Commuting and wellbeing in London: The roles of commute mode and local public transport connectivity

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Commuting and wellbeing in London: The roles of commute mode and local public transport connectivity.

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Abstract

Objectives. To explore the relationships between commute mode, neighbourhood public transport connectivity and subjective wellbeing.

Method. The study used data on 3,630 commuters in London from wave two of Understanding Society (2010/11). Multivariate linear regressions were used to investigate how commute mode and neighbourhood public transport connectivity were associated with subjective wellbeing for all London commuters and for public transport commuters only. Subjective wellbeing was operationalized in terms of both a positive expression (life satisfaction measured by a global single-item question) and a more negative expression (mental distress measured by the General Health Questionnaire). Logistic regression was also used to explore the predictors of public transport over non-public transport commutes.

Results. After accounting for potentially-confounding area-level and individual-level socioeconomic and commute-related variables, only walking commutes (but not other modes) were associated with significantly higher life satisfaction than car use but not with lower mental distress, compared to driving. While better public transport connectivity was associated with significantly lower mental distress in general, train users with better connectivity had higher levels of mental distress. Moreover, connectivity was unrelated to likelihood of using public transport for commuting. Instead, public transport commutes were more likely amongst younger commuters who made longer distance commutes and had comparatively fewer children and cars within the household.

Conclusion. The findings highlight the heterogeneity of relationships between commute mode, public transport connectivity and subjective wellbeing and have implications for intervention strategies and policies designed to promote commuting behaviour change.

Keywords: Commute; Public transport connectivity; Subjective wellbeing; Urban

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Introduction

A growing literature suggests that the means by which people travel to and from work, that is, their commute mode can significantly affect their health and wellbeing. Active commuting, such as walking and cycling, and even commuting by public transport, as opposed to driving, increases daily physical activity with associated health benefits (NICE, 2012; Flint, Cummins, & Sacker, 2014; Laverty, Mindell, Webb, & Millett, 2013; Pucher, Buehler, Bassett, & Dannenberg, 2010; Stathopoulou, Powers, Berry, Smits, & Otto, 2006; Wanner, Götschi, Martin-Diener, Kahlmeier, & Martin, 2012). It has also been proposed that non-car commuting may be associated with higher self-reported, or subjective, wellbeing (Humphreys, Goodman, & Ogilvie, 2013; Martin, Goryakin, & Suhrcke, 2014; St-Louis, Manaugh, van Lierop, & El-Geneidy, 2014), operationalised as both higher life satisfaction (Stutzer & Frey, 2008) and lower mental distress, e.g., fewer symptoms of depression and anxiety (Roberts, Hodgson, & Dolan, 2011). The benefits of subjective wellbeing are increasingly recognised by governments worldwide (ONS, 2013), not least because psychological ill-health places a large burden on health and social care (Roberts et al., 2011). Thus, improving our understanding of how commuting relates to subjective wellbeing offers important insights into reducing the burden of disease and ill-being among commuters.

Several questions remain unanswered. First, previous studies tended to collapse different transport modes (e.g., bus and train; walking and cycling) into over-arching categories (i.e., public transport and active transport, respectively; Flint et al., 2014; Martin et al., 2014). However, there may be important differences in commuter experiences of these different travel modes. Second, few have investigated the effects of public transport infrastructure quality near one's residence, i.e., the level of 'neighbourhood connectivity' (Chng, White, Abraham, Alcock, & Skippon, 2015). Connectivity may simultaneously affect: a) public transport use; and b) public transport commuter wellbeing. For example, while we might expect people to use public transport more often if available, some studies suggest that people may be unaware of transport options (Beirão & Cabral, 2007). No previous studies of the relationship between connectivity and wellbeing among public transport users were found.

Finally, the limited studies that considered relationships between commute mode and wellbeing focused on whether certain modes are associated with either: a) positive wellbeing (e.g., life satisfaction; Stutzer & Frey, 2008), or b) (reduced) mental distress (e.g., symptoms of anxiety and depression; Humphreys et al., 2013; Martin et al., 2014; Roberts et al., 2011), and tended to assume that one is the inverse of the other. However, research in positive psychology suggests that, although related, these measures should be considered separately (Kahneman & Krueger, 2006; Seligman, 2002). For example, research examining relationships between wellbeing and urban green space found that controlling for one facet of wellbeing (life satisfaction) did not eliminate the effects of green space on the other (mental distress) or vice versa, suggesting that urban green space may act to improve wellbeing both by decreasing negative symptoms and promoting positive outcomes through different mechanisms (White, Alcock, Wheeler, & Depledge, 2013). A richer understanding of the relationship between commute mode and wellbeing may be gained by considering both aspects, e.g., cycling to work might promote wellbeing by encouraging positive emotions (which are known to be associated with physical activity in general; Stathopoulou et al., 2006) and/or by reducing mental distress, e.g., anxiety associated with traffic jams.

The Present Study

This study explores these issues using cross-sectional data from the Understanding Society panel survey (also known as the UK Household Longitudinal Study, UKHLS). In particular, we focused on a sub-sample of participants residing within Greater London and commuted to work. This sub-sample was chosen because London's public transport infrastructure, relative to the rest of UK, is well developed and accessible, and neighbourhood-level public transport connectivity data (Transport for London, 2010) could be merged with existing individual-level data. We investigated four key questions: 1) Are subjective wellbeing relationships with commute mode homogenous within mode categories (e.g., are all public transport modes associated with similar wellbeing results)?; 2) Are commute mode relationships with wellbeing the same for positive and negative wellbeing measures – or independent?; 3) Are individuals living in neighbourhoods with good connectivity more likely to use public transport to get to work?; 4) Is wellbeing higher among public transport users with good connectivity?

Our analyses controlled for a range of sociodemographic factors known to be associated with wellbeing (Dolan, Peasgood, & White, 2008) and relevant observable commute-related factors, such as number of cars in the household and commute distance, which are also important in the present context.

Methods

Data source and sample

The sample was drawn from wave 2 (2010/11; n = 54,597) of the UKHLS (University of Essex, 2013), a longitudinal panel survey of 40,000 UK households that began in 2009. Participants are surveyed annually on their socioeconomic circumstances, attitudes, and behaviour via a computer-assisted personal interview. Detailed study and sampling methodology information is reported elsewhere (Lynn, 2011). The commuting module in wave 2 explores commute behaviour. Participants were categorised as commuters if they were in employment and worked somewhere other than at home.

The samples used for analyses were commuters in London (n = 3,630) who provided data for one or both of the main dependent measures (life satisfaction, n = 2704; General Health Questionnaire, n = 2,694). The appropriate UKHLS cross-sectional weight was applied to improve the sample's population representativeness, thus sample sizes reported are weighted respondent samples rounded to integer values.

Measures

Positive wellbeing was measured using the single-item global life satisfaction question "How dissatisfied or satisfied are you with your life overall?", with responses ranging from "not satisfied at all" (1) to "completely satisfied" (7). Mental distress was measured using the 12-item General Health Questionnaire (GHQ), a widely used and validated instrument in patient and general populations (Goldberg et al., 1997; Goldberg & Williams, 1991), on a 36-point Likert scale with increasing levels of distress.

Commute mode was assessed using responses to the question "How do you usually get to your place of work?" Responses were categorised as either a) car/van (the reference category in subsequent analyses); public transportation b) train; c) bus/coach; d) underground; and active transport e) walking, and f) cycling. The remaining travel mode observations (car/van passengers [1.91% of total observations], taxi [0.98%], motorcycle [0.11%] and combination of modes [1.07%]) were excluded due to small sample sizes. A binary public transport variable (reference category [ref] = non-public transport) was also derived for further analysis.

Connectivity was operationalised using the London-based 'Public Transport Accessibility Level' (PTAL) dataset (Transport for London, 2013), which measures public transport network density in small geographical areas, after accounting for walking access time, service availability and reliability (Transport for London, 2010). The PTAL is categorised into 6 levels from 1 (very poor or low accessibility) to 6 (excellent or high accessibility). Further information is available elsewhere (Transport for London, 2010). For current purposes, in part due to relatively small sample sizes, we collapsed the 6-point scale into a binary variable reflecting either i) 'Poor' connectivity (i.e., Level 1 [very poor] to Level 3 [moderate]); or ii) 'Good' connectivity (i.e., Level 4 [good] to Level 6 [excellent]). This data is specified at the geographical unit of a Lower Layer Super Output Area (LSOA). There are 4,835 LSOAs in London with an average population of 1,720 (2012 data). As UKHLS provides individual-level LSOA data (with special licence access), we were able to assign specific LSOA PTAL values to specific individuals to reflect their neighbourhood's connectivity. Subsequent analyses used 'Poor' connectivity as the reference category.

To account for potentially observable confounding variables, covariates included in the fully adjusted models were age, sex (ref = male), presence of work-limiting illness or disability (ref = no illness), monthly household income (quintiles equivalized using the Organisation for Economic Co-operation and Development modified scale indexed to March 2012, ref = lowest quintile), educational attainment (high school qualifications, degree or above, ref = no qualifications), London congestion zone location (derived by identifying LSOAs that are located within the 2007-2011 boundary that includes the Western extension; ref = outside congestion zone), month of interview, commute distance, number of cars in the household, and the urban density (number of people per km^2), indices of deprivation (income, employment, education, crime rate and environment) and percentage of green space of the LSOA in which they lived.

Statistical analysis

Previous research suggests it makes little difference whether wellbeing variables are treated as linear or ordinal data (Ferrer-i-Carbonell & Frijters, 2004), so the current analyses operationalised life satisfaction and GHQ as continuous variables.

Multivariate linear regressions investigated their relationship with commute mode and connectivity, controlling for potentially confounding variables. In each case several models were tested. The first (unadjusted) model included only commute mode. A second (PTAL-adjusted) model included connectivity. A third (fully-adjusted) model added sociodemographic variables. A fourth (SWB-controlled) model added the negative wellbeing measure to the positive wellbeing model and vice-versa. Any effects remaining significant once the second wellbeing measure was added indicates independent effects on the positive versus negative aspects of wellbeing, suggesting that both measures tap into different facets of wellbeing.

Next, we focused specifically on public transport commutes. First we used multivariate logistic regression to investigate whether London commuters residing in neighbourhoods with better connectivity were more likely to use public transport. Then we explored whether using public transport in neighbourhoods with better connectivity was associated with greater wellbeing.

All analyses were undertaken with Stata 13 software using the appropriate sampling probability weights provided by UKHLS.

Results

Sample descriptive and subjective wellbeing by commute mode

Of the London commuters in our estimation sample, 53.3% were women and the mean (SD) age was 38.97 (0.47) years. Public transport was the most common travel mode (50.1% of commutes) with underground/light railway mode being the most frequent. About a quarter (25.9%) commuters resided in neighbourhoods with ‘good’ connectivity and car commutes amongst this group were less than half (15.4%) the level observed amongst those with ‘poor’ (35.0%) connectivity. Detailed descriptive information is found in Table A.1.

Relationships between commute mode, public transport connectivity and wellbeing

Table 1 shows the results of multivariate linear regressions modelling for the relationship between wellbeing and commute mode and public transport connectivity. In the unadjusted model of life satisfaction, underground/light railway (B = 0.32, $p < .05$), cycling (B = 0.33, $p < .05$) and walking (B = 0.32, $p < .05$) commutes were associated with significantly greater life satisfaction than car commutes. There were no significant differences between train or bus/coach commuters and drivers. Results were unchanged when PTAL was added to the model, and living with 'good' connectivity was not, of itself, related to higher life satisfaction. In the fully adjusted model, only walkers reported significantly higher life satisfaction than drivers and, unsurprisingly, individuals in the highest household income quintile reported higher life satisfaction than individuals in the lowest quintile. When GHQ scores were added, walkers continued reporting significantly higher life satisfaction than drivers (B = 0.35, $p < .05$), suggesting that walking to work affects wellbeing through mechanisms over and above reduction in mental distress.

By contrast, no commute mode was associated with significant differences in GHQ scores compared to travelling by car in any models. Connectivity was, however, negatively associated with GHQ in both the fully-adjusted and life satisfaction-controlled models. Individuals with 'good' connectivity reported fewer symptoms of mental distress than individuals with 'poor' connectivity (fully adjusted model B = -1.10, $p < .05$, see Table A.2). To better understand the scale of this effect, note that the average difference in GHQ scores between individuals in the highest vs. lowest income quintiles was only B = -1.79, $p < .05$ (fully adjusted model, Table A.2), suggesting that the connectivity effect was relatively large and thus potentially meaningful.

Predicting public transport commutes with public transport connectivity

Multivariate logistic regression explored if public transport connectivity influences the use of public over non-public transport (car and active transport combined) commutes. Connectivity did not significantly predict public transport commutes in the unadjusted model, OR (95% CI) = 1.18 (0.84, 1.66). This observed effect remained unchanged with sociodemographic variables added to the model, OR (95% CI) = 1.00 (0.62, 1.16). Nonetheless, public transport commute was significantly more likely as commute distances increased. Whilst household income did not significantly predict public transport commutes, public transport use was significantly lower when commuters had at least one car (OR [95% CI] = 0.19 [0.12, 0.29]) and one child in the household, OR (95% CI) = 0.67 (0.49, 0.91). In addition, the odds of public transport commutes decreased with age, OR (95% CI) = 0.97 (0.96, 0.99) – see Table 2.

Wellbeing amongst public transport commuters

Did those commuting by public transport show higher levels of wellbeing if they lived in areas with better connectivity? Analyses were run for all public transport commuters combined (ref = train commutes) and also by each public transport mode separately (i.e., trains, bus/coaches, underground/light railway) and are presented in Table 3. Here we focus only on fully-adjusted and wellbeing-controlled results. When considering all public transport commuters, living in 'good', compared to 'poor', connectivity areas were associated with significantly higher life satisfaction (B = 0.35, $p < .01$) and lower mental distress (B = -1.74, $p < .05$). Adding the alternative wellbeing measure to these models rendered both effects non-significant, suggesting that the influence of connectivity on wellbeing may be operating through the general or shared variance assessed by both wellbeing measures. In the fully-adjusted life satisfaction models, bus/coach and underground commuters reported significantly higher life satisfaction than train commuters, with this effect remaining significant for underground commuters even after GHQ was added to the model. These effects were not replicated in the GHQ models, suggesting that for underground commuters in particular, any evidence of higher wellbeing is related to positive aspects of wellbeing rather reductions in mental distress. However, this may also be influenced by whether the commuter is residing within the London congestion zone. Residing within the zone was associated with significantly lower life satisfaction (B = -0.79, $p < .01$) in the fully-adjusted model with this effect remaining significant after GHQ was added to the model. This effect was not replicated in the GHQ models, suggesting that living within the congestion zone, characteristically with 'good' connectivity, is only related to reductions in positive aspects of wellbeing.

In the fully-adjusted individual transport mode models, 'good' vs. 'poor' connectivity was associated with higher life satisfaction (B = 0.50, $p < .05$) and lower mental distress among underground users (B = -1.82, $p < .05$). By contrast, living with good connectivity was associated with greater mental distress amongst train commuters (B = 1.88, $p < .05$). Controlling for the second wellbeing measure did not affect the relationship between mental distress and connectivity for train commuters but did result in a significant positive relationship between connectivity and life satisfaction. This is particularly intriguing as it suggests that train commuters' wellbeing may be affected by complex interactions between positive and negative aspects of wellbeing. Adding the second wellbeing variable to the fully-adjusted models for underground commuters rendered previous effects non-significant suggesting that, for these commuters, shared variance between life satisfaction and mental distress was important. Finally, once life satisfaction was added to the model, mental distress scores were significantly lower among bus/coach commuters with 'good' vs. 'poor' connectivity. Interestingly, bus/coach commuters residing within, compared to outside, the congestion zone reported significantly lower life satisfaction (B = -0.78, $p < .05$) and lower mental distress (B = -1.75, $p < .05$) when the alternative wellbeing measure was added to the models. This suggests that whilst living and commuting by bus/coach within the congestion zone potentially reduces negative aspects of wellbeing, it does not necessarily result in corresponding increases in positive aspects of wellbeing. Full results are presented in Tables A.3 and A.4.

Discussion

We explored the relationships between commute mode, local public transport connectivity and wellbeing among a large sample of London-based commuters, while controlling for a range of area and individual level factors. Our use of 6 specific commute mode categories and both positive and negative wellbeing measures revealed complex patterns of associations previously untested. For example, although both cycling and walking are active commutes, compared to driving, only walkers reported higher life satisfaction compared to driving (even controlling for commute distance and other factors). This is important for interpreting previous results, which despite using longitudinal designs and/or comparatively more advanced methodology (e.g., fixed-effets models; Humphreys et al., 2013; Martin et al., 2014; St-Louis et al., 2014) were unable to address the impacts on wellbeing of different types of active commute. Walking, but not cycling, to work emerged as being associated with higher life satisfaction. This is of particular interest in the context of London where cycling is being increasingly promoted via cycle lanes and the Santander Cycle scheme (a self-service, bike sharing scheme for short journeys). The current data may suggest that cycling in London is still not an enjoyable experience and more could be done to improve this.

Mental distress was lower among all groups of public transport commuters (i.e. bus/train/underground users) in areas with better public transport connectivity. Moreover, the scale of these benefits was only slightly smaller than the benefits of being in the highest versus lowest income quartile. This information may be of interest to both: a) individuals, e.g. when they consider the trade-offs between a better paid job vs. living in an area of London with poorer public transport connectivity; and b) planners, who want to address socio-economic disparities in health and wellbeing; i.e. mental distress among the poorest sectors of the working population might be reduced through better public transport infrastructure.

Residing within versus outside of the congestion zone was associated with lower life satisfaction amongst public transport commuters. However, looking at individual public transport modes, it became clear that this was only observed among bus/coach commuters. Interestingly, commuting by bus/coach while residing within the zone was also associated with lower mental distress. The magnitude of observed coefficients for residing within the congestion zone was comparable, if not greater, to coefficients observed for having ‘good’ connectivity. This builds on previous research that found bus/coach commutes were generally associated with poorer wellbeing (Legrain, Eluru, & El-Geneidy, 2015; ONS, 2014) and highlights the importance of considering how travel location potentially attenuates relationships between commute type and wellbeing. Particularly for London, this calls for an assessment of the impact of reducing the congestion zone (in 2011; after this wave of UKHLS) on commuter wellbeing. For instance, bus/coach commuters re-zoned out of the new congestion zone may report increases in life satisfaction but also in mental distress, hypothetically due to increases in traffic-related stressors.

Our findings suggest that while life satisfaction appears to be more closely related to the *type* of public transport used, mental distress appears more closely related to the *connectivity* of public transport. This is supported by the observation that the relationship between walking and life satisfaction remains even after controlling for mental distress, and the relationships between connectivity and mental distress remains for train and bus commutes even after controlling for life satisfaction. We are reluctant, however to speculate as to whether policymakers should *a priori* focus on reducing distress or promoting positive wellbeing. Such decisions depend on contextual factors such as baseline levels of distress and wellbeing, the feasibility and acceptability of interventions and implications for equity. Nonetheless, our findings highlight that different transport policies may affect positive and negative aspects of life differently and policymakers may need to consider this.

Strengths and limitations

Using the UKHLS provided us with a large sample of commuters, often difficult to access through primary studies, providing us with the statistical power to explore these associations. Whilst using a London sample addressed representation heterogeneity of certain travel modes previously reported (Martin et al., 2014) and provided richer data and insights, our findings are also limited to London and cannot be generalised to the wider UK population. However, it is possible that similar associations may be found in other large cities both in the UK (e.g., Glasgow), and elsewhere (e.g., Singapore and New York).

We used two measures of wellbeing assessing positive and negative aspects and this revealed independent effects. While such analyses are suggestive of how changes in measured variables might impact on wellbeing, the cross-sectional nature of survey data means that these questions can only be definitively answered by experimental studies; evaluation of policy implementation is needed. Future work and policies would also benefit from exploring other individual-level factors influencing travel mode choices and wellbeing such as personal attitude and willingness to modifying commute behaviour.

We also recognise that PTAL does not provide the perfect measure for this kind of work because it does not differentiate between rail and bus connectivity, which may be important given our current findings of different wellbeing across travel modes. Our findings thus suggest a need to keep different forms of travel connectivity separate in future analyses. In addition, connectivity at LSOA level is only a proxy for actual transport availability. Some individuals may live at intersections of two or more LSOAs and it may actually be closer to access a public transport hub in another LSOA than one in the LSOA in which an individual lives. Further work could reduce potential errors of this kind by estimating walking distances to specific public transport sites for each participant, irrespective of small geographical boundaries, to explore marginal gains from improving connectivity.

Conclusion

These limitations notwithstanding, our study extends previous findings on the potential impact of commute mode on wellbeing by demonstrating that active transport options (i.e. walking and cycling) should not be collapsed for data collection and analysis purposes and that neighbourhood public transport connectivity moderates relationships between wellbeing and public transport use. Though London's public transport infrastructure is relatively well established, policymakers should continue enhancing its accessibility in tandem with growing needs, which potentially helps address growing mental health disparities. In addition, given walking commutes' associations with higher life satisfaction, perhaps stronger promotion of walking, to augment current policies encouraging cycling, should be considered. More generally, effective interventions could also lead to population-relevant wellbeing benefits in addition to previously documented physical health gains.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Table 1
Results of linear regression models investigating the association between commuting modes, public transport connectivity and life satisfaction amongst London commuters. Values are difference (95% confidence interval) in life satisfaction/GHQ scores.

	Life satisfaction (higher score = better wellbeing)				GHQ (higher score = higher mental distress)			
	Unadjusted (*n* = 2,704)	PTAL adjusted (*n* = 2,704)	Fully adjusted[a] (*n* = 2,574)[b]	GHQ-controlled[c] (*n* = 2,549)[d]	Unadjusted (*n* = 2,694)	PTAL adjusted (*n* = 2,694)	Fully adjusted[a] (*n* = 2,567)[b]	LS[e]-controlled[c] (*n* = 2,549)[d]
Commute mode								
Car/van	0	0	0	0	0	0	0	0
Public transport								
Train	0.10 (-0.14, 0.34)	0.10 (-0.14, 0.33)	-0.03 (-0.30, 0.24)	0.02 (-0.23, 0.26)	-0.28 (-1.45, 0.89)	-0.26 (-1.42, 0.91)	0.30 (-0.99, 1.60)	0.29 (-0.87, 1.45)
Bus/coach	-0.14 (-0.48, 0.20)	-0.15 (-0.48, 0.20)	0.23 (-0.08, 0.54)	0.11 (-0.14, 0.36)	-0.32 (-1.56, 0.91)	-0.21 (-1.46, 1.04)	-1.21 (-2.43, 0.01)	-0.80 (-1.83, 0.23)
Underground/light railway	0.32 * (0.06, 0.58)	0.31* (0.04, 0.57)	0.24 (-0.04, 0.52)	0.19 (-0.04, 0.42)	-0.91 (-2.35, 0.53)	-0.69 (-2.05, 0.66)	-0.46 (-1.87, 0.94)	-0.07 (-1.28, 1.13)
Active transport								
Cycle	0.33* (0.02, 0.65)	0.31* (0.00, 0.62)	0.24 (-0.08, 0.55)	0.17 (-0.08, 0.43)	-0.94 (-2.08, 0.20)	-0.73 (-1.91, 0.45)	-0.56 (-1.90, 0.79)	-0.17 (-1.27, 0.94)
Walk	0.32* (0.05, 0.60)	0.31* (0.02, 0.59)	0.48** (0.14, 0.81)	0.35* (0.05, 0.66)	-0.44 (-1.43, 0.55)	-0.26 (-1.28, 0.76)	-0.90 (-2.03, 0.22)	-0.13 (-1.13, 0.88)
Public transport accessibility level (PTAL)								
Very poor to moderate		0	0	0		0	0	0
Good to excellent		0.06 (-0.16, 0.28)	0.16 (-0.03, 0.35)	0.04 (-0.14, 0.21)		-0.70 (-1.72, 0.33)	-1.10* (-2.08, -0.12)	-0.85 (-1.75, 0.06)

Notes:

* Indicates statistical significance at the $p < 0.05$ level.

** Indicates statistical significance at the $p < 0.01$ level.

[a] Fully adjusted models controlled for commute distance, location relative to congestion zone, population density, educational attainment, OECD equivalised gross household income indexed by the consumer price index, number of children, the presence of limiting illness or disability, age, gender, neighbourhood income deprivation, neighbourhood employment deprivation, neighbourhood education deprivation, neighbourhood crime rate deprivation, neighbourhood environment deprivation and neighbourhood percentage of green space.

[b] Changes in *n* are due to missing values in the following variables: commute distance, location relative to congestion zone, population density, educational

attainment, OECD equivalised gross household income indexed by the consumer price index, number of children, the presence of limiting illness or disability, neighbourhood income deprivation, neighbourhood employment deprivation, neighbourhood education deprivation, neighbourhood crime rate deprivation, neighbourhood environment deprivation and neighbourhood percentage of green space.

[c] The models controlled for the other of wellbeing (life satisfaction or GHQ).

[d] Changes in *n* are due to missing values in the additional wellbeing variable.

[e] Life satisfaction

Table 2
Results of logistic regression models investigating the association between public transport connectivity and the use of public transport amongst London commuters.

	Unadjusted (n = 3,630)	Fully adjusted (n = 3,512)[a]	
	Odds ratio (95% CI)	Odds ratio (95% CI)	Wald
Public transport accessibility level			
Very poor to moderate	1	1	
Good to excellent	1.18 (0.84, 1.66)	1.00 (0.62, 1.16)	
Congestion zone			
Outside zone		0	
Inside zone		0.93 (0.29, 2.96)	
Residential density (1000 person per sq km)		1.00 (1.00, 1.00)	
Distance to work (miles)			*p < .001*
0 to 2		1	
3 to 5		4.77 (2.74, 8.30)***	
6 to 10		10.89 (6.54, 18.15)***	
11 to 20		21.32 (11.75, 38.68)***	
> 20		5.00 (2.36, 10.61)***	
Equivalised household income (5ths)			*p = .76*
1 Lowest		1	
2		1.09 (0.57, 2.07)	
3		1.46 (0.75, 2.83)	
4		1.29 (0.69, 2.43)	
5 Highest		1.34 (0.75, 2.42)	
Highest educational qualification			*p = .49*
None		1	
Other		0.70 (0.35, 1.41)	
≥Degree		0.80 (0.39, 1.66)	
Gender			
Male		1	
Female		1.16 (0.83, 1.63)	
Age		0.97 (0.96, 0.99)***	
Child in household			
No children		1	
Children <16		0.67 (0.49, 0.91)**	
Number of cars in household			
None		1	
At least one		0.19 (0.12, 0.29)***	
Limiting illness or disability			
None		1	
Yes		0.84 (0.56, 1.26)	
Month of interview		1.02 (0.97, 1.06)	

Notes:
** Indicates statistical significance at the $p < 0.01$ level.
*** Indicates statistical significance at the $p < 0.001$ level.
[a] Changes in n are due to missing values in the following variables: commute distance, location relative to congestion zone, population density, educational attainment, OECD equivalised gross household income indexed by the consumer price index, number of children and the presence of limiting illness or disability.

Table 3

Results linear regression models investigating the association between public transport commuting, public transport connectivity and wellbeing.

Life satisfaction: Values are difference (95% confidence interval) in life satisfaction scores (higher score = better wellbeing).

	All public transport		Train		Bus/coach		Underground/light railway	
	Fully adjusted[a] (*n* = 1,349)[b]	GHQ-controlled[c] (*n* = 1,331)[d]	Fully adjusted[a] (*n* = 442)[b]	GHQ-controlled[c] (*n* = 442)[d]	Fully adjusted[a] (*n* = 370)[b]	GHQ-controlled[c] (*n* = 360)[d]	Fully adjusted[a] (*n* = 537)[b]	GHQ-controlled[c] (*n* = 529)[d]
Commute mode								
Train	0	0						
Bus/coach	0.34** (0.01, 0.67)	0.16 (-0.09, 0.42)						
Underground/light railway	0.29* (0.02, 0.57)	0.22 (-0.01, 0.46)						
Public transport accessibility level								
Very poor to moderate	0	0	0	0	0	0	0	0
Good to excellent	0.35** (0.12, 0.59)	0.18 (-0.08, 0.45)	0.33 (-0.08, 0.74)	0.50* (0.12, 0.89)	-0.14 (-0.39, 0.68)	-0.16 (-0.65, 0.32)	0.50* (0.09, 0.90)	0.34 (-0.12, 0.81)

GHQ: Values are difference (95% confidence interval) in GHQ-12 scores (higher score = higher mental distress).

	All public transport		Train		Bus/coach		Underground/light railway	
	Fully adjusted[a] (*n* = 1,344)[b]	LS[e]-controlled[c] (*n* = 1,331)[d]	Fully adjusted[a] (*n* = 445)[b]	LS[e]-controlled[c] (*n* = 442)[d]	Fully adjusted[a] (*n* = 362)[b]	LS[e]-controlled[c] (*n* = 360)[d]	Fully adjusted[a] (*n* = 536)[b]	LS[e]-controlled[c] (*n* = 529)[d]
Commute mode								
Train	0	0						
Bus/coach	-1.66 (-3.42, 0.09)	-1.17 (-2.67, 0.33)						
Underground/light railway	-0.59 (-2.11, 0.93)	-0.17 (-1.52, 1.18)						
Public transport accessibility level								
Very poor to moderate	0	0	0	0	0	0	0	0
Good to excellent	-1.74* (-3.18, -0.29)	-1.22 (-2.68, 0.25)	1.88* (0.06, 3.70)	2.31** (0.58, 4.05)	-2.56* (-4.61, -0.51)	-2.32* (-4.19, -0.44)	-1.82* (-3.60, -0.03)	-0.97 (-3.04, 1.10)

Notes:
* Indicates statistical significance at the $p < 0.05$ level.
** Indicates statistical significance at the $p < 0.01$ level.

[a] Fully adjusted models controlled for commute distance, location relative to congestion zone, population density, educational attainment, OECD equivalised gross household income indexed by the consumer price index, number of children, the presence of limiting illness or disability, age, gender, neighbourhood income deprivation, neighbourhood employment deprivation, neighbourhood education deprivation, neighbourhood crime rate deprivation, neighbourhood environment deprivation and neighbourhood percentage of green space.

[b] Changes in *n* are due to missing values in the following variables: commute distance, location relative to congestion zone, population density, educational attainment, OECD equivalised gross household income indexed by consumer price index, number of children, the presence of limiting illness or disability, neighbourhood income deprivation, neighbourhood employment deprivation, neighbourhood education deprivation, neighbourhood crime rate deprivation, neighbourhood environment deprivation and neighbourhood percentage of green space.

[c] The models controlled for the other measure of wellbeing (life satisfaction or GHQ).

[d] Changes in *n* are due to missing values in the additional wellbeing variable.

[e] Life satisfaction

Highlights

- Two aspects of wellbeing (life satisfaction and mental distress) were explored.
- Results controlled for key predictors of wellbeing and commute mode choice.
- Individuals who walked to work had higher life satisfaction than car drivers.
- Underground commuters had higher life satisfaction than car drivers or train users.
- Good public transport connectivity was associated with lower mental distress.