Walking through a Pandemic: How did Utilitarian Walking change during COVID-19?

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**In loving memory of Dr. Guillem Vich (1982-2022), a valued colleague and trusted friend.

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Abstract

Walking for transportation has well-known environmental, social, and health-related benefits. However, its daily use may have been especially altered by restrictions to population activities and mobility during the post-lock-down phase of the recent COVID-19 pandemic. In this study we aimed to explore how daily walking for transportation during a period of partial restrictions on mobility, and to evaluate whether its traditional individual and area-level determinants were modified during that period. We used an official travel survey in Southern Catalonia, which was deployed in two phases: right before (n = 9,065) and after the lock-down phase of the pandemic (n = 3,944). We observed not only that utilitarian walking frequency and time spent on daily walking trips had significantly decreased, but also did walking mode share. The positive association between age and walking not only remained unaltered during the study period but became stronger for those between 56 and 70 years old. During the pandemic, household income and area-level income inequality were no longer predictors of utilitarian walking. Policymakers will need to consider the possible mid and long-term behavioral changes derived from habits adopted during the different phases of the COVID-19 pandemic, especially considering that restrictions on activities and mobility had a specific impact on sustainable and healthy forms of everyday mobility, and for specific groups of population.

Keywords: SARS-CoV-2, Travel behavior, Sustainable mobility, Active transportation, Built environment

1. Introduction

The COVID-19 pandemic in 2020 represented an indisputable disruption of human activities in general, and of mobility patterns in particular. Restrictions aimed at limiting the spread of a novel coronavirus (SARS-CoV-2) caused population movement levels to drop drastically, first resulting from domiciliary lockdowns or stay-at-home orders, and later on derived from partial restrictions on mobility, limitations on indoor activities and services, and the promotion of remote working or studying (Askitas et al., 2021; Google, 2021; Hale et al., 2020; Huang et al., 2020), which remained for a longer period of time. Along this line, the COVID-19 pandemic is likely to have also impacted the characteristics and patterns of individual day-to-day travel behavior, with a particular focus on changes to how transportation modes were used daily, either derived from different mobility needs during the pandemic (e.g., travelling farther may have been less possible or necessary), or resulting from personal choices based on the perceived risk of contagion when travelling.

Despite the fact the COVID-19 pandemic decreased all forms of mobility, the restrictions imposed after the initial lock-down, together with the fear of infection, are likely to have affected the use of certain transportation modes more than others. A clear example was the use of public transportation, which dropped significantly more than other modes during the pandemic (Anke et al., 2021; Shamshiripour et al., 2020). This notwithstanding, the pandemic was seen by some as a turning point in how active modes of transportation (i.e., walking and cycling) were going to perceived and used, considering that these tend to be used for shorter distances and individually, and that they mostly take place outdoors (Brooks et al., 2021; De Vos, 2020). Similarly, others suggested that the pandemic may have resulted in a change in our relationship with open public spaces (Honey-Rosés et al., 2020).

Thus, a critical issue that appears to emerge in the post-pandemic era will be to understand what extent the behavioral changes adopted in the context of COVID-19 restrictions and disrupted everyday life will remain in the mid and the long term (van Wee & Witlox, 2021). This is a particular point in case for walking for transportation, considering its many individual and social benefits, and the subsequent need to identify challenges or opportunities in promoting it. Along this line, we hypothesize that the restrictions imposed on population activities and mobility in urban areas likely had a particular effect on active forms of transportation, and especially in utilitarian walking. Moreover, given that walking for transportation largely varies from one individual to another, it is of particular interest to explore whether the combination of mobility restrictions and fear of contagion during the pandemic modified not only walking levels, but also its traditional determinants. This is crucial information that may help inform national, regional, and local policies and actions aiming at not only returning walking activity to pre-pandemic levels, but especially aiming to increasing it in the long run as a means of transportation in cities worldwide. Consequently, in this study we aim to provide evidence that could help answering two key questions: (a) How was walking for transportation modified during the time of COVID-19 restrictions? (b) Were the traditional determinants of walking for transportation altered at that time?

2. Background

2.1. Walking for Transportation and its Determinants

Active modes of transportation have been gaining traction for at least two decades, both from the transportation and urban policy perspective (Lyons, 2020), and in terms of public health (Lee & Buchner, 2008). Regarding the former, active transportation modes are clearly the most efficient means in terms of energy consumption and are almost emission-free (Duffy & Crawford, 2013).

Additionally, walking in particular can be regarded as the most democratic mode of transportation, considering it provides almost universal accessibility since nearly everyone can be a pedestrian regardless of their individual physical and social characteristics (Curtis & Scheurer, 2010; Hanson, 2010). In terms of public health, promoting urban environments that are conducive for walking and cycling activity not only can help reducing road fatalities (Chen & Zhou, 2016; Pucher & Dijkstra, 2003), but also can help people to achieve recommended physical activity levels (Delclòs-Alió et al., 2021; Spinney et al., 2012).

Owing to the relevance of active mobility socially, environmentally and in terms of public health, the levels and determinants of walking for transportation in particular have gained attention equally among researchers and urban practitioners (Loukaitou-Sideris, 2020). Walking for transportation refers specifically to pedestrian movement that is conducted as a means to travel from an origin to a destination in the context of everyday life (also known as utilitarian walking) and is different from walking that is an ends per se (i.e., recreational walking). Studies focusing on walking as a means of transportation generally use a set of measures that allow to capture its different dimensions: frequency, distance or time, and its proportion relative to all trips conducted daily. Walking trip frequency (e.g., number of trips per person) has been one of the most common approaches to measure overall walking levels (Moniruzzaman et al., 2015; Targa & Clifton, 2005). However, other measures of absolute walking levels could include distance travelled, step counts, or temporal measures of walking such as daily or weekly walking time (Besser & Dannenberg, 2005; Marquet & Miralles-Guasch, 2017; Zapata-Diomedi et al., 2019), which are generally used in health-related studies considering that the World Health Organization physical activity guidelines refer to recommendations based on weekly or daily minutes (WHO, 2010). On the other hand, a different measure refers to the proportion of all daily trips that are made walking (e.g., walking share), which is generally used to capture the relative importance of walking in the context of everyday mobility (Habibian & Hosseinzadeh, 2018; Weinberger & Sweet, 2012). This is not a minor distinction, since an individual could have low mobility levels (and thus low walking levels), but could conduct all trips on foot, which would account for a large walking share.

There are many factors that can explain different levels and patterns of walking for transportation, but these can generally be framed under a socio-ecological model (Götschi et al., 2017; Sallis et al., 2006; Stokols, 1992). This framework includes aspects that range from the individual to the social and environmental dimensions (Sulikova & Brand, 2021). Individually, walking for transportation is largely shaped by needs and possibilities that derive from demographic and socioeconomic characteristics. For instance, walking for transportation tends to be more frequent among children and seniors (Buehler et al., 2011; Buehler & Pucher, 2017), women (Herrmann-Lunecke et al., 2020; Maciejewska, Marquet, et al., 2019; Maciejewska & Miralles-Guasch, 2019), low-income individuals (Agrawal & Schimek, 2007; Murakami & Young, 1997), and those without access to a car (Michelson & Lachapelle, 2016). In turn, walking for transportation is usually more common in more deprived neighborhoods (Hilland et al., 2020; Marquet & Miralles-Guasch, 2015).

The built environment around us also plays a determinant role in allowing or deterring day-to-day walking levels. Travel demand, as well as walking for transportation in particular, has been generally associated with variables of the built environment framed under three main dimensions or 3Ds (Cervero & Kockelman, 1997), which are Density, Diversity and Design. Generally, denser, and more compactly developed areas are associated with more walking activity due to the concentration of people and activities at shorter distances (Cervero & Kockelman, 1997; Rodríguez et al., 2009; Wang et al., 2016). Similarly, diverse environments (i.e., areas that combine residential, commercial, industrial uses) are also capable of fostering higher levels of walking activity (Frank et al., 2006; Saelens et al., 2003). In addition, urban form can also play a role in determining walking activity. For example, urban developments that consist of more circuitous street networks and have fewer intersections (and thus larger blocks) are generally more easily navigated by cars and can significantly hinder pedestrian activity (Hirsch et al., 2014; Sarkar et al., 2015; Sung & Lee, 2015). Accordingly, indices created to evaluate the conduciveness of the built environment towards promoting walking activity (i.e., walkability*)*, have been traditionally based on a combination of the abovementioned indicators (Frank et al., 2010).

2.2.Walking for Transportation during a Pandemic

The overall impact of COVID-19 on daily mobility has already been widely evidenced. People's everyday trips drastically declined during the early stages of the pandemic resulting from the most restrictive policies aimed at reducing the spread of the virus, to slowly recover towards the end of 2020 (Kim & Kwan, 2021; Molloy et al., 2021). However, depending on the country and even the region, the changes in mobility levels may have presented different patterns derived from differences in the incidence of the virus and government restrictions imposed on activities and population mobility. For example, based on mobile phone data from Google Mobility Reports, during March-April 2020th mobility in Spain dropped to a minimum of 10-20% of what it would be under normal circumstances, to recover to almost pre-pandemic levels during the summer months, and to decrease again in the fall coinciding with the beginning of the second wave situating mobility at 70% of the baseline levels (Google, 2021). Additionally, some studies have pointed out that the impact of the pandemic on day-to-day trips was not homogeneous across transportation modes. The main example of the latter was the clear drop observed in the use of public transportation due to the increase in the perceived risk of contracting the virus in enclosed spaces

(Anke et al., 2021; Barbieri et al., 2020; Beck & Hensher, 2020; Shamshiripour et al., 2020). In this line, a study based on an international online survey among 585 participants found that public transport users were 31.5 times more likely to change their commuting mode than car uses, 10.6 times more than motorcycle users, and 6.9 times more than walkers (Dingil & Esztergár-Kiss, 2021). Similarly, a study focused on Germany found that most car users who continued to travel during the early stage of the pandemic maintained or even increased their car use, basically derived from the higher perception of safety while travelling (Eisenmann et al., 2021).

In this context, studies exploring how COVID-19 and the restrictions on activities and mobility impacted active forms of transportation are still limited but growing and has so far produced mixed results. First of all, there is a general agreement that utilitarian walking levels decreased during the pandemic, as seen in all other transportation modes derived from the overall reduction in overall mobility. For example, a large-scale study based on mobile phone data showed how both the number of utilitarian walking bouts and the daily distance walked for transport per person sharply decreased in the first half of 2020 (Hunter et al., 2021). Similarly, a study based on Apple data showed how walking trips declined during the pandemic, although the decrease was lower than that observed in public transport while larger than that of driving (Wen et al., 2021). Other studies based on objective measures of walking such as GPS tracks, pedometers and pedestrian counts also observed reductions of walking for transportation activity during this period, especially in urban areas (Hino & Asami, 2021; Molloy et al., 2021; Zhang & Fricker, 2021). Studies based on surveys also showed that walking for transportation in the early stages of the pandemic became less frequent than under normal circumstances (Shakibaei et al., 2021; Tarasi et al., 2021).

However, other studies showed evidence that would nuance the previous results: a survey among more than 4,000 German citizens showed that while 60% of respondents declared no changes in the frequency in which they walked for transportation since the outbreak of the virus, and even 10% decreased their use, while another 30% of survey respondents reported a slight or significant increase in its use (Anke et al., 2021). Along this line, another study also in Germany stated that walking for transportation showed significant higher levels in periods of COVID-19 restrictions compared to pre-COVID-19-times among participants in a survey (Schmidt et al., 2021). On the other hand, one study in Italy found inconclusive results regarding the impact of the pandemic on walking levels: the proportion of individuals who reported higher walking frequency after the lockdown (40.6%) was similar and even lower than those who reported lower walking frequency after the outbreak of COVID-19 (42.7%) (Campisi et al., 2020).

Beyond absolute measures of walking for transportation activity, some studies found that walking share (i.e., the proportion of all trips that are made walking) increased during the pandemic (Abdullah et al., 2020; Anke et al., 2021; Dingil & Esztergár-Kiss, 2021; Scorrano & Danielis, 2021). This is in agreement with studies focusing on individuals attitudes and perceptions regarding mobility, which suggest that the perception of active modes of transportation and walking in particular improved during the pandemic, considering it was generally seen as a low risk means of contracting the virus (Habib & Anik, 2021; Shamshiripour et al., 2020). Consequently, several studies point out that many individuals would expect to increase their walking frequency in the post-pandemic scenario and the 'new normality' (Schmidt et al., 2021; Zafri et al., 2021). However, increases in relative shares of walking could be simply the result of the decrease in other modes, especially public transportation. Conversely, there are also some studies that point to the opposite direction, showing that walking share decreased during the pandemic (Aloi et al., 2020; van der Drift et al., 2021).

2.3. Research Gaps and Contribution

By considering the characteristics of the abovementioned studies, certain gaps emerge that require additional research. First and foremost, most of the available analyses focused on the impact of the pandemic on walking are focused on the very early phases of the COVID-19 pandemic (mainly on the first half of 2020). This was a very particular stage of the pandemic, characterized by higher levels of restrictions on activities and population movement. While such studies are very informative, more research is needed that explores what walking looked like in later phases of the pandemic, especially as mobility levels started to recover while maintaining some level of restrictions on mobility. Second, most of the studies here briefly reviewed used either quantitative data from large scale datasets that lacked contextual information (e.g., sociodemographic or regarding the built environment), or convenience samples based on online surveys. Lastly, there is still a need for a better understanding of how the pandemic may have changed not only individuals' preferences, attitudes, and actual mobility patterns, but also comprehend if the pandemic has changed the base determinants of travel behavior and of walking for transportation. Few studies have shown that the association between traditional determinants of walking such as income or gender significantly changed during the pandemic (Campisi et al., 2020; Hunter et al., 2021), while another study found that built environment characteristics continued to be highly determinant of walking during this period (Shaer et al., 2021).

Thus, with our study we aim to contribute filling these research gaps by analyzing how walking for transportation was modified during the period of partial COVID-19 restrictions. We focus on Camp de Tarragona, a region in Southern Catalonia, Spain. We used an official travel survey that was conducted in 2020 in two phases: in January-March 2020 and then in November 2020. This research design allowed us to capture the effect of the pandemic in a very particular moment in the evolution of the pandemic, when everyday life had partially resumed after a summer of almost no restrictions on population movement and coinciding with the start of the second wave of SARS-CoV-2 spread in Spain. We focused on three different aspects of individual walking patterns: whether individuals walked or not on a regular day, the proportion of all daily trips that were made walking, and the amount of time spent daily on walking for transportation.

3. Data and methods

3.1 Study Area

This study is set in Camp de Tarragona, a region in Southern Catalonia, on the Northern Mediterranean coastline of the Iberian Peninsula (**Figure 1**). Camp de Tarragona consists of 132 municipalities that in 2020 had a combined population of approximately 620,000. This region is structured around a central urban core (**Figure 1.b**), composed of two neighboring cities with over 100.000 inhabitants each, Reus (106,168) and Tarragona (136,496), and a third conurbation along the coastline composed of the municipalities of Cambrils, Salou and Vila-seca/La Pineda, which have a combined year-round population of approximately 85,000. The economic activity of the region is mostly based on the petrochemical sector (and related secondary activities), located in two main industrial sites, and tourism, which mainly takes place during the summer in the abovementioned coastal municipalities.

While the coastline is rather urbanized, outside of the urban core, Camp de Tarragona mostly consists of small towns and villages surrounded by agrarian land or forest. To illustrate this, it is useful to consider that the six municipalities that constitute the main urban core are home to over 50% of the population of the region and have an average population density of over 21,000 inh./sq.km (**Figure 1.c**). The main transport infrastructures (airport, port, highways, and railways) are also located near the main urban core. The provision of public transportation services in Camp de Tarragona consists of urban bus lines run by municipal operators within the main urban areas, interurban bus lines offered by private companies operating on public concessions, and public regional train services that are mostly used to travel farther. Together, the use of these transit options accounts for approximately 6% of all daily trips in the region (Autoritat Territorial de Mobilitat del Camp de Tarragona, 2021). Conversely, most trips are either conducted by private vehicles or on foot, given that while urban centers are compact and walkable, trips between municipalities tend to be conducted by car.

[Figure 1 near here].

3.2. Data

To analyze walking for transportation patterns in Camp de Tarragona we used the latest official travel survey in the region, called *Enquesta de Mobilitat Quotidiana del Camp de Tarragona* or EMQ (Camp de Tarragona Daily Mobility Survey). The EMQ is an official travel survey organized by the *Autoritat Territorial de la Mobilitat del Camp de Tarragona* (Territorial Mobility Authority of Camp de Tarragona). The EMQ aims to provide a detailed account of daily mobility patterns of Camp de Tarragona ultimately to inform regional mobility strategies and policies. To do so, the EMQ is based on Computer-Assisted Telephone Interviews (CATI) to a random sample of residents in the region.

The core of the survey consists of a recollection of all trips conducted by survey respondents in the day prior to the telephone interview. For each trip reported, survey respondents provide details about the motivation of the trip, the transportation mode use, the trip's origin and destination, and its overall duration, among other details. The survey also includes a set of questions regarding survey respondents' perceptions and opinions about different mobility-related topics, which were not used in this study. The questionnaire also includes a section with sociodemographic questions about survey respondents (e.g., age, gender, education level, professional status, driver's licenses) and their household (e.g., number and characteristics of other household members, household income, number of available vehicles at the household).

The fieldwork of the 2020 EMQ survey was planned to be conducted from February to April 2020. However, when the COVID-19 pandemic hit Spain and national lockdown was officially announced on March 14th, 2020, the national government issued a stay-at-home order that lasted until May 2nd, 2020. Consequently, on March 13th, 2020, the EMQ fieldwork was put on hold temporarily. After the summer, the ATM planned to resume the EMQ fieldwork and decided to conduct a second wave of the survey in November 2020. Consequently, the 2020 EMQ has the particularity that it includes mobility data both from right before the pandemic and during the pandemic, which allows to measure how everyday mobility in Camp de Tarragona changed during COVID-19. As a result, the 2020 EMQ consists of a total sample of 13,229 surveyed individuals, 9,228 of which correspond to the first wave of the survey (between February and March 2020, "pre-COVID-19" from here onwards) and 4,001 were surveyed during the second wave (November 2020, "during COVID-19" from here onwards). Both samples are representative of the overall population of Camp de Tarragona, an estimated error of 1,01% and 1,54% respectively considering a confidence interval of 95%.

At the time of the survey, there were still some remaining measures in place in Catalonia to limit population activities and movement to decrease SARS-CoV-2 transmission. These measures included the closing of Catalonia's regional borders (except for justified reasons), the closure of indoor venues such as theaters, cinemas, or gyms, as well as bars and restaurants (but with take-out options allowed), the prohibition of group gatherings above six people, the suspension of in-person theory lectures at universities, and limitations to occupancy in places of worship and retail establishments (limited to 30% of occupancy in establishments that had a floor area under 800 square meters), and museums (33% of occupancy). Remote working was recommended but not compulsory. According to Google COVID-19 Community Mobility Reports (Google, 2021), while the most significant drop in mobility levels in Catalonia had occurred in Spring 2020 during the stay-at-home orders, during the summer mobility had almost recovered to pre-pandemic levels. However, with the beginning of the second wave of the pandemic and the abovementioned measures and restrictions issued by the government, mobility levels in November 2020 were between 20-30% lower than at the baseline period, February 2020 (see **Figure 2**).

[Figure 2 near here].

3.3. Variables

To analyze weekday walking for transportation in Camp de Tarragona and how it was impacted by the COVID-19 pandemic, we focused on three main outcomes:

(a) The proportion of surveyed individuals that conducted at least one walking trip for transportation on a weekday (% of individuals who walked).

(b) The modal share of walking for transportation on weekdays (i.e., the proportion of all trips by an individual on a weekday that were made walking) (% of trips that were walking).

(c) The total time spent daily on walking trips on a weekday (daily walking minutes).

As independent variables in the analysis we included a set of both individual and neighborhood characteristics, following previous evidence on what factors can be related to walking for transportation as described in the literature review section. At the individual level, we included participants' gender, age, educational attainment, their monthly household income, whether they held a driver's license and the number of vehicles available at the household. To include both socioeconomic and built environment characteristics of respondents' residential neighborhood, we used residential census tracts as spatial units, which is the most common spatial unit for socioeconomic data in Spain. We included population density (population in thousands per square km), the Gini index of income, built-up patch density as a measure of urban fragmentation (built-up patches per square km), proportion of land area that is developed (% of built-up area in the census tract), intersection density (intersections per square km) and land use mix. Land use mix was adapted from its traditional definition (Frank et al., 2010), and in this case we used data from the Spanish Municipal Cadaster that provides data on uses at the building level, which we classified into 6 groups (residential, commercial, work-related, recreational and others). For each census tract, we calculated land use mix as described in **Equation (1)**, consistent with previous research (Christian et al., 2011):

$$LUM = -1 \left(\frac{\sum_{i=1}^{n} p_i \cdot \ln(p_i)}{\ln(n)}\right) \quad (1)$$

where;

- *p* refers to the proportion of use *i* in the census tract,
- and *n* is the total number of uses.

3.4. Analysis

In the analysis phase we only included survey respondents that presented complete data for both the outcomes and all the independent variables described earlier. We analyzed data from a total of 13,009 EMQ 2020 survey respondents: 9,065 individuals interviewed in the first wave of the survey (pre-COVID-19) and 3,944 individuals surveyed during the second wave of the fieldwork (during COVID-19). Their characteristics are presented in **Table 1.** From a descriptive point of view, we could not identify significant changes in the characteristics of the sample between the first and the second wave of the survey.

First, we examined the effect of the pandemic on daily walking for transportation in the study area by estimating a general model for each of the three outcomes and including an indicator for the wave of the survey. Then, we ran separate regressions for the first and the second wave of the survey, to identify any relevant changes in the associations observed in the global model. Thus, each of the outcomes (1. the probability of having conducted at least one walking trip on a weekday; 2. proportion of all daily trips that were conducted on foot; 3. total time spent walking for transportation on a weekday) will have three different regressions (A. total sample; B. Before the COVID-19; C. During COVID-19). Confidence intervals will signal whether the coefficients of the sub-samples *B. Before the COVID-19*, and *C. During the COVID-19* are significantly different from those of total sample (A). If the coefficients of the sub-samples fall outside the limits of their respective confidence interval, it implies that they are statistical different from the total sample.

Each outcome required a different model, due to their different statistical distributions. For the first outcome we modeled the probability of having conducted at least one walking trip on a weekday. Given that the original variable had only two potential outcomes (0: no walking trips; 1: at least one walking trip), we estimated a logistic regression, which suits to the characteristics of the dependent variable. In this sense, as stated by Hoetker (2007), the logit model is appropriate whenever modeling which of two alternatives occurs, and hence, it adapts to the non-linear nature of the distribution of the probability of walking or not walking. This probability, which is estimated in the model, is indeed not observed, as data only contain information on whether the individual walked or did not walk. The second outcome referred to the proportion of all daily trips that were conducted on foot. Considering that this variable was naturally bounded between 0 and 1, and that most values accumulate on the extremes, we used a generalized linear model with a logistic distribution function and a negative binomial link. This method is technically supported by Baum (2008) and Papke and Wooldridge (1996), who provide theoretical evidence for the unbiasedness of the estimator but considering efficiency issues when treating the limits. The third and last outcome referred to the total time spent walking for transportation on a weekday. This variable was also naturally bounded by the lower extreme, 0, but could take any integer positive value, inside non-defined physical limitations, and showed an accumulation of observations in the lower extreme. In this case, we applied a Tobit model which, according to Papke and Wooldridge (1996), should provide a more efficient approach when treating the lower limit, as also described by Liu *et al.* (2015) in an empirical study.

The explanatory variables were treated in the same manner in all three models: dichotomous and categorical variables were introduced in the model as dummy variables. All continuous variables were converted to their logarithm to avoid non-linearity issues, except for the number of vehicles in the household, in which the range of potential values is not large enough to apply this methodology efficiently.

Statistical analyses were performed using STATA 16 (StataCorp, 2016, College Station, Texas).

The framework for the study design and analysis is represented graphically in **Figure 3**.

[Figure 3 near here].

4. Results

4.1. Walking for Transportation during COVID-19

Under normal circumstances, 37% of residents in Camp de Tarragona conducted at least one walking trip for transportation on a weekday, as evidenced by the results from the first wave of the EMQ, pre-COVID-19 (**Table 1**). Before the pandemic, individuals conducted on average 29% of their weekday trips on foot and on average spent 11.2 minutes on walking trips (including both individuals who walked and those who did not walk).

[Table 1 near here].

Daily walking levels remained significantly lower than normal in November 2020, as suggested by the results from the second wave of the EMQ survey. At that phase of the pandemic, the proportion of individuals who conducted at least one walking trip reduced from 37% to 29%, which implies that the absolute volume of daily walking trips significantly decreased in the region. In addition, not only the amount of walking trips had decreased, but also their proportion relative to all trips (i.e., walking share). In November 2020, the proportion of daily trips that individuals conducted walking decreased from 29% to 25%. Lastly, the average daily time spent walking for transportation diminished from 11.01 to 8.02 minutes.

The reduction of daily walking for transportation in Camp de Tarragona is further confirmed by the results from the overall models for each of the three outcomes (models for the total sample in **Tables 2, 3**, and **4**). In each of these models, we included a variable, "*Period of the survey (During COVID-19)*", to account for the effect of the specific period of the pandemic on each of the walking-related indicators. First, we observed a highly statistically significant negative association between the study period and the probability that someone conducted at least one walking trip (Std. Coef. = -0.40) (**Table 2**). Second, we observed also a strong negative association between the second wave of the survey and the proportion of individuals' daily trips that were made walking (Std. Coef. = -0.22) (**Table 3**). Lastly, we observed a subsequent negative association between the time of the survey and daily time spent individually on walking trips (Std. Coef. = -9.3) (**Table 4**).

[Tables 2, 3 and 4 near here].

4.2. Changes in the Determinants of Walking for Transportation

Traditionally, walking for transportation on weekdays is associated with a set of key individual sociodemographic variables as well as with socioeconomic and urban form neighborhood characteristics, as evidenced by the regression models presented in **Tables 2** to **4**. We observed that being a woman had a significant positive relationship with all three walking-related indicators: with the probability of walking (Std. Coef, = 0.292), with the share of walking amongst all daily trips (Std. Coef. = 0.270), and with daily walking time (Std. Coef = 6.329). Age also showed a consistent association with walking for transportation: compared to the reference group (adults between 35 and 55), children (4-18 years old) and older adults (those from 56 to 70 years old, and also those above 71 years old) had a higher probability of walking (Std. Coef. = 0.507, 0.509 and 0.506 respectively), had a larger share of walking trips (Std. Coef. = 0.443, 0.596 and 0.627 respectively), and spent more time walking for transportation daily (Std. Coef. = 9.247, 13.647

and 11.563 respectively). In socioeconomic terms, those with education levels higher than primary education but less than college showed significantly lower shares of walking trips (Std. Coef. = -0.134 and -0.224), and those with higher income (above 3,000 and 4,000 monthly euros) showed lower probability of walking (Std. Coef. = -0.355 and -0.243 respectively), lower shares of walking relative to all trips (Std. Coef. = -0.439 and -0.342 respectively), and shorter daily walking times (Std. Coef. = -7.867 and -6.112). In terms of variables related to mobility options, individuals that hold a drivers' license and those who are part of a household that owns a larger number of vehicles also showed significantly lower levels of walking in the three outcomes analyzed. For example, the probability of walking was significantly lower for those with a higher number of vehicles in the household (Std. Coef. = -0.185) and for those with a driver's license (Std. Coef. = -0.206). Lastly, the characteristics of the residential built and socioeconomic environment also showed consistent associations with daily walking for transportation patterns. Generally, walking indicators had significant positive associations with greater income inequality (for example, for the probability of walking, Std Coef. = 0.411), higher population density (Std. Coef. = 0.375) and land use mix at the census tract level (Std. Coef. = 0.451). On the other hand, urban fragmentation (built-up patch density) showed strong negative associations with the outcomes (again, as an example, for the probability of walking, Std. Coef. = -0.158).

At this point, it is particularly relevant to examine if any of the traditional determinants of utilitarian walking were modified under the second wave of the pandemic in the study area. To do so, we identified what variables showed a significant change in their coefficients in the models adjusted pre-COVID-19 and the models ran for the data collected during the pandemic. As explained in section 3.4, to detect statistically significant changes in the associations, we focused on those variables for which the coefficient in the model of the data collected during the pandemic fell outside the confidence intervals identified for the coefficients in the global models. First, we identified two changes in the associations that were consistent across all three outcomes analyzed. We observed how the positive association between walking for transportation and being part of the 56-70 age group (compared to the reference group, 35-55) intensified during the pandemic, as exemplified by the fact that the coefficient for this age group during pandemic of the survey was significantly higher than that observed in the overall model. Also, we observed how the relationship between household income and individual walking for transportation also changed during the pandemic. We observed how the associations between part of household with medium levels of income (especially between 2,000 to 4,000 monthly euros) and walking-related indicators during the pandemic fell outside the confidence intervals observed in the overall model. The second main change observed was that the coefficients of the associations between income inequality at the census tract level and probability of conducting at least one trip and the proportion of all trips that are walking also fell below the confidence intervals of the associations identified in the overall models.

5. Discussion

In November 2020, during the second wave of COVID-19 and during a period of partial restrictions on activities and mobility, utilitarian walking in Camp de Tarragona became less frequent, as evidenced by both a significantly lower proportion of individuals walked for transportation and by a reduction in time spent daily on walking trips. The reduction in walking for transportation levels can be first explained by the overall reduction in mobility levels during the study period, which we have showed were approximately 20-30% lower than baseline mobility (Google, 2021). This reduction in mobility was in part a result of measures taken by the government to limit the spread of SARS-CoV-2 after a relatively relaxed summer of 2020, of which the majority consisted either of direct restrictions of population mobility, or restrictions to indoor activities. The reduction in utilitarian walking observed in our study is generally aligned what has been observed in other world regions and using different data sources and methods (Hino & Asami, 2021; Hunter et al., 2021; Molloy et al., 2021; Shakibaei et al., 2021; Tarasi et al., 2021; Wen et al., 2021; Zhang & Fricker, 2021).

In our study we observed that walking for transportation was especially impacted by the pandemic, considering that not only walking frequency decreased, but also that its share in individual trips reduced from 29% to 25%. This result is similar to what has been evidenced in some studies (Aloi et al., 2020; van der Drift et al., 2021), but contrary to other findings that suggested that walking share increased during the pandemic (Abdullah et al., 2020; Anke et al., 2021; Dingil & Esztergár-Kiss, 2021; Schmidt et al., 2021; Scorrano & Danielis, 2021). In our case, we believe that the decrease in the relative share of walking in the region can be first explained by the fear of SARS-CoV-2 contagion. On the one hand, walking is traditionally the means of transportation used for personal errands or medical appointments, among others, which could have been reduced to the fear of contagion at the destination. On the other hand, there is also a possibility that a portion of walking reduced because of a higher risk of contagion in public spaces, and thus such trips could have been replaced, for instance, by trips conducted by car. In addition to these two explanations, we believe that the main cause behind the specific reduction in walking for transportation was related to the fact that some of the activities and venues that were limited or restricted at the time of the survey corresponded to destinations to which walking was the most common means of transportation, especially indoor cultural and recreational venues, bars and restaurants, and many small and medium-sized retail establishments (under 800 sq. m). This is especially true in urban areas, where most of these venues are generally accessible on foot.

Similarly, limitations to group gatherings to under six people could have also reduced the possibility of visiting family and friends that live nearby.

The fact that walking for transportation was reduced both in absolute and relative terms would argue against, or at least nuance, the notion that the pandemic may have constituted an opportunity to promote and consolidate walking as a means of transportation (Schmidt et al., 2021). While it may be true that walking could have been perceived as a healthier and risk-free mode of transportation during the pandemic (Habib & Anik, 2021; Shamshiripour et al., 2020), this has not been the case in our urban study area, as a result of both a combination of lower overall mobility levels, and of utilitarian walking in particular, and the possible fear of contagion in both destinations and in the public space. This finding, however, does not necessarily mean that other forms of walking may have indeed increased during the pandemic. This would be the case, for instance, of walking as a form of recreation, conducted either in urban environments (i.e., wandering, strolling) or elsewhere (i.e., hiking), as found in other studies (Hunter et al., 2021) and explained by an increase in the preference for outdoor recreation activities during the pandemic (Landry et al., 2021; Spenceley et al., 2021).

While at lower levels, walking for transportation in our study area during the period of partial restrictions remained relatively dependent of its traditional individual and area-level determinants. For example, at the time of the survey, being a woman continued to be significantly associated with greater odds of walking, with larger relative shares of walking, and with longer daily walking times. This result is consistent with previous studies that have showed how women are more reliant on walking as a day-to-day means of transportation (Delclòs-Alió et al., 2021; Ferrari et al., 2020; Maciejewska, McLafferty, et al., 2019). Along this line, our results evidence that this relationship has been continued to be the case even during the pandemic, despite many of the walking-distance trips reduced due to measures aimed at reducing the spread of SARS-CoV-2. Similarly, indicators relative to individuals' accessibility levels also continued to be relevant predictors of walking for transportation during the COVID-19 pandemic. Both having a drivers' license and having more vehicles available at the household continued to show a significant negative association with all-walking related indicators (frequency, share, and time). This evidence is not new and has previously led to consider that a significant proportion of individuals who walk more on a daily basis can be labelled as 'captive walkers' (Cervero, 2013), a reality that in Camp de Tarragona seems to have remained unaltered during the pandemic. Lastly, in terms of the residential built environment, two of the basic components of walkability, i.e., population density and land use mix (Frank et al., 2010; Lamíquiz & López-Domínguez, 2015), and among others, remained significantly positively associated with walking for transportation in all its forms, in agreement with one study that had focused on perceived built environment (Shaer et al., 2021).

However, it is of particular interest to look closer at the traditional determinants of walking that were altered during the second wave of COVID-19 in our study area. Changes that could be related either to mobility restrictions that particularly affected some more than others, or to different degrees of perceived risk of contagion. Starting from the individual context, it is important to first note that, under normal circumstances, younger and older people tend to walk significantly more than young and middle-aged adults (especially those aged between 35 and 55). However, the positive association between walking and pertaining to the group of individuals between 56 and 70 years old intensified during the pandemic. In other words, being between 56 and 70 at the time of the pandemic made individuals especially likely (compared to being in the 35-55 age range) not only to conduct at least one walking trip on a daily basis, but also to present a larger share of walking and to spend more time walking on a daily basis. Individuals in this age group correspond to the oldest individuals among those who can still be professionally active (retirement in Spain is between 65 and 70). Thus, considering the higher risk of developing severe cases of COVID-19 among this age demographic (Esai Selvan, 2020), and the consideration of walking as an individual and low-risk means of transportation in terms of SARS-CoV-2 infection, it could be plausible that individuals in this group more frequently chose to walk as a means of transport compared to their younger counterparts, and thus replacing trips that could have otherwise taken place by public transportation. We thus hypothesize that this change is not equally observed among those above 70 years of age because the reduction in their mobility levels may have been more acute than those who are still professionally active.

Moreover, two other relevant changes in the determinants of walking for transportation observed in our study area refer to income-related variables. Under normal circumstances, household monthly income, especially in its medium to high ranges, had a negative association with all walking-related indicators (this is, those with mid to high household incomes were less likely to walk for transportation). However, this negative association lost significance in November 2020. Second, and somewhat related to the previous point, we observed how even though individuals residing in neighborhoods with higher levels of income inequality would generally be more likely to walk as a means of transportation, this relationship also disappeared at the time of the survey. The fact that either household income and area-level income inequality were no longer predictors of utilitarian walking during the pandemic would suggest that the effect of the pandemic on walking for transportation was larger among individuals with lower incomes and living in areas with larger income inequalities. This would be clearly aligned with a large-scale study in the United States that found that income-related variables were no longer associated with utilitarian walking during the pandemic, which exacerbated existing inequalities (Hunter et al., 2021). This study argued that the effect of the pandemic on day-to-day walking would not only have unequal implications in terms of accessibility, but also potentially in terms of public health, since only individuals in high-income areas could have replaced utilitarian walking with more leisure walking, to levels even higher than before the pandemic.

The main strength of this study is the use of an official and representative travel survey to evaluate how walking for transportation decreased during a period of partial restrictions on activities and mobility during the COVID-19 pandemic, and to examine whether such context may had altered the traditional determinants of walking. Our study, however, is not exempt from several considerations that could help both correctly interpret the abovementioned findings and to inform future studies that may explore this topic further. First, and as noted previously, this study focused on utilitarian walking conducted on weekdays. Consequently, no information was gathered about how other forms of walking may have increased, for instance as a healthy and risk-free form of outdoor recreation, especially on weekends. Along this line, in this first study we did not examine how walking for different purposes varied during the pandemic, and thus it will be a relevant avenue for future research. A possible research design for this purpose would be to focus on trips rather than on individuals, and deploy a multilevel analysis where trips are nested in individuals, and trip and person characteristics could be analyzed at different levels. Especially, we believe that the impact of COVID-19 restrictions on walking for recreation and on its predictors would be a research topic of particular interest in this and similar regions. Second, this study is based on a very specific moment of the pandemic, in November 2020, at the beginning of the so-called second wave of the pandemic in Spain, characterized by a middle but growing incidence of the virus and with a specific set of restrictions on activities and mobility. Thus, studies that explore the topic of this paper in other stages of the pandemic, in other geographic context, and with different incidence levels and different degrees and forms of mobility restrictions, would also be helpful not only for fellow researchers in the field of active mobility but also for local policymakers who may be interested to plan and design scenarios to promote walking in future scenarios of population restrictions. Lastly, as it is common in all kinds of surveys, and in particular in mobility surveys, the analysis presented in this study is based on self-reported information. Along this line, mobility surveys are likely affected by recall biases and are also likely to underreport short walking trips (Zmud & Wolf, 2003).

6. Conclusion

In this study we examined how walking as a means of transportation changed during the post-lock-down period of the COVID-19 pandemic, a period characterized by a certain degree of restrictions on activities and mobility, together with the still persistent fear of contagion. Specifically, we analyzed whether the pandemic modified a set of walking-related indicators, as well as their traditional individual- and area-level determinants. We observed that in November 2020, at the beginning of the second wave of the COVID-19 pandemic, walking for transportation drastically decreased not only in terms of the number of walking trips conducted per person and the amount of time spent daily on walking, but also in terms of the modal share of walking (proportion of all trips that are made walking). At these lower levels of walking, most of its traditional socioeconomic and built environment determinants remained unaltered, with several key exceptions such as the association between age and walking, which not only remained unaltered during the study period but became stronger for those between 56 and 70 years old, and household income and area-level income inequality, which were no longer predictors of walking at the time of the study.

The evidence generated in this study regarding how walking for transportation was altered during the post-lock-down period may be helpful both for urban and transport policy makers as well as public health practitioners. Before the COVID-19 pandemic, many local administrations had started implementing policies aimed at promoting active forms of transportation such as walking, considering its many environmental and accessibility benefits. However, the restrictions applied to mobility during the pandemic, together with a higher fear of contagion in day-to-day activities, are likely to have had a particular impact on utilitarian walking, which seems to have lost ground in the region. In the short term, it will be especially necessary to monitor if the walking habits adopted during the pandemic persist in the post-COVID-era, and what policies and measures are required to not only bring back pre-pandemic walking levels but also continue to promote its use among urban residents. Moreover, the reduction in weekday walking as a means of transportation is likely to have impacted day-to-day physical activity levels, considering that walking for transportation is one of the most common and accessible forms of daily exercise. In this sense, it is crucial to note how the pandemic did not reduce everyone's walking habits equally, which consequently calls for measures that are targeted to specific population groups. In the long term, the evidence presented in our study also suggests that for future hypothetical scenarios that may require restrictions on mobility, policymakers will need to consider that such measures can have especially acute impacts on sustainable and healthy mobility, and especially among specific population subgroups that already base a large proportion of their overall mobility strategies on active mobility.

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Tables and figures

Table 1. Description of outcomes and individual and neighborhood characteristics, overall and by survey period.

	Total sample	**Pre-COVID-19[a]**	**During COVID-19[b]**
n	13,009	9,065	3,944
Outcomes			
Conducted at least one walking trip daily (n, %)			
Yes	4,487 (34.49)	3,347 (36.92)	1,140 (28.90)
No	8,522 (65.51)	5.718 (63.08)	2,804 (71.10)
Proportion of daily trips that were walking (mean, SD)	0.28 (0.42)	0.29 (0.42)	0.25 (0.41)
Daily time spent in walking trips (mean, SD)	10.12 (21.06)	11.01 (22.27)	8.09 (17.81)
Profile characteristics			
Sex (n, %)			
Women	6,626 (50.93)	4,655 (51.35)	1,971 (49.97)
Men	6,383 (49.07)	4,410 (48.65)	1,973 (50.03)
Age (n, %)			
4-18	2,664 (20.48)	1,975 (21.79)	689 (17.47)
19-35	2,040 (15.68)	1,308 (14.43)	732 (18.56)
36-55	4,287 (32.95)	2,966 (32.72)	1,321 (33.49)
56-70	2,483 (19.09)	1,765 (19.47)	718 (18.20)
71=<	1,535 (11.80)	1,051 (11.59)	484 (12.27)
Educational attainment (n, %)			
Primary education or less	4,023 (30.85)	2,852 (31.46)	1,161 (29.44)
Secondary education	3,178 (24.43)	2,143 (23.64)	1,035 (26.24)
Vocational training	1,500 (11.53)	1,032 (11.38)	468 (11.87)
College education	1,967 (15.12)	1,316 (14.52)	651 (16.51)
No data	2,351 (18.07)	1,722 (19.00)	629 (15.95)
Monthly household income in € (n, %)			
<1,000	1,279 (9.83)	879 (9.70)	400 (10.14)
1,000-1,999	3,542 (27.32)	2,502 (27.60)	1,040 (26.37)
2,000-2,999	2,353 (18.09)	1,640 (18.09)	713 (18.08)
3,000-3,999	1,022 (7.86)	744 (8.21)	278 (7.05)
4,000=<	556 (4.27)	391 (4.31)	165 (4.18)
No data	4,257 (32.72)	2,909 (32.09)	1,348 (34.18)
Driver's license (n, %)			
Yes	10,908 (83.85)	7.558 (83.38)	3,350 (84.94)
No	2,101 (16.15)	1,507 (16.62)	594 (15.06)
Number of vehicles in the household (mean, SD)	1.64 (0.94)	1.64 (0.94)	1.64 (0.93)
Neighborhood characteristics			

Gini of income (0-1) (mean, SD)	0.31 (0.03)	0.31 (0.03)	0.31 (0.03)
Population density (thou. inh. /sq.km) (mean, SD)	7.32 (11.26)	6.99 (10.76)	8.08 (12.29)
Built-up patch density (n/sq.km) (mean, SD)	221.19 (238.15)	218.50 (236.21)	227.36 (242.48)
Built-up area (sq.km) (mean, SD)	0.16 (0.13)	0.16 (0.13)	0.16 (0.13)
Intersection density (n/sq.km) (mean, SD)	108.77 (118.91)	107.04 (117.52)	112.76 (121.97)
Land use mix (0-1) (mean, SD)	0.48 (0.15)	0.48 (0.15)	0.48 (0.15)

a. February and March 2020. b. November 2020.

Table 2. Logistic regressions of the **probability of conducting at least one walking trip daily**, among the total sample, among individuals surveyed in February 2020, before COVID-19, and among individuals surveyed in November 2020, during COVID-19.

	Model for the total sample (n=13,009)		**Model for the sample before COVID-19 (n = 9,065)**	**Model for the sample during COVID-19 (n = 3,944)**
Independent variables	*Std. Coef. (S.E.)*	*95% CI*	*Std. Coef. (S.E.)*	*Std. Coef. (S.E.)*
Period of the survey (During COVID-19)	-0.400 (0.044)***	-0.487; -0.314		
Sex (Women)	0.292 (0.041)***	0.212; 0.372	0.292 (0.048)***	0.294 (0.077)***
Age (4-18) (Ref= 35-55)	0.507 (0.111)***	0.290; 0.724	0.558 (0.128)***	0.378 (0.222)
Age (19-35) (Ref= 35-55)	0.016 (0.065)	-0.111; 0.143	0.049 (0.077)	-0.044 (0.120)
Age (56-70) (Ref= 35-55)	0.509 (0.058)***	0.395; 0.622	0.440 (0.068)***	0.688 (0.109)***
Age (71=<) (Ref= 35-55)	0.506 (0.072)***	0.364; 0.648	0.522 (0.086)***	0.463 (0.134)***
Education (Secondary) (Ref= Primary or less)	-0.091 (0.057)	-0.202; 0.020	-0.126 (0.067)	-0.017 (0.106)
Education (Professional education) (Ref= Primary or less)	-0.154 (0.076)*	-0.303; -0.005	-0.180 (0.089)*	-0.105 (0.146)
Education (College) (Ref= Primary or less)	0.045 (0.070)	-0.093; 0.183	0.071 (0.083)	-0.028 (0.134)
Education (Missing)	0.565 (0.115)***	0.340; 0.791	0.479 (0.134)**	0.777 (0.228)**
Household monthly income (1,000-1,999) (Ref= <1,000)	-0.023 (0.073)	-0.165; 0.119	-0.054 (0.087)	0.034 (0.135)
Household monthly income (2,000-2,999) (Ref= <1,000)	-0.145 (0.081)	-0.304; 0.015	-0.220 (0.097)*	0.044 (0.152)
Household monthly income (3,000-3,999) (Ref= <1,000)	-0.355 (0.102)**	-0.555; -0.156	-0.455 (0.119)***	-0.089 (0.197)
Household monthly income (4,000=<) (Ref= <1,000)	-0.243 (0.123)*	-0.485; -0.001	-0.318 (0.145)*	-0.061 (0.236)
Household income (Missing)	-0.171 (0.072)*	-0.312; -0.031	-0.216 (0.086)*	-0.072 (0.131)
Number of vehicles in the household	-0.185 (0.026)***	-0.236; -0.133	-0.170 (0.030)***	-0.224 (0.052)***
Driver's license (Yes)	-0.206 (0.063)**	-0.331; -0.082	-0.178 (0.075)*	-0.254 (0.119)*
Gini coefficient (Log)	0.411 (0.198)*	0.022; 0.799	0.570 (0.234)*	-0.001 (0.375)
Population density (Log)	0.375 (0.028)***	0.320; 0.430	0.386 (0.033)***	0.344 (0.053)***
Built-up patch density (Log)	-0.158 (0.044)***	-0.245; -0.072	-0.154 (0.052)**	-0.176 (0.083)*
Built-up area (Log)	0.020 (0.031)	-0.040; 0.080	0.022 (0.036)	0.010 (0.058)
Intersection density (Log)	0.030 (0.047)	-0.062; 0.122	0.032 (0.056)	0.033 (0.088)
Land Use Mix (Log)	0.451 (0.069)***	0.315; 0.587	0.472 (0.082)***	0.408 (0.132)**
AIC	15,164.51		10,878.20	4,339.16
BIC	15,343.87		11,041.78	4,483.60
LR Chi-square test	LR Chi2 = 1,644.41 Prob > Chi2 = 0.000		LR Chi2 = 1,128.22 Prob > Chi2 = 0.000	LR Chi2 = 453.95 Prob > Chi2 = 0.000
Pseudo R^2	0.098		0.094	0.096

*Significance test: *p-value < 0.05, **p-value < 0.01, ***p-value < 0.001*

Table 3. Generalized linear model (with a logistic distribution function and a negative binomial link) of the **proportion of daily trips that are walking**, among the total sample, among individuals surveyed in February 2020, before COVID-19, and among individuals surveyed in November 2020, during COVID-19.

	Model for the total sample (n=13,009)		Model for the sample before COVID-19 (n = 9,065)	Model for the sample during COVID-19 (n = 3,944)
Independent variables	*Std. Coef. (S.E.)*	*95% CI*	*Std. Coef. (S.E.)*	*Std. Coef. (S.E.)*
Period of the survey (During COVID-19)	-0.224 (0.044)***	-0.310; -0.138		
Sex (Women)	0.270 (0.040)***	0.191; 0.348	0.282 (0.047)***	0.243 (0.078)**
Age (4-18) (Ref= 35-55)	0.443 (0.104)***	0.239; 0.648	0.429 (0.123)***	0.492 (0.201)*
Age (19-35) (Ref= 35-55)	0.004 (0.064)	-0.122; 0.130	0.000 (0.075)	0.021 (0.123)
Age (56-70) (Ref= 35-55)	0.596 (0.057)***	0.484; 0.708	0.534 (0.067)***	0.749 (0.109)***
Age (71=<) (Ref= 35-55)	0.627 (0.074)***	0.483; 0.772	0.618 (0.088)***	0.650 (0.139)***
Education (Secondary) (Ref= Primary or less)	-0.134 (0.056)*	-0.244; -0.024	-0.196 (0.066)**	0.005 (0.108)
Education (Professional education) (Ref= Primary or less)	-0.224 (0.075)**	-0.372; -0.077	-0.287 (0.088)**	-0.086 (0.145)
Education (College) (Ref= Primary or less)	-0.061 (0.069)	-0.197; 0.075	-0.064 (0.081)	-0.061 (0.136)
Education (Missing)	0.680 (0.109)***	0.466; 0.894	0.629 (0.129)***	0.795 (0.209)***
Household monthly income (1,000-1,999) (Ref= <1,000)	-0.031 (0.071)	-0.171; 0.110	-0.057 (0.084)	0.027 (0.137)
Household monthly income (2,000-2,999) (Ref= <1,000)	-0.247 (0.080)**	-0.403; -0.091	-0.320 (0.094)**	-0.057 (0.150)
Household monthly income (3,000-3,999) (Ref= <1,000)	-0.439 (0.100)**	-0.634; -0.244	-0.535 (0.115)***	-0.178 (0.198)
Household monthly income (4,000=<) (Ref= <1,000)	-0.342 (0.122)**	-0.581; -0.103	-0.402 (0.141)**	-0.184 (0.242)
Household income (Missing)	-0.176 (0.071)*	-0.315; -0.037	-0.198 (0.085)*	-0.118 (0.134)
Number of vehicles in the household	-0.246 (0.027)***	-0.299; -0.193	-0.247 (0.032)***	-0.245 (0.053)***
Driver's license (Yes)	-0.319 (0.065)***	-0.447; -0.192	-0.293 (0.077)***	-0.374 (0.125)**
Gini coefficient (Log)	0.520 (0.193)**	0.143; 0.897	0.714 (0.225)**	0.048 (0.372)
Population density (Log)	0.354 (0.027)***	0.301; 0.406	0.362 (0.032)***	0.332 (0.051)***
Built-up patch density (Log)	-0.222 (0.043)***	-0.306; -0.138	-0.225 (0.050)***	-0.219 (0.083)**
Built-up area (Log)	0.011 (0.030)	-0.047; 0.070	0.021 (0.035)	-0.014 (0.058)
Intersection density (Log)	0.069 (0.045)	-0.019; 0.157	0.077 (0.052)	0.053 (0.088)
Land Use Mix (Log)	0.412 (0.068)***	0.279; 0.545	0.426 (0.080)***	0.395 (0.131)**
AIC	13,077.14		9,216.58	3,889.02
BIC	13,256.50		9,380.16	4,033.45
Pseudo $R^{2\ a}$	0.084		0.107	0.025

*Significance test: *p-value < 0.05, **p-value < 0.01, ***p-value < 0.001.*

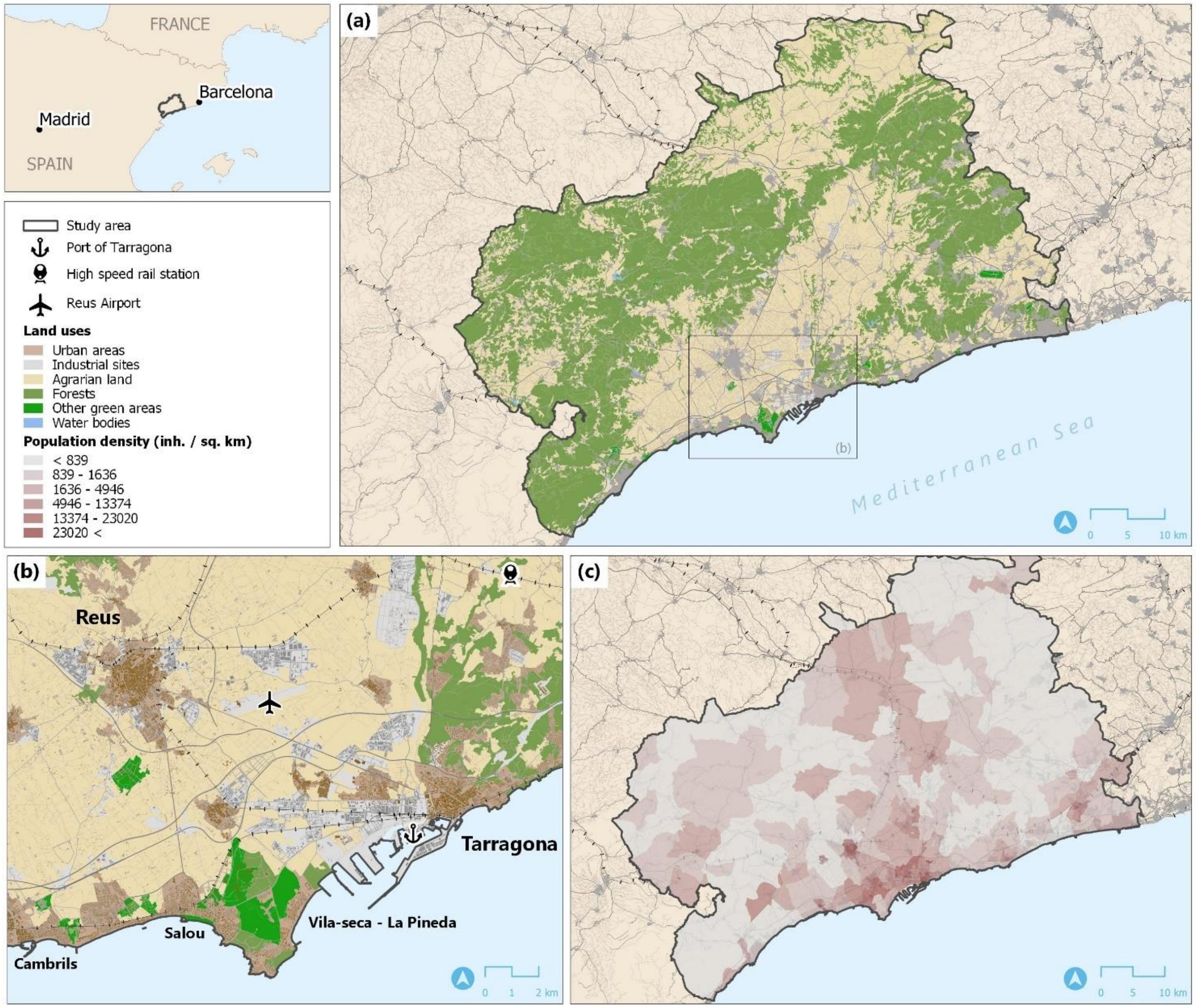
a. Proxy obtained by calculating the proportion of residual deviance over the null deviance and deducting it to 1

Table 4. Tobit regressions of **daily time spent in walking trips**, among the total sample, among individuals surveyed in February 2020, before COVID-19, and among individuals surveyed in November 2020, during COVID-19.

	Model for the total sample (n=13,009)		**Model for the sample before COVID-19 (n = 9,065)**	**Model for the sample during COVID-19 (n = 3,944)**
Independent variables	*Std. Coef. (S.E.)*	*95% CI*	*Std. Coef. (S.E.)*	*Std. Coef. (S.E.)*
Period of the survey (During COVID-19)	-9.320 (1.064)***	-11.405; -7.235		
Sex (Women)	6.329 (0.985)***	4.398; 8.259	6.573 (1.175)***	5.665 (1.792)*
Age (4-18) (Ref= 35-55)	9.247 (2.731)**	3.893; 14.601	10.301 (3.181)**	6.412 (5.368)
Age (19-35) (Ref= 35-55)	0.410 (1.566)	-2.659; 3.479	0.860 (1.901)	-0.371 (2.739)
Age (56-70) (Ref= 35-55)	13.647 (1.402)***	10.898; 16.396	12.290 (1.675)***	16.814 (2.547)***
Age (71=<) (Ref= 35-55)	11.563 (1.736)***	8.160; 14.967	11.702 (2.092)***	11.092 (3.099)***
Education (Secondary) (Ref= Primary or less)	-2.266 (1.371)	-4.954; 0.422	-2.904 (1.650)	-0.936 (2.445)
Education (Professional education) (Ref= Primary or less)	-3.299 (1.828)	-6.882; 0.284	-4.141 (2.179)	-1.614 (3.332)
Education (College) (Ref= Primary or less)	0.237 (1.703)	-3.101; 3.574	0.491 (2.036)	-0.498 (3.085)
Education (Missing)	10.639 (2.836)**	5.080; 16.198	8.546 (3.320)*	15.613 (5.500)**
Household monthly income (1,000-1,999) (Ref= <1,000)	-0.368 (1.738)	-3.774; 3.038	-0.399 (2.090)	-0.814 (3.110)
Household monthly income (2,000-2,999) (Ref= <1,000)	-3.513 (1.954)	-7.344; 0.318	-4.146 (2.348)	-2.003 (3.513)
Household monthly income (3,000-3,999) (Ref= <1,000)	-7.867 (2.445)**	-12.660; -3.074	-9.379 (2.901)**	-4.035 (4.540)
Household monthly income (4,000=<) (Ref= <1,000)	-6.112 (2.975)*	-11.944; -0.280	-6.944 (3.547)	-4.225 (5.432)
Household income (Missing)	-4.602 (1.712)**	-7.958; -1.246	-4.958 (2.070)*	-3.915 (3.039)
Number of vehicles in the household	-4.621 (0.624)***	-5.844; -3.398	-4.492 (0.736)***	-4.862 (1.171)***
Driver's license (Yes)	-5.644 (1.518)***	-8.620; -2.668	-4.880 (1.819)*	-7.076 (2.744)*
Gini coefficient (Log)	9.565 (4.766)*	0.223; 18.908	11.553 (5.679)*	4.636 (8.697)
Population density (Log)	8.783 (0.679)***	7.452; 10.114	9.196 (0.810)***	7.694 (1.237)***
Built-up patch density (Log)	-3.258 (1.055)**	-5.325; -1.191	-3.665 (1.264)**	-2.288 (1.899)
Built-up area (Log)	0.616 (0.742)	-0.839; 2.072	0.959 (0.890)	-0.244 (1.336)
Intersection density (Log)	1.176 (1.126)	-1.031; 3.384	1.835 (1.345)	-0.419 (2.045)
Land Use Mix (Log)	10.409 (1.653)***	7.169; 13.648	10.757 (1.976)***	9.672 (2.995)**
AIC	54,036.10		39,841.49	14,221.69
BIC	54,222.93		40,012.19	14,372.41
LR Chi-square test	LR Chi2=1,667.48 Prob > Chi2 = 0.000		LR Chi2=1,187.78 Prob > Chi2 = 0.000	LR Chi2= 444.47 Prob > Chi2 =0.000
Pseudo R^2	0.023		0.022	0.024

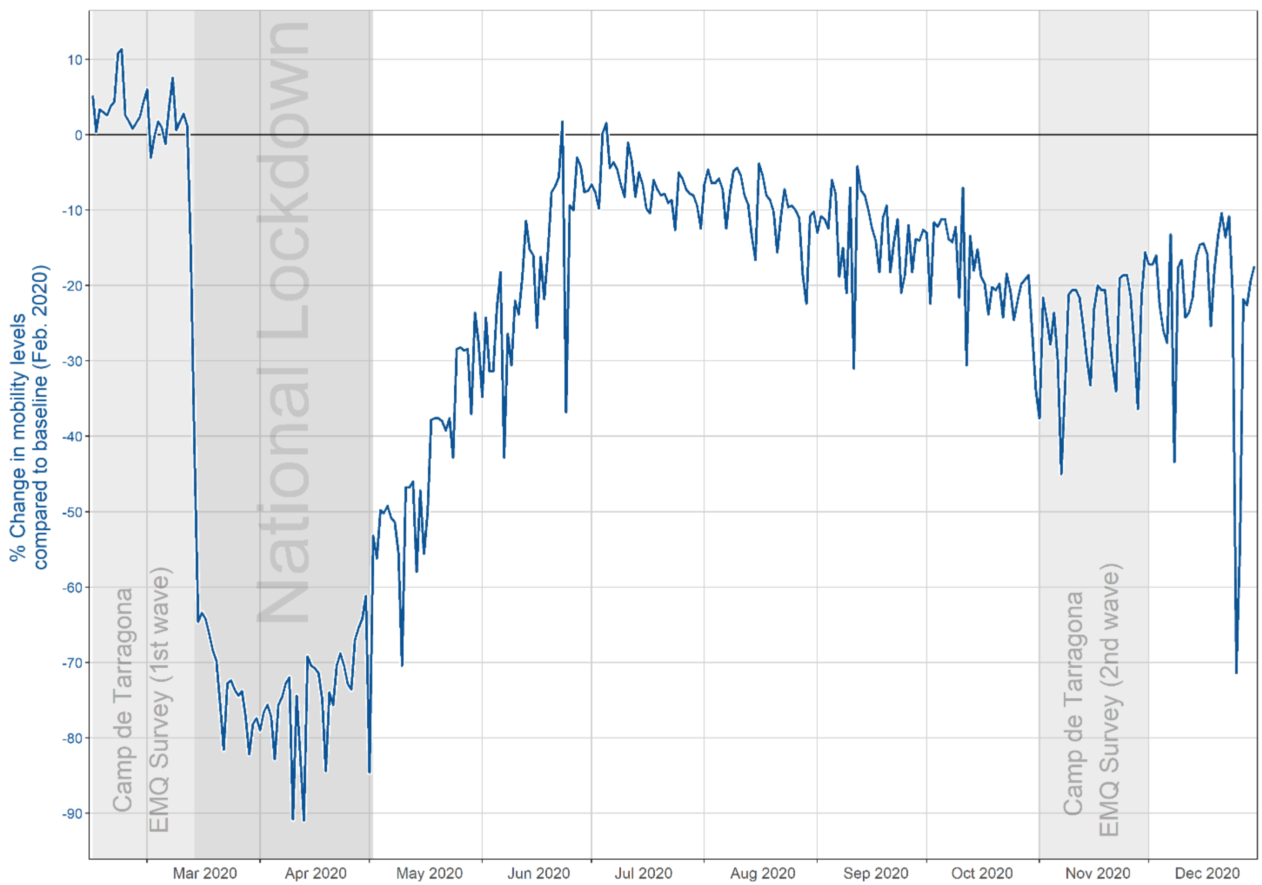
*Significance test: *p-value < 0.05, **p-value < 0.01, ***p-value < 0.001*

Figure 1. Map of the study area: Camp de Tarragona.



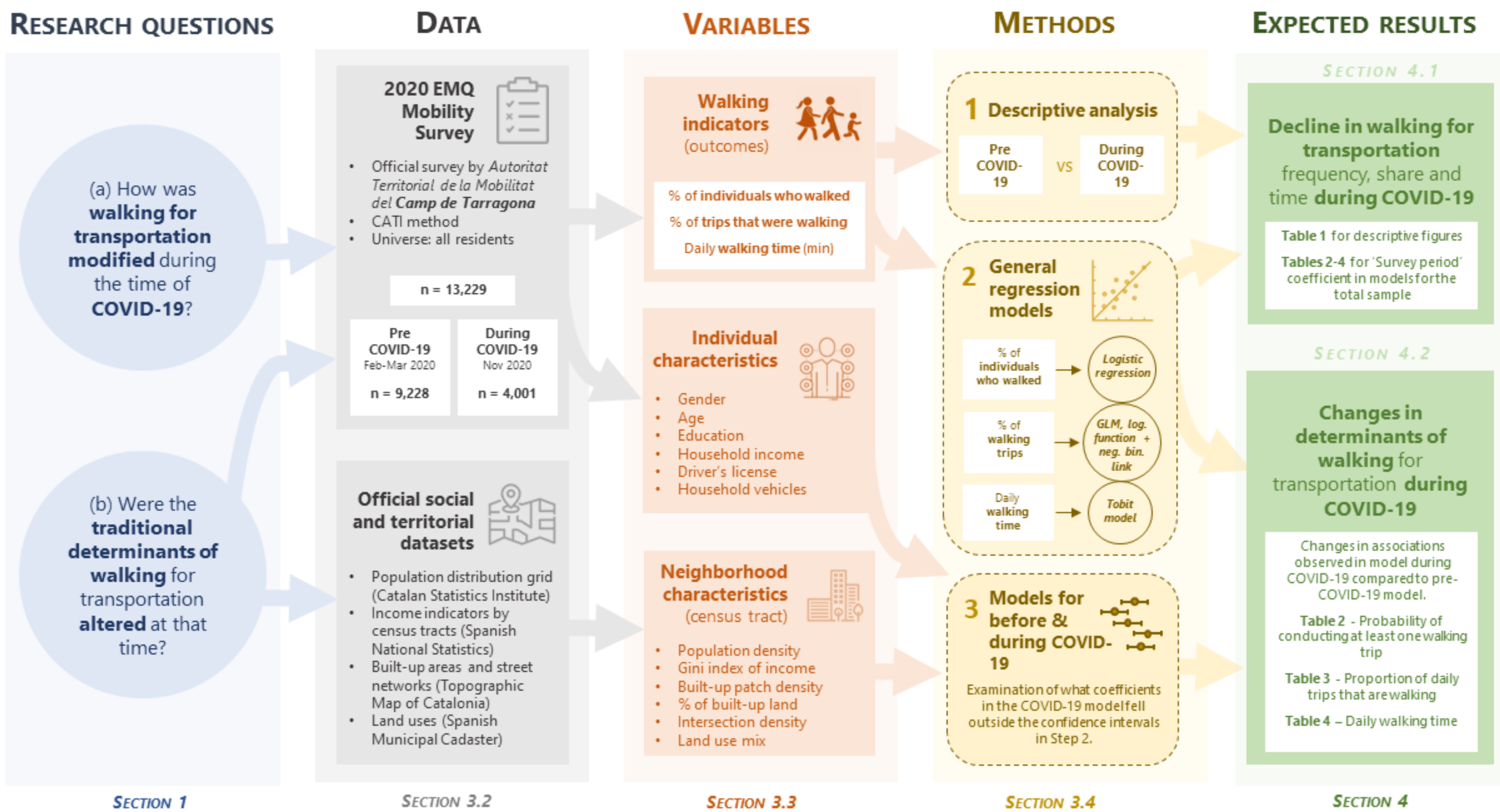
(a) Extent of Camp de Tarragona. (b) Urban core of Camp de Tarragona. (c) Population density in Camp de Tarragona. Source: Own production.

Figure 2. Change in mobility levels in 2020 in Catalonia according to Google in relation to the national lockdown period, and to the first and second waves of the Camp de Tarragona EMQ 2020 survey.



Own production based on Google Community Mobility Reports (Google, 2021).

Figure 3. Framework for the study design and analysis.



Word count: 12,998 words