**Daily mobility patterns of small business owners and homeworkers in post-industrial cities**

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**Abstract**

The rise of small businesses, self-employment, and homeworking are transforming traditional industrial ways of working. Our research fills a noticeable gap in the literature by using portable devices (i.e., smartphones) to capture individual mobility data on an understudied population group – small business owners (owner managers and self-employed with up to 49 employees) and whether they work from home in comparison with employees who work at their employer’s premises or partly or mainly from home. We recorded week-long individual GPS data on 702 participants and derived a set of measures of daily mobility (number of trips, trip duration, trip distance, and maximum distance from home). Each measure is modelled against a range of individual and neighbourhood-level covariates. Our findings contrast with existing studies that suggest homeworking or self-employment may be associated with lower levels of daily mobility or with compensatory effects between work and non-work travel. Overall, our study points to higher levels of daily mobility of owners of small businesses and the self-employed in cities as they travel longer distances. Further, some homeworkers have on aggregate longer daily trip distances than ‘traditional’ premise-based employees. Most striking, female home-based business owners fall into this group. If homeworking is here to stay after the COVID-19 pandemic, we may see both increases and/or decreases of daily mobility depending on worker types and gender.

# 1. Introduction

Key fixed geographical locations of people’s daily activities associated with work-related activities are undergoing radical changes (even before the onset of COVID-19 travel restrictions), at least partially due to the proliferation of information and communication technologies (ICTs) and new modes of work (Choo & Mokhtarian, 2007; Kwan, 2007). ICTs have blurred the boundaries between home and work as they allow people to work partially or exclusively in their own home. More recently, we are seeing widespread shift to remote and home-based working as a result of COVID-19 (Reuschke & Felstead, 2020). Telecommuting of employees, defined as working from or at home, has received much attention in the transportation literature even before the COVID-19 pandemic. Primary focus has been understanding residential choices and changes in total travel distance and time through the reduction of commuting trips (Helminen & Ristimäki, 2007; Ory & Mokhtarian, 2006; Zhu, 2013) and the timing of the commute (Lachapelle et al., 2018). However, much less attention has been given to homeworking by workers who are self-employed or run their own businesses (rather than employees).

In many post-industrial economies, self-employment and small business ownership have increased substantially in its share of the overall workforce as a result of parallel processes shaping the nature of work: structural changes in the economy (e.g., changing supply chains and, outsourcing), and the rise of the gig economy (Wood et al., 2018), new technologies that enable small businesses to access distant markets and compete with larger firms (Clark & Douglas, 2011), and a changing workforce that places more emphasis on non-monetary values of work such as work-life balance (Baumberg & Meager, 2015; Burchell et al., 2014). For women especially, self-employment and small business ownership appears to offer opportunities to combine work and family (Craig et al., 2012; Walker et al., 2008; Wellington, 2006).

Men and women who are self-employed or run their own businesses may work from commercial premises (e.g. shops, offices, art studios); but many work from home (Mason et al., 2011) or various other places (Liegl, 2014) such as co-working spaces (Clifton et al., 2019). Thus, the diversity in both worker types and work locations has become profoundly higher in contemporary post-industrial economies than was the case in industrial economies – even before the COVID-19 pandemic that resulted in a surge in homeworking in mature economies. The COVID-19 pandemic has underlined that an increased level of workers who are less bound to employer’s premises will have a profound impact on urban travel and city systems (Tranos et al., 2013). Those who mainly work from home may travel less or may spend more time in their neighbourhood or in proximate areas, when compared with premise-based workers (Saxena & Mokhtarian, 1997; Zenkteler et al., 2019). While current research in homeworking has attracted a lot of attention, to date very little research has focused on the daily travel patterns of self-employed workers and those running a small business, that are workers who are not working for an employer. With few exceptions (Mokhtarian & Henderson, 1998; Shin, 2019), transport studies have rarely disaggregated workers by their employment status and whether they run their own business and have thus paid little attention to the transformations being observed in in the workplace.

The overall objective of this paper is to use detailed GPS tracking data to study the daily mobility of under-researched socio-economic groups. Our first research question is whether the daily mobility of individuals in cities is significantly influenced by whether workers are employees or business owners (including as self-employed). Our second research question addresses how individuals who work partly or mainly from home differ (or not) in their daily mobility from those who do not work from home. We further break down these travel patterns by gender and ask in our third research question, whether the daily mobility of homeworkers and business owners/the self-employed is shaped by gender differences. With this approach, we reveal, for the first time, the complexity of homeworking, employment status or small business ownership and gender in cities. With an interest in small business ownership (an established category in business research defined as businesses with 0-49 employees including sole proprietors and owner managers), we specifically investigate the extent to which small business owners are associated with daily mobility patterns that diverge from the daily mobility of ‘traditional’ workers (i.e. employees with separate employer’s premises), whether homeworking is producing new daily mobility patterns in cities, and whether this is shaped by differences between men’s and women’s travel. Specifically, we ask whether small business ownership reproduces established gender differences in daily mobility.

To capture daily mobility patterns of small business owners and contrast them with those of employees, we collected a detailed primary GPS dataset from a survey of workers in two cities in England (United Kingdom). Data were collected pre-COVID-19 but our findings have rather increased in relevance since more and more people started to work from home during the global COVID-19 pandemic, and it is predicted that homeworking is here to stay (Felstead and Reuschke, 2020). GPS tracking data are particularly well-suited to capture highly detailed records of individual daily mobility activity (places visited, travel routes, and timing) without incurring recall error associated with daily travel diaries (Stopher & Shen, 2011) . The GPS data we collected cover several days of a standard working week of the surveyed workers thus it contains sufficient variability in daily activity patterns (Kang & Scott, 2010). The GPS data are augmented by an extensive individual questionnaire allowing us to investigate daily mobility patterns related to personal, work and location factors of each individual in our study. We derive four measures of overall daily travel (number of trips, trip duration, trip distance, maximum distance from home) and model each measure against a range of individual and neighbourhood-level covariates believed to be associated with individual-level daily mobility. Findings demonstrate that differences in daily mobility patterns of business ownership/self-employment become apparent most strongly in the intersection with gender.

# 2. Existing literature

## 2.1 Self-employment, small business ownership and individual mobility

Economic geographers have highlighted the importance of local social ties and knowledge spill-overs for entrepreneurship and developing a business (Andersson & Larsson, 2016). It is assumed that entrepreneurs and small business owners are strongly embedded in place through their networks (Hanson, 2005). However, there is little research on the daily mobility of small business owners.

Few transport studies exist that have investigated the commutes of the self-employed (rather than small business owners) compared to employees (Giuliano, 1998; Gimenez-Nadal et al., 2018; Lee & McDonald, 2003; Reuschke & Houston, 2020; Shin, 2019; van Ommeren & van der Straaten, 2008). These studies have provided a fairly coherent picture – that of short commutes of the self-employed. Strikingly, these studies use data from a variety of countries (Netherlands, South Korea, USA) as well as data at different geographical scales (national, regional, city) suggesting that the shorter commutes of the self-employed is a broader phenomenon that is likely to be related to the fact that the self-employed are more flexible in the choice where they locate their business (van Ommeren & van der Straaten, 2008).

Commuting distance and time are highly relevant for understanding residential choice and job accessibility. In terms of overall travel or daily mobility patterns of individuals, however, the commute forms only one element in a wider mobility network. There is very limited research that has investigated – in addition to commutes – non-work travel of the self-employed in comparison with employees (but not of small business owners more generally)(Henderson & Mokhtarian, 1998; Shin, 2019). Although Shin’s study does not investigate overall daily travel, findings from this one-day travel diary survey suggest that the self-employed with commutes have on aggregate a higher level of non-work-related travel. The self-employed according to Shin’s study therefore seem to offset shorter commutes with non-work travel suggesting that time saved for commutes are compensated through more or longer trips, for example, for shopping, family errands or leisure. This finding seems to be in line with travel time-budget theory according to which individuals have a constant budget of time dedicated for travelling (Ahmed & Stopher, 2014; Mokhtarian & Chen, 2004). However, compared to employees, it remains uncertain from Shin’s (2019) study whether the self-employed with premises (or other small business owners) have a higher level of daily travel altogether and whether the observed mobility pattern apply similarly to men and women.

## 2.2 Homeworking and travel

Most of the self-employed do not have regular commutes, which makes a wider focus on their daily mobility levels more important. Shin’s study (2019) reports that homeworkers, independent of whether they are employed or self-employed, travel less in terms of both distance and time for non-work purposes than regular commuters. Similarly, Mokhtarian and Henderson’s (1998) transport study on homeworking is the only one we are aware of that included home-based business owners and reported many work trips by home-based business owners but their overall travel was less compared to workers who did not work from home and they also travelled short distances. These findings are congruent with early research on telecommuting summarized by Mokhtarian (1991), which found lesser or no increased travel and a shift of activity destinations closer to the home (Pendyala et al., 1991; Saxena & Mokhtarian, 1997). This conclusion that homeworking decreases overall travel (although not necessarily work-related travel when people combine working from home with working at other places) is at odds with more recent studies on homeworking which have found evidence of a so-called rebound effect (Kim, 2016; Lachapelle et al., 2018; Rietveld, 2011).

The conceptualization of the rebound effect can be thought about as being associated with either of two processes (Kitou & Horvath, 2003). First, induced or non-work-related travel that occurs to compensate for the introduction of homeworking in a household (e.g., increased number of shopping or leisure trips) and, second, induced energy demand (e.g., heating the house for more hours). Previous research has shown that homeworking decreases the proportion of linked trips (i.e., trip chaining; Pendyala et al., 1991) which means that accessing the same set of destinations/activities may be done so less efficiently than with commute-related trip chaining.

Much debate also exists about how homeworking impacts residential location choices, but the limited evidence available supports that more often homeworking *follows* residential relocations that lengthen commutes (Ory & Mokhtarian, 2006). Further, the geographical structure of cities, the transportation network, and the presence of sprawling suburban regions can further influence patterns of both work and non-work travel which may magnify or offset changes in travel demand associated with homeworking depending on individual circumstances (Bomhof et al., 2009; Romm et al., 1999).

## 2.3 Gender and daily mobility

A large body of literature has shown that women’s daily mobility patterns have specific characteristics when compared to men. Women more often than men use public transport and active modes of travel, and more so in urban areas with high accessibility of public transport (Miralles-Guasch et al., 2016). This means that women travel slower than men (Kwan & Kotsev, 2015). Women also have more complex activity patterns which has been related to their more complex lives resulting from higher share in housework, childcare and care for elderly people compared to men (Scheiner & Holz-Rau, 2017). The higher share in household responsibilities means that women have more ‘anchor’ points that are fixed in place (e.g. home, workplace, children’s school) (Schwanen et al., 2008).

It is well-established that women have shorter commutes than men (Crane, 2007; Fanning Madden, 1981; Frändberg & Vilhelmson, 2011; Hjorthol & Vågane, 2014; McQuaid & Chen, 2012) although due to their slow travel women tend to spend disproportionately more time than men on their commutes (Kwan & Kotsev, 2015). The gender commute gap is prevalent in both urban (Gordon et al., 1989) and rural contexts (Sandow, 2008). Several reasons for the gender commute gap have been suggested including household responsibilities and labour market mechanism (MacDonald, 1999; Reuschke & Houston, 2020).

Similar to work trips, women’s non-work trips tend to be shorter than men’s (Scheiner, 2010). However, women tend to undertake more non-work trips than men (Gordon et al., 1989) and the total number of daily trips was also found to be higher for women than men (Miralles-Guasch et al., 2016). One reason for the higher number of trips of women compared to men is that mothers chain household-related trips more than men to their trips to and from work (McGuckin & Murakami, 1999).

Thus, on the basis of shorter trips coupled with slow modes of transport it would seem as if women may organise their activity patterns more than men around their home. However, some research that investigated activity spaces rather than trip numbers, distance or time found little support for mobility restrictions of women compared to men (Schönfelder & Axhausen, 2003; Vich et al., 2017). In particular young women seem to have, for the first time, overtaken young men in the level of daily travel (Tilley & Houston, 2016). Amongst the self-employed, Reuschke and Houston (2020) also could not find significant differences in commute times of men and women (although the study did not investigate other types of travel). Based on these findings it is unclear whether self-employed women may have a different travel behaviour to employee women.

# 3. Methods

## 3.1. Participant Recruitment and study groups

We study daily mobility of workers in two cities in England (United Kingdom): Brighton & Hove and Leeds, chosen based on their geographical attributes and their employment characteristics drawn from the 2011 Census of Population data. Brighton & Hove was selected as a medium-sized city (2018 population; 290 400) in the economically strong South East. Brighton & Hove has high proportions of self-employed workers (13.4%; 2018 data) and homeworkers (11%; 2011 data), directly relating to our research focus. Leeds, the third largest city of the United Kingdom (2018 population; 789 200) located in the North of England, was chosen to contrast Brighton & Hove’s location within England and thus to cover a wider variety of cities in terms of their industrial past and workforce composition. The workforce in Leeds is represented by a diverse service sector and with average levels of self-employment (9.5% compared to a national average of 10.7%) and homeworking (7% based on 2011 Census data)[[1]](#endnote-1).

Participants were recruited from the Dun & Bradstreet business directory. We sampled small business owners (with less than 50 employees including ‘home offices’) by the address of their business (which is in the case of ‘home offices’ also the residential address of the owner) which had to be located within the local authority boundaries of our two cities. Accordingly, we only selected employees when they worked in one of these cities. We further restricted the study sample to 18-64-year-olds who work at least 15 hours per week[[2]](#endnote-2). Participants were recruited between October 2018 and May 2019.

In each city we targeted our stratified sample as follows; i) small business owner or self-employed without separate business premises, ii) small business owner/self-employed with external business premises, and iii) employees. We targeted recruitment of 450 participants from each city with sufficient numbers in each target group approximately even split between women and men. As part of this survey we asked each participant the proportion of time they spend working in the home. Further, small business owner/self-employed target groups were asked whether they have external business premises, have their home as premises for their business, or use their home as a base for their business while the work is done from various locations. From these two questions we defined six study groups: 1) employees working solely at external premises, 2) employees who work less than half of their work time from home, 3) employees who work the majority (≥ 50%) of their work time from home, 4) small business owners/self-employed with external business premises, 5) small business owners/self-employed with the home as premises of the business, 6) small business owner/self-employed who use their home as a base but the work occurs elsewhere. The 50% of work time as a threshold for identifying principally home-based work is based on the definition in the European Labour Force Survey used in previous studies (e.g., Felstead, 2012; ONS, 2014).

## 3.2. Location/tracking data collection

After participants were screened and deemed eligible, they were first interviewed (via telephone or face-to-face) using a standardized questionnaire and then asked to participate, second, in a mobile-phone application survey. We used a third-party software company (https://Wubbleyou.co.uk) to help us develop and design a bespoke mobile survey application. The mobile application was installed on participant smartphones (both Android and iOS were available) with the help of the recruitment team. The user interface was kept relatively simple and we found that we had to provide very little extra guidance to participants on the usage of the mobile application. The mobile app consisted of two components: i) a location tracking component and ii) real-time survey questions send via push notification that also logged people’s location. The app was developed as a bespoke application to feature customized project branding, but its functionality was very similar to that of existing, popular mobile survey applications (e.g., Patterson et al., 2019).

Mobile phone-based survey applications have become the preferred method for collecting individual movement data despite having some drawbacks in comparison to GPS-loggers (Shen & Stopher, 2014). There are essentially two approaches to location tracking via mobile smartphone applications 1) continuous location tracking whereby location points are recorded continuously at some pre-defined time interval (e.g., 1 point every 30 seconds), and 2) motion-based location tracking, which attempts to minimize data redundancy by only capturing location points while the participant is moving. While continuous GPS tracking (which can be done using mobile phones) is often preferred because it captures participant location (near) continuously it has the significant downside of high battery consumption. Whereas, motion-based approaches to location tracking have the downside that it is difficult to infer if participants have turned-off the location tracking component of their phone or are simply not moving. Therefore, using a dynamic, motion-based approach represents a tradeoff to minimize battery consumption because we know participants care a great deal about battery life on their smartphones (Jariyasunant et al., 2014) and we did not want this to be a source of participant drop-out or non-compliance with the app.

The mobile-phone based application we developed used a motion-based approach with a two-state (moving vs stationary) rolling geofence, with a threshold of 50 m. Location data were recorded with high frequency within the moving state. In the non-moving state, location positions were only recorded when push notifications were sent the participant or upon a state transition (i.e., stationary to moving). We also used the native, dynamic location tracking modules within the Apple iOS and Android systems, which means that the time and distance between recorded locations will vary depending on operating system and movement speed. These location points are primarily derived from GPS, but can also be acquired using other available locating technologies associated with mobile phones (e.g., via WiFI IPs). For each location point we also have a record of location accuracy provided by the native system.

Based on our data, we found that Apple iOS devices tended to have higher rates of location data acquisition compared to Android devices (Figure 1). Within recorded trips, we captured location points with a mean of 64.6 (s.d. = 86.1) location points per trip. This equates to a mean of 20.9 (s.d. = 18.0) location points per km or a mean of 2.9 (s.d. = 1.8) location points per minute, but there was a great deal of variation in these acquisition rates depending on movement speed, with more points taken per minute when higher movement speeds were observed (Figure 1b).

< Figure 1 here >

Participants were asked to use the mobile-phone application for seven days representing a standard working week for them. Seven days represents a suitable time to capture routine patterns in individual mobility behavior (Stanley et al., 2018). To encourage uptake and retention, and offset the demands of completing our GPS-based survey, we offered participants financial incentive in the form of an online shopping gift card (with a choice of different major retailers). Participants were given a first payment of £5 upon completion of the initial survey and upon downloading the mobile app, a further installment of £20 was provided after participation in the GPS-based survey for 7 days.

## 3.3. Data processing

Location tracking data collected via mobile phone apps require substantive post-processing. For the purpose of this analysis, our post-processing took a typical workflow for GPS tracking data (Stopher et al., 2005), where we removed location data errors based on accuracy thresholds and geometrical relationships observed within the tracking data (more details in Supplementary Material 1). We first processed the tracking data into sequences of stops (representing activities) and moves (Siła-Nowicka et al., 2016; Spaccapietra et al., 2008). By using a two-state rolling geofence tracking algorithm to collect location data, we defined stops as locations where both no movement occurred for >5 minutes and movement between consecutive points was <75 m. Trips were then defined as the sequences of continuous GPS data collected between stops while the application was in the moving state. All stops and trips occurring outside of the United Kingdom are removed from subsequent analysis to remove the bias of very long trips and vacation related travel.

## 3.4 Study sample

We surveyed 908 participants (who both completed the questionnaire-based survey and downloaded the survey app). We removed the day when participants boarded onto the app, as this day would represent incomplete daily mobility information. For each participant we defined a day as being compliant with the survey (after the day when they downloaded the app) where a participant recorded at least one answer to a real-time survey question **or** completed at least one trip (based on the location tracking data). We chose this relatively simple measure of effort as based on our two-state rolling geofence tracking implementation, we cannot differentiate between true no movement and non-compliance (i.e., phone turned off or not on their person). We used a threshold of three days of survey effort for inclusion in further analysis. Many participants also provided data for much more than the required seven days, likely because they did not uninstall the app after being prompted that they had completed their survey requirement. Thus, to account for diminishing compliance over time, we chose to include only the first eight days of data for any participant who had more than eight days of survey effort.

In total, 702 participants provided high-quality location data and are included in subsequent analysis. This sample includes more employees than business owners/self-employed due to willingness of people to move from the questionnaire stage onto the app-stage of the survey. Moreover, more participants are from Leeds than Brighton as it was more feasible to recruit more people in the larger of the cities. In total, we recorded 994 576 location points for our 702 participants (x̅ = 1417 sd = 1036, range = [89, 6758]). Our 702 participants provided in total 4683 days of survey effort (x̅ = 6.7 sd = 1.2, range = [3, 8]). The average number of location points per participant/per day was 212.4 (sd = 226.9, range = [1, 2521]).

## 3.5 Measures

We use four measures to capture the daily mobility of our participants in a comprehensive fashion. We adhere to standard mobility measures: (1) number of trips taken daily by participants, (2) daily cumulative travel duration (travel time), (3) daily cumulative travel distance. We add to these (4) maximum daily distance from home which is a measure that is not available in many other transport studies which rely on survey data. For measuring the maximum distance from home, we had to identify participants’ home location. We identified participants’ home as the stop location associated with the greatest number of stops/visits. Previous studies have used similar measures to identify home locations from raw GPS tracking data (e.g., location with the longest duration of time spent (Siła-Nowicka et al., 2016); or longest duration of time spent at night (Kung et al., 2014)). In our survey questionnaire, we asked participants for their home postal code (as an approximate measure of home location for reference). We compared the GPS-derived home location with the United Kingdom Office for National Statistics postal code centroid locations. We found that the GPS-derived home location, based on largest number of stops, was the most reliable predictor of the true home location in comparison with other methods (i.e., 79% of GPS-based derived home locations were within 1 km of the self-reported home postal code centroid).

## 3.6 Statistical Models

Modelling daily mobility patterns (i.e., with repeated daily measurements for individuals) requires that we account for this individual-level variation (e.g., Helbich et al., 2016). To do this, all daily mobility indicators are analysed using a generalized linear mixed-effects modelling (GLMM) framework (Gelman & Hill, 2006) with the individual as a random effect and all remaining covariates included as fixed effects. We modelled daily number of trips as a Poisson response in the GLMM. Participants’ daily cumulative travel durations (minutes), distances (km), and maximum distance from home (km) were modelled using a linear (i.e., Gaussian) response with a log-link function. Model goodness-of-fit was assessed using the GLMM R2 method described by (Johnson, 2014). In the model for daily number of trips we use all survey effort days (*ndays*  = 4683, *nparticpants* = 702), but for the daily trip duration, trip distance, and maximum distance from home models we only use those days where at least one trip was observed (*ndays* = 3982, *nparticpants* = 702).

The primary independent variable we are focusing on represents our six worker type groups (Table 1). While in our sample some groups disaggregated by gender are small, it should be noted that our study uses repeated measures from each individual. We control for a number of other individual-level social and demographic variables (Table 1) that were found to influence individuals’ mobility behavior and relate to gender differences in mobility patterns (Scheiner & Holz-Rau, 2017). Along with the individual-level social/demographic factors, we also controlled for the participant’s city location (Leeds or Brighton & Hove). Based on their home location (see section 2.3) we also calculated the distance from individual’s home location to the city centre (defined as the location of the town hall which in either city represents the centre point) to proximate for inner and outer areas (as in previous research; Turcotte, 2008) and associated differences in travel behavior (Scheiner, 2010). We tested for multicollinearity using the variance inflation factor (VIF) between the chosen covariates and found there was no evidence of multicollinearity (VIF < 3 for all variables). Following Heinze et al. (2018), we use the same controls across all models which were chosen based on previous literature on transport behaviour. We display the results for all covariates even though in many cases variables did not prove to be significant in our model.

< Table 1 here>

For each measure of daily mobility, we ran the statistical model first using a gender dummy variable (with men as the reference category), alongside other controls (Model A). Models B and C are like Model A, but for men and women separately (i.e. the gender dummy variable is not included in here). We then ran Model A with interaction terms between gender and the worker-type group variable (Model D) in order to test gender differences within the worker type groups. Throughout we use α = 0.05 as significant model effects, but report all coefficients, standard errors, and *p*-values in Tables 2-6. To ease interpretation, we report for all models the exponent of the coefficient – exp().

Although our study is longitudinal and using repeated measures improves our modelling findings compared to cross-sectional survey, we did not observe any change in people’s job, workplace location, household composition, residential location etc. and therefore we can only infer associative relationships between the outcome measures and the captured covariates.

All analyses were conducted using the R statistical computing environment. We used the package lme4 (Bates et al., 2015) for fitting the GLMMs, the package MuMIn (Barton, 2019) for calculating the GLMM R2, the package car (Fox & Weisberg, 2019) for calculating VIF, the package sf (Pebesma, 2018) for all geographical data manipulation, and the package ggplot2 (Wickham, 2016) for generating graphical outputs.

# 4. Results

## 4.1. Daily Number of Trips

Daily number of trips showed very little variation between study group types (Figure 2). After controlling for individual and neighbourhood-level covariates (Table 2; R2GLMM = 0.436), we found no significant differences in the daily number of trips taken between the different worker type groups. However, when more closely analysed by gender, we found that among men, business owners/the self-employed with the home as their base made significantly more trips (about 20% more; exp(*β*) = 1.213) than premise-based employees. Among women, employees who mainly work from home made significantly fewer trips than premise-based employees (about 35% less; exp(*β*) = 0.652). Women employees who mainly work from home also travel less in terms of daily number of trips compared to men who mainly work from home. Of the other variables included in the models, we found women made significantly fewer trips than men (about 15% fewer; exp(*β*) = 0.843). Only a few of the other variables we controlled for showed were found to be significant in any of the models.

< Figure 2 here >

<Table 2 here >

## 4.2 Daily Trip Duration

Daily trip duration showed little variability between worker type groups (Figure 3). We also did not find a significant difference in daily trip duration between our six different worker type groups (Model A in Table 3; R2GLMM = 0.266). However, we find significant differences in travel time related to our worker-type groups among men (but not women). Specifically, male employees who mainly worked from home spent more time travelling daily (74% more time; exp(*β*) = 1.737) compared to premise-based male employees. Of the other variables we tested, gender was a significant predictor of trip duration with women having significantly lower daily trip durations (by about 16%) when compared to men (exp(*β*) = 0.836). There was again little association between other independent variables and daily trip duration although in the model for men (Model B) we found that men’s trip duration is more dependent on individual (job) characteristics, car ownership and residential location than women’s daily trip duration.

< Figure 3 here >

< Table 3 here >

## 4.3. Daily trip distance

Daily trip distances exhibited noticeable variation between different worker-type groups (Figure 4). Specifically, after controls, we found that all three of the self-employed/ business owner groups had larger daily cumulative trip distances (by between 25% - 41%) relative to the premise-based employees (Table 4; R2GLMM = 0.470). When analysed separately by gender (Models B and C), the groups with significantly longer daily trips differed for men and women. Whereas among men it is premise-based business owners/self-employed and those with the home as the base as well as employees who mainly work from home who have longer trips; amount women it is business owners/self-employed who mainly work from home who stand out among with longer trip distances.

Overall, gender was found to be a significant predictor of daily cumulative trip distances (Model A), with women having lower distances (by about 15%; exp(*β*) = 0.852) than men – although there were no differences between worker-type groups by gender (Model D). Further, part-time work, not having access to a car and having a health issue limiting individual mobility are associated with shorter daily cumulative trip distance, while having a home location further from the city center was positively associated with daily cumulative trip distances.

< Figure 4 here >

< Table 4 here >

4.4. Daily maximum distance from the home

The maximum distance individuals were observed from their home each day showed variation between the six different worker-type groups (Figure 5). Our statistical models reveal that some business owners/self-employed make long trips away from their home on a daily basis. Among men, those with the home as a base for their businesses exhibited a 59% increase (exp(*β*) = 1.594) in travel distance away from the home relative to premise-based employees. Among women those self-employed business workers who work mainly from home travelled on average 50% further from the home (exp(*β*) = 1.496) relative to premise-based employees. Female business owners/self-employed who use their home as the base for their businesses travel over significantly shorter distances away from their home than their male counterparts (by upwards of 46%; exp(*β*) = 0.535; Model D). The models for men and women (Models B and C) confirm significant travel further away from home for home-based business owners/the self-employed.

Overall, while gender has proven to be strongly associated with the previous travel measures (Tables 2-4); it is not associated with our measure of daily maximum distance from home (Model A in Table 5). Similar to the daily cumulative distance, the daily maximum distance from home is also negatively associated with access to a car and health and positively associated with the distance of the residential location from the city centre.

< Figure 5 here >

< Table 5 here >

# 5. Summary and Discussion

Using a longitudinal primary GPS survey augmented by a questionnaire-based survey, we tested for differences in daily mobility of small business owners (including the self-employed) versus employees further disaggregated by whether they work primarily in the home or from separate premises and by gender. In the case of small business owners, we further differentiated between those who run their business from home or use their home as the base for the business but the activities are performed mainly outside of the home. This latter group has not been explored in existing research and only few geographical studies have investigated homeworking amongst small business owners.

Overall, our first key finding, related to our first research question about differences in daily mobility of business owners/the self-employed and employees, is that small business owners (including the self-employed) varied in their daily mobility levels when compared with ‘traditional’ premise-based employees in relation to daily trip duration and daily trip distances travelled further from the home, but showed no significant differences in their daily number of trips or daily trip durations. Possible explanations might be that business owners either travel faster in urban areas or they travel at different times than employees given that their work allows them to set their work schedule more freely. We controlled for access to car which may not fully capture travel speed. Hence, we conclude that business ownership/self-employment are associated with increased level of daily mobility in cities (although this is not associated with more trips). With a further increase in self-employment and small business ownership, travel in cities could increase.

A second key finding, relates to *homeworking* andour second research question whether the daily mobility of those working partly or mainly from home differs to those who do not work from home. Overall, we find little support for the assumption that homeworking reduces travel (Moos et al., 2006; Pendyala et al., 1991). Importantly, however, we found not only differences between homeworkers and non-homeworkers but also amongst homeworkers calling for the need of a more detailed analysis of homeworking by worker types and its relationship with mobility in cities in the future. Associations of working from home with daily mobility could be observed in our study more among small business owners/the self-employed and to a lesser extent among employees (who have been the focus in previous studies on homeworking/telecommuting). Small business owners with the home as the premises for their businesses showed *higher* levels of daily mobility across distance-based measures, exhibiting larger daily travel distances and maximum distance from home relative to premise-based employees. These same relations were not observed among employees who work from home. Furthermore, and most striking, women who were small business owners and run their business from home had *longer* daily trips in terms of travelling time, had *larger* daily trip distances relative to men in the same group.

In stark contrast to the view that homeworking may reduce travel, male employees who mainly worked from home, showed significantly longer daily trips in terms of both time and distance. We cannot explain our observation with our data, however, it may be that homeworking among employees is more related with shifts in sharing household responsibilities. The only evidence in support of the view of homeworking and travel reduction is for female employees who mainly worked from home in relation to number of daily trips.

People who work from home have been shown to trip chain less in previous studies (Balepur et al., 1998; Wells et al., 2001). This may result in the pattern of increased overall daily mobility of homeworkers, except female employees, observed in our city survey. It could also be that homeworking especially among business owners/self-employed induces new travel, for example in order to combat the social isolation of working at home (Spinuzzi, 2012). Business owners who use their home as a base are likely to be involved in relatively high levels of work-related travel and this may explain the high level of travel in this group and/or the different levels of travel observed between men and women. Rather than a rebound effect (Rietveld, 2011) – according to which telecommuters compensate for reduced commuting travel by introducing other types of daily travel – the work of business owners with the home as a base may require high level of mobility. Many who use their home as a base are likely to work in the skilled trades (although we controlled for this). Previous work has shown men make up a larger proportion of workers in the skilled trades and have longer commutes within this group (McQuaid & Chen, 2012). Further, workers in the skilled trades may require substantial other daily travel moving between job sites and/or provisioning materials. Mobile working practices have increasingly attracted interest of researchers although more so in professional/creative occupations due to the interest of the research in the impact of ICT on work practices and locations (Hislop & Axtell, 2009; Ojala & Pyöriä, 2018). Our findings add to this strand of research and call, at the same time, for greater attention to differences in relation to gender.

Regarding our third research question, whether gender influences the daily mobility of homeworkers and business owners/self-employed, gender was a key influencing factor in our study of working people generally highlighting well-known gender differences in mobility (Hanson, 2010). While our findings confirm the shorter daily distance and duration trips made by women compared to men found in previous research (Scheiner, 2010), in our city survey, women overall also made *fewer trips* than men, which is in contrast to some other studies (Gordon et al., 1989; Miralles-Guasch et al., 2016). Importantly, differences in worker types as investigated in our study through business ownership/self-employment and paid employment emerged when we investigated travel measures by gender. We rigorously tested gender differences within worker-type groups and in many respects these were not significant. Therefore, we conclude that treating gender as a control or one influencing factor is not sufficiently capturing that within certain socio-economic groups or worker types, gender differences may be small and statistically insignificantly. Related to this, we found little evidence of the effects of children in the household and/or social/professional status relative to findings in previous research (Scheiner, 2010; Scheiner & Holz-Rau, 2017; Vich et al., 2017). We could not find, however, that gender differences had reversed in any of the worker groups we studied. Since gender occupation and industry segregation remains high and the self-employment and business ownership rates of women are substantially lower than those of men in post-industrial economies, gender differences are reflected in aggregate analysis.

Although not directly related to our research questions, it is worth mentioning that having access to a car was a significant predictor of daily mobility (in terms of daily trip distance and maximum distance from the home), but not number of trips or daily trip duration. This suggests, in line with previous research, that in places such as the UK quite simply travel distance and range increases with car ownership/access but that the number/duration of trips are fairly constant over time (Metz, 2010).

Our study further contributes to the growing literature demonstrating the value of detailed GPS-based surveys combined with individual questionnaires over anonymous big mobility datasets. We included an extensive individual questionnaire, which combined with our relatively large sample, allowed us to provide insights into the daily mobility of different groups of workers and to control for a variety of individual factors which may influence individual mobility patterns. Several examples in the contemporary literature are now using anonymous (or partially anonymous) datasets that capture the mobility patterns of millions of individuals derived from their mobile phones (e.g., Becker et al., 2013; Jiang et al., 2017; Liu et al., 2019). While these data are large in volume, they are limited in the semantic information they contain about each individual included in the data. Such studies are unable to address targeted questions about specific sub-groups of the population (such as small business owners) and they cannot control (in statistical models) for various individual factors.

With homeworking possibly remaining at a high level in times of COVID-19 (which may continue longer term), the daily mobility of workers in cities is likely to change. Our study showed that homeworking can be associated with both increased and decreased levels of daily mobility (depending on whether the worker is business owner/self-employed and a man or women) although we did not find that daily mobility patterns were more localized. If homeworking is here to stay, analysis would be useful that considers the timing of travel activity. Our findings lean towards the conclusion that different groups of workers may be adjusting the timing of their travel requirements to, for example, avoid travel during peak times in the morning and evening. By avoiding peak rush hour times, individuals may be able to increase their overall travel range by travelling more frequently, or over larger distances, in the same amount of time.

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Table 1. Individual-level variables (self-reported) included in all models of daily mobility and their descriptive statistics (frequencies or means and standard deviations). Notes: aStandard Occupation Classification (ONS, 2010), bElementary agricultural, construction, process plant, trades, administrative and service jobs, cWe asked participants if they felt they had a health issue that might limit their mobility in any way, dLower Super Output Area, from the UK National Census 2016.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Employee | | | Bus. owner/ Self-empl. | | |
|  |  | premise-based | home-based   (1-50%) | home-based   (≥ 50%) | premise-based | Hom-based | home as a base |
| Total |  | 274 | 36 | 20 | 169 | 66 | 137 |
| Gender | Men | 94 | 14 | 8 | 90 | 32 | 64 |
|  | Women | 180 | 22 | 12 | 79 | 34 | 73 |
| Age | 18-24 | 90 | 5 | 3 | 6 | 5 | 13 |
|  | 25-34 | 69 | 16 | 8 | 32 | 12 | 41 |
|  | 35-44 | 57 | 9 | 3 | 52 | 17 | 41 |
|  | 45-54 | 44 | 4 | 4 | 58 | 17 | 26 |
|  | 55-64 | 14 | 2 | 2 | 21 | 15 | 16 |
| Work | full time (>35 hrs/week) | 173 | 31 | 13 | 156 | 56 | 112 |
|  | part-time | 101 | 5 | 7 | 13 | 10 | 25 |
| Education | No Qualifications | 4 | 0 | 0 | 6 | 0 | 3 |
|  | Degree | 110 | 19 | 15 | 82 | 36 | 64 |
|  | No Degree | 160 | 17 | 5 | 81 | 30 | 70 |
| Occupationa | Manager/Director | 19 | 5 | 2 | 72 | 18 | 32 |
|  | Professional | 27 | 11 | 4 | 25 | 10 | 30 |
|  | Associate professional/technical | 35 | 9 | 4 | 17 | 16 | 25 |
|  | Administrative and secretarial | 61 | 6 | 3 | 21 | 5 | 31 |
|  | Skilled trades | 10 | 3 | 1 | 14 | 8 | 7 |
|  | Caring, leisure, and other service | 31 | 0 | 0 | 11 | 2 | 8 |
|  | Sales and customer service | 39 | 1 | 1 | 5 | 3 | 3 |
|  | Process plant, machine operative | 3 | 0 | 0 | 0 | 1 | 0 |
|  | Elementaryb | 42 | 1 | 2 | 1 | 1 | 0 |
|  | Other / not classified | 7 | 0 | 3 | 3 | 2 | 1 |
| Children | No child | 189 | 22 | 12 | 70 | 32 | 77 |
|  | Has child/ren | 85 | 14 | 8 | 99 | 34 | 60 |
| Household | Single occupant | 243 | 33 | 17 | 150 | 62 | 126 |
|  | Multiple occupant | 31 | 3 | 3 | 19 | 4 | 11 |
| Car | Access to car | 159 | 21 | 10 | 131 | 56 | 102 |
|  | No access to car | 115 | 15 | 10 | 38 | 10 | 35 |
| Mobility issuec | No mobility issue | 261 | 34 | 19 | 166 | 62 | 131 |
|  | Has a mobility issue | 13 | 2 | 1 | 3 | 4 | 6 |
| % of semi or detached homes in neighbourhoodd - Mean | | 33.0 | 40.3 | 37.0 | 47.4 | 42.6 | 44.1 |
|  | Standard deviation | 29.4 | 32.6 | 34.7 | 30.4 | 29.9 | 31.8 |
| Distance to city centre (km) - Mean | | 8.1 | 11.7 | 4.6 | 11.3 | 8.8 | 14.6 |
|  | Standard deviation | 23.2 | 35.8 | 3.3 | 20.0 | 17.0 | 43.0 |
| Study city | Brighton & Hove | 92 | 17 | 12 | 57 | 24 | 56 |
|  | Leeds | 182 | 19 | 8 | 112 | 42 | 81 |

Table 2. Estimates for daily number of trips using Poisson generalized linear mixed effects model. Model A includes both men and women, B includes only men, C includes only Women, and D includes an interaction term between gender and worker-type group. Greyed relationships are significant at p < 0.05.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Base (Model A)** | | | | **Men-Only (Model B)** | | | | **Women-Only (Model C)** | | | | **Interaction-effect (Model D)** | | | |
|  | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** |
| (Intercept) | 0.944 | 2.570 | 0.189 | 0.000 | 0.804 | 2.234 | 0.229 | 0.000 | 0.889 | 2.433 | 0.335 | 0.008 | 0.942 | 2.565 | 0.193 | 0.000 |
| Study Group (Ref. employee, premise based) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Employee, home-based 1 - 50% of time | 0.007 | 1.007 | 0.106 | 0.949 | 0.122 | 1.130 | 0.161 | 0.448 | -0.131 | 0.877 | 0.138 | 0.340 | 0.040 | 1.041 | 0.166 | 0.812 |
| Employee, home-based ≥ 50% of time | -0.120 | 0.887 | 0.141 | 0.396 | 0.412 | 1.510 | 0.210 | 0.050 | -0.428 | 0.652 | 0.189 | 0.023 | 0.218 | 1.244 | 0.216 | 0.314 |
| Business owner/self empl., premise based | 0.011 | 1.011 | 0.065 | 0.864 | 0.153 | 1.165 | 0.099 | 0.121 | -0.051 | 0.950 | 0.086 | 0.554 | 0.013 | 1.013 | 0.094 | 0.891 |
| Business owner/self empl., home based | -0.036 | 0.965 | 0.085 | 0.671 | 0.000 | 1.000 | 0.120 | 0.999 | -0.035 | 0.966 | 0.117 | 0.763 | -0.092 | 0.912 | 0.121 | 0.450 |
| Business owner/self empl., home as a base | 0.082 | 1.085 | 0.065 | 0.205 | 0.193 | 1.213 | 0.097 | 0.047 | -0.009 | 0.991 | 0.087 | 0.915 | 0.103 | 1.108 | 0.097 | 0.289 |
| Gender Women (Men Ref. ) | -0.171 | 0.843 | 0.049 | 0.000 |  |  |  |  |  |  |  |  | -0.157 | 0.855 | 0.079 | 0.046 |
| Age (Ref. 18-24) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-34 | -0.063 | 0.939 | 0.075 | 0.404 | -0.139 | 0.870 | 0.114 | 0.224 | 0.009 | 1.009 | 0.099 | 0.927 | -0.074 | 0.929 | 0.075 | 0.328 |
| 35-44 | -0.036 | 0.965 | 0.084 | 0.672 | -0.017 | 0.983 | 0.120 | 0.887 | -0.049 | 0.952 | 0.114 | 0.666 | -0.040 | 0.961 | 0.084 | 0.631 |
| 45-54 | -0.080 | 0.923 | 0.088 | 0.363 | -0.088 | 0.916 | 0.131 | 0.502 | -0.030 | 0.970 | 0.116 | 0.796 | -0.086 | 0.918 | 0.088 | 0.331 |
| 55-64 | -0.072 | 0.931 | 0.099 | 0.465 | -0.052 | 0.949 | 0.138 | 0.705 | -0.056 | 0.946 | 0.140 | 0.688 | -0.077 | 0.926 | 0.099 | 0.438 |
| Part-time (Ref. full-time > 35 hrs / week) | -0.050 | 0.951 | 0.059 | 0.398 | -0.102 | 0.903 | 0.113 | 0.369 | -0.027 | 0.973 | 0.070 | 0.703 | -0.040 | 0.961 | 0.059 | 0.495 |
| Education (Ref. No qualifications) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Degree | -0.016 | 0.984 | 0.167 | 0.925 | 0.099 | 1.104 | 0.195 | 0.611 | -0.101 | 0.904 | 0.306 | 0.741 | -0.008 | 0.992 | 0.167 | 0.959 |
| No Degree | 0.061 | 1.063 | 0.165 | 0.711 | 0.232 | 1.261 | 0.190 | 0.221 | -0.082 | 0.921 | 0.302 | 0.786 | 0.064 | 1.066 | 0.164 | 0.697 |
| Occupation (Ref. Managers/directors) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Professional | 0.079 | 1.082 | 0.077 | 0.305 | -0.064 | 0.938 | 0.101 | 0.525 | 0.164 | 1.178 | 0.114 | 0.151 | 0.067 | 1.069 | 0.077 | 0.382 |
| Associate professional and technical | 0.048 | 1.049 | 0.075 | 0.527 | 0.014 | 1.014 | 0.099 | 0.884 | 0.028 | 1.028 | 0.112 | 0.801 | 0.047 | 1.048 | 0.076 | 0.532 |
| Administrative and secretarial | 0.079 | 1.082 | 0.076 | 0.298 | 0.158 | 1.171 | 0.132 | 0.230 | 0.044 | 1.045 | 0.101 | 0.662 | 0.080 | 1.083 | 0.076 | 0.295 |
| Skilled trades | 0.102 | 1.107 | 0.101 | 0.313 | 0.125 | 1.133 | 0.115 | 0.277 | 0.129 | 1.138 | 0.186 | 0.488 | 0.108 | 1.114 | 0.101 | 0.284 |
| Caring, leisure, and other service | 0.112 | 1.119 | 0.098 | 0.257 | 0.301 | 1.351 | 0.169 | 0.075 | 0.026 | 1.026 | 0.127 | 0.840 | 0.108 | 1.114 | 0.099 | 0.273 |
| Sales and customer service | 0.012 | 1.012 | 0.104 | 0.905 | 0.335 | 1.398 | 0.186 | 0.072 | -0.092 | 0.912 | 0.130 | 0.479 | 0.010 | 1.010 | 0.104 | 0.923 |
| Process, plant, and machine operatives | 0.060 | 1.062 | 0.294 | 0.839 | 0.131 | 1.140 | 0.286 | 0.645 |  |  |  |  | 0.078 | 1.081 | 0.295 | 0.790 |
| Elementary | -0.243 | 0.784 | 0.115 | 0.035 | -0.049 | 0.952 | 0.158 | 0.758 | -0.439 | 0.645 | 0.168 | 0.009 | -0.244 | 0.783 | 0.116 | 0.035 |
| Other / non-classified | -0.032 | 0.969 | 0.158 | 0.838 | 0.046 | 1.047 | 0.182 | 0.798 | -0.240 | 0.787 | 0.293 | 0.413 | -0.064 | 0.938 | 0.159 | 0.687 |
| Children (Ref. No Children) | 0.062 | 1.064 | 0.057 | 0.273 | -0.105 | 0.900 | 0.083 | 0.207 | 0.148 | 1.160 | 0.077 | 0.055 | 0.061 | 1.063 | 0.057 | 0.283 |
| Single Household (Ref. Multiple household) | -0.064 | 0.938 | 0.080 | 0.420 | -0.059 | 0.943 | 0.111 | 0.598 | -0.043 | 0.958 | 0.109 | 0.690 | -0.069 | 0.933 | 0.080 | 0.388 |
| No Car Access (Ref. Access to a car) | -0.078 | 0.925 | 0.054 | 0.153 | -0.240 | 0.787 | 0.078 | 0.002 | 0.004 | 1.004 | 0.074 | 0.953 | -0.091 | 0.913 | 0.054 | 0.094 |
| Have a mobility issue (Ref. no mobility issue) | 0.091 | 1.095 | 0.112 | 0.419 | 0.442 | 1.556 | 0.193 | 0.022 | -0.050 | 0.951 | 0.139 | 0.721 | 0.092 | 1.096 | 0.113 | 0.415 |
| % Households detached or semi-detached | 0.015 | 1.015 | 0.030 | 0.613 | -0.058 | 0.944 | 0.043 | 0.176 | 0.066 | 1.068 | 0.041 | 0.107 | 0.020 | 1.020 | 0.030 | 0.502 |
| Distance to city centre | -0.026 | 0.974 | 0.029 | 0.365 | 0.017 | 1.017 | 0.041 | 0.678 | -0.056 | 0.946 | 0.041 | 0.173 | -0.030 | 0.970 | 0.029 | 0.300 |
| Leeds (Ref. Brighton & Hove) | 0.018 | 1.018 | 0.050 | 0.720 | 0.054 | 1.055 | 0.070 | 0.443 | -0.018 | 0.982 | 0.070 | 0.797 | 0.017 | 1.017 | 0.050 | 0.739 |
| Interaction Gender: Study Group |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Women: Empl., home based 1 - 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | -0.048 | 0.953 | 0.212 | 0.821 |
| Women: Empl., home based ≥ 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | -0.584 | 0.558 | 0.284 | 0.040 |
| Women: Bus. owner, premise based |  |  |  |  |  |  |  |  |  |  |  |  | 0.001 | 1.001 | 0.117 | 0.991 |
| Women: Bus. owner, home based |  |  |  |  |  |  |  |  |  |  |  |  | 0.107 | 1.113 | 0.160 | 0.506 |
| Women: Bus., home as a base |  |  |  |  |  |  |  |  |  |  |  |  | -0.036 | 0.965 | 0.124 | 0.774 |

Table 3. Estimates for daily trip duration (min) using a Gaussian generalized linear mixed effects model with a log-link function. Model A includes both men and women, B includes only men, C includes only Women, and D includes an interaction term between gender and worker-type group. Greyed relationships are significant at p < 0.05.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Base (Model A)** | | | | **Men-Only (Model B)** | | | | **Women-Only (Model C)** | | | | **Interaction-effect (Model D)** | | | |
|  | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** |
| (Intercept) | 3.953 | 52 | 0.198 | 0.000 | 3.611 | 37 | 0.243 | 0.000 | 4.183 | 66 | 0.345 | 0.000 | 3.968 | 53 | 0.202 | 0.000 |
| Study Group (Ref. employee, premise based) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Employee, home-based 1 - 50% of time | 0.032 | 1.033 | 0.110 | 0.771 | -0.006 | 0.994 | 0.170 | 0.973 | -0.056 | 0.946 | 0.141 | 0.693 | -0.051 | 0.950 | 0.174 | 0.770 |
| Employee, home-based ≥ 50% of time | 0.096 | 1.101 | 0.142 | 0.499 | 0.552 | 1.737 | 0.220 | 0.012 | -0.143 | 0.867 | 0.184 | 0.437 | 0.339 | 1.404 | 0.224 | 0.131 |
| Business owner/self empl., premise based | 0.102 | 1.107 | 0.068 | 0.135 | 0.172 | 1.188 | 0.103 | 0.097 | 0.047 | 1.048 | 0.089 | 0.601 | 0.079 | 1.082 | 0.098 | 0.422 |
| Business owner/self empl., home based | 0.124 | 1.132 | 0.088 | 0.160 | 0.010 | 1.010 | 0.126 | 0.938 | 0.201 | 1.223 | 0.120 | 0.094 | -0.040 | 0.961 | 0.126 | 0.750 |
| Business owner/self empl., home as a base | 0.104 | 1.110 | 0.068 | 0.126 | 0.187 | 1.206 | 0.102 | 0.067 | 0.000 | 1.000 | 0.089 | 0.997 | 0.116 | 1.123 | 0.101 | 0.254 |
| Gender Women (Men Ref. ) | -0.179 | 0.836 | 0.051 | 0.000 |  |  |  |  |  |  |  |  | -0.213 | 0.808 | 0.081 | 0.009 |
| Age (Ref. 18-24) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-34 | -0.028 | 0.972 | 0.078 | 0.722 | 0.002 | 1.002 | 0.120 | 0.984 | -0.008 | 0.992 | 0.102 | 0.934 | -0.033 | 0.968 | 0.078 | 0.676 |
| 35-44 | -0.002 | 0.998 | 0.087 | 0.977 | 0.093 | 1.097 | 0.127 | 0.463 | -0.071 | 0.931 | 0.117 | 0.548 | -0.008 | 0.992 | 0.087 | 0.928 |
| 45-54 | -0.146 | 0.864 | 0.092 | 0.112 | -0.120 | 0.887 | 0.138 | 0.384 | -0.124 | 0.883 | 0.119 | 0.296 | -0.149 | 0.862 | 0.091 | 0.103 |
| 55-64 | -0.052 | 0.949 | 0.103 | 0.611 | 0.061 | 1.063 | 0.146 | 0.677 | -0.104 | 0.901 | 0.143 | 0.466 | -0.060 | 0.942 | 0.103 | 0.555 |
| Part-time (Ref. full-time > 35 hrs / week) | -0.080 | 0.923 | 0.061 | 0.189 | -0.031 | 0.969 | 0.118 | 0.791 | -0.055 | 0.946 | 0.072 | 0.442 | -0.070 | 0.932 | 0.061 | 0.251 |
| Education (Ref. No qualifications) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Degree | -0.041 | 0.960 | 0.175 | 0.813 | 0.159 | 1.172 | 0.207 | 0.443 | -0.301 | 0.740 | 0.314 | 0.339 | -0.030 | 0.970 | 0.174 | 0.862 |
| No Degree | 0.060 | 1.062 | 0.172 | 0.730 | 0.322 | 1.380 | 0.201 | 0.109 | -0.243 | 0.784 | 0.310 | 0.433 | 0.070 | 1.073 | 0.172 | 0.685 |
| Occupation (Ref. Managers/directors) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Professional | 0.067 | 1.069 | 0.080 | 0.400 | -0.087 | 0.917 | 0.104 | 0.406 | 0.155 | 1.168 | 0.118 | 0.191 | 0.059 | 1.061 | 0.080 | 0.462 |
| Associate professional and technical | 0.112 | 1.119 | 0.079 | 0.156 | 0.059 | 1.061 | 0.104 | 0.570 | 0.093 | 1.097 | 0.115 | 0.421 | 0.113 | 1.120 | 0.079 | 0.152 |
| Administrative and secretarial | 0.089 | 1.093 | 0.079 | 0.260 | 0.208 | 1.231 | 0.139 | 0.135 | 0.029 | 1.029 | 0.104 | 0.779 | 0.098 | 1.103 | 0.079 | 0.215 |
| Skilled trades | 0.198 | 1.219 | 0.106 | 0.060 | 0.250 | 1.284 | 0.122 | 0.041 | 0.174 | 1.190 | 0.190 | 0.360 | 0.211 | 1.235 | 0.105 | 0.045 |
| Caring, leisure, and other service | 0.133 | 1.142 | 0.102 | 0.194 | 0.335 | 1.398 | 0.182 | 0.066 | 0.034 | 1.035 | 0.130 | 0.795 | 0.138 | 1.148 | 0.102 | 0.178 |
| Sales and customer service | 0.094 | 1.099 | 0.107 | 0.379 | 0.509 | 1.664 | 0.198 | 0.010 | -0.058 | 0.944 | 0.132 | 0.661 | 0.093 | 1.097 | 0.107 | 0.385 |
| Process, plant, and machine operatives | 0.049 | 1.050 | 0.308 | 0.873 | 0.128 | 1.137 | 0.301 | 0.670 |  |  |  |  | 0.069 | 1.071 | 0.308 | 0.822 |
| Elementary | -0.069 | 0.933 | 0.118 | 0.556 | 0.199 | 1.220 | 0.164 | 0.224 | -0.397 | 0.672 | 0.169 | 0.019 | -0.070 | 0.932 | 0.118 | 0.549 |
| Other / non-classified | 0.070 | 1.073 | 0.162 | 0.665 | 0.060 | 1.062 | 0.190 | 0.750 | 0.095 | 1.100 | 0.285 | 0.739 | 0.044 | 1.045 | 0.162 | 0.788 |
| Children (Ref. No Children) | 0.097 | 1.102 | 0.059 | 0.100 | 0.079 | 1.082 | 0.088 | 0.371 | 0.095 | 1.100 | 0.079 | 0.227 | 0.099 | 1.104 | 0.059 | 0.095 |
| Single Household (Ref. Multiple household) | -0.081 | 0.922 | 0.082 | 0.322 | -0.047 | 0.954 | 0.116 | 0.689 | -0.087 | 0.917 | 0.111 | 0.432 | -0.082 | 0.921 | 0.082 | 0.317 |
| No Car Access (Ref. Access to a car) | -0.094 | 0.910 | 0.056 | 0.095 | -0.254 | 0.776 | 0.082 | 0.002 | -0.055 | 0.946 | 0.075 | 0.464 | -0.107 | 0.899 | 0.056 | 0.057 |
| Have a mobility issue (Ref. no mobility issue) | -0.166 | 0.847 | 0.117 | 0.154 | 0.313 | 1.368 | 0.211 | 0.138 | -0.320 | 0.726 | 0.140 | 0.023 | -0.158 | 0.854 | 0.117 | 0.176 |
| % Households detached or semi-detached | -0.028 | 0.972 | 0.031 | 0.371 | -0.090 | 0.914 | 0.045 | 0.045 | 0.027 | 1.027 | 0.042 | 0.521 | -0.022 | 0.978 | 0.031 | 0.471 |
| Distance to city centre | 0.054 | 1.055 | 0.030 | 0.072 | 0.095 | 1.100 | 0.042 | 0.024 | 0.012 | 1.012 | 0.041 | 0.768 | 0.051 | 1.052 | 0.030 | 0.089 |
| Leeds (Ref. Brighton & Hove) | -0.002 | 0.998 | 0.052 | 0.968 | 0.063 | 1.065 | 0.073 | 0.394 | -0.070 | 0.932 | 0.071 | 0.327 | -0.001 | 0.999 | 0.052 | 0.988 |
| Interaction Gender: Study Group |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Women: Empl., home based 1 - 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | 0.138 | 1.148 | 0.220 | 0.530 |
| Women: Empl., home based ≥ 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | -0.399 | 0.671 | 0.287 | 0.164 |
| Women: Bus. owner, premise based |  |  |  |  |  |  |  |  |  |  |  |  | 0.038 | 1.039 | 0.122 | 0.755 |
| Women: Bus. owner, home based |  |  |  |  |  |  |  |  |  |  |  |  | 0.307 | 1.359 | 0.166 | 0.064 |
| Women: Bus., home as a base |  |  |  |  |  |  |  |  |  |  |  |  | -0.030 | 0.970 | 0.129 | 0.816 |

Table 4. Estimates for cumulative daily trip distance (m) using a Gaussian generalized linear mixed effects model with a log-link function. Model A includes both men and women, B includes only men, C includes only Women, and D includes an interaction term between gender and worker-type group. Greyed relationships are significant at p < 0.05.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Base (Model A)** | | | | **Men-Only (Model B)** | | | | **Women-Only (Model C)** | | | | **Interaction-effect (Model D)** | | | |
|  | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** |
| (Intercept) | 9.487 | 13187 | 0.314 | 0.000 | 8.783 | 6522 | 0.380 | 0.000 | 10.107 | 24514 | 0.548 | 0.000 | 9.430 | 12457 | 0.319 | 0.000 |
| Study Group (Ref. employee, premise based) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Employee, home-based 1 - 50% of time | 0.042 | 1.043 | 0.174 | 0.811 | -0.109 | 0.897 | 0.265 | 0.681 | -0.027 | 0.973 | 0.224 | 0.903 | -0.138 | 0.871 | 0.275 | 0.615 |
| Employee, home-based ≥ 50% of time | 0.187 | 1.206 | 0.225 | 0.407 | 0.738 | 2.092 | 0.345 | 0.032 | -0.203 | 0.816 | 0.291 | 0.486 | 0.485 | 1.624 | 0.355 | 0.172 |
| Business owner/self empl., premise based | 0.339 | 1.404 | 0.108 | 0.002 | 0.516 | 1.675 | 0.162 | 0.001 | 0.171 | 1.186 | 0.142 | 0.229 | 0.411 | 1.508 | 0.155 | 0.008 |
| Business owner/self empl., home based | 0.346 | 1.413 | 0.140 | 0.013 | 0.173 | 1.189 | 0.196 | 0.378 | 0.448 | 1.565 | 0.191 | 0.019 | 0.118 | 1.125 | 0.199 | 0.553 |
| Business owner/self empl., home as a base | 0.221 | 1.247 | 0.108 | 0.039 | 0.490 | 1.632 | 0.160 | 0.002 | -0.071 | 0.931 | 0.142 | 0.616 | 0.413 | 1.511 | 0.160 | 0.010 |
| Gender Women (Men Ref. ) | -0.160 | 0.852 | 0.080 | 0.046 |  |  |  |  |  |  |  |  | -0.115 | 0.891 | 0.128 | 0.370 |
| Age (Ref. 18-24) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-34 | -0.074 | 0.929 | 0.124 | 0.550 | 0.070 | 1.073 | 0.187 | 0.709 | -0.110 | 0.896 | 0.161 | 0.495 | -0.076 | 0.927 | 0.123 | 0.537 |
| 35-44 | -0.191 | 0.826 | 0.138 | 0.168 | 0.009 | 1.009 | 0.198 | 0.963 | -0.359 | 0.698 | 0.187 | 0.054 | -0.214 | 0.807 | 0.138 | 0.120 |
| 45-54 | -0.313 | 0.731 | 0.146 | 0.031 | -0.157 | 0.855 | 0.216 | 0.468 | -0.370 | 0.691 | 0.189 | 0.050 | -0.323 | 0.724 | 0.145 | 0.025 |
| 55-64 | -0.200 | 0.819 | 0.163 | 0.219 | 0.048 | 1.049 | 0.228 | 0.832 | -0.378 | 0.685 | 0.227 | 0.095 | -0.232 | 0.793 | 0.162 | 0.152 |
| Part-time (Ref. full-time > 35 hrs / week) | -0.253 | 0.776 | 0.097 | 0.009 | -0.239 | 0.787 | 0.185 | 0.197 | -0.202 | 0.817 | 0.115 | 0.078 | -0.242 | 0.785 | 0.096 | 0.012 |
| Education (Ref. No qualifications) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Degree | 0.032 | 1.033 | 0.278 | 0.909 | 0.216 | 1.241 | 0.324 | 0.504 | -0.215 | 0.807 | 0.500 | 0.667 | 0.064 | 1.066 | 0.276 | 0.817 |
| No Degree | 0.173 | 1.189 | 0.273 | 0.527 | 0.466 | 1.594 | 0.315 | 0.139 | -0.161 | 0.851 | 0.493 | 0.744 | 0.198 | 1.219 | 0.272 | 0.466 |
| Occupation (Ref. Managers/directors) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Professional | 0.112 | 1.119 | 0.127 | 0.377 | 0.068 | 1.070 | 0.163 | 0.678 | 0.060 | 1.062 | 0.188 | 0.752 | 0.106 | 1.112 | 0.126 | 0.401 |
| Associate professional and technical | 0.195 | 1.215 | 0.125 | 0.118 | 0.264 | 1.302 | 0.162 | 0.104 | 0.018 | 1.018 | 0.183 | 0.921 | 0.203 | 1.225 | 0.124 | 0.102 |
| Administrative and secretarial | 0.043 | 1.044 | 0.126 | 0.732 | 0.211 | 1.235 | 0.218 | 0.333 | -0.107 | 0.899 | 0.165 | 0.519 | 0.067 | 1.069 | 0.125 | 0.594 |
| Skilled trades | 0.247 | 1.280 | 0.167 | 0.141 | 0.283 | 1.327 | 0.191 | 0.138 | 0.359 | 1.432 | 0.302 | 0.235 | 0.278 | 1.320 | 0.167 | 0.096 |
| Caring, leisure, and other service | 0.114 | 1.121 | 0.162 | 0.483 | 0.445 | 1.560 | 0.285 | 0.119 | -0.096 | 0.908 | 0.207 | 0.641 | 0.122 | 1.130 | 0.162 | 0.450 |
| Sales and customer service | -0.041 | 0.960 | 0.170 | 0.809 | 0.757 | 2.132 | 0.309 | 0.014 | -0.399 | 0.671 | 0.210 | 0.057 | -0.050 | 0.951 | 0.169 | 0.768 |
| Process, plant, and machine operatives | 0.354 | 1.425 | 0.488 | 0.469 | 0.610 | 1.840 | 0.471 | 0.195 |  |  |  |  | 0.458 | 1.581 | 0.488 | 0.347 |
| Elementary | -0.092 | 0.912 | 0.186 | 0.621 | 0.468 | 1.597 | 0.256 | 0.068 | -0.689 | 0.502 | 0.268 | 0.010 | -0.067 | 0.935 | 0.186 | 0.717 |
| Other / non-classified | -0.026 | 0.974 | 0.256 | 0.918 | -0.150 | 0.861 | 0.297 | 0.613 | 0.466 | 1.594 | 0.453 | 0.304 | -0.045 | 0.956 | 0.256 | 0.861 |
| Children (Ref. No Children) | 0.060 | 1.062 | 0.094 | 0.519 | 0.141 | 1.151 | 0.138 | 0.307 | -0.023 | 0.977 | 0.125 | 0.851 | 0.055 | 1.057 | 0.093 | 0.557 |
| Single Household (Ref. Multiple household) | -0.225 | 0.799 | 0.130 | 0.084 | -0.097 | 0.908 | 0.182 | 0.592 | -0.326 | 0.722 | 0.176 | 0.063 | -0.228 | 0.796 | 0.130 | 0.079 |
| No Car Access (Ref. Access to a car) | -0.602 | 0.548 | 0.089 | 0.000 | -0.759 | 0.468 | 0.129 | 0.000 | -0.619 | 0.538 | 0.119 | 0.000 | -0.622 | 0.537 | 0.089 | 0.000 |
| Have a mobility issue (Ref. no mobility issue) | -0.405 | 0.667 | 0.185 | 0.028 | 0.325 | 1.384 | 0.330 | 0.324 | -0.652 | 0.521 | 0.223 | 0.003 | -0.386 | 0.680 | 0.184 | 0.036 |
| % Households detached or semi-detached | 0.011 | 1.011 | 0.049 | 0.822 | -0.078 | 0.925 | 0.070 | 0.265 | 0.120 | 1.127 | 0.066 | 0.071 | 0.020 | 1.020 | 0.049 | 0.675 |
| Distance to city centre | 0.242 | 1.274 | 0.047 | 0.000 | 0.279 | 1.322 | 0.066 | 0.000 | 0.184 | 1.202 | 0.066 | 0.005 | 0.240 | 1.271 | 0.047 | 0.000 |
| Leeds (Ref. Brighton & Hove) | 0.058 | 1.060 | 0.082 | 0.479 | 0.220 | 1.246 | 0.115 | 0.056 | -0.118 | 0.889 | 0.113 | 0.299 | 0.065 | 1.067 | 0.082 | 0.427 |
| Interaction Gender: Study Group |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Women: Empl., home based 1 - 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | 0.306 | 1.358 | 0.348 | 0.380 |
| Women: Empl., home based ≥ 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | -0.481 | 0.618 | 0.453 | 0.288 |
| Women: Bus. owner, premise based |  |  |  |  |  |  |  |  |  |  |  |  | -0.115 | 0.891 | 0.192 | 0.549 |
| Women: Bus. owner, home based |  |  |  |  |  |  |  |  |  |  |  |  | 0.464 | 1.590 | 0.262 | 0.077 |
| Women: Bus., home as a base |  |  |  |  |  |  |  |  |  |  |  |  | -0.340 | 0.712 | 0.204 | 0.096 |

Table 5. Estimates for daily maximum distance (m) from home using generalized linear mixed effects model with a log-link function. Model A includes both men and women, B includes only men, C includes only Women, and D includes an interaction term between gender and worker-type group. Greyed relationships are significant at p < 0.05.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Base (Model A)** | | | | **Men-Only (Model B)** | | | | **Women-Only (Model C)** | | | | **Interaction-effect (Model D)** | | | |
|  | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** | ***β*** | **exp(*β*)** | **SE** | ***p*** |
| (Intercept) | 9.373 | 11766 | 0.352 | 0.000 | 8.775 | 6470 | 0.458 | 0.000 | 9.614 | 14973 | 0.587 | 0.000 | 9.253 | 10436 | 0.358 | 0.000 |
| Study Group (Ref. employee, premise based) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Employee, home-based 1 - 50% of time | 0.146 | 1.157 | 0.195 | 0.453 | 0.154 | 1.166 | 0.320 | 0.629 | -0.013 | 0.987 | 0.240 | 0.955 | 0.280 | 1.323 | 0.309 | 0.364 |
| Employee, home-based ≥ 50% of time | 0.391 | 1.478 | 0.252 | 0.121 | 0.468 | 1.597 | 0.416 | 0.260 | 0.233 | 1.262 | 0.311 | 0.455 | 0.509 | 1.664 | 0.399 | 0.201 |
| Business owner/self empl., premise based | 0.162 | 1.176 | 0.121 | 0.180 | 0.197 | 1.218 | 0.195 | 0.313 | 0.061 | 1.063 | 0.152 | 0.686 | 0.296 | 1.344 | 0.174 | 0.088 |
| Business owner/self empl., home based | 0.399 | 1.490 | 0.156 | 0.011 | 0.358 | 1.430 | 0.237 | 0.130 | 0.403 | 1.496 | 0.204 | 0.048 | 0.434 | 1.543 | 0.223 | 0.052 |
| Business owner/self empl., home as a base | 0.165 | 1.179 | 0.120 | 0.171 | 0.466 | 1.594 | 0.192 | 0.015 | -0.173 | 0.841 | 0.152 | 0.255 | 0.527 | 1.694 | 0.180 | 0.003 |
| Gender Women (Men Ref. ) | -0.169 | 0.845 | 0.090 | 0.060 |  |  |  |  |  |  |  |  | 0.025 | 1.025 | 0.144 | 0.863 |
| Age (Ref. 18-24) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25-34 | -0.131 | 0.877 | 0.139 | 0.347 | 0.131 | 1.140 | 0.226 | 0.562 | -0.202 | 0.817 | 0.173 | 0.243 | -0.130 | 0.878 | 0.138 | 0.349 |
| 35-44 | -0.198 | 0.820 | 0.155 | 0.201 | 0.200 | 1.221 | 0.239 | 0.404 | -0.417 | 0.659 | 0.200 | 0.037 | -0.223 | 0.800 | 0.154 | 0.150 |
| 45-54 | -0.259 | 0.772 | 0.163 | 0.112 | 0.158 | 1.171 | 0.260 | 0.543 | -0.436 | 0.647 | 0.203 | 0.031 | -0.272 | 0.762 | 0.162 | 0.093 |
| 55-64 | -0.305 | 0.737 | 0.182 | 0.095 | 0.135 | 1.145 | 0.275 | 0.622 | -0.537 | 0.584 | 0.243 | 0.027 | -0.339 | 0.712 | 0.182 | 0.062 |
| Part-time (Ref. full-time > 35 hrs / week) | -0.115 | 0.891 | 0.108 | 0.290 | -0.384 | 0.681 | 0.223 | 0.085 | 0.031 | 1.031 | 0.123 | 0.800 | -0.115 | 0.891 | 0.108 | 0.290 |
| Education (Ref. No qualifications) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Degree | 0.091 | 1.095 | 0.311 | 0.770 | 0.100 | 1.105 | 0.391 | 0.798 | 0.230 | 1.259 | 0.535 | 0.668 | 0.107 | 1.113 | 0.310 | 0.730 |
| No Degree | 0.014 | 1.014 | 0.306 | 0.964 | 0.048 | 1.049 | 0.380 | 0.900 | 0.111 | 1.117 | 0.528 | 0.834 | 0.012 | 1.012 | 0.305 | 0.970 |
| Occupation (Ref. Managers/directors) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Professional | 0.191 | 1.210 | 0.142 | 0.179 | 0.306 | 1.358 | 0.197 | 0.120 | 0.045 | 1.046 | 0.201 | 0.822 | 0.194 | 1.214 | 0.142 | 0.172 |
| Associate professional and technical | 0.101 | 1.106 | 0.140 | 0.471 | 0.361 | 1.435 | 0.196 | 0.065 | -0.224 | 0.799 | 0.196 | 0.254 | 0.098 | 1.103 | 0.139 | 0.481 |
| Administrative and secretarial | 0.073 | 1.076 | 0.141 | 0.605 | 0.002 | 1.002 | 0.263 | 0.994 | -0.088 | 0.916 | 0.177 | 0.617 | 0.084 | 1.088 | 0.140 | 0.550 |
| Skilled trades | 0.088 | 1.092 | 0.188 | 0.639 | 0.093 | 1.097 | 0.230 | 0.687 | 0.094 | 1.099 | 0.324 | 0.773 | 0.099 | 1.104 | 0.187 | 0.596 |
| Caring, leisure, and other service | -0.090 | 0.914 | 0.182 | 0.619 | 0.179 | 1.196 | 0.344 | 0.603 | -0.413 | 0.662 | 0.221 | 0.062 | -0.110 | 0.896 | 0.182 | 0.545 |
| Sales and customer service | -0.119 | 0.888 | 0.190 | 0.531 | 0.488 | 1.629 | 0.373 | 0.191 | -0.490 | 0.613 | 0.225 | 0.029 | -0.138 | 0.871 | 0.189 | 0.466 |
| Process, plant, and machine operatives | -0.144 | 0.866 | 0.547 | 0.792 | 0.337 | 1.401 | 0.568 | 0.552 |  |  |  |  | -0.011 | 0.989 | 0.547 | 0.985 |
| Elementary | -0.381 | 0.683 | 0.209 | 0.068 | 0.391 | 1.478 | 0.309 | 0.206 | -0.955 | 0.385 | 0.287 | 0.001 | -0.350 | 0.705 | 0.209 | 0.093 |
| Other / non-classified | -0.478 | 0.620 | 0.287 | 0.096 | -0.446 | 0.640 | 0.358 | 0.213 | -0.104 | 0.901 | 0.485 | 0.830 | -0.462 | 0.630 | 0.287 | 0.107 |
| Children (Ref. No Children) | -0.124 | 0.883 | 0.105 | 0.238 | 0.082 | 1.085 | 0.166 | 0.620 | -0.330 | 0.719 | 0.134 | 0.014 | -0.136 | 0.873 | 0.105 | 0.195 |
| Single Household (Ref. Multiple household) | -0.131 | 0.877 | 0.146 | 0.367 | 0.003 | 1.003 | 0.219 | 0.991 | -0.268 | 0.765 | 0.188 | 0.154 | -0.149 | 0.862 | 0.145 | 0.306 |
| No Car Access (Ref. Access to a car) | -0.509 | 0.601 | 0.100 | 0.000 | -0.515 | 0.598 | 0.155 | 0.001 | -0.562 | 0.570 | 0.128 | 0.000 | -0.517 | 0.596 | 0.100 | 0.000 |
| Have a mobility issue (Ref. no mobility issue) | -0.425 | 0.654 | 0.207 | 0.040 | 0.282 | 1.326 | 0.398 | 0.479 | -0.749 | 0.473 | 0.238 | 0.002 | -0.426 | 0.653 | 0.207 | 0.039 |
| % Households detached or semi-detached | 0.005 | 1.005 | 0.055 | 0.927 | 0.016 | 1.016 | 0.085 | 0.854 | 0.035 | 1.036 | 0.071 | 0.623 | 0.012 | 1.012 | 0.055 | 0.824 |
| Distance to city centre | 0.330 | 1.391 | 0.053 | 0.000 | 0.295 | 1.343 | 0.079 | 0.000 | 0.319 | 1.376 | 0.070 | 0.000 | 0.329 | 1.390 | 0.053 | 0.000 |
| Leeds (Ref. Brighton & Hove) | -0.077 | 0.926 | 0.092 | 0.405 | -0.153 | 0.858 | 0.139 | 0.269 | -0.074 | 0.929 | 0.121 | 0.543 | -0.073 | 0.930 | 0.092 | 0.426 |
| Interaction Gender: Study Group |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Women: Empl., home based 1 - 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | -0.207 | 0.813 | 0.390 | 0.597 |
| Women: Empl., home based ≥ 50% of time |  |  |  |  |  |  |  |  |  |  |  |  | -0.189 | 0.828 | 0.508 | 0.711 |
| Women: Bus. owner, premise based |  |  |  |  |  |  |  |  |  |  |  |  | -0.190 | 0.827 | 0.216 | 0.379 |
| Women: Bus. owner, home based |  |  |  |  |  |  |  |  |  |  |  |  | -0.005 | 0.995 | 0.294 | 0.987 |
| Women: Bus., home as a base |  |  |  |  |  |  |  |  |  |  |  |  | -0.626 | 0.535 | 0.229 | 0.006 |

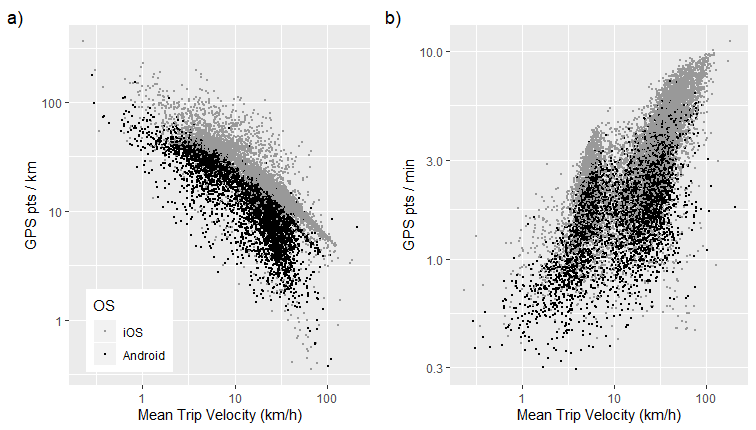


Figure 1: Relationship between mean trip velocity and a) location data acquisition rate over distance, and b) location data acquisition rate over time, for Android and Apple iOS devices.

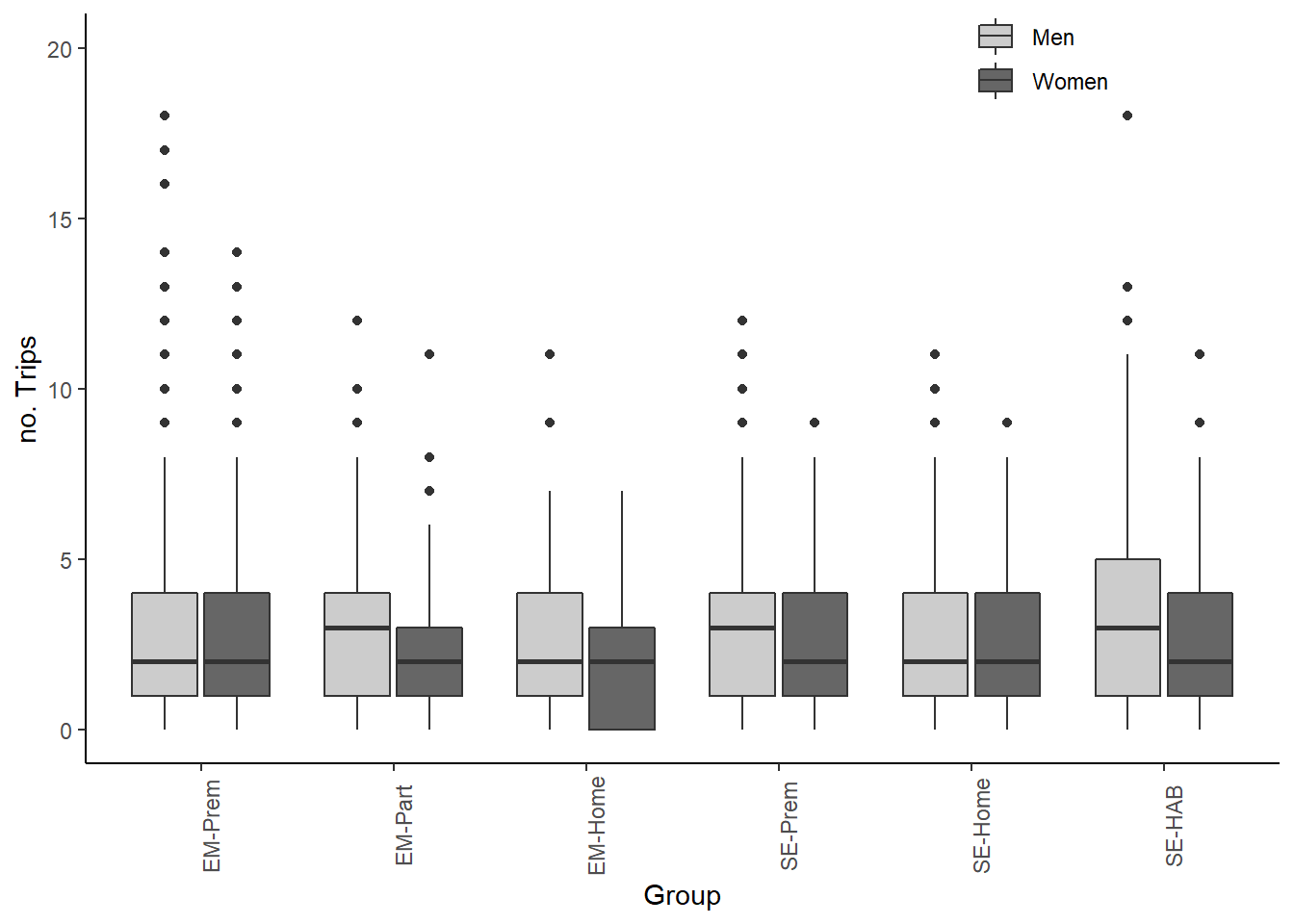


Figure 2: Daily number of trips across the six worker type groups, further separated by gender. *Note: EM-Prem = Employee, premise-based; EM-Part = employee works from home < 50% of the time; EM-Home = employee, works from home ≥ 50% of the time; SE-Prem = small business owner/self-employed, premise-based; SE-Home = small business owners/self-employed, home-based; and SE-HAB = small business owner/self-employed uses home as a base.*

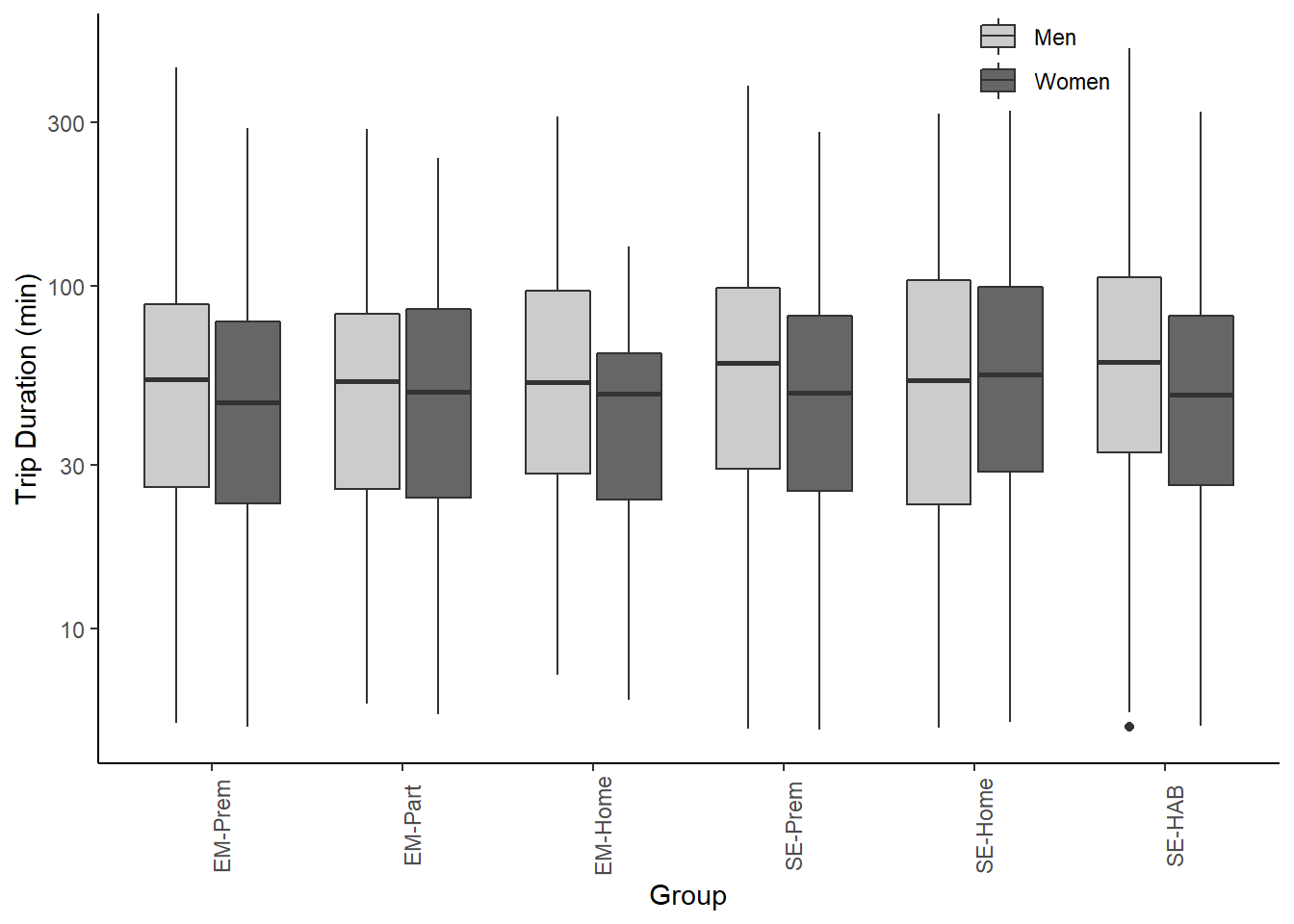


Figure 3: Daily cumulative trip duration across the six worker-type groups we surveyed, further separated by gender. *Note: EM-Prem = Employee, premise-based; EM-Part = employee works from home < 50% of the time;EM-Home = employee, works from home ≥ 50% of the time; SE-Prem = small business owner/self-employed, premise-based; SE-Home = small business owners/self-employed, home-based; and SE-HAB = small business owner/self-employed uses home as a base.*

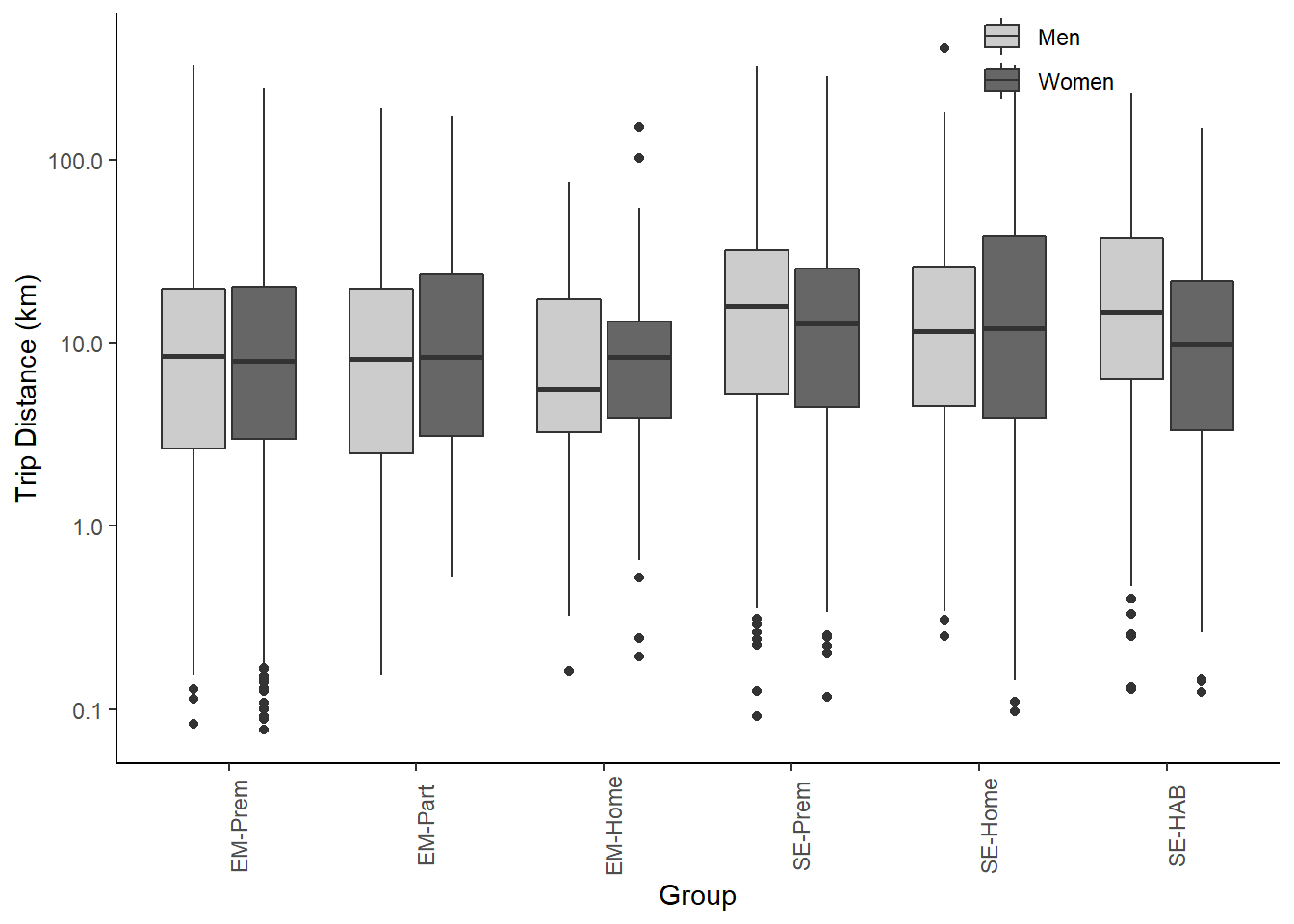


Figure 4. Daily cumulative trip distance across the six worker-type groups we surveyed, further separated by gender. *Note: EM-Prem = Employee, premise-based; EM-Part = employee works from home < 50% of the time; EM-Home = employee, works from home ≥ 50% of the time; SE-Prem = small business owner/self-employed, premise-based; SE-Home = small business owners/self-employed, home-based; and SE-HAB = small business owner/self-employed uses home as a base.*

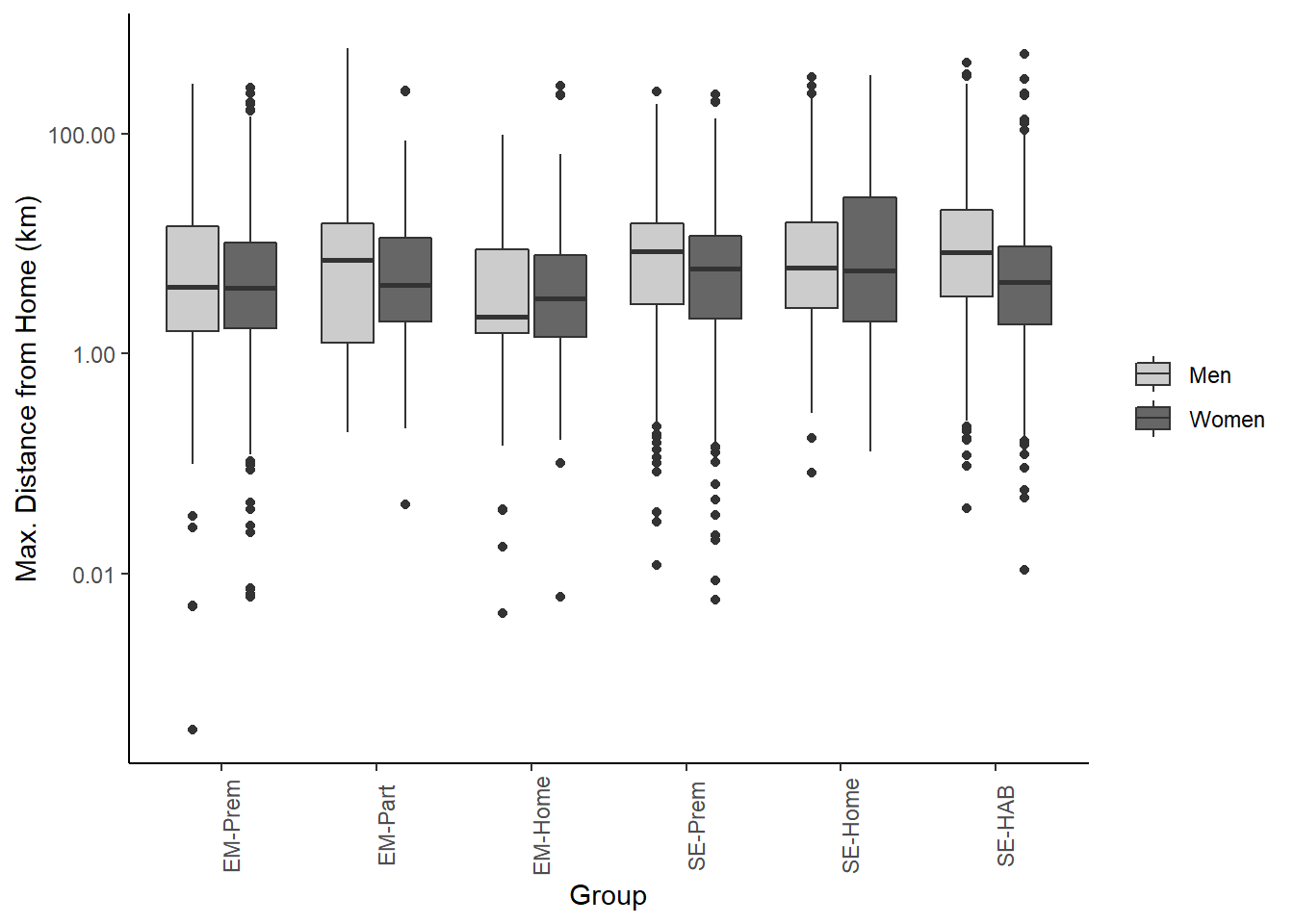


Figure 5. Daily maximum distance (Euclidean) from the home across the six worker-type groups, further separated by gender. *Note: EM-Prem = Employee, premise-based; EM-Part = employee works from home < 50% of the time; EM-Home = employee, works from home ≥ 50% of the time; SE-Prem = small business owner/self-employed, premise-based; SE-Home = small business owners/self-employed, home-based; and SE-HAB = small business owner/self-employed uses home as a base.*

1. All data were compiled by the authors from NOMIS official labour market statistics (nomisweb.co.uk) [↑](#endnote-ref-1)
2. The average working time of part-time workers in the UK was 16.2 hours per week in December 2017 (data based on the UK Labour Force Survey). [↑](#endnote-ref-2)