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Environmental And Psychological Correlates of Older Adult's Active Commuting

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Abstract

Purpose—This study explored the environmental and psychological correlates of active commuting in a sample of adults from the European Prospective Investigation into Cancer (EPIC) Norfolk cohort.

Methods—Members of the cohort who were in employment, lived within 10km of work, and did not report a limitation that precluded walking were included in this analysis. Psychological factors, perceptions of the neighbourhood environment and travel mode to work were reported using questionnaires. Neighbourhood and route environmental characteristics were estimated objectively using a Geographical Information System. The mediating effects of psychological factors were assessed using a series of regression models.

Results—1279 adults (mean age of 60.4 years SD=5.4) were included in this analysis, of which, 25% actively commuted to work. In multivariable regression analyses, those who reported strong habits for walking or cycling were more likely to actively commute, whilst those living 4-10km from work were less likely to actively commute. In addition, living in a rural area was associated with a decreased likelihood of men's active commuting and in women, living in a neighbourhood with high road density and having a route to work which was not on a main or secondary road was associated with an increased likelihood of active commuting. There was weak evidence that habit acted to partly mediate the associations between environmental correlates and active commuting in both sexes.

Conclusions—The findings suggest that interventions designed to encourage the development of habitual behaviours for active commuting may be effective, especially amongst those living close to work.

Keywords

walking; cycling; EPIC-Norfolk; neighbourhood; route

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Introduction

It is important to improve the health of middle-aged adults in order to reduce the incidence of disease and combat the substantial health care costs associated with an ageing population (14). Engagement in physical activity is part of a healthy lifestyle and can prevent the development of obesity, certain types of cancers and type 2 diabetes (13). However, few adults are sufficiently active. In the UK 40% of men and 28% of women meet the recommended levels of at least 30 minutes of moderate intensity activity five times a week, whereas in those aged 65 and over, only 14% of men and 11% of women meet this recommendation (15).

The most commonly recommended ways to promote physical activity in older adults are participation in walking and cycling. These activities are accessible to the majority of the population and can be undertaken for a variety of purposes, including recreation and transport. Transport-related walking or cycling, known as 'active transport', is most frequently undertaken as a means of travelling to and from work ('active commuting'(12)). Thus for many people, active commuting provides an accessible way to integrate physical activity into daily life. Yet despite this, only 26% of trips are made by bicycle or on foot in the UK, a prevalence that is low compared to many other European countries; in the Netherlands for example, 47% of trips are made by active modes (6).

In order to design effective interventions to encourage active commuting behaviour, we need to better understand the reasons why people do or do not actively commute. Existing research that has examined the environmental and psychological predictors of the behaviour is equivocal. Some studies suggest that certain environmental factors, such as short distance between home and work, diverse land use mix and well-connected streets in the neighbourhood are associated with an increased likelihood of active commuting (3). Others have reported few or no environmental characteristics to be associated with the behaviour (21, 24). As for the psychological factors, high self-efficacy (11), positive intentions and strong habits for walking and cycling (10, 21) have been found to be important.

A recent review highlighted that few studies have simultaneously examined the psychological and environmental predictors of active commuting behaviour (27). The results of these studies are inconsistent; some have found that both psychological and environmental factors are associated with active commuting (such as de Geus *et al.* (11)) whilst others have found that only psychological factors predicted active commuting, (such as Lemieux and Godin (21)).

Conceptual models suggest that psychological factors may mediate the associations between environmental factors and physical activity behaviours (20). For example, a lack of safe cycle paths in a neighbourhood may lead residents to exhibit lower self-efficacy towards cycling and this may result in a decreased likelihood of cycling. Yet these potential mediating effects have not been well tested. Furthermore, a major limitation of this previous work is its reliance environmental measures captured through participant reported perceptions, rather than the use of more objective measures which quantify characteristics of the environment, either via street audits or spatial data analysed in a Geographical Information System (GIS). As a result, it is unknown whether interventions should be focussed on changing the actual environment or how it is perceived amongst those who may use it. Finally, most of the evidence to date predominantly comes from North America (e.g. Lemieux and Godin (21)), Australia (e.g. Ball *et al.*(4)) and Europe (e.g. de Bruijn *et al* (10)). It may be that evidence from these areas is not generalisable to other settings such as the UK. In the Netherlands, for example, there is a strong tradition for cycling and the US

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and Australia both have distinctive urban areas which are designed with an emphasis on car use.

In order to address the limitations outlined, this study explores the associations between environmental and psychological factors and active commuting in a sample of older English working adults from the European Prospective Investigation into Cancer (EPIC) cohort in the county of Norfolk, England.

Methods

Study design

The EPIC-Norfolk study was designed as a prospective cohort study and the methods of recruitment, sampling and overall sample representativeness have been described in detail elsewhere (7). Briefly, 25 639 participants aged 45-74 who were registered at 121 General Practices within Norwich and surrounding towns were recruited into the study (1993-1997). After the baseline health check visit, there were several follow-up assessments including a repeat health check visit (1998-2000), which was completed by 15 276 participants. In 2006, those who had not refused further participation and were available to approach (n=13 696) were invited to complete two postal questionnaires. The first asked about domain specific activity and is known as EPAQ2 (39) (available at http://www.srl.cam.ac.uk/epic/questionnaires/epaq2/epaq2.pdf) and the second focussed on their perceptions of the environment and views on physical activity. Participants provided written informed consent and ethical approval for the study was given by the Norfolk Research Ethics Committee.

Travel behaviour measures

Participation in active commuting was assessed using responses to EPAQ2 (39). Participants were asked to report how often they used four types of travel mode to get to their main job (car, works or public transport, bicycle or on foot) using the response categories of "always", "usually", "occasionally" and "never or rarely". Participants were classified as active commuters if they reported "always" or "usually" travelling to work by bicycle or on foot. Some reported multi-modal travel; those who reported "always" or "usually" travelling by car or bus as well as on foot or by bicycle were recorded as non-active commuters.

Selection of hypothesised correlates of active commuting

The environmental and psychological measures tested were based on conceptual models of behaviour and previous literature. Psychological measures from the Theory of Planned Behaviour (2) and those environmental measures included in the framework developed by Pikora *et al.(29)* were used. Additional measures were used which captured constructs that had been recommended as an area for future research, such as habit (21) or which were hypothesised to be associated with active commuting behaviour, such as route-related environmental measures. The existing literature suggested that both perceived and objective environmental measures may be associated with active commuting behaviour and hence both types were included here. Table 1 provides an overview of those used in the study, the derivation of which is described below.

1) Psychological measures—Participants were asked to report their agreement with the following seven statements about their habits for walking and cycling for transport: Walking or cycling to get somewhere (e.g the shops, work, school) is something… 1) "I do frequently", 2) "I do automatically" 3,)"I have been doing a long time", 4)" I would find it hard no to do", 5) "that belongs to my (daily, weekly or monthly) routine", 6) "that would require effort not to do" and 7) "that's typically me". These items were derived from the Habit Strength Index (38), which assesses self-identity and automaticity of behaviour. It has

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shown high test-retest and internal reliability (9, 38) and has been validated against other measures of habit strength (37). In this study, it also had high internal reliability with a Cronbach's α of 0.92.

A previously validated questionnaire (18) was used to measure perceived behavioural control (PBC), intention, instrumental attitude, affective attitude and subjective norms for active travel behaviours. Each was assessed using two items. In addition, three items were newly developed to assess social support for walking. These consisted of statements describing situations which may encourage someone to walk regularly; seeing other people walking, having encouragement from friends or relatives, and having friends and family to walk with. All items were tested for face-validity in a pilot study and were understood and completed correctly. Respondents gave agreement using a 5-point Likert scale, from which mean scores were calculated.

2) Perceived environment—Respondents were asked to report their level of agreement with sixteen statements that could be used to describe their residential neighbourhood environment. These were adapted from the Neighbourhood Environment Walkability Survey (NEWS) which has been shown to be valid and reliable in US (31) and Belgian samples (8) and has been used previously in a UK sample (26). The perceptions assessed were; i) residential density, ii) land use mix diversity, iii) access to services, iv) street connectivity, vi) provision of walking and cycling facilities, vii) aesthetics, viii) traffic safety and ix) safety from crime.

3) Objective neighbourhood and route environment—Objective assessments of neighbourhood and route environmental characteristics were computed using a GIS (ESRI ArcGIS 9.2). Participants reported their home postcodes and these were converted into a map location using Code Point, a dataset that identifies the centre point for all postcodes in Great Britain (25). The neighbourhood of each adult was defined using a modified digital representation of the Norfolk street network (Ordnance Survey Integrated Transport Network) which was interrogated to identify the area within an approximate 10-minute walk (corresponding to 800m) of their postcode. This distance is commonly used in research examining associations between neighbourhood characteristics and walking (36). The network was modified to include publicly accessible roads and pedestrianised streets as well as the locations of public footpaths from maps supplied by local government.

The work locations of participants were identified either using the full address or where provided the postcode using the method previously described. The shortest route between home and work locations via the modified street network was identified using the GIS. The length of this route was calculated and seven measures representing environmental characteristics of the zone within 100m surrounding it were estimated (Table 1). This distance was chosen as this was felt to capture the environment that users of the route would experience, and has been used previously in similar research (28).

Covariates—Date of birth and social class were collected at Health Check 1. Social class was measured according to the Registrar General's occupation based classification which uses six categories; "professional", "managerial or technical", "skilled-non manual", "skilled-manual", "partly skilled" and "unskilled" (16). For the purposes of analysis, participants were assigned to one of three categories; "professional, managerial and technical", "skilled-manual and non-manual" and "partly skilled or unskilled". Height and weight were measured by trained nurses at Health Check 2 and were used to derive Body Mass Index (BMI).

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Data analyses—Of the 13 696 invited participants, 11 050 (89.4%) and 10 883 (94.3%) responded to the EPAQ2 and the environment questionnaires. 10665 (77.9%) participants completed both EPAQ2 and the environment questionnaire and provided data on social class, gender and date of birth at Health Check 1. As the cohort was recruited into the study at middle-age between 1993-1997, by 2006 (when later follow up surveys were administered) many of the participants were retired. For these analyses, we excluded participants who reported that they did not work (n=7177), a limitation which precluded walking (n=289), failed to provide any travel data (n=495), failed to provide either a home or work location or reported the same home and work location (n=687) or who lived more than 10km from work (720). Participants in the latter category were excluded as they were deemed unlikely to actively commute. This left 1297 participants for this analysis.

If participants answered less than two-thirds of the psychological and perceived environmental items, which comprised a composite score, the composite score was coded as missing. Otherwise, missing responses were conservatively imputed with the response that was least likely to be associated with active transport based on findings reported in a recent review of the literature (27).

Descriptive statistics were generated to characterize participants in these analyses. Independent t-tests and chi-squared tests were used to compare scores of individual, psychological and environmental characteristics between active commuters and non-active commuters. Simple associations were explored between all potential predictors and active commuting using logistic regression. Predictors were then selected for inclusion in multivariable regression models using a p-value cut-point of <0.05. Where the psychological, distance and environmental predictors showed strong correlations with each other ($r > 0.5$), only the strongest predictor of active commuting was carried forward.

As the literature suggests that the prevalence of active commuting (34) and the importance of environmental predictors for walking may vary by gender (17), interactions were fitted to test for any differences by gender in the selected individual or environmental predictors.

Statistically significant differences were found for many predictors and therefore the analyses were stratified by gender. Selected predictors were then added into multiple logistic regression models to examine the associations between active commuting and all psychological predictors (model 1), distance between home and work (model 2), and environmental predictors (model 3). In all multiple models, adjustment was made for age, BMI, and social class. To create a combined best-fit model, backward stepwise regression was used to identify the predictors from models 1-3 that were statistically significantly associated with active commuting (model 4).

Using the combined best fit model, the potential mediating effects of psychological factors on the relationship between distance, environmental predictors, and active commuting were assessed using the method described by Baron and Kenny (5). Linear and logistic regression analyses were conducted (dependent on whether the factors assessed were continuous or binary) to test the associations between i) the predictor and potential mediators and ii) between potential mediators and active commuting, adjusting for the predictor. If statistically significant associations ($p<0.05$) were observed in both these models, associations between the predictor and active commuting were compared with the potential mediator included and omitted. The percentage change in odds ratios associated with active commuting for each predictor was then calculated and these were used to assess the strength of the possible mediation (19). All analyses adjusted for other predictors included in the final model. Predictors were modelled in the same way as in the main analysis, except for

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the distance variable, which was modelled as a continuous measure. All analyses were performed in SPSS version 16.

Results

Sample characteristics

Compared to all potentially eligible participants (who reported working and did not report a limitation; n=3199), the participants included in these analyses (n=1297, aged 49-80) were younger (mean age 60.4 years versus 61.18 years), had a lower BMI (25.6 versus 26.08) and were more likely to be female (61.1% versus 53.1%), all p<0.01. The majority were employed in professional, managerial or technical roles (44.2%), with 30.8% undertaking skilled work (manual and non-manual) and 15% in partly skilled or unskilled professions. Levels of active commuting in the sample were not significantly different between men and women (26.8% versus 26.5%). For both genders, the prevalence of active commuting was highly dependent on distance to work, with decreasing prevalence as distance increased (p=0.01; Table 1). There were few differences in sample characteristics according to commuting behaviour (Table 2). Two exceptions were that female active commuters were more likely to be of lower social class than female non active commuters and male active commuters were more likely to have lower BMI scores than their non active commuting counterparts.

Simple associations

In men, the prevalence of active commuting declined with each increase in unit of BMI (OR=0.88, 95%CI 0.82-0.95, p=0.01). Only social class was a statistically significant predictor of women’s active commuting. Compared to women in professional or managerial roles, those having skilled (OR=1.48, 95%CI 1.04-2.11, p=0.02) or partly skilled or unskilled (OR=2.14, 95%CI 1.35-3.38, p=0.01) occupations were more likely to actively commute.

Table 1 shows that compared to non-active commuters, active commuters report higher scores for all the psychological predictors except social support, indicating more positive attitudes and intentions towards active commuting (p<0.05). They also generally lived in neighbourhoods which were more supportive for walking according to both perceived and objective measures and had a shorter distance to travel between home and work (Table 2).

Multiple associations

Table 3 presents multivariable models 1-3. In model 1, it is noteworthy that, for both men and women, habit is the strongest predictor of active commuting and none of the other psychological predictors are statistically significant. When habit was excluded from Model 1, (results not presented in the table) both perceived behavioural control (in men OR= 2.35 95%CIs 1.48-3.71, p=0.01, in women OR= 1.42 95%CIs 1.06-1.90, p=0.01) and intention (in men OR=1.30 95%CIs 1.02-1.66, p= 0.03, in women OR= 1.51 95%CIs 1.23-1.85, p<0.01) became statistically significant. Distance to work was a very strong predictor of active commuting behaviour for both genders (Model 2), whilst very few of the environmental predictors were statistically significant in Model 3. In the combined model (Table 4), both men and women reporting stronger habits for walking and cycling and living a shorter distance from work were more likely to actively commute. In men, urban-rural status was the only additional predictor of active commuting. Women living in neighbourhoods with higher road density were more likely to actively commute, whilst having a main or secondary road on the route to work was associated with a decreased likelihood.

Mediation analyses

As habit was the only psychological factor which featured in the final model, this was the only variable that was tested as a mediator. In men, the inclusion of habit in the regression model resulted in a 4% decrease in odds ratios for the association between distance to work and active commuting. In women, this association was reduced by 21%. Furthermore, in women, odds ratios for the association between active commuting and the presence of a main or secondary road on the route and road density were reduced by 5% and 8% respectively. These reductions in odds ratios suggest that habit may partly mediate the association between environmental factors and active commuting, although the direct effects of environmental factors on active commuting remained statistically significant.

Discussion

This is one of the first studies to investigate the associations between psychological and environmental factors and active commuting amongst a sample of older British working adults. In both men and women, short distance to work and stronger habit scores were associated with higher odds of active commuting. In addition, men living in more rural areas were less likely to actively commute, whilst high road density in the neighbourhood and having no busy road on the route to work was associated with an increased likelihood of women's active commuting.

The findings reported here are generally consistent with the existing literature, despite the slightly older sample used here. Similar to previous work (e.g Lemiuex and Godin, (21)), this study found that few environmental measures were statistically significant predictors of active commuting after adjustment. In addition, the environmental predictors identified explained a small proportion of the variance in commuting behaviour, supporting the findings of Ogilvie and colleagues (24) that the environment may be a relatively minor determinant of commuting behaviour.

The fact that distance was the strongest predictor of behaviour suggests that the application of interventions to encourage walking or cycling for short distance may be particularly efficacious. In the UK, a number of 'park and stride' schemes have been implemented around schools in order to encourage children to walk a short distance to school (33). Parents are encouraged to park away from the school and then walk with or allow their children to walk the last part of the journey to school. This type of intervention could be adapted to adults via the use of off-site car parks which are within walking distance of the workplace, although the effectiveness of this strategy would require careful evaluation.

Of the few environmental predictors that persisted in final models after adjustment for distance, rural location was associated with a decreased likelihood of active commuting in men, possibly reflecting greater availability of personal motorised transport amongst rural males (12). Those women who lived in neighbourhoods with high road density were more likely to actively commute, which may reflect the effects of improved road connectivity and hence greater walkability (22). The presence of a main or secondary road on the route to work however, was associated with a decreased odds of women reporting active commuting. Such presence of a principal road on route may be a reflection of high traffic volumes or speeds on these roads, and this might result in heightened safety concerns. This may be particularly important for older women who more commonly report fears about safety, including fast traffic (40). The provision of facilities such as pedestrian crossings to improve traffic safety could be an important component of a broader intervention to promote active commuting in busy neighbourhoods.

Like Lemieux and Godin(21) we found some evidence that habit may act to at least partly mediate the associations between environmental factors and active commuting. This observation supports the concept that habitual activities, such as commuting, may be somewhat environmentally cued (1), although in this cross-sectional study, it was not possible to assess the direction of causality and as a result we cannot say whether habit acted as an influence on behaviour or was a consequence of it. Aarts *et al.* (1) presented a model of exercise and habit formation where the social and physical environment is thought to influence decision-making. This occurs when perceptions of a behaviour and intention are formed, when people reflect on their experiences of a behaviour and when habits are developed. However, it is unknown at which point the environment is most influential in the formation of habits. Thus, further longitudinal research is required to explore the potential role of the environment in habit formation.

This work has a number of strengths and limitations. Strengths include the use of data collected from a well-characterised sample of adults living and working in both urban and rural environments. The study also uses where possible a wide range of perceived and objective environmental indicators and combines these with validated psychological measures, allowing the possible mediating effects of psychological factors on the environment to be explored.

In terms of the limitations, this study uses cross-sectional data and therefore causality cannot be inferred from the associations observed. Furthermore, we have no information on self-selection bias whereby some participants may choose to live in areas that were more conducive to active travel or work in areas which are proximate to home (35). In this study, participants self-reported their usual travel mode to work in the last year. This masks day-to-day variations and may have lead to some over-reporting of active travel. Our sample of working adults were slightly older than a typical working age population, and all lived in Norfolk which is a predominantly rural county with a largely British White population (96.2% at the 2001 UK Census(23)), which may limit the generalisability of these results to other populations. Although we excluded participants who were not working and reported some difficulty walking, the fact that our sample is older than the population average means that we anticipate the group would find active travel more difficult than a younger cohort would. Whether this may translate into the environment being a more or less important determinant of commuting behaviour is unknown. Greater family commitments in this age group may further moderate the importance of psychological or environmental factors; for example, considerations such as the need for children to be driven to school may be pertinent in behavioural choices.

In this study we used data on co-variates such as social class and BMI, which were collected around 9 and 6 years prior to the collection of exposure and outcome measures and may have changed in the interim. We also used participant's postcodes rather than exact addresses. On average one unique postcode covers about 15 addresses, however in some rural areas they can cover up to 80 addresses (30), hence this may limit the accuracy of our objectively assessed measures. Furthermore, our modelled routes were based on the assumption that participants would choose the shortest route between home and work and whilst this provides a measure of the environmental potential of the route environment, it may not reflect the actual routes used. Another limitation was that the numbers of respondents reporting exclusively walking or cycling to work was too small to separate these groups. This is coupled with the fact that we had no information on workplace facilities for walkers and cyclists (for example, lockers or showers), which might be important influences on behaviour (32).

As this work was exploratory in nature, we chose not to use particular a theory in the statistical modelling of active commuting behaviour, but rather used a best-fit approach based on observed associations within the data. This more data driven approach may have influenced our findings and therefore conclusions. We choose to adjust for BMI in our analysis as this has been found to be a negatively correlated with active travel behaviour(6). It may be that lower BMI is a result of engagement in active travel, in which case the inclusion of BMI in the models may attenuate the observed effects. However, we undertook a sensitivity analysis by removing BMI and found our results to be largely unchanged.

Conclusion

This study identified a number of individual characteristics, psychological and environmental measures as correlates of older adult's active commuting. The findings suggest that interventions designed to encourage the development of habitual behaviours for active commuting may be particularly effective, especially amongst those living shorter distances from work

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Table 1

Description of psychological and environmental variables

Domain	Construct	Variable coding	Mean (SD) or % (number)			
			Men (n= 500)		Women	
			Non AC (n=366)	AC (n=134)	Non AC (n=586)	AC (n=211)
Psychological	Habit	Mean score (1-7)	2.83 (1.13)	4.42 (0.66) **	2.99 (1.14)	4.40 (0.72) **
	Perceived behavioural control (PBC)	Mean score (1-2)	4.31 (0.67)	4.67 (0.52) **	4.22 (0.79)	4.51 (0.63) **
	Intention	Mean score (1-2)	3.35 (1.15)	3.88 (1.17) **	3.43 (1.09)	4.03 (1.03) **
	Instrumental attitude	Mean score (1-2)	4.50 (0.56)	4.62 (0.55) *	4.57 (0.53)	4.66 (0.56) *
	Affective attitude	Mean score (1-2)	3.88 (0.88)	4.20 (0.90) **	4.06 (0.85)	4.35 (0.79) **
	Subjective norm	Mean score (1-2)	3.38 (0.90)	3.59 (0.98) *	3.39 (0.86)	3.67 (0.90) **
	Social support	Mean score (1-3)	3.03 (0.93)	3.07 (1.01)	3.27 (0.95)	3.15 (1.12)
Distance to work	Route length	<1.5km	34.5 (29)	65.5 (55) **	36.0 (76)	64.0 (135) **
		1.5-4km	61.4 (89)	38.6 (56)	74.0 (182)	26.0 (64)
		4-10km	91.5 (248)	8.5 (23)	96.0 (326)	0.4 (14)
Perceived Environment	Types of residences	3 separate scores	2.69 (0.51)	2.64 (0.64)	2.74 (0.47)	2.73 (0.47)
			1.59 (0.67)	1.83 (0.74) **	1.65 (0.69)	1.89 (0.76) **
			1.37 (0.55)	1.60 (0.62) **	1.43 (0.59)	1.66 (0.63) **
	Land use mix diversity	Mean score (1-14)	2.81 (0.73)	3.21 (0.69) **	2.70 (0.79)	3.13 (0.59) **
	Access to services	Mean score (1-4)	2.85 (0.81)	3.26 (0.68) **	2.88 (0.81)	3.26 (0.68) **
	Street connectivity	Mean score (1-4)	2.97 (0.59)	3.08 (0.49) *	2.98 (0.60)	3.07 (0.60) *
	Walking and cycling facilities	Mean score (1-3)	2.50 (0.82)	2.74 (0.71) **	2.55 (0.86)	2.71 (0.65) *
	Aesthetics	Mean score (1-3)	2.89 (0.67)	2.93 (0.62)	2.88 (0.68)	2.85 (0.61)
	Pedestrian and traffic safety	Mean score (1-5)	2.60 (0.52)	2.69 (0.52)	2.59 (0.51)	2.67 (0.55) *
	Safety from crime	Mean score (1-5)	3.10 (0.48)	3.24 (0.46) **	2.98 (0.51)	3.00 (0.53)
Objective neighbourhood environment	Urban-rural status	Urban	66.8 (187)	33.2 (93)	71.5 (318)	28.5 (127)
		Town & fringe	73.6 (78)	26.4 (28)	65.5 (110)	34.5 (58)
		Village & hamlet	88.6 (101)	11.4 (13) **	85.9 (158)	14.1 (26) **
	Road density	-	10.56 (3.61)	12.52 (3.28) **	10.61 (3.57)	12.26 (3.15) **
	Percentage of primary roads	-	6.68 (9.52)	7.97 (9.57)	5.90 (8.95)	7.25 (8.54)
	Density of employment locations	-	0.04 (0.08)	0.09 (0.15) **	0.03 (0.05)	0.08 (0.13) **
	Streetlight density	-	12.77 (12.67)	20.03 (13.28) **	13.20 (13.18)	17.01 (12.88) **
	Pavement density	-	2.48 (1.22)	2.91 (1.05) **	2.49 (1.24)	2.93 (0.93) **
	Building density	-	105.41 (60.71)	145.55 (65.77) **	105.21 (58.76)	138.99 (62.06) **
	Density of RTAs	-	2.46 (2.24)	3.45 (2.87) **	2.27 (2.06)	3.20 (2.87) **
	Density of fatal & serious RTAs	-	0.38 (0.39)	0.48 (0.47) *	0.35 (0.35)	0.45 (0.46) **
	Effective walkable area (EWA)	-	0.37 (0.11)	0.37 (0.13)	0.36 (0.11)	0.38 (0.12)
	Junction density	-	0.24 (0.12)	0.30 (0.12) **	0.23 (0.12)	0.29 (0.10) **

Domain	Construct	Variable coding	Mean (SD) or % (number)			
			Men (n= 500)		Women	
			Non AC (n=366)	AC (n=134)	Non AC (n=586)	AC (n=211)
	Land use mix[1]	-	2846.57 (1052.49)	2581.57 (840.85) **	2935.82 (1100.90)	2575.33 (711.18) **
	Socioeconomic deprivation	-	13.88 (8.06)	16.47 (8.55) **	13.79 (8.37)	15.48 (8.63) *
	Crime rate	-	78.02 (187.74)	92.47 (165.37)	63.90 (31.12)	91.64 (185.90) **
	Park in neighbourhood	No	77.9 (264)	22.1 (75)	77.6 (413)	22.4 (119)
		Yes	63.4 (102)	36.6 (59)	65.3 (173)	34.7 (92)
Objective route environment	Route length ratio[2]	-	1.33 (0.65)	1.48 (0.53) *	1.37 (0.52)	1.53 (0.65) **
	Main road on route	No	61.5 (96)	38.5 (60)	62.1 (223)	37.9 (136)
		Yes	78.5 (270)	21.5 (74) **	82.9 (363)	17.1 (75) **
	Secondary road on route	No	69.0 (205)	31.0 (92)	68.7 (311)	31.3 (142)
		Yes	79.3 (161)	20.7 (42) *	79.9 (275)	20.1 (69) **
	Main or Secondary road on route	No	56.8 (54)	43.2 (41)	51.0 (98)	49.0 (94)
		Yes	312 (77.0)	23.0 (93) **	80.7 (488)	19.3 (117) **
	Land use mix1	-	2384.35 (882.55)	2317.11 (46.97)	2457.17 (845.86)	2628.43 (820.79) *
	Density of RTAs on route	-	2.35 (2.32)	2.84 (2.90) *	2.19 (2.28)	2.55 (3.20)
	Density of fatal & serious RTAs on route	-	0.34 (0.43)	0.49 (0.78) **	0.31 (0.41)	0.38 (0.75)

AC, active commuting; Non AC, Non-active commuting; RTAs, road traffic accidents. P values indicate differences between active commuting and non-active commuting

*p<0.05,

**p<0.01

[1]Seventeen different land uses were classified: farmland, woodland, grassland, uncultivated land, other urban, beach, marshland, sea, small settlement, private gardens, parks, residential, commercial, multiple use buildings, other buildings, unclassified buildings and roads. This score is also known as the Herfindahl-Hirschman Index developed by Rodriguez and Song (2005).

[2]Route length ratio is the road length divided by the straight line distance between the home and workplace.

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Table 2

Personal and household factors stratified by adult's travel mode to work

Characteristic	Men (n=500)		Women (n=500)	
	Non AC (n=366)	AC (n=134)	Non AC (n=586)	AC (n=211)
Mean age (SD)	61.73 (5.88)	60.66 (5.02)	59.87 (5.16)	59.68 (5.16)
Mean BMI (SD)	26.54 (2.99)	25.51 (2.99) *	25.72 (4.43)	25.72 (3.98)
Percentage (n)				
Social class				
Professional	73.6 (181)	26.4 (65)	78.9 (255)	21.1 (68) *
Skilled	68.8 (121)	31.3 (55)	71.6 (250)	28.4 (99)
Partly skilled/unskilled	83.3 (60)	16.7 (12)	63.6 (77)	36.4 (44)

AC, active commuting; Non AC, Non-active commuting; BMI, Body Mass Index; SD, Standard Deviation.

* $p < 0.01$

Percentages are row percentages.

P values indicate the differences in characteristics between those active commuters and non active commuters (for men and women respectively).

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Table 3

Logistic regression models showing odds of active commuting for males and females (model 1, individual and psychological factors; model 2, individual factors and distance; model 3, individual and environmental factors)

	Model 1 Psychological predictors		Model 2 Distance		Model 3 Environmental predictors	
	Males	**Females**	**Males**	**Females**	**Males**	**Females**
Individual factors						
Age	0.96 (0.91-1.01)ns	1.00 (0.96-1.04)ns	0.91 (0.87-0.96)ns	0.97 (0.94-0.97)ns	0.97 (0.93-1.01ns)	0.99 (0.95-1.03)ns
BMI	0.92 (0.83-1.01)ns	1.00 (0.95-1.05)ns	0.83 (0.77-0.91)ns	0.93 (0.89-0.97) **	0.86 (0.79-0.93) **	0.95 (0.91-0.99) *
Social class (professional = reference)	1.00	1.00	1.00	1.00	1.00	1.00
Skilled	1.33 (0.74-2.3)ns	1.61 (1.04-2.49) *	1.24 (0.74-2.08)ns	1.47 (0.95-2.26)ns	1.06 (0.65-1.74)ns	1.54 (1.01-2.35) *
Partly skilled/unskilled	0.59 (0.25-1.41)ns	1.98 (1.12-3.52) *	0.42 (0.19-0.92) *	1.84 (1.05-3.23) *	0.49 (0.22-1.11)ns	2.09 (1.22-3.58) **
Psychological factors						
Habit	6.75(4.46-10.22) **	4.65 (3.54-6.12) **				
PBC	1.72 (0.99-2.99)ns	1.25 (0.90-1.74)ns				
Intention	0.85 (0.63-1.16)ns	0.96 (0.74-1.23)ns				
Instrumental attitude	0.67 (0.36-1.27)ns	0.72 (0.44-1.18)ns				
Affective attitude	0.94 (0.62-1.41)ns	0.80 (0.56-1.14)ns				
Subjective norm	0.83 (0.58-1.19)ns	1.18 (0.94-1.49)ns				
Distance						
Route length (<1.5km = reference)			1.00	1.00		
1.5km-4km			0.24 (0.13-0.45) **	0.19 (0.12-0.28) **		
4-10km			0.03 (0.01-0.06) **	0.01 (0.01-0.03) **		
Environmental factors						
Perceived neighbourhood environment						
Terraced housing density					1.03 (0.70-1.51)ns	1.38 (1.03-1.86) *
Apartment density					1.25 (0.79-1.98)ns	1.18 (0.81-1.73)ns
Land use mix diversity					1.28 (0.79-2.05)ns	1.83 (1.25-2.70) **
Access to services					1.40 (0.90-2.16)ns	1.17 (0.83-1.65)ns
Street connectivity					-	1.09 (0.78-1.52)ns
Walking and cycling facilities					0.93 (0.62-1.37)ns	0.84 (0.61-1.14)ns
Safety from crime					1.46 (0.87-2.47)ns	-
Objective neighbourhood environment						
Urban rural status (urban = reference)					1.00	1.00
Town and fringe					1.00 (0.51-1.98)ns	1.33 (0.78-2.24)ns
Village					0.89 (0.29-2.70)ns	1.26 (0.60-2.67)ns
Road density					1.06 (0.94-1.19)ns	1.10 (1.00-1.21) *
Density of employment locations						
(low = reference)					1.07 (0.60-1.94)ns	1.52 (0.95-2.45)ns
Land use mix score (low = reference)					1.15 (0.68-1.98)ns	1.18 (0.77-1.80)ns
Deprivation score					1.00 (0.97-1.04)ns	0.98 (0.95-1.01)ns
Park in the neighbourhood					1.36 (0.88-2.44)ns	1.35 (0.90-2.03)ns

	Model 1		Model 2		Model 3	
	Psychological predictors		Distance		Environmental predictors	
	Males	Females	Males	Females	Males	Females
Objective route environment g						
Route length ratio					1.29 (0.83-2.01)ns	1.46 (1.10-1.94) **
Main or secondary road on route (no = reference)					0.22 (0.13-0.45) **	0.18 (0.11-0.28) **
Density of road traffic accidents					1.05 (0.98-1.21)ns	-
Land use mix score (low = reference)					-	0.64 (0.42-0.98) *
Nagelkerke R2	0.53	0.42	0.40	0.42	0.28	0.30

- not included in multivariable analysis

*p<0.05,

**p<0.01, ns not significant.

Within each model all factors were included simultaneously and therefore al the factors are adjusted for each other. All analyses adjusted for age, BMI, social class. Non-active commuting is used as the reference category.

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Table 4

Logistic regression models showing odds of active commuting for males and females.

	Model 4	
	Males	**Females**
Individual factors		
Age	0.91 (0.85-0.97) *	0.98 (0.93-1.03)ns
BMI	0.85 (0.77-0.95) *	0.98 (0.92-1.04)ns
Social class (professional = reference)	1.00	1.00
Skilled	1.57 (0.78-3.16)ns	1.60 (1.04-2.73) *
Partly skilled/unskilled	0.46 (0.16-1.28)ns	1.38 (0.68-2.81)ns
Psychological factors		
Habit	7.02 (4.41-11.15) **	4.87 (3.57-6.63) **
Distance		
Route length (<1.5km = reference)	1.00	1.00
1.5km-4km	0.16 (0.06-0.39) **	0.18 (0.10-0.31) **
4-10km	0.02 (0.01-0.05) **	0.02 (0.01-0.05) **
Environmental factors		
Objective neighbourhood environment		
Urban rural status (urban = reference)	1.00	
Town and fringe	0.40 (0.17-0.95) **	
Village	0.33 (0.13-0.87) *	
Road density		1.09 (1.00-1.17) *
Main or secondary road on route (no = reference)		0.43 (0.25-0.74) **
Nagelkerke R2	0.70	0.65

* p<0.05,

** p<0.01, ns not significant.

Within each model all factors were included simultaneously and therefore all the factors are adjusted for each other. All analyses adjusted for age, BMI, social class. Non-active commuting is used as the reference category.