling but not walking. There was more AT walking in more densely built areas, but cycling was only positively linked to living in relatively urban areas with medium building density. Mood and personal outlook attributes were mostly not linked to any type of AT.

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References

Audrey, S., Procter, S., Cooper, A.R., 2014. The contribution of walking to work to adult physical activity levels: a cross sectional study. Int. J. Behav. Nutr. Phys. Act. 11, 37.
Barnes, R., Winters, M., Ste-Marie, N., McKay, H., Ashe, M.C., 2016. Age and retirement status differences in associations between the built environment and active travel behaviour. J. Transp. Health 3, 513–522.
Barnett, I., van Sluijs, E., Ogilvie, D., Wareham, N.J., 2014. Changes in household, transport and recreational physical activity and television viewing time across the transition to retirement: longitudinal evidence from the EPIC-Norfolk cohort. J. Epidemiol. Community Health 8, 747–753 (jech-2013-203225).
Bibby, P., Brindley, P., 2012. 2011 Rural-Urban Classification of Local Authority Districts and Similar Geographic Units in England: A User Guide. (p. 26pp).
Bonham, J., Wilson, A., 2012. Bicycling and the life course: the start-stop-start experiences of women cycling. Int. J. Sustain. Transp. 6, 195–213.
Bowling, A., 2005. Mode of questionnaire administration can have serious effects on data quality. J. Public Health 27, 281–291.
Büchs, M., Bahaj, A., Blunden, L., Bourikas, L., Falkingham, J., James, P., Kamanda, M., Wu, Y., 2018. Sick and stuck at home–how poor health increases electricity consumption and reduces opportunities for environmentally-friendly travel in the United Kingdom. Energy Res. Soc. Sci. 44, 250–259.
Cao, X., 2015. Examining the impacts of neighborhood design and residential self-selection on active travel: a methodological assessment. Urban Geogr. 36, 236–255.
Celis-Morales, C.A., Lyall, D.M., Welsh, P., Anderson, J., Steell, L., Guo, Y., Maldonado,

R., Mackay, D.F., Pell, J.P., et al., 2017. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. Br. Med. J. j1456, 357.
Cerin, E., Nathan, A., Van Cauwenberg, J., Barnett, D.W., Barnett, A., 2017. The neighbourhood physical environment and active travel in older adults: a systematic review and meta-analysis. Int. J. Behav. Nutr. Phys. Act. 14, 15.
Chen, C.-F., Chao, W.-H., 2011. Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. Transport. Res. F: Traffic Psychol. Behav. 14, 128–137.
Chief Medical Officers, 2011. Start Active Stay Active: A Report on Physical Activity From the Four Home Countries. Department of Health and Social Care, London, pp. 62.
Clark, B., Chatterjee, K., Melia, S., Knies, G., Laurie, H., 2014. Life events and travel behavior: exploring the interrelationship using UK household longitudinal study data. Transp. Res. Rec. 2413, 54–64.
Cole-Hunter, T., Donaire-Gonzalez, D., Curto, A., Ambros, A., Valentin, A., Garcia-Aymerich, J., Martínez, D., Braun, L., Mendez, M., et al., 2015. Objective correlates and determinants of bicycle commuting propensity in an urban environment. Transp. Res. Part D: Transp. Environ. 40:132–43.
Coronini-Cronberg, S., Millett, C., Laverty, A.A., Webb, E., 2012. The impact of a free older persons' bus pass on active travel and regular walking in England. Am. J. Public Health 102, 2141–2148.
Dalton, M.A., Longacre, M.R., Drake, K.M., Gibson, L., Adachi-Mejia, A.M., Swain, K., Xie, H., Owens, P.M., 2011. Built environment predictors of active travel to school among rural adolescents. Am. J. Prev. Med. 40, 312–319.
Department for Communities and Local Government, 2017. Housing Infrastructure Fund. pp. 23.
Department for Transport, 2017a. £64 million government funding to encourage more cycling and walking to work. In: Local Transport Funding to Help People Walk or Cycle Safely to Work.
Department for Transport, 2017b. Cycling and Walking Investment Strategy. pp. 38.
Department for Transport, 2018. PM Announces Ten Cities Shortlisted for Major Transport Funding across England. Prime Minister's Office.
Dept. for Communities and Local Government, 2015. English Indices of Deprivation 2015. Ministry of Housing, Communities & Local Government.
Fairnie, G.A., Wilby, D.J., Saunders, L.E., 2016. Active travel in London: the role of travel survey data in describing population physical activity. J. Transp. Health 3, 161–172.
Falconer, C.L., Cooper, A.R., Flint, E., 2017. Patterns and correlates of active commuting in adults with type 2 diabetes: cross-sectional evidence from UK Biobank. BMJ Open 7, e017132.
Flint, E., Cummins, S., Sacker, A., 2014. Associations between active commuting, body fat, and body mass index: population based, cross sectional study in the United Kingdom. Br. Med. J. 349, g4887.
Foley, L., Dumuid, D., Atkin, A.J., Olds, T., Ogilvie, D., 2018. Patterns of health behaviour associated with active travel: a compositional data analysis. Int. J. Behav. Nutr. Phys. Act. 15, 26.
Freeman, L., Neckerman, K., Schwartz-Soicher, O., Quinn, J., Richards, C., Bader, M.D., Lovasi, G., Jack, D., Weiss, C., et al., 2013. Neighborhood walkability and active travel (walking and cycling) in New York City. J. Urban Health 90:575–85.
Grimes, D.A., Schulz, K.F., 2002. Bias and causal associations in observational research. Lancet 359, 248–252.
Guell, C., Panter, J., Jones, N., Ogilvie, D., 2012. Towards a differentiated understanding of active travel behaviour: using social theory to explore everyday commuting. Soc. Sci. Med. 75, 233–239.
Hansen, A.Y., Meyer, M.R.U., Lenardson, J.D., Hartley, D., 2015. Built environments and active living in rural and remote areas: a review of the literature. Curr. Obes. Rep. 4, 484–493.
Humphreys, D.K., Goodman, A., Ogilvie, D., 2013. Associations between active commuting and physical and mental wellbeing. Prev. Med. 57, 135–139.
Ipsos Mori, 2017. Active Lives Survey: Year 1 Technical Report, London. pp. 82.
Ipsos Mori, 2018. Active Lives Survey Y2 Data User Guide, London. pp. 12.
Jarrett, J., Woodcock, J., Griffiths, U.K., Chalabi, Z., Edwards, P., Roberts, I., Haines, A., 2012. Effect of increasing active travel in urban England and Wales on costs to the National Health Service. Lancet 379, 2198–2205.
Jones, H., Chatterjee, K., Gray, S., 2015. Understanding change and continuity in walking and cycling over the life course: A first look at gender and cohort differences. In: Räumliche Mobilität und Lebenslauf. Springer, pp. 115–132.
Keeter, S., Hatley, N., Kennedy, C., Lau, A., 2017. What Low Response Rates Mean for Telephone Surveys. Pew Research Center, pp. 15.
Laverty, A.A., Mindell, J.S., Webb, E.A., Millett, C., 2013. Active travel to work and cardiovascular risk factors in the United Kingdom. Am. J. Prev. Med. 45, 282–288.
Laverty, A.A., Palladino, R., Lee, J.T., Millett, C., 2015. Associations between active travel and weight, blood pressure and diabetes in six middle income countries: a cross-sectional study in older adults. Int. J. Behav. Nutr. Phys. Act. 12, 65.
Martin, A., Goryakin, Y., Suhrcke, M., 2014. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. Prev. Med. 69, 296–303.
McDonald, N.C., 2008. Critical factors for active transportation to school among low-income and minority students: evidence from the 2001 National Household Travel Survey. Am. J. Prev. Med. 34, 341–344.
Mertens, L., Compernolle, S., Deforche, B., Mackenbach, J.D., Lakerveld, J., Brug, J., Roda, C., Feuillet, T., Oppert, J.-M., et al., 2017. Built environmental correlates of cycling for transport across Europe. Health Place 44:35–42.
Milton, K., Engeli, A., Townsend, N., Coombes, E., Jones, A., 2017. The Selection of a Project Level Measure of Physical Activity: Final Report. Sport England, London, pp. 44.
Mueller, N., Rojas-Rueda, D., Cole-Hunter, T., de Nazelle, A., Dons, E., Gerike, R., Goetschi, T., Panis, L.I., Kahlmeier, S., et al., 2015. Health impact assessment of active transportation: a systematic review. Prev. Med. 76:103–14.
Office for National Statistics, 2018. Socioeconomic Status, Census 2011.
Ogilvie, D., Mitchell, R., Mutrie, N., Petticrew, M., Platt, S., 2008a. Perceived characteristics of the environment associated with active travel: development and testing of a new scale. Int. J. Behav. Nutr. Phys. Act. 5, 32.
Ogilvie, D., Mitchell, R., Mutrie, N., Petticrew, M., Platt, S., 2008b. Personal and environmental correlates of active travel and physical activity in a deprived urban population. Int. J. Behav. Nutr. Phys. Act. 5, 43.
O'Hern, S., Oxley, J., 2015. Understanding travel patterns to support safe active transport for older adults. J. Transp. Health 2, 79–85.
Panter, J.R., Jones, A., 2010. Attitudes and the environment as determinants of active travel in adults: what do and don't we know? J. Phys. Act. Health 7, 551–561.
Panter, J., Griffin, S., Jones, A., Mackett, R., Ogilvie, D., 2011. Correlates of time spent walking and cycling to and from work: baseline results from the commuting and health in Cambridge study. Int. J. Behav. Nutr. Phys. Act. 8, 124.
Perchoux, C., Enaux, C., Oppert, J.-M., Menai, M., Charreire, H., Salze, P., Weber, C., Hercberg, S., Feuillet, T., et al., 2017. Individual, social, and environmental correlates of active transportation patterns in French women. Biomed. Res. Int. 2017.
Public Health England, 2016. Working Together to Promote Active Travel: A Briefing for Local Authorities. pp. 33.
Pucher, J., Buehler, R., 2012. Promoting Cycling for Daily Travel: Conclusions and Lessons From Across the Globe. MIT Press, Cambridge MA USA.
Rissel, C., Curac, N., Greenaway, M., Bauman, A., 2012. Physical activity associated with public transport use—a review and modelling of potential benefits. Int. J. Environ. Res. Public Health 9, 2454–2478.
Sahlqvist, S., Song, Y., Ogilvie, D., 2012. Is active travel associated with greater physical activity? The contribution of commuting and non-commuting active travel to total physical activity in adults. Prev. Med. 55, 206–211.
Solomon, E., Rees, T., Ukoumunne, O.C., Metcalf, B., Hillsdon, M., 2013. Personal, social, and environmental correlates of physical activity in adults living in rural south-West England: a cross-sectional analysis. Int. J. Behav. Nutr. Phys. Act. 10, 129.
Sport England, 2015. The Active Lives Survey - Questionnaire Content. (p. 10pp).
Sport England, 2018. Active Lives Adult Survey November 16/17 Report. (p. 18pp).
Stop Street Harassment, 2019. undated. Statistics – The Prevalence of Street Harassment. . http://www.stopstreetharassment.org/resources/statistics/statistics-academic-studies/.
Susilo, Y.O., Cats, O., 2014. Exploring key determinants of travel satisfaction for multi-modal trips by different traveler groups. Transp. Res. A Policy Pract. 67, 366–380.
Susilo, Y.O., Liu, C., Börjesson, M., 2018. The changes of activity-travel participation across gender, life-cycle, and generations in Sweden over 30 years. Transportation 1–26.
Sustrans, 2012. Is England Taking Action on Active Travel?.
Sustrans, 2015. Cycle City Ambition Monitoring Plan. pp. 18.
Transport Scotland, 2016. Review of Active Travel Policy Implementation.
Van de Mortel, T.F., 2008. Faking it: social desirability response bias in self-report research. Aust. J. Adv. Nurs. 25, 40.
Van Holle, V., Van Cauwenberg, J., Deforche, B., Van de Weghe, N., De Bourdeaudhuij, I., Van Dyck, D., 2015. Do psychosocial factors moderate the association between objective neighborhood walkability and older adults' physical activity? Health Place 34, 118–125.
Waygood, E., Sun, Y., Letarte, L., 2015. Active travel by built environment and lifecycle stage: case study of Osaka metropolitan area. Int. J. Environ. Res. Public Health 12, 15900–15924.
Ye, R., Titheridge, H., 2017. Satisfaction with the commute: the role of travel mode choice, built environment and attitudes. Transp. Res. Part D: Transp. Environ. 52, 535–547.
Zander, A., Rissel, C., Rogers, K., Bauman, A., 2015. Active travel to work in NSW: trends over time and the effect of social advantage. Health Promot. J. Aust. 25, 167–173.