



# How commuting affects subjective wellbeing

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Published online: 11 March 2019  
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## Abstract

Commuting between home and work is routinely performed by workers and any wellbeing impacts of commuting will consequently affect a large proportion of the population. This paper presents findings from analyses of the impact of commuting (time and mode) on multiple aspects of Subjective Well-Being (SWB), including: satisfaction with life overall and the SWB sub-domains of job satisfaction, satisfaction with leisure time availability and self-reported health. Measures of strain and mental health (GHQ-12) are also examined. Six waves of individual-level panel data from Understanding Society (2009/10 to 2014/15) are analysed, providing a sample of over 26,000 workers living in England. Associations between commuting and SWB are identified, paying particular attention to those arising from individual changes in commuting circumstances over the six waves. It is found that longer commute times are associated with lower job and leisure time satisfaction, increased strain and poorer mental health. The strongest association is found for leisure time satisfaction. Despite these negative associations with the SWB sub-domains, longer commute times were not associated with lower overall life satisfaction (except where individuals persisted with them over all six waves). Workers in England appear to be successful in balancing the negative aspects of commuting against the wider benefits, e.g. access to employment, earnings and housing. Differences amongst selected population sub-groups are also examined. The job satisfaction of younger adults and lower income groups are not found to be negatively associated with longer commute times; longer commute times are more strongly negatively associated with the job satisfaction of women compared to men. With respect to mode of transport, walking to work is associated with increased leisure time satisfaction and reduced strain. The absence of the commute, via working from home, is associated with increased job satisfaction and leisure time satisfaction. Overall, the study indicates that shorter commute times and walkable commutes can contribute to improved SWB—particularly through the release of leisure time. But life satisfaction overall will only be maintained if the benefits of undertaking the commute (earnings and satisfactory housing/employment) are not compromised.

**Keywords** Commuting · Subjective Wellbeing · Mental Health · Panel Data

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## Introduction

There has been increasing attention internationally on how transport policies and practices can contribute to better health (for example, see UNECE (2015) for Europe and CIHT (2016) for UK). The focus has mostly been on reducing the impacts on physical health from traffic injuries and pollution and reversing the decline in physical activity. However, it is also acknowledged that transport systems and different forms of travel behaviour can have effects beyond physical health on people's mental health and happiness. This has coincided with concern about the limits of GDP as a measure of economic performance and social progress and growing interest globally in measuring people's wellbeing<sup>1</sup> (OECD 2011).

Personal wellbeing can be measured using objective measures (e.g. income) and subjective measures (e.g. happiness)—measurement of the subjective measures are argued to be particularly important as only the person themselves knows how they are feeling (Layard 2005). Subjective wellbeing (SWB) is defined formally in the 2013 OECD Guidelines on Measuring SWB as “Good mental states, including all of the various evaluations, positive and negative, that people make of their lives, and the affective reactions of people to their experiences” (OECD 2013). As such, SWB is a broad concept encompassing (1) self-evaluations of satisfaction with different aspects (or domains) of one's life (e.g. satisfaction with home, family, job, health) and with life overall—referred to as ‘evaluative wellbeing’; (2) the frequency with which one experiences different emotions,—referred to as ‘experiential wellbeing’, and (3) whether individuals feel they are fulfilling their potential—referred to as ‘eudaimonic wellbeing’. The first two of these SWB dimensions are sometimes jointly referred to as ‘hedonic wellbeing’, since they relate to pleasure and satisfaction (e.g. de Vos et al. 2013).

Recent research has sought to identify whether the commute to work has an impact on the SWB of workers. The rationale for this research is that the journey to and from work is routinely repeated—for example, full-time workers in England commute to work on about 160 days of the year (DfT 2016). Any SWB benefits or dis-benefits of commuting will potentially affect a large proportion of the population. Indeed, there are multiple ways through which commuting could affect SWB. The journey to work may consume more time and money than individuals would prefer and may also be a stressful experience (Koslowsky et al. 1995). On the other hand, the commute may offer SWB benefits in providing time to relax (Redmond and Mokhtarian 2001) or to undertake physical activity. The impact on SWB of commuting is likely to depend upon its duration, the mode of transport used and the conditions experienced during the journey.

This paper presents an analysis of the impact of commuting (time and mode) on multiple aspects of SWB, including: satisfaction with life overall and the SWB sub-domains of job satisfaction, satisfaction with leisure time availability and self-reported health. Measures of strain and mental health are also examined. Six waves of individual-level panel data from Understanding Society (2009/10 to 2014/15) (University of Essex 2016) are analysed, providing a sample of over 26,000 workers living in England. The paper expands on the summary of an examination of commuting and wellbeing reported in Chatterjee et al.

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<sup>1</sup> OECD comment on defining wellbeing: “Although there is no single definition of well-being, most experts and ordinary people around the world would agree that it requires meeting various human needs, some of which are essential (e.g. being in good health), as well as the ability to pursue one's goals, to thrive and feel satisfied with their life” (OECD 2011).

(2017). Specifically, the paper provides a detailed explanation and justification of (1) the models used to identify robust associations between commuting and SWB, paying particular attention to those arising from individual changes in commuting circumstances over the six waves, (2) the results of these models and (3) their implications.

In the next section we summarise the existing evidence on how commuting influences different aspects of SWB. Through this, we build the argument that it is valuable to take a multi-dimensional view of SWB within a single research framework. This is the contribution of our empirical analysis, which set out to identify and compare which specific aspects of SWB are affected by commute time and mode. The remainder of the paper is structured as follows: The objectives and research framework are explained under “[Study objectives and contribution](#)”, in relation to evidence gaps identified through the literature review. The data set used in the empirical work is then described under “[Data](#)”, followed by an explanation of the approach to the analysis, under “[Analytical approach](#)”. The “[Results](#)” are summarised next, with implications and opportunities for further research considered in the “[Discussion](#)”.

## Literature review

There is a growing body of research examining the relationship between travel behaviour and SWB, reviewed by Ettema et al. (2010), De Vos et al. (2013) and, most recently, Mokhtarian (2018). For example, a recent study by Friman et al. (2017) found that satisfaction with daily travel directly influences both experiential wellbeing and life satisfaction and that greater satisfaction with daily travel is highest for those that walk and cycle and lowest for those that use public transport. This review concentrates, however, on summarising the findings from studies that have specifically looked at the relationship between commuting travel and SWB. We begin by reviewing studies of commuting and overall life satisfaction, and then move on to consider evidence of the effects of commuting on (1) sub-domains of life, (2) experiential wellbeing and (3) mental health.

### Commuting and satisfaction with life overall

A review of the economic literature on SWB found that higher life satisfaction is associated with being in good physical health, being employed, being married or cohabiting and not being in middle age (Dolan et al. 2008). Income has a positive association with life satisfaction, but with diminishing returns. Women report higher life satisfaction scores than men (ibid). Turning to the effect of commuting on life satisfaction, cross-sectional studies have consistently found a negative relationship between commute time and life satisfaction, including studies in Sweden (Olsson et al. 2013), the United States (Choi et al. 2013), Great Britain (ONS 2014) and China (Nie and Sousa-Poza 2018).

With concern that cross-sectional associations between commute time and life satisfaction may be spurious, researchers have conducted longitudinal analysis by obtaining panel data and estimating fixed effects regression models (which consider within-individual differences in SWB and account for unobserved differences between individuals which persist over time such as personality factors). Stutzer and Frey (2008) used data from the German Socio-economic Panel Study (GSOEP), which included observations for the same individuals between 1985 and 2003. Fixed effects models indicated that longer commute times were associated with lower life satisfaction. Stutzer and Frey (2008) noted that economic

theory implies rational individuals will only take on burdensome commutes if compensated by better jobs or housing. Hence, they would not have expected the negative association between longer commute times and life satisfaction.<sup>2</sup> The authors offered the explanation that this ‘commuting paradox’ arises from people underestimating the negative effects of commuting and their ability to adapt to it.

By contrast to Stutzer and Frey (2008), Lorenz (2018) found no association between commute *distance* and life satisfaction using the same data source and method but data for years 2007–2013. In the UK context, no association was found between commute time and life satisfaction in a fixed effects regression analysis of data from 1996 to 2008 for participants of the British Household Panel Survey (BHPS) (Dickerson et al. 2014).

With respect to commute *mode*, Stutzer and Frey (2008) found no significant differences in the negative association between commute time and life satisfaction for those using different modes. Similarly, the non-significant association between commute time and life satisfaction applied to all commute modes for the UK analysis by Dickerson et al. (2014).

### Commuting and satisfaction with sub-domains of life

Some researchers have considered how commuting affects different domains of life, including satisfaction with family and social networks, housing, employment, leisure time availability and health. One reason for exploring sub-domains is that self-reported life satisfaction responses are relatively stable over time (which has been attributed to genetics and personality) and only differ substantially after extreme events (e.g. bereavement, unemployment) (Lucas 2007). Furthermore, it is plausible that commuting might affect one sub-domain differently from another.

A number of studies have found longer commute times to be associated with reduced *satisfaction with leisure time* (Dickerson et al. 2014; Stutzer and Frey 2008). Lorenz’s (2018) assessment of multiple life domains (based on GSOEP data for 2007–2013) found that longer commute *distances* have a negative association with *satisfaction with leisure and family life*. But no association was identified between commute distance and *job satisfaction*. This differs with the result of Stutzer and Frey (2008) which showed a negative association between commute time and *job satisfaction* (using the same panel data, but for years 1985–2003). It could be (1) that there are differing effects of commute *time* and *distance* on job satisfaction and/or (2) that the relationship between commuting and job satisfaction in Germany has changed over time.

Other studies have shown a relationship between commuting and *subjective assessments of physical health*. Künn-Nelen (2016) found (from an analysis of BHPS data for 1991–2008, using fixed effects models) that longer commute times are associated with lower health satisfaction, but not with objective health measures such as the presence of health problems and sickness absences from work.

The studies that have analysed the relationship between commuting time and satisfaction with sub-domains of life have not reported differences by commute *mode* but their main focus has been on the effects of commute time and this might reflect absence of analysis rather than lack of association.

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<sup>2</sup> Their fixed effect models did not include income, or any other job or housing characteristics, as independent variables. If these were included it would be expected that there is a negative association between commute time and life satisfaction which is offset by positive associations between income (and any other job or housing benefits of long commutes) and life satisfaction.

Commuting could be considered a sub-domain of life given it occupies a considerable amount of time in many workers' lives. Recent research has investigated satisfaction with the commute and the factors that influence this. These generally show that longer commute durations decrease commute satisfaction and that commuters using active modes of transport (walking and cycling) report the highest levels of commute satisfaction and public transport users the lowest levels (e.g. Olsson et al. 2013, St-Louis et al. 2014).

There are few studies that measure SWB in terms of commuting as well as other sub-domains and life overall. One exception is a cross-sectional study of Swedish commuters which found satisfaction with the commute contributed to explaining both experiential wellbeing and life satisfaction (Olsson et al. 2013). It would be valuable to examine whether this relationship also holds with longitudinal data. However, large-scale, longitudinal data sets which capture different aspects of SWB do not capture satisfaction with the commute. Hence our study explores the relationship between different commuting behaviours and SWB, measured in terms of life overall and other major sub-domains, without directly considering satisfaction with the commute itself.

### Commuting and experiential wellbeing

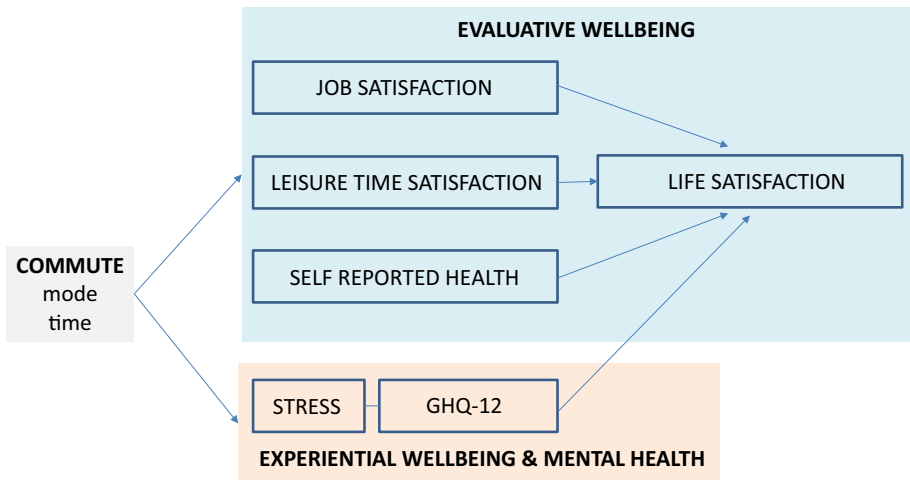
Kahneman et al. (2004) analysed how people rated their mood (positive affect) during various daily activities. Commuting received the lowest positive affect scores and one of the highest negative affect scores, indicating that mood is worsened during the journey to/from work. Some studies have examined whether there is a relationship between commuting and people's overall experiential wellbeing (their emotions across all activities). Cross-sectional studies have shown longer commute times associated with reduced happiness (Olsson et al. 2013; Choi et al. 2013; ONS 2014; Nie and Sousa-Poza 2018). However, Lorenz (2018) found no association between commute distance and frequency of feeling angry, worried, happy or sad (based on panel data and fixed effects models for workers in Germany). It is unclear whether these contrasting results might be explained by differences in exposure measures used (commute *time* versus *distance*) or differences in the data and type of analysis used (cross-sectional data/analysis versus longitudinal data/analysis).

### Commuting and mental health

Other studies have examined the effect of commuting on *mental health*, as measured using the General Health Questionnaire (GHQ-12) scale (which involves 12 questions designed to detect symptoms of psychological distress). Mental health has been defined as a "state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community" (WHO 2018).<sup>3</sup> Mental health is distinct from SWB, since mental health refers to an objective state of the individual. However, there are some overlapping features—mental health is often measured through asking people about themselves, albeit with the aim to identify their level of cognitive-emotional functioning (Manwell et al. 2015).

Roberts et al. (2011) carried out fixed effects modelling analysis of BHPS data (1991–2004) and found that longer duration commutes were associated with worse mental health for women, but not men. Martin et al. (2014) analysed the same data set (for

<sup>3</sup> There is not however a full consensus on a definition of mental health (Manwell et al. 2015).



**Fig. 1** Analytical framework

1991–2008) and with fixed effects modelling found walking to work and using the bus to be associated with better mental health than commuting by car. Martin et al. (2014) also separately analysed associations between commute mode and responses for the 12 different GHQ-12 symptoms and found that car travel was associated with higher likelihood of reporting ‘being constantly under strain’ and ‘being unable to concentrate’ compared to walking or cycling to work, but no significant differences for other symptoms.

## Study objectives and contribution

Previous studies have indicated associations between commuting and SWB. However, the results are mixed, with the effect of commuting being found to vary according to the outcome measure used (for SWB), the exposure measure used (for commuting), the country setting and the data sets and type of analysis employed. Hence, it is valuable to examine the effects of different aspects of commuting behaviour *on multiple outcome measures in a single analytical framework* (see Fig. 1). Accordingly, the empirical study presented in this paper addresses three objectives:

1. To identify how commuting (in terms of time and mode) influences sub-domains of SWB;
2. To identify how commuting (in terms of time and mode) influences overall life satisfaction and to what extent this is explained by its effects on sub-domains of SWB; and
3. To identify whether the relationships between commuting and SWB differ for different groups in the population (considering gender, age and position in the income distribution).

Note that, although our primary focus is on SWB, we have also considered a measure of mental health (GHQ-12) as this provides complementary insights (explained in the next section). Lorenz (2018) considered the relationship between commuting and multiple outcome

**Table 1** Understanding Society measures of commuting

Variable	Question	Measure
Commute time	About how much time does it usually take for you to get to work each day, door to door (in minutes)?	Integer number of minutes
Commute mode	And how do you usually get to your place of work? (mode used for the longest part of the journey)	Categorical variable: drive by car or van, get a lift, motorcycle, taxi, bus, train, metro, cycle, walk, other

measures of SWB using panel data, but only considered the influence of commuting distance. Our study focusses on the effects of commuting time and mode, rather than distance. We suggest that the burden of commuting is most likely to be related to its duration, i.e. commute time, and conditions experienced, i.e. commute mode. We believe the data we use captures the most salient characteristics of commuting likely to influence SWB.

## Data

We addressed the objectives through an analysis of a six-wave panel sample of over 26,000 employed people living in England (from 2009/10 to 2014/15), drawn from Understanding Society, also known as the UK Household Longitudinal Study (UKHLS) and prior to 2009/10 known as the British Household Panel Survey (BHPS) (University of Essex 2016). Understanding Society captures a wide range of social, economic and attitudinal information about the lives of members of 40,000 households, through an annual interview. Two measures of (self-reported) commuting are captured for employed participants in every wave: (1) the one-way door-to-door journey time (in minutes) and (2) the mode of transport normally used to get to work (Table 1). Although self-reported journey times may not

**Table 2** Understanding Society measures of SWB

Measure	Question wording	Measurement
Life satisfaction	How dissatisfied or satisfied are you with your life overall?	7-Point scale with 7 representing the most positive response
Job satisfaction	How dissatisfied or satisfied are you with your job?	7-Point scale with 7 representing the most positive response
Leisure time satisfaction	How dissatisfied or satisfied are you with the amount of leisure time you have?	7-Point scale with 7 representing the most positive response
Self-reported health	In general, would you say your health is? (poor to excellent)	5-Point scale with 5 representing the most positive response
Mental health	Based on the General Health Questionnaire (GHQ-12) scale	36 Point scale with 0 representing the most positive response. This was reversed for our analysis with 36 representing the most positive response
Strain	Have you recently felt constantly under strain? (asked with respect to the 'last few weeks')	4-Point scale with 1 'not at all', 2 'no more than usual', 3 'rather more than usual' and 4 'much more than usual'



provide a precise representation of objective journey times (see Witlox 2007), this was not considered to introduce any serious systematic biases.

The analysis sample included Understanding Society participants that were employed, resident in England and that had reported a valid commute time and commute mode (including working from home). The sample was limited to England since the broader analysis (not all of which is reported in the paper) included testing to see whether a number of spatial context variables (e.g. residential settlement type) influenced the relationship between commuting and SWB. These were linked to Understanding Society from external data sets, which were only available for England. Spatial context variables were not found to be statistically significant in most cases. Observations pertaining to commute times of over 180 min were excluded as these were found to be outliers (representing 0.18 percent of all observations) and it was thought unlikely that such long commutes would be undertaken every working day. This analysis sample included 26,551 individuals with a total of 79,793 person-year observations recorded across the six waves.

We analysed six measures of SWB that are captured in Understanding Society every wave (Table 2). These include evaluative and experiential measures of SWB (see Fig. 1) but no eudaimonic measure as this was not available at every wave. We examined an evaluative measure of overall life satisfaction, noting that other studies have shown no association between commute time and life satisfaction for workers in England (Dickerson et al. 2014). This may be because the negative impacts of commuting on life satisfaction are compensated by commuting benefits such as improved income, employment or housing. Hence, in addition to examining life satisfaction, we analysed three SWB sub-domains that could plausibly be directly impacted by commuting, whilst not being compensated for by other factors. These sub-domains were satisfaction with the job and leisure time availability and self-reported health (we assume the latter measure is interpreted by respondents as relating to their physical health).

We also assessed the relationship between commuting and mental health and strain. Mental health is measured in Understanding Society using the General Health Questionnaire (GHQ-12) scale—a composite score based on responses to 12 questions which are designed to identify psychiatric disorders. A number of the GHQ-12 questions record frequency of experiencing negative emotions and hence can also be interpreted as indicators of experiential wellbeing. Martin et al. (2014) previously identified an association between commuting and the GHQ12 question about strain and this question was analysed independently.

As noted previously, a number of studies have examined satisfaction with the commute itself (e.g. St-Louis et al. 2014). Commute satisfaction is not measured in Understanding Society, as is typically the case for multi-topic surveys that obtain diverse wellbeing measures. The focus of this study was, therefore, on the broader impacts of commuting on people's lives.

## Analytical approach

### Model specification

The regression model used for the analysis can be expressed as:

$$SWB_{it} = \beta X_{it} + \gamma \bar{X}_i + \alpha_i + \varepsilon_{it} \quad (1)$$

The dependent variable is the SWB score (we tested six different measures of SWB) for individual  $i$  at time  $t$ .  $X_{it}$  is a vector of independent variables (including commuting time



and mode and control variables) and  $\bar{X}_i$  is a vector of the means of the independent variables over the time interval 1,...6.  $\beta$  and  $\gamma$  are coefficients to be estimated by the model. The unknown components are  $\alpha_i$  which is a time-invariant idiosyncratic (random) effect (assumed to be Normal distributed with mean 0 and standard deviation  $\sigma_\alpha$ ), uncorrelated with  $\bar{X}_i$  or with  $X_{it}$ , and  $\varepsilon_{it}$  which is a random error term that is assumed to be independently distributed over  $i$  with arbitrary serial correlation.

This specification was suggested by Mundlak (1978) and is referred to as the *correlated random effects* model. It is a variant of the fixed effects models typically used to analyse panel data (by Stutzer and Frey (2008) and others in the previously reviewed commuting and wellbeing studies) and has some advantages. Fixed effects models provide coefficient estimates that only reflect within-individual variation of independent variables. The introduction of the mean values of time-varying independent variables removes cross-sectional variation from the coefficients of the time-varying variables which are then effectively the coefficients that would have been estimated from a fixed effects model. However, additionally, the coefficient estimates for the means of time-varying independent variables enable the association between SWB and time invariant variables (such as gender) to be estimated and also represent associations between SWB and between-individual variation in independent variables.<sup>4</sup>

In interpreting the results, we place greater weight on the coefficients for within-individual variation in independent variables. However, we do not dismiss associations based on between-individual variation in independent variables since we consider this still provides plausible evidence for effects on SWB (given that we control for other independent variables and given that six waves of data provides somewhat limited data on within-individual variation in commuting over time, a point argued by Dolan et al. (2008)).

The SWB indicators used in our analysis are measured on an ordinal scale but in our main models we treat them as cardinal variables and estimate linear, ordinary least squares (OLS) models. Substantive differences have not been found when comparing OLS and ordered models in previous work (Ferrer-i-Carbonell and Frijters 2004). This was checked and confirmed for our data by estimating fixed effect ordered logit models for each dependent variable, using the ‘Blow-up and Cluster’ (BUC) approach proposed by Dickerson et al. (2014).

The independent variables included commute time, commute mode and a set of control variables as set out in Table 3. We also included dummy variables for each wave to allow for the possibility for differences in SWB over time that are common to all individuals (fixed time effects, as included by Roberts et al. 2011 and others). The controls were selected based on previous studies of SWB (Dolan et al. 2008; Stutzer and Frey 2008; Dickerson et al. 2014; Roberts et al. 2011; Martin et al. 2014), an assessment of bivariate correlations in the data set and an incremental process of regression model development. The functional form incorporated a linear relationship between commute time and SWB and a log form relationship between income and SWB, to recognise diminishing SWB returns on income.<sup>5</sup>

<sup>4</sup> Between-individual variation refers to variation across all individuals in the sample pooled across six waves. Note that the sample includes multiple individuals within households and we did not account for this in the error structure to simplify the model specification. However, the Mundlak estimation does adjust for error term correlations for individuals with multiple observations, as per a random effects model.

<sup>5</sup> In contrast to Stutzer and Frey (2008) but in common with other studies (Dickerson et al. 2014; Lorenz 2018), we included income (and other job and housing characteristics) as independent variables in our models. Their inclusion was expected to lead to larger negative associations between commute time and SWB than would otherwise be the case (as rational workers would be expected to accept the burden of longer commutes only if compensated by improved job and housing benefits). It was of specific interest to see if this was the case.

**Table 3** Descriptive statistics for dependent and independent variables

	Mean/mode	SD overall <sup>a</sup>	SD between <sup>b</sup>	SD within <sup>c</sup>	Min	Max
<b>Dependent variables</b>						
Job satisfaction	5.28/6	1.45	1.23	0.94	1	7
Leisure time satisfaction	4.37/6	1.58	1.34	1.01	1	7
Self-reported health	3.66/4	0.96	0.88	0.50	1	5
Strain	2.03/2	0.75	0.64	0.50	1	4
Mental health	25.33/30	4.99	4.36	3.05	0	36
Life satisfaction	5.19/6	1.39	1.18	0.90	1	7
<b>Independent continuous variables</b>						
Commute time (mins)	27.03	21.93	20.55	10.24	1	175
Age	41.12	12.86	13.66	1.43	16	87
Gross monthly personal income (£100 per month)	21.88	17.52	16.44	6.81	0.0007	150
Equivalent net monthly household income (£100 per month)	18.47	10.95	9.87	5.78	0.01	200
	n	%				
<b>Independent categorical variables</b>						
Female	43,651	54.71	–	–	–	–
Ethnicity: white UK	61,675	77.29	–	–	–	–
Ethnicity: missing	508	0.64	–	–	–	–
Live with a partner	54,166	67.88	–	–	–	–
Live with a child	28,913	36.24	–	–	–	–
Belong to a religion: yes	38,505	48.26	–	–	–	–
Belong to a religion: no	39,113	49.02	–	–	–	–
Belong to a religion: missing	2175	2.73	–	–	–	–
Education: degree	25,596	32.08	–	–	–	–
Education: 'A' Level	17,783	22.29	–	–	–	–
Education: GCSE	16,600	20.8	–	–	–	–
Education: other higher	10,738	13.46	–	–	–	–
Education: other or none	9076	11.37	–	–	–	–
Long standing health condition	19,334	24.23	–	–	–	–
Area: inner London	5029	6.30	–	–	–	–
Area: outer London	8945	11.21	–	–	–	–
Area: metropolitan	12,034	15.08	–	–	–	–
Area: large urban (250 k+)	8856	11.10	–	–	–	–
Area: medium urban (25–250 k)	21,272	26.66	–	–	–	–
Area: small urban (10–25 k)	6271	7.86	–	–	–	–
Area: very small urban (3–10 k)	4102	5.14	–	–	–	–
Area: rural	13,284	16.65	–	–	–	–
Tenure: own outright	14,409	18.06	–	–	–	–
Tenure: own with a mortgage	43,267	54.22	–	–	–	–
Tenure: rent public sector	9270	11.62	–	–	–	–
Tenure: rent private sector	12,309	15.43	–	–	–	–
Tenure: other	538	0.67	–	–	–	–
Working hours < 30 h/wk	23,509	29.46	–	–	–	–

**Table 3** (continued)

	n	%				
Working hours 30–40 h/wk	47,385	59.38	–	–	–	–
Working hours > 40 h/wk	8899	11.15	–	–	–	–
Temporary employment	6630	8.31	–	–	–	–
Emp. type: management	33,893	42.48	–	–	–	–
Emp. type: intermediate	11,790	14.78	–	–	–	–
Emp. type: small emp./self-emp.	3925	4.92	–	–	–	–
Emp. type: lower supervisory	5927	7.43	–	–	–	–
Emp. type: misc/unknown	24,258	30.4	–	–	–	–
Ethnic minority boost sample member	9943	12.46	–	–	–	–

Source: Understanding Society, waves 1–6, pooled sample, n = 79,793

<sup>a</sup>Standard deviation for full sample pooled across 6 waves

<sup>b</sup>Standard deviation based on variation between individuals

<sup>c</sup>Standard deviation based on variation within individuals

Due to large numbers of missing values, categories for missing values were explicitly coded for ‘Belong to a religion’ and ‘Ethnicity’ and included as dummy variables in the regression models

GCSE refers to General Certificate of Secondary Education taken at aged 16

‘A’ Level refers to Advanced Level qualification taken at aged 18

Emp. refers to employment/employer/employed

Ethnic minority boost sample member: ethnic minorities are over-sampled in Understanding Society to enable sub-group analyses of these population groups. We included the ethnic minority boost sample component in the regression models and controlled for over-sampling of this population group by including a binary flag variable

Descriptive statistics for commute mode and move home/employment location (two further independent variables included in the models) are shown in Table 4 and Table 5 respectively

These functional forms have been adopted in previous studies (Dickerson et al. 2014; Lorenz 2018) and were also consistent with our own assessment of the nature of the relationships. For example, including commute time as a categorical variable in the models showed that SWB decreases approximately linearly with commute time. Some previous studies have included a commute time squared term as well as a commute time linear term (e.g. Stutzer and Frey 2008) but our data did not demonstrate the need for this.

It was observed that significant changes in commute time often correspond with a change in the origin or destination of the commute (see “[Descriptive analyses](#)” section). Binary variables were included to control for home and employment location changes, since each of these events (as choices made to improve personal/household circumstances) might be expected to improve SWB. As a robustness check we excluded the binary variables controlling for home and employment location changes. As expected, these variables were found to confound the commute time-SWB relationship i.e. the commute time coefficients were smaller, but remained significant when the move home/employment location controls were removed.

We examined the effects of working from home on SWB compared to commuting, by estimating a model variant in which working from home was included as a dummy ‘commute mode’ category. Commute time was coded as zero for observations where the individual worked from home. Compared to commuters with non-zero but low commute

times, the working from home dummy variable represents the additive effects of working from home beyond the effect of a zero commute time. The dummy variable will also pick up unmeasured characteristics of respondents working from home relating to factors such as job type, but this effect is likely to be limited when considering associations based on within-individual variation (where the same person works from home on some occasions and elsewhere on other occasions).

### Population sub-groups

We were also interested in identifying whether relationships between commuting and SWB differ for different sub-groups in the population (such as where Roberts et al. (2011) found that longer commute times had a more negative association with mental health of women than men). Sub-group analysis was conducted by estimating four separate sets of fixed effects models<sup>6</sup> for each SWB indicator with interaction terms between commute time and categorical variables for: (1) commute mode, (2) gender, (3) age group, and (4) personal income quintile. This enabled an assessment to be made of whether the commute time—SWB relationship was stronger/weaker for particular sub-groups in the population.

### Life satisfaction mediation

It is possible that the relationship between commuting and life satisfaction is mediated through the impact of commuting on SWB sub-domains such as satisfaction with leisure or job (as indicated in Fig. 1). Mediation of the life satisfaction relationship was examined by including selected SWB sub-domains as additional controls in the life satisfaction model. The development of this model variant and its interpretation is explained in further detail in the “Results” section.

## Results

We first of all present some descriptive analyses as a basis for discussing the regression models.

### Descriptive analyses

The commute mode and time distributions are summarised in Table 4. The majority of people included in the sample drove to work (61%) with walking the second most common means of travelling to work (12%).

The mean (one-way) commute time across the pooled sample was 27 min, but there are large differences between modes. For example, rail commuters travelled for nearly an hour on average, compared to 25 min for drivers.

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<sup>6</sup> Correlated random effects estimates were not used for this part of the analysis (i.e. means of the independent variables were excluded), as we were not seeking to investigate associations based on between individual variation.

**Table 4** Commute mode and time, sample distributions

Commute mode	n	Percentage	One-way commute time (mins)	
			Mean	SD
Drive by car/van	48,550	60.8	24.7	19.1
Bus	5959	7.5	39.2	21.3
Rail/metro	6937	8.7	58.0	26.1
Cycle	2925	3.7	20.1	13.9
Walk	9869	12.4	14.8	12.2
Other	5553	7.0	21.1	17.2
Full commuting sample	79,793	100.0	27.0	21.9
Work from home	6631	7.7	–	–
Full work from home sample	86,424	100	–	–

Source: Understanding Society, waves 1–6, pooled sample

**Table 5** Prevalence of changes to the commute origin or destination

Commuting change	n	Percentage	Mean absolute change in commute time (mins) <sup>a</sup>
Changed origin (moved to a new local area)	5278	6.61	14
Changed destination (employer/workplace)	7744	9.71	17
Changed origin or destination	11,908	14.92	16
Total observations	79,793	100.00	8

Source: Understanding society, waves 1–6, Pooled sample

<sup>a</sup>Based on absolute wave to wave commute time changes

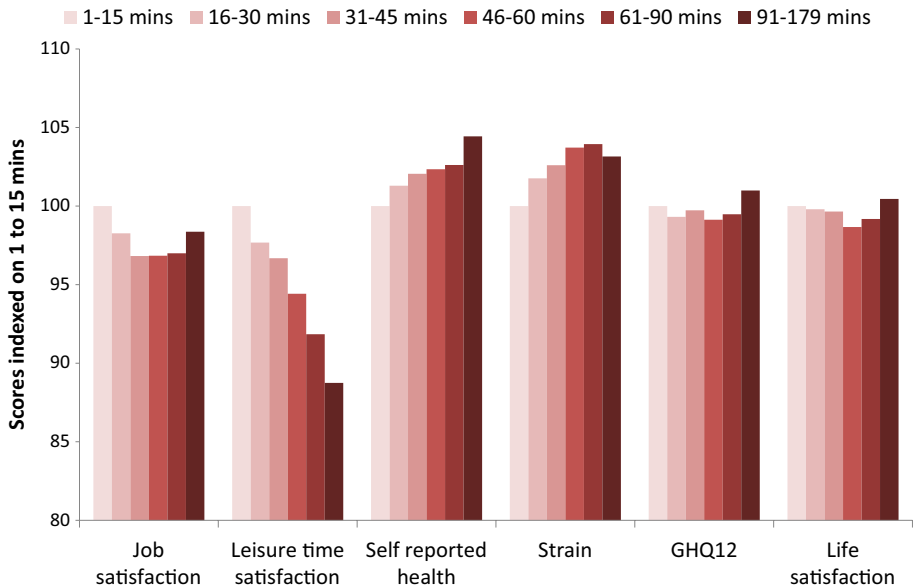
## Changes to commuting behaviour

We examined the prevalence of commute mode changes occurring from one observation to the next and found that a change in commute mode occurred for 18% of observations. Consistent with a previous study (Clark et al. 2016), driving is found to be the most stable commuting mode compared to alternative options. For example, 91 per cent of car drive commutes were still being driven by the following observation, compared to just 12 per cent of walking commutes.

Substantial changes in commute time are most likely to occur for those who change the origin or destination of their journey or change their mode. Increases in delay owing to congestion are only likely to introduce modest changes in commute time from 1 year to the next. Table 5 shows that a change in origin or destination occurred from 1 year to the next for 15% of panel observations. The mean wave to wave change in commute time for those with no change in origin or destination was 6 min, compared to 16 min for those that changed the origin or destination of the commute.

## Bivariate associations

Figure 2 shows the bivariate (between-individual) associations between commute time and each measure of SWB (for the wave 1–6 sample). This indicates that the satisfaction with



**Fig. 2** Bivariate association between subjective wellbeing and commute time

job, leisure time and life scores are lower amongst those with longer commute times. The trend is strongest for leisure time satisfaction and only modest for life satisfaction. Strain is higher amongst those with longer commute times, and this is a contributing factor to slightly lower mental health (GHQ12) for those with longer commutes. The higher job and life satisfaction and mental health for those with commutes of over 90 min only applies to a small group, constituting just 1% of the sample. A limitation in the data is that we do not know how many times in the week such long commutes are performed. Self-reported health is higher for those with longer commute times.

## Regression models

The results for the main regression models are summarised in Table 6, with the results for the working from home variant reported separately in Table 7. The additional tests of interaction performed to identify population sub-group differences are summarised in Table 8. We provide a detailed description of the results for each measure of SWB in this section. The key findings and their implications are then summarised in the “Discussion” section.

### Job satisfaction

We found a negative association between job satisfaction and time spent travelling to work (every extra 10 min (each way) reduces job satisfaction by 0.011 points on the 7-point scale—Table 6). This is based on the within-individual commute time coefficient which provides the strongest indication of a causal relationship. The between-individual coefficient is consistent with the within-individual coefficient, providing confidence in the result. The coefficients for control variables (not shown in Table 6) show that job satisfaction

**Table 6** Main models: correlated random effects model coefficients for commuting variables

	Job satisfaction	Leisure time satisfaction	Self reported health <sup>a</sup>	Strain	GHQ12	Life satisfaction
<b>Within-individual variation</b>						
Commuter time (mins)	-0.0011***	-0.0030***	-0.0004	0.0004**	-0.0028**	-0.0001
Commuter mode [Ref: drive]						
Bus	0.0249	0.0407	0.0162	-0.0148	-0.0035	-0.0101
Rail/metro	-0.0032	-0.0074	-0.0046	-0.0157	0.0010	-0.0632*
Cycle	-0.0239	0.0690	0.0331	-0.0146	0.0321	0.0636
Walk	-0.0100	0.0792***	0.0117	-0.0467***	0.0487	-0.0105
Other	0.0044	-0.0002	0.0008	-0.0162	-0.0179	-0.0380
<b>Between-individual variation</b>						
Commuter time (mins)	-0.0018***	-0.0015**	0.0002	0.0005	-0.0039*	-0.0014**
Commuter mode [Ref: drive]						
Bus	-0.0196	0.0508	-0.0785***	-0.0570**	0.3861**	-0.0006
Rail/metro	0.0752	0.1318**	0.0457	-0.0018	0.0484	0.1074**
Cycle	0.0733	0.0503	0.1589***	0.0229	-0.0035	0.0288
Walk	0.0980**	0.0256	-0.0153	0.0394**	0.0316	0.0545
Other	0.0714	0.1139**	-0.0553**	-0.0177	0.2454	0.0761*
No. of observations	79,577	79,577	68,306	79,577	79,577	79,577
No. of individuals	26,498	26,498	25,242	26,498	26,498	26,498
R-sq (between and within) <sup>b</sup>	0.0327	0.0662	0.2057	0.049	0.0556	0.0622

*Source:* Understanding Society, waves 1–6, Pooled sample

Control variables: changed commute destination, changed commute origin, age, gender, ethnicity, live with partner, live with a child as parent, belong to religion, education level, long standing health condition, settlement type, tenure, employment hours, temporary employment, employment type, log gross monthly personal income, log equivalised net monthly household income, ethnic minority boost sample member, survey wave

<sup>a</sup>Self-reported health based on waves 1–5 (as not available in wave 6)

<sup>b</sup>The R-sq metrics are similar to those reported in other SWB studies, e.g. Lorenz (2018), Martin et al. (2014)

\*\*\*99%, \*\*95%, \*90%



**Table 7** Working from home models: correlated random effects model coefficients for commuting variables

	Job satisfaction	Leisure time satisfaction	Self reported health <sup>a</sup>	Strain	GHQ12	Life satisfaction
<b>Within-individual variation</b>						
Commuter time (mins)	-0.0011***	-0.0027***	-0.0003	0.0003	-0.0021	0.0002
Commuter mode [Ref: drive]						
Bus	0.0178	0.0368	0.0163	-0.0063	-0.0203	-0.0230
Rail/metro	-0.0095	0.0011	0.0008	-0.0050	-0.0355	-0.0786**
Cycle	-0.0101	0.0696	0.0426*	-0.0029	0.0153	0.0474
Walk	0.0020	0.0837***	0.0167	-0.0403***	0.0548	-0.0205
Work from home	0.0847**	0.1004***	-0.0209	0.0051	-0.1804	0.0162
Other	0.0084	0.0075	0.0000	-0.0149	-0.0099	-0.0438
<b>Between-individual variation</b>						
Commuter time (mins)	-0.0020***	-0.0021***	0.0001	0.0007**	-0.0051**	-0.0018***
Commuter mode [Ref: drive]						
Bus	-0.0167	0.0567	-0.0789***	-0.0703***	0.4126***	0.0172
Rail/metro	0.0760	0.1317**	0.0416	-0.0160	0.1160	0.1411***
Cycle	0.0445	0.0446	0.1462***	0.0082	0.0161	0.0499
Walk	0.0709*	0.0121	-0.0253	0.0333*	0.0014	0.0647*
Work from home	-0.0020***	-0.0021***	0.0001	0.0007**	-0.0051**	-0.0018***
Other	0.0522	0.1035**	-0.0570**	-0.0188	0.2202	0.0813*
No. of observations	86,088	86,088	73,837	86,088	86,088	86,088
No. of individuals	27,975	27,975	26,739	27,975	27,975	27,975
R-sq (between and within) <sup>b</sup>	0.0365	0.0704	0.049	0.0505	0.056	0.0612

Source: Understanding Society, waves 1–6, Pooled sample

Control variables: changed commuter destination, changed commuter origin, age, gender, ethnicity, live with partner, live with a child as parent, belong to religion, education level, long standing health condition, settlement type, tenure, employment hours, temporary employment, employment type, log gross monthly personal income, log equivalised net monthly household income, ethnic minority boost sample member, survey wave

<sup>a</sup>Self-reported health based on waves 1–5 (as not available in wave 6)

<sup>b</sup>The R-sq metrics are similar to those reported in other SWB studies, e.g. Lorenz (2018), Martin et al. (2014)

\*\*\*99%, \*\*95%, \*90%

increases with personal income and with certain job roles (self-employed and manager) and decreases when working long hours (over 40 h per week). We examined the magnitude of effect of commute time by comparing it against the effect of personal income on job satisfaction (see Appendix A for details). This suggested that an additional 10 min (each way) of commuting time is associated with the equivalent effect on job satisfaction as a 19% reduction in gross personal income, i.e. a £4080 reduction in gross annual personal income for a worker earning the sample median annual gross income of £21,600.

With respect to differences in the population (Table 8), the job satisfaction of females is more sensitive to longer commute times (although this is not significant at the 95% confidence level,  $p$  value of the interaction term is 0.12), as is the job satisfaction of workers with higher incomes (noting that job satisfaction increases with income). By contrast, the job satisfaction of young workers aged 16–29 (who tend to have lower job satisfaction than older workers) is not sensitive to commute time.

The commute mode is also shown to moderate the commute time relationship. Job satisfaction is higher for short bus journeys (compared to short journeys by other modes) but decreases by more for every additional minute of commute time by bus compared against other modes (Table 8). Beyond the commute time effect, walking to work is associated with higher job satisfaction on average by 0.10 points (on the 7-point scale, see Table 6, between-individual variation) compared to driving (after accounting for journey time differences and other personal differences such as income and occupation type), but for the same individuals we do not see walking to work associated with higher job satisfaction on occasions when they walk to work compared to driving.

Working from home is associated with 0.08 points higher job satisfaction compared to driving (on the 7-point scale-Table 7, within-individual variation).

### Leisure time satisfaction

The regression models indicated that lifestyle factors that intensify personal time constraints are associated with lower leisure time satisfaction. This included longer commute times, as well as working long hours and having children (these all have negative and statistically significant coefficients). Every extra 10 min of commute time (each way) is associated with a reduction in satisfaction with leisure time availability by 0.030 points (on the 7-point scale-Table 6, within-individual variation). The between-individual coefficient is consistent with the within-individual coefficient, providing confidence in the result.

With respect to differences in the population (Table 8), we find that people in the middle income quintile are less sensitive to longer commute times with respect to their leisure time satisfaction than people with lower and higher incomes (although the confidence level is 90%). The association with commute time is the same for females and males, although it should be noted that females have substantially lower leisure time satisfaction scores than males. There are no differences in commute time associations by age group.

Walking to work is associated with higher levels of satisfaction with leisure time availability (by 0.08 points) compared to driving (after accounting for journey time differences-Table 6, within-individual variation). Commuting by rail is associated with higher leisure time satisfaction on average by 0.13 points (on the 7-point scale-Table 6, between-individual variation) compared to driving (after accounting for journey time differences and other personal differences such as income and occupation type), but for the same individuals we do not see commuting by rail associated with higher leisure time satisfaction on occasions when they use rail compared to driving.

**Table 8** Fixed effects model coefficients for commuting variables and interaction terms

	Job satisfaction	Leisure time satisfaction	Self reported health <sup>a</sup>	Strain	GHQ12	Life satisfaction
(1) Commute mode [Ref: drive]						
Bus	0.1099*	-0.0084	-0.0037	-0.0406	0.2564	0.0256
Rail/metro	0.0164	-0.0049	-0.0686*	0.0338	0.0583	-0.0480
Cycle	-0.0723	0.0598	0.0437	-0.0404	0.0888	0.1100*
Walk	-0.0153	0.0659	-0.0005	-0.0536**	0.0417	0.0125
Other	0.0345	0.1122**	0.0058	-0.0169	0.0288	0.0382
Commute time (mins)	-0.0007	-0.0030***	-0.0008**	0.0005	-0.0015	0.0005
Commute time × Bus	-0.0022*	0.0013	0.0006	0.0007	-0.0070*	-0.0012
Commute time × Rail/metro	-0.0005	-0.0001	0.0013**	-0.0008	-0.0018	-0.0007
Commute time × Cycle	0.0026	0.0006	-0.0006	0.0014	-0.0026	-0.0022
Commute time × Walk	0.0005	0.0010	0.0006	0.0004	0.0011	-0.0010
Commute time × Other	-0.0013	-0.0049***	-0.0002	0.0001	-0.0019	-0.0034**
No. of observations	79,577	79,577	68,306	79,577	79,577	79,577
No. of individuals	26,498	26,498	25,242	26,498	26,498	26,498
R-sq <sup>c</sup>	0.0041	0.03	0.096	0.0167	0.0092	0.0097
(2) Gender [Ref: male]						
Commute time (mins)	-0.0005	-0.0031***	-0.0006*	0.0007**	-0.0026	0.0002
Commute time × Female	-0.0012	0.0001	0.0005	-0.0005	-0.0004	-0.0006
No. of observations	79,577	79,577	68,306	79,577	79,577	79,577
No. of individuals	26,498	26,498	25,242	26,498	26,498	26,498
R-sq <sup>c</sup>	0.0039	0.03	0.0968	0.0152	0.0093	0.0096
(3) Age [Ref: 30–45]						
Commute time (mins)	-0.0015**	-0.0036***	-0.0005	0.0003	-0.0027	-0.0002
Age 16–24	-0.1969***	0.0414	-0.1366***	0.0007	0.2965	0.0043
Age 25–29	-0.0930**	0.0376	-0.0494*	0.0141	0.0082	0.0155
Age 45–59	0.0358	0.0130	0.0068	-0.0350*	0.1472	0.0135
Age 60+	0.1166*	0.1041	-0.0184	-0.1245***	0.5684***	0.0461
Commute time × age 16–24	0.0028**	0.0012	0.0004	0.0004	-0.0029	0.0001
Commute time × age 25–29	0.0035***	0.0009	0.0000	-0.0007	0.0029	-0.0002

**Table 8** (continued)

	Job satisfaction	Leisure time satisfaction	Self reported health <sup>a</sup>	Strain	GHQ12	Life satisfaction
Commute time X age 45–59	-0.0007	0.0011	0.0002	0.0004	0.0002	0.0002
Commute time X age 60+	-0.0025	-0.0013	0.0005	0.0012	-0.0035	0.0009
No. of observations	79,577	79,577	68,306	79,577	79,577	79,577
No. of individuals	26,498	26,498	25,242	26,498	26,498	26,498
R-sq <sup>c</sup>	0.0047	0.0301	0.0966	0.0165	0.0092	0.0096
(4) Personal income [Ref: quint 5] <sup>b</sup>						
Commute time (mins)	-0.0018***	-0.0034***	-0.0002	0.0003	-0.0027	0.0000
Inc quint 1	-0.2456***	0.1066**	-0.0083	-0.0383	-0.1300	-0.0677
Inc quint 2	-0.2121***	-0.0142	0.0346	-0.0464**	0.1083	-0.0895**
Inc quint 3	-0.1759***	-0.0173	0.0203	-0.0483***	0.0920	-0.0605*
Inc quint 4	-0.0581**	0.0274	0.0165	-0.0268*	0.0601	-0.0623**
Commute time X inc quint 1	0.0029**	0.0009	0.0001	0.0000	0.0049	-0.0006
Commute time X inc quint 2	0.0013	0.0013	-0.0004	0.0007	-0.0059	-0.0003
Commute time X inc quint 3	0.0019**	0.0017*	-0.0004	0.0001	0.0008	-0.0009
Commute time X inc quint 4	0.0002	-0.0001	-0.0003	0.0001	-0.0002	0.0002
No. of observations	79,643	79,643	68,333	79,643	26,514	79,643
No. of individuals	26,514	26,514	25,250	26,514	26,514	26,514
R-sq <sup>c</sup>	0.004	0.0292	0.0954	0.0168	0.0081	0.0092

*Source:* Understanding Society, waves 1–6, pooled sample

Inc. refers to personal monthly income (gross monthly)

Coefficients comparable to within individual coefficients shown in Table 6

<sup>a</sup>Self-reported health based on waves 1–5 (as not available in wave 6)

<sup>b</sup>1 is lowest income quintile and 5 is highest income quintile

<sup>c</sup>The R-sq metrics are similar to those reported in other SWB studies, e.g. Lorenz (2018), Martin et al. (2014)

\*\*\*99%, \*\*95%, \*90%

Control variables: changed commute destination, changed commute origin, age, live with partner, live with a child as parent, belong to religion, education level, long standing health condition, settlement type, tenure, employment hours, temporary employment, employment type, log gross monthly personal income, log equivalised net monthly household income, survey wave

Working from home is associated with 0.10 points higher leisure time satisfaction (on the 7-point scale-Table 7, within-individual variation).

### Self-reported health

Longer commute times were not found to be associated with a difference in self-reported health, although Fig. 2 indicates that people that undertake longer commutes report good health. This suggests that those people in good health are more likely to take on a longer duration commute.

We found that cycling to work is associated with higher self-reported health compared to driving (after accounting for differences between individuals, including commute time-Table 6, between-individual variation), but for the same individuals we do not see cycling to work associated with higher self-reported health on occasions when they cycle compared to driving. In a similar way, commuting by bus is associated with lower self-reported health compared to driving.

### Strain

Longer commute times are associated with increased strain (by 0.004 points on the 4-point scale for every extra 10 min each way-Table 6, within-individual variation) with higher strain also associated with working long hours (over 40 h per week), a management job, a higher personal income, having children and having a longstanding health condition (based on coefficients for control variables which are not shown in Table 6).

With respect to differences in the population (Table 8), females are associated with higher levels of strain than males (by 0.12 points on the 4-point scale, not shown in Table 6), but the positive association of strain with commute time applies more strongly to males (increasing strain by 0.007 points for every extra 10 min (each way)). There are no differences in associations of strain with commute time by age or income quintile.

Walking to work is associated with lower strain compared to driving (by 0.047 points on the 4-point scale-Table 6, within-individual variation) and this is equivalent to the increased strain (of 0.041 points) associated with having a management role. The positive association between strain and walking to work found for between-individual variation contradicts this result and suggests the need to examine the within-individual relationship further in future when more waves of data are available. Commuting by bus is associated with lower strain compared to driving based on between-individual variation (Table 6), but no statistically significant association is found for within-individual variation.

### Mental health

Not many personal factors were found to be associated with the GHQ12 measure of mental health, but longer commute times were found to be associated with lower mental health (by 0.028 points on the 36-point scale for every extra 10 min each way-Table 6, within-individual variation). Females have substantially lower mental health than men (by 1.02 points) but are no different in sensitivity to longer commute times (Table 8). This contrasts with the result of Roberts et al. (2011). Their analysis of the same GHQ12 measure (for an

earlier time period) indicated that longer commutes were more detrimental to the mental health of women than men.

The commute mode was shown to moderate the commute time relationship. Every additional minute of commute time is associated with a greater decrease in mental health when people use the bus compared to driving. On the other hand, commuting by bus is associated with higher mental health scores compared to driving (Table 6—between-individual variation) for which reasons are unclear.

### Life satisfaction

Our models confirmed that living with a partner, being in good health, financial security, and not being in middle age are associated with higher life satisfaction (as has been shown by previous studies). The fixed effects coefficient is not significant for commute time, i.e. for the same individuals we did not find that longer duration commutes are associated with lower life satisfaction (and no differences were identified by population sub-group—Table 8). The between-individual coefficient is negative and statistically significant, indicating that longer duration commutes are associated with lower life satisfaction after accounting for other differences between individuals (by 0.014 points on the 7-point scale for every extra 10 min each way—Table 6).

The finding of a statistically significant between-individual association but not within-individual association merited further investigation. It implies individuals with varying commute times over the six observations did not tend to have lower life satisfaction when their commutes were longer. They might have been compensated by better jobs or housing when this was the case. A separate analysis we conducted comparing those who persisted with long commutes (over 45 min) for the six observations with those who persisted with short commutes (45 min or less) showed that the former had consistently lower life satisfaction. This indicates there is a group of commuters who accept unfavourable commutes and are unable or unwilling to change them despite adverse impacts on their life satisfaction (for further details see Chatterjee et al. (2017)).

Commuting by rail is associated with higher life satisfaction compared to driving (Table 6) in terms of between-individual variation but the opposite association is shown for within-individual variation. This implies that rail users tend to have higher life satisfaction (for reasons not captured by our control variables) but switching to rail by individuals is not associated with an improvement in life satisfaction.

Working from home is not associated with any difference in life satisfaction (Table 7) in terms of within-individual variation, although the between-individual association indicates working from home is associated with lower life satisfaction, potentially due to characteristics of this group that were not captured by our control variables.

There are no notable differences in associations of life satisfaction with commute time by commute mode, gender, age or income quintile.

### Life satisfaction mediation analysis

Overall, the results indicate the absence of a *direct* within-individual association between commute time and life satisfaction. However, life satisfaction would be expected to be associated with the SWB sub-domains which have been found to be negatively associated with longer commute times; namely job satisfaction, levels of strain, and leisure time availability.

Table 9 shows the results of model variants estimated on life satisfaction, in which the SWB sub-domains that are negatively associated with commute time have been included as additional controls. In models (1)–(3) the three SWB sub-domains are included individually, while all three sub-domains are included together in model (4).<sup>7</sup>

The results indicate that the relationship between commute time and life satisfaction is mediated through leisure time satisfaction. When leisure time satisfaction is included, the commute time coefficient switches from negative (and non-significant) to positive (and significant), i.e. longer commute times are associated with reduced leisure time satisfaction which in turn is associated with reduced life satisfaction (since leisure time satisfaction is positively correlated with life satisfaction). After accounting for this mediation pathway, the residual effect of longer commute times is found to be positive. This implies that there are unobserved compensatory factors associated with longer commutes—such as improved residential and/or employment situations which are not captured in the control variables we had available.

## Discussion

In this section we (1) compare the results across the six dimensions of SWB examined; (2) discuss potential mechanisms to explain the relationships between commuting and different aspects of SWB; (3) examine implications for policy and practice; and (4) consider limitations and areas for further research.

### Commute time

The strongest relationship we identified is between commute time and leisure time satisfaction and there is a direct mechanism to explain it—the more time an individual spends commuting, the less time is available for other activities. The association is smaller in magnitude for those in the middle-income quintile, suggesting they are more willing to sacrifice leisure time to access employment.

The results also indicate that when commute time increases, job satisfaction reduces. The coefficient representing within-individual variation is significant at the 99% confidence level, indicating a robust relationship and the magnitude of effect is also quite large, at least when compared against the effect of income on job satisfaction—a 10-min increase in commute time (one-way) is equivalent to a 19% reduction in monthly income in terms of the effect on job satisfaction (on average). This finding implies that the journey to work has a bearing on how workers evaluate their jobs. Hence it is important for employers to recognise that the commute has a direct impact on employee satisfaction. This observation provides added justification for initiatives such as employer-based measures to improve commuting options and incentives for (new) employees to live within easy reach of the workplace. It also suggests potential to integrate employer-based initiatives for mobility management with wider ‘wellbeing at work’ policies.

The job satisfaction of women is more sensitive to longer commute times than men. This is likely to be a consequence of their greater household and family responsibilities, as

<sup>7</sup> A cross-sectional path analysis was also performed, as reported in Chatterjee et al. (2017).



suggested by Roberts et al. (2011). It is important for employers to recognise how the commute affects staff differently according to their life situation. It is notable that the commute time association with job satisfaction was not found to apply to young adults and those in the bottom two income quintiles. These groups appear willing to accept longer commutes for their job. For young adults, this could be because it is easier and more acceptable to perform longer commutes at this life stage, which may be seen as beneficial and necessary in terms of achieving future career goals. It may also be that expectations concerning commuting change as people get older. In later life, people may expect to achieve a more comfortable daily routine and may also have greater demands on their time such as those associated with looking after family. Alternatively, it could indicate that young adults and lower income workers have less choice over where they live and work.

The results indicate that when commute time increases, strain increases and mental health worsens. These relationships are not as strong as those for leisure time and job satisfaction (and we found no association between commute time and self-reported health). Nevertheless, they are based on within individual variation, providing robust evidence of a direct relationship, i.e. that longer commute times introduce greater stress into daily life. It is notable that the association with mental health was found to be stronger for women than men in a previous study covering the period 1991–2004 (Roberts et al. 2011), but this was not found to be the case in our study. It is possible that conditions for coping with long commutes have become more equitable. However, we have seen that job satisfaction of women is more sensitive to longer commutes than men and hence the evidence is inconclusive. This is an area that warrants further research.

The coefficient representing within-individual variation in commute time is not significant for life satisfaction. This is consistent with the findings of Dickerson et al. (2014), who used older panel data for Great Britain, indicating that there is no direct association between commute time and life satisfaction for workers in England. Longer commutes are taken on to accommodate family, housing, career and income preferences. On the other hand, longer commute journeys have been shown to be associated with negative impacts on the sub-domains of SWB described above. The mediation analysis indicated that longer commute times reduce satisfaction with leisure time which in turn reduces life satisfaction. Our overall interpretation for commuters in England is that they are generally successful in trading off the drawbacks of a longer commute journey against the benefits they bring in relation to overall life satisfaction (at least in the short-term as we found evidence that persisting with long commutes over the long-term was associated with lower life satisfaction).

### **Commute mode and working from home**

Our results indicate that longer commute times by bus are associated with reductions in job satisfaction and mental health compared to driving and other modes. This indicates that commuting by bus is unsatisfactory for many and implies a policy need to improve the journey experience by bus between residential areas and employment centres in England.

The mode of transport used also plays a role beyond the time taken to get to work and active commuting is found to have some specific benefits. Walking to work is associated with improved SWB in terms of increased leisure time satisfaction and reduced strain. Cycling is associated with higher self-reported health, but we cannot be certain of the direction of the effect. It is possible that healthier people choose to cycle. Working from home is shown to be associated with increased job satisfaction and leisure time satisfaction, indicating benefits of working in this way for those for whom this is possible.

**Table 9** Life satisfaction mediation models: correlated random effects model coefficients

	Main model	(1)	(2)	(3)	(4)
<b>Within individual variation</b>					
Job satisfaction		0.1015***			0.0567***
Leisure time satisfaction			0.3855***		0.3709***
Strain				-0.2708***	-0.1514***
Commute time (mins)	-0.0001	0.0000	0.0011***	0.0001	0.0012***
Commute mode [Ref: drive]					
Bus	-0.0101	-0.0126	-0.0258	-0.0141	-0.0288
Rail/metro	-0.0632*	-0.0628*	-0.0603*	-0.0674*	-0.0626**
Cycle	0.0636	0.0660	0.0370	0.0596	0.0371
Walk	-0.0105	-0.0095	-0.0410*	-0.0231	-0.0464*
Other	-0.0380	-0.0384	-0.0379	-0.0424	-0.0406
<b>Between individual variation</b>					
Job satisfaction		0.1608***			0.0571***
Leisure time satisfaction			0.1183***		0.0555***
Strain				-0.4010***	-0.1576***
Commute time (mins)	-0.0014**	-0.0008	-0.0003	-0.0009*	-0.0001
Commute mode [Ref: drive]					
Bus	-0.0006	0.0000	-0.0327	-0.0456	-0.0458
Rail/metro	0.1074**	0.0879*	0.0401	0.0993**	0.0377
Cycle	0.0288	0.0136	-0.0046	0.0377	0.0012
Walk	0.0545	0.0312	0.0351	0.0640*	0.0368
Other	0.0761*	0.0570	0.0190	0.0579	0.0120
No. of observations	79,577	79,577	79,577	79,577	79,577
No. of individuals	26,498	26,498	26,498	26,498	26,498
R-sq (between and within)	0.0622	0.1153	0.3124	0.1498	0.3439

Source: Understanding Society, waves 1–6. Pooled sample

Control variables: changed commute destination, changed commute origin, age, gender, ethnicity, live with partner, live with a child as parent, belong to religion, education level, long standing health condition, settlement type, tenure, employment hours, temporary employment, employment type, log gross monthly personal income, log equivalised net monthly household income, ethnic minority boost sample member, survey wave

\*\*\*99%, \*\*95%, \*90%

### Changes to the commute situation

It is important to recognise that significant changes in the commuting situation (time and/or mode) are most likely to occur in conjunction with a change in the home or employment location (as highlighted in the “Descriptive analyses” section). It is at these ‘moments of change’ that people have opportunities to reduce the burden of the commute and hence to achieve SWB benefits. Influencing the decisions of individuals is clearly challenging. The degree to which commute time can be reduced may be constrained by a number of factors including lack of (affordable/desirable) housing in closer proximity to work, and the spatial distribution of employment opportunities. This may have a disproportionate effect on lower socio-economic groups who may have less choice over housing and employment locations, be more likely to live in housing areas that are poorly connected to employment and hence

be more willing to accept arduous commutes (as is indicated by our results). Nevertheless, the findings imply that: (1) it is useful to remind people of the wellbeing benefits of shorter commutes during employment and residential relocations; and (2) that macro-level land use, housing and employment policies should be designed over the longer term to enable people to live within easy reach of employment opportunities.

### Limitations and opportunities for further research

This study draws on a large panel data set which supports examination of multiple aspects of commuting on individual-level SWB, including for selected population sub-groups. There are a number of limitations of the study.

Firstly, the study relies on basic measures of commuting. In common with other large-scale social surveys, no information was available on whether (1) people vary the mode used to get to work across the week/month/year; (2) whether people use more than one mode for their journey to work; (3) the extent to which people have any choice over when and how to travel to work; and (4) how many days a week the commute is undertaken. It was only possible to consider a very coarse measure of working from home in our models (whether workers usually work from home or not), and it was not possible to distinguish between those with fixed and flexible working schedules. People with the longest duration commutes may combine commuting with working from home and it is not known to what extent such lifestyle choices impact on SWB. It is also plausible that multi-modal commutes are more stressful than single mode commutes, as a consequence of interchange penalties or increased likelihood of unreliable journeys. Further research is warranted to investigate how variability/flexibility in commuting behaviour influences SWB.

Secondly, the study is based on up to six waves of data per individual and with more waves of data it will be possible to obtain more robust estimates of within-individual coefficients.

Thirdly, the effect sizes (implied by the coefficients) in most cases are small.<sup>8</sup> The SWB benefits of commuting alone may not justify investment in the transport system to improve commuting, but there are likely to be many other justifications for such investment. It would be valuable to build up the evidence base by starting to evaluate the impact of transport interventions on SWB and other outcomes. Furthermore, whilst a strength of the dataset we have used is that it enabled us to examine multiple aspects of SWB and commuting, we have included a multitude of statistical analyses, with multiple comparisons. Thus statistical significance levels that are close to the standard thresholds used in statistical tests (e.g.  $p < 0.05$ ) should be treated with due caution.

Fourthly, it is also necessary to recognise that there is a great deal of heterogeneity in both employment situations and the nature and experience of commuting. For example, shift work in a factory presents a very different employment context compared to working in an office—active commuting may have particular benefits for those with sedentary desk jobs which do not apply to those with more physical roles. This study was limited to evaluating differences in the relationship between commute time and SWB for four broad population groups (defined by commuting mode, gender, age and income quintile). Hence further research, including the application of qualitative methods, would be valuable to

<sup>8</sup> Although it is notable that the coefficients for SWB scores estimated on other independent variables are also often small—see for example, the income coefficients presented in [Appendix A](#).

provide explanatory insights into (1) the level of choice people have over their commuting situation and (2) the mechanisms through which commuting influences different aspects of SWB for different groups in the population.

## Concluding remark

A shorter commute time has benefits in terms of increased job satisfaction, increased leisure time satisfaction and reduced strain/improved mental health. Walking to work has benefits in terms of increased leisure time satisfaction and reduced strain. Hence shorter commute times and walkable commutes can contribute to improved SWB—particularly through the release of leisure time. However, life satisfaction overall will only be maintained if the benefits of undertaking the commute (earnings and satisfactory housing/employment) are not compromised. This implies a need for integrated policies across transport, land use, housing and employment to deliver affordable housing within easy reach of desirable employment.

**Author contributions** BC and KC: Literature search and review, analysis, manuscript writing. AM: Analysis, manuscript editing. AD: Literature search, manuscript editing.

## Compliance with ethical standards

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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## Appendix A: Income equivalence calculation

The magnitude of effect of commute time on job satisfaction (or another SWB domain) cannot be established by inspecting the commute time coefficient on its own. Comparing the size of the commute time coefficient on job satisfaction to that of another known correlate like personal income provides a means of interpreting the *relative size of effect*. Indeed, Fujiwara and Campbell (2011) develop Eq. 2 as a means of estimating a monetised value (a measure of ‘willingness to accept’) for the effect of a particular parameter (e.g. commute time) on a SWB measure (e.g. job satisfaction).

$$WTA = e^{\left(\ln \left( \bar{M} - \left( \frac{\beta_2}{\beta_1} \right) \right) \right)} - \bar{M} \quad (2)$$

WTA: Willingness to accept, M: Position in the income distribution,  $\beta_1$ : Income coefficient,  $\beta_2$ : Commute time coefficient.

We undertook an income-equivalence calculation for commute time and job satisfaction, using the model specification presented in the “[Model specification](#)” section, but with household income removed (to eliminate the confounding effects of household

**Table 10** Correlated random effects model coefficients used for income equivalence calculation

Variable	Coefficient
Commute time (minutes)	−0.000838
Log personal gross monthly income (£100)	0.045398

Source: Understanding Society waves 1–6, n = 79,643  
R-sq = 0.0252

income on the personal income coefficient). The coefficients used in the calculation are presented in Table 10. This indicated that a 10 min increase in one way commute time has the equivalent effect on job satisfaction as a 19% reduction in gross personal income. This equates to a £4080 reduction in gross annual personal income for a worker earning the sample median income of £21,600 per month.

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**Publisher’s Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.


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