IDENTIFYING MOBILITY PATTERNS AND BARRIERS FROM AGEING POPULATION TO ACCESS TO RETAIL ACTIVITY

Amor Ariza-Álvarez
Transport Research Centre – TRANSyT – Universidad Politécnica de Madrid, Spain
David Martínez Montes
Transport Research Centre – TRANSyT – Universidad Politécnica de Madrid, Spain
Aldo Arranz-López
Institute für Humangeographie, Goethe University, Germany
Rosa M. Arce-Ruiz
Transport Research Centre – TRANSyT – Universidad Politécnica de Madrid, Spain
Julio A. Soria-Lara
Transport Research Centre – TRANSyT – Universidad Politécnica de Madrid, Spain
CSIC - Instituto de Economía, Geografía y Demografía.

ABSTRACT

While the role of ageing population is considered crucial for Sustainable Development Goal at city level, limited attention has been paid to study the walking accessibility level of this population group to retail activity. Moreover, one missing element is the analysis of the ageing population willingness to reach retail activity on foot, which is here seen as a key point to generate friendly, liveable, and decarbonised urban environments. The city of Granada (Spain) is taken as spatial laboratory for the research. For this city, the planning of ageing population mobility in the mid-term seems to be challenging. First, a questionnaire regarding the willingness of ageing population to walk to daily, weekly, and incidental retail locations was conducted, including the identification of the main barriers to cover those distances on foot. Data were collected between January 2018 and January 2019. Second, a detailed description of the main existing problems to access to different types of retail activities be explored and compared, distilling findings for urban diagnosis. This research provides a strong basis for policy-making formulation, which can be orientated towards making cities more inclusive, liveable, and sustainable. Its findings can facilitate the identification and mapping of locations where ageing population groups can be under risk of walking accessibility disadvantage.

1. INTRODUCTION

It is widely believed that accessibility planning can be a powerful tool to effectively link transport and land use planning, two disciplines traditionally rooted in separated realms (Bertolini, 2017; van Wee & Handy, 2016). In this sense, the accessibility planning approach has gained prominence between academics, professionals, and institutions to become a key aspect in achieving sustainable planning outcomes at city and regional levels (Arranz-López et al., 2017; Geurs & van Wee, 2004; van Wee, 2016). Moreover, accessibility to major opportunities has been even recognised as a human right (United Nations, 2014), as it is one of the crucial factors that enable the participation of individuals in social life (Kenyon et al., 2003; Lucas et al., 2016).

Accessibility is usually seen as the relationship between the availability of opportunities in a given location and the transportation supply to reach them (Bocarejo S. & Oviedo H., 2012), being traditionally applied as an absolute concept affecting equally to the full spectrum of population. However, accessibility is conditioned by contingencies such as cultural norms, physical environment, and personal characteristics (Morency et al., 2011). In other words, different individuals display varying levels of willingness to travel to reach opportunities (Morency et al., 2011; Moniruzzaman, Paez, Nurul Habib, & Morency, 2013). Limited attention has been paid to how accessibility levels vary between population groups (Chang & Liao, 2011; Chia et al., 2016; Páez, et al., 2010), and the study of walking accessibility variations between seniors is a significant case in point (Böcker, van Amen, & Helbich, 2017; Negron-Poblete, Séguin, & Apparicio, 2016; Cao, Mokhtarian, & Handy, 2010; Hess, 2012).

A more in-depth understanding on how the senior population can reach major locations on foot is crucial for policy-making at local level (Givoni and Banister, 2013; Vale et al., 2015). That has triggered a growing number of studies focused on the accessibility levels of seniors (Páez et al., 2010; Páez et al., 2013). It has been reported how within the senior population exists significant differences regarding its travel behaviour and its capacity to access to certain locations (Hildebrand, 2003; Rahaf and Hensher, 2003).

Nevertheless, the senior population is frequently analysed as a homogenous group to be compared with other socio-economic groups. It is also known that the willingness of the senior population to reach retail locations on foot significantly diverges from the rest of population groups (Arranz-López et al., 2018; Negron-Poblete et al., 2016). It is evidenced that at least 1/3 of daily travels between the senior population is on foot (Paez et al., 2013). However, studies on walking accessibility focused on the senior population are limited.

To bridge the abovementioned gaps, this paper aims at exploring if and to what extent walking accessibility to retail activities is similar for different socio-economic groups among the senior population. The empirical focus will be the city of Granada in Spain, as it is a city with a high ageing population rate and where retail locations are widely dispersed across the city reducing distances between population and destinations. A questionnaire regarding the willingness to reach daily, weekly, and incidental retail locations on foot was elaborated and disseminated in the case study among population older than 55 years old. Then, a K-modes clustering method was implemented distinguishing four socio-economic groups among seniors (the “non-motorized seniors”; the “motorized seniors”; the “older seniors”; the "younger seniors"), followed by a statistical comparison of time-willingness decay functions to reach retail locations on foot for each identified cluster. Finally, walking accessibility to retail activity was estimated and mapped by using a gravity-based model.

The remainder of the paper is organized as follows: Section 2 reviews previous studies on accessibility to major destinations among the senior population. Section 3 presents the case study, while Section 4 shows the research design. Section 5 summarizes the main obtained findings. Finally, Section 6 closes the paper with some concluding remarks, including reflections on future research lines.

2. ACCESSIBILITY STUDIES ON THE SENIOR POPULATION

The strong ageing population trends in developed countries have facilitated a growing concern regarding travel patterns associated to seniors and its accessibility levels to major locations. Most of the consulted studies in the field are based on comparing motorised accessibility standards between seniors and other socio-economic groups. For example, Ricciardi et al., (2015) explored the accessibility levels to public transport systems in the context of Perth (Australia) between seniors, low-income people, people without car availability, and the rest of population. The authors showed how the biggest accessibility differences were focused on the group of seniors, who had the lowest accessibility levels to public transport systems. Similarity, Delbosc & Currie (2011) also analysed the access to bus system stops in Melbourne (Australia), finding that the low-income people had the lowest accessibility levels followed by the senior population. Páez et al., (2013) demonstrated that the likelihood to access to major destinations by car was higher for the senior population in comparison with other population groups in the city of Montreal (Canada). Also in Montreal, Páez et al., (2010) evidenced how the accessibility of seniors to health care facilities was significantly lower in suburban areas than in the city centre compared with other population groups in the same location.

Less attention has been traditionally paid to compare non-motorised accessibility levels between seniors and other groups. In that way, Arranz-López et al. (2018) demonstrated significant differences between seniors and the rest of population regarding their time-willingness to reach retail by walking and cycling in the city of Zaragoza (Spain). Generally, seniors were more willing to cover distance on foot to most of retail types, while the rest of population preferred taking motorised modes. On the contrary, Chia et al. (2016) showed that seniors walked shorter distances than younger people to reach public transport systems in Brisbane (Australia), affecting to its accessibility levels. Lord et al. (2011) also found that seniors from Brisbane had more difficulties to participate in the social life of its community when the access to car was limited, signalling the need for increasing non-motorised levels among seniors in comparison with other population groups. While most of accessibility studies identified seniors as a genuine group, it is almost unexplored how those accessibility standards can vary within this group and its consequences for policy-making.

3. THE CITY OF GRANADA IN SPAIN

Granada is a medium-size city (232.770 inhabitants) located in the southern Spain (Figure 1). The city shows a strong increase of the senior population during the last decades. Specifically, the demographic cohorts of people over 55 years old have experienced an increase of 20.000 individuals in 20 years, supposing a total of 34.5% of the population in 2020 (INE, 2020). The spatial distribution of seniors across the case study is not homogenous. The neighbourhoods with the highest rate of seniors (greater than 35%) are historical places, located in the city centre. Conversely, peripheral neighbourhoods have experienced a positive population growth in recent years, predominating young and active-age population.

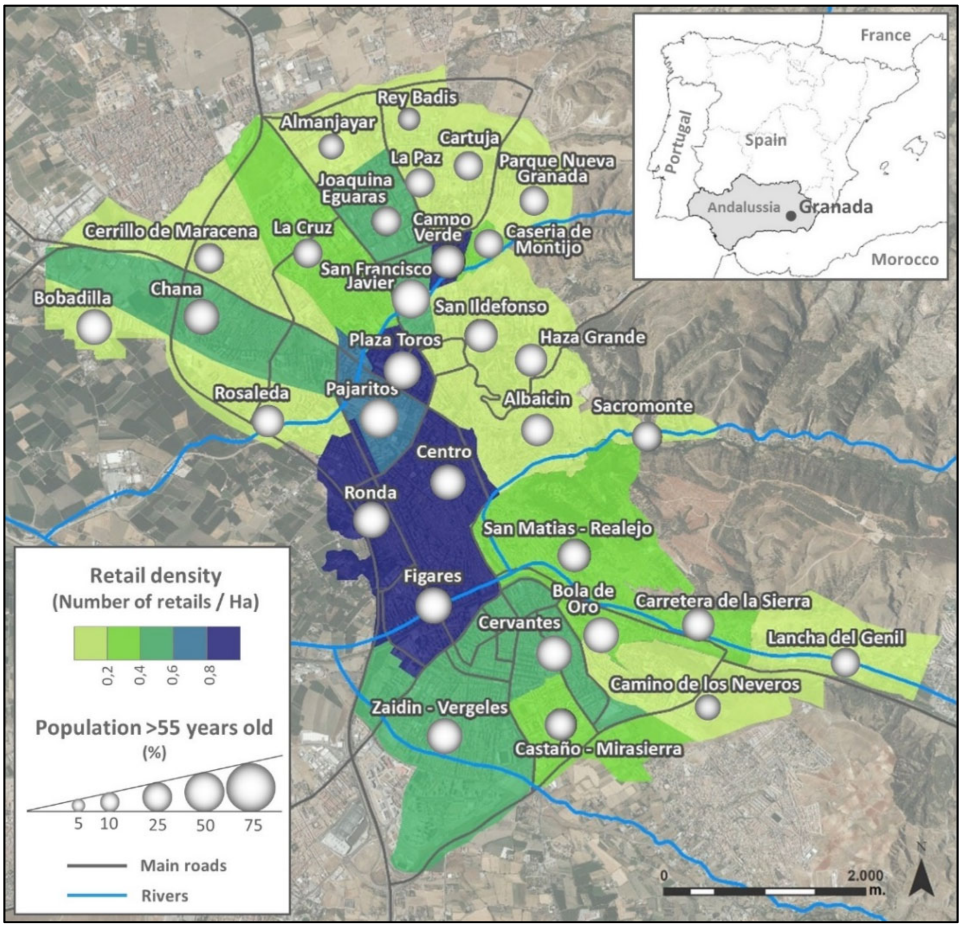

Figure 1: The city of Granada

Regarding transportation issues, short distances between population and destinations predominate across the city, providing with a good local environment to foster non-motorised transport modes. Non-motorized trips represent a total of 54% of local movements (PMUS, 2013). However, the rate of motorised trips has been drastically increased to approx. 80%, especially when trips take place between Granada and surrounding municipalities (The Metropolitan Area of Granada), where the main shopping centres are located. Shopping trips are almost a total of 38% of all local trips (PMUS, 2013). The density of retail activity decreases from the city centre to the periphery, where the new residential neighbourhoods located. Consequently, an important number of motorised shopping trips are originated from those neighbourhoods in the periphery to the city centre or to the surrounding shopping centres.

4. RESEARCH DESIGN

This research followed a three-stage approach (Figure 2):

- data gathering
- clustering analysis of seniors and comparison of its time-willingness decay functions
- calculating and mapping relative walking accessibility.

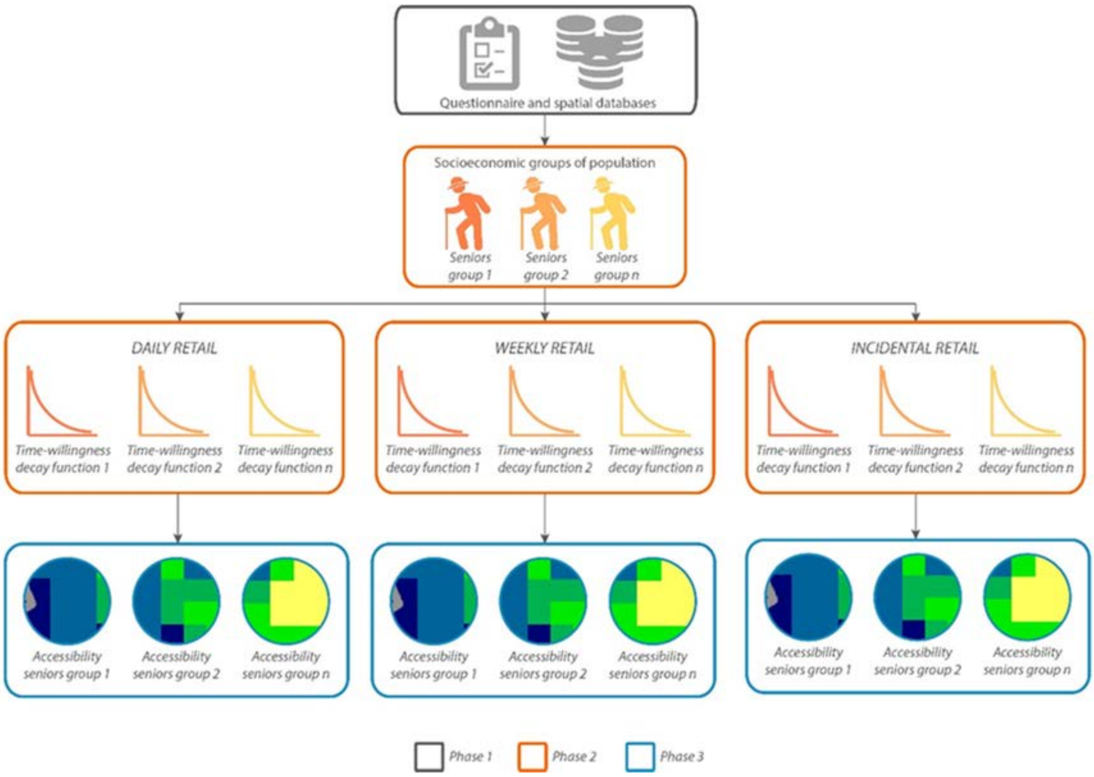

Figure 2: Methodological scheme

4.1. Data gathering

The main data source for this study was a questionnaire addressed to population over 55 years old. A total of 171 questionnaires were via face-to-face conducted visiting to the public active participation centres for seniors. Such centres were distributed equally across the city of Granada with a total of 6 centres, and all of them were visited during the fieldwork. The questionnaire was also disseminated online, obtaining a total of 31 responses. Totally, 202 valid questionnaires were collected, representing a 95% confidence interval with a bias of 5% in the context of the case study. Face-to-face interviews were especially relevant since the target population of study was seniors, who had limited access to online resources and a high rate of digital divide.

The questionnaire was structured in two blocks. The first block consisted of questions focused on demographic and socio-economic characteristics of the target group, such as gender, age, neighbourhood, household size, living alone, monthly household income, household car availability, educational level, and employment status. The second block of the questionnaire asked to seniors for their time-willingness to reach daily, weekly, and incidental retail locations on foot. Daily retail included food store, butcher, charcuterie, greengrocers, bakery, fishmonger, supermarket, and kiosk. Weekly retail included bazar, drugstore, perfumery, pharmacy, DIY store, copy shop, tobacconist, herbalist, houseware store, stationer's shop, hairdresser's, barbershop, clothing store and shoe store. Finally, incidental retail included travel agency, car/motorcycle/bicycle rental, pet shop, comic store, car dealership, sports shop, electronic/informatics shop, florist, garden store, jewellery, toy store, bookshop, furniture store, music store, optics, orthopaedics, gift shop, souvenirs, and videogame store. An example of question was: "*Independently of the neighbourhood where you are currently living, how much time are you willing to spend to reach daily/weekly/incidental retail stores on foot?*".

Additionally, spatial databases required to calculate accessibility indicators were both collected and manually digitised. A grid from the European Environment Agency was used as a spatial basis to represent accessibility values. Furthermore, a street network from the Spanish National Centre of Geographic Information was used to calculate the distance between origins and destinations. On the other hand, retail locations were manually digitised from a databased developed by the Andalusia Regional Government, and cross-checked with Google Maps and Open Street Maps, yielding a total of 2,929 retail locations.

4.2 Clustering analysis of seniors and comparison of distance-decay functions

Clustering techniques were employed to group seniors into homogeneous socio-economic groups of population. Those groups were the basis for both analysing time-willingness decay functions and conducting accessibility analysis. A k-modes algorithm was used due to the categorical nature of the data involved. During the process, special attention was paid to the choice of the variables that would characterise those population groups as well as the optimal number of clusters.

Regarding the choice of the variables for the clustering process, it was calculated Pearson correlation coefficients at $p<0.05$ level between socio-demographic variables to assess the relationships between them, being the most correlated variables discarded. It was noticed that age, monthly household income, household car availability, and living alone were the less correlated variables, and therefore, the most suitable for the clustering process.

On the other hand, the choice of the optimal number of clusters was based on the gap-statistic method, which compares for different numbers of clusters the total intra-cluster variance observed and it finds the value with which the cluster structure obtained is as far as possible from a random uniform distribution. An error bar analysis with a confident interval of 95% was carried out to check the suitability of the clusters to the sample. This has allowed a correct definition of the socioeconomic groups based on the representative variables.

Time-willingness decay functions to reach daily, weekly, and incidental retail were empirically obtained for each socio-economic cluster from the questionnaire, being a total of 12 walking time-willingness decay functions. The mentioned functions were statistically compared to identify time-willingness thresholds between the socio-economic clusters by using the following process:

- The first step consisted of the simultaneous comparison of the absolute values of time-willingness between clusters. To address this step, the non-parametric Kruskal-Wallis test was used. Significant differences at $p<0.05$ level indicated that at least one socio-economic cluster had its time-willingness decay function significantly different to other clusters for any time-willingness slot.
- If no significant differences were found during the first step, the second step consisted of the simultaneous comparison of the percentile values of time-willingness between clusters. This allowed the identification of statistical differences between clusters within a specific time-willingness slot.
- Finally, the non-parametric Mann-Whitney U test was used to analyse pairs of time-willingness decay functions for those cases where differences at $p<0.05$ level were obtained for the Kruskal-Wallis test during steps one or two.

4.3 Calculating and mapping relative accessibility

Relative accessibility to retail locations for each socio-economic group was calculated by using a gravity-based model (Equation 1), meaning that access indicators are based on the distance between origins and destinations, weighted by both the availability of retail stores at the destination and the time-willingness decay functions of each cluster. Accessibility was calculated for daily, weekly, and incidental retail.

$$GA_i = \Sigma_{j \neq i} E_j e^{-\beta X_{ij}} \tag{1}$$

where A_i is the accessibility for zone i; E_j is the number of stores at destination j; X_{ij} is the distance, along a street network, between origins and destinations, and β is the parameter of the time-willingness decay function.

5. RESULTS

5.1 Clustering and distance-decay analysis

The population sample included a higher number of women (56%) than men, and the average age of the respondents was 69 years old. A total of 79% of individuals reported to be retired, while 83% of participants indicated that they had some type of motorized vehicle. The most common monthly family income was between 1000-2000 €, while at least a total of 20% of the respondents declared to live alone (mostly women). Regarding transport modes choices, 88% of seniors stated to go to daily retail stores on foot. However, that ratio was lower for reaching both weekly (66%) and incidental retail destinations (44%).

From the described sample, a total of four socio-economic groups were identified by using the K-modes algorithm and according to the following variables: age, motorized vehicle availability at home, monthly household income, and whether seniors lived alone or did not (Figure 3). Cluster#1 was labelled as “the non-motorised seniors”, including people between 65-75 years old, most of them had not vehicle availability at home, their average monthly household income was around €1000-2000, and mostly they did not live alone. Cluster#2 was called “the motorised seniors”. That is population who were 65-75 years old, with motorised vehicle availability (usually car), with a high monthly household income between €3000-5000, and who usually did not live alone. Cluster#3 were nominated as “older seniors”. Their ages were over 75 years old, without motorised vehicle availability at home, with a low monthly household income (<€1000), and most of them were living alone. Cluster#4 were labelled as “younger seniors”. Their age range was 55-65 years old, with availability of a motorised vehicle at home, medium-high monthly household income (€2000-3000), and rarely lived alone.

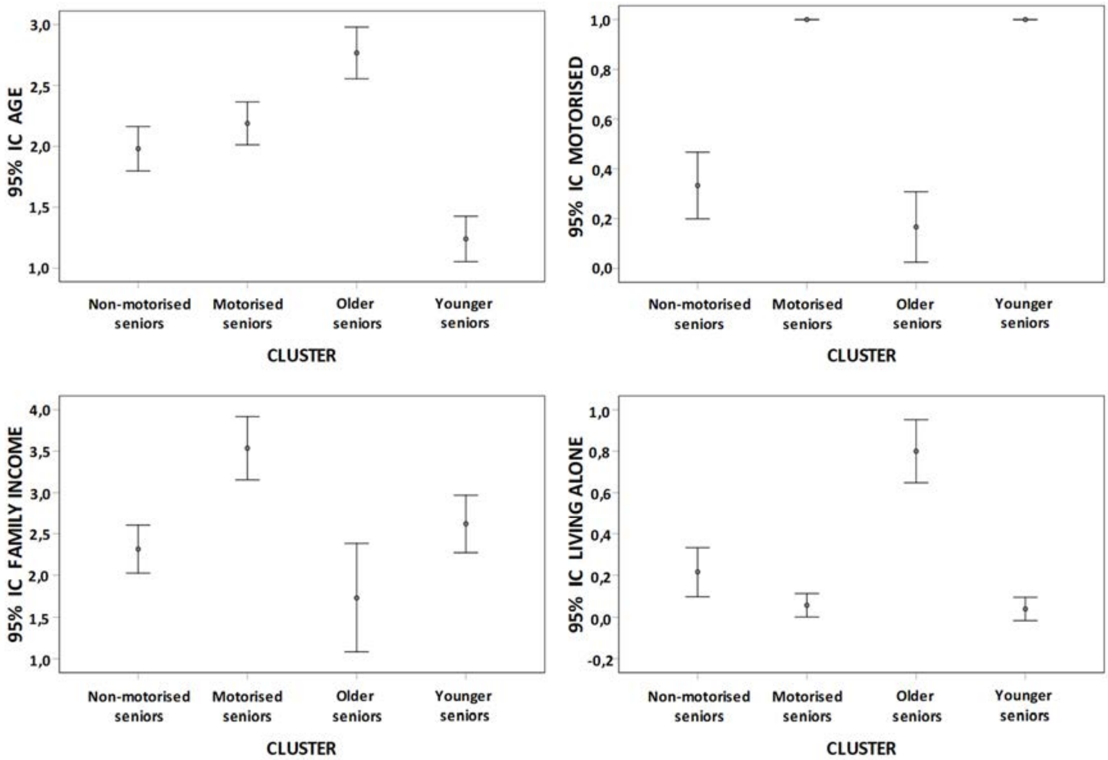

Figure 3: 95% IC error bars by cluster and socio-economic variable

For each socio-economic group, the time-willingness decay functions for walking to daily, weekly and incidental retail were empirically obtained by using the questionnaire described in the methodological section. When analysed the absolute values of the time-willingness decay functions with the Kruskal-Wallis test, significant differences at p-level 0.05 were not found to any type of retail (daily, weekly, and incidental). That meant that there were no differences when the full range of time-willingness decay function was studied. Accordingly, percentiles of time-willingness for walking were then analysed by using again the Kruskal-Wallis test. That would facilitate the identification of significant time-willingness differences for specific time-slots. For both daily and incidental retail significant differences were not found for any particular time-slot (Figure 4a and Figure 4c).

In the case of daily retail, it was seen that the time-willingness decay functions were very similar between the four population clusters. In all cases, participants were not willing to walk more than 15 minutes to reach daily retail locations, as it was generally assumed that daily retail should be located very close to residential areas in the case study. The need for daily retail proximity was especially relevant for the group of “non-motorised seniors” (C#1), since 94% of them are only willing to walk 10 minutes. Most of respondents from the four socio-economic clusters declared that they usually reached daily retail on foot. All clusters preferred local small stores followed by medium-sized stores (e.g., supermarkets) for daily retail. It was also signalled how seniors felt more confident buying in retail stores located in their own neighbourhood and knowing the shopkeeper. No differences between socio-economic clusters were seen in that respect.

For the incidental retail, differences were not found for any particular time-slot. Most of people from the different socio-economic groups stated to be willing to walk until 30 minutes to reach incidental retail destinations. Those average time-willingness were higher than the rest of the retail types because of the infrequent use those stores. Some differences were seen according to the modal choice to reach retail between the clusters. On the one hand, the “non-motorised seniors” (C#1) and the “older seniors” (C#3) opted for reaching incidental retail on foot and by using the public transport, as individuals from those groups tended to go to small and medium stores highly dispersed around the city. On the other hand, the “motorised-seniors” (C#2) and the “younger seniors” (C#4) preferred using the private vehicle to reach bigger shopping centres where incidental retail was mainly concentrated in one single place. Nevertheless, the average to walk to incidental retail were similar between groups of seniors, independently of the mentioned differences regarding modal choice preferences.

The analysis of time-willingness by percentiles showed significant differences for weekly retail. Results showed statistical differences in the time-willingness slots between 20 to 30 minutes, as well as for the 60 minutes (Figure 4b). It indicates that at least one socio-economic cluster had a walking time-willingness decay function significantly different from the other clusters within those time-willingness slots. The results for the Mann-Whitney test, used to identify significant differences between pairs of time-willingness decay functions for weekly retail, shown that the time-willingness decay function for “the younger seniors” (C#4) was significantly different from the other clusters for the 20 to 30 min slot (Figure 4b). This is especially relevant if we consider that 40% of the sample revealed that its willingness to walk to weekly retail was within that 20 to 30 min slot. On the other hand, for the 60 min slot, the distance-decay function for “the motorised seniors” (C#2) is significantly different from the rest of the clusters (Figure 4b). The “younger seniors” (C#4) had one of the lowest willingness to walk to the weekly retail. In particular, the percentage of people included in C#4, who were willing to walk more than 20 minutes to reach the weekly retail is very small compared to the rest of the groups. This suggests that, if weekly retail is located at a distance that takes more than 20 minutes to walk, there would be high probability that the “younger seniors” opted for motorised transport modes. The previous can be explained by the characteristics of the “younger seniors”, who are mostly workers with family responsibilities, so they could have major temporary restrictions in comparison with the rest of senior groups. In addition, the “younger seniors” declared to go more often to weekly retail than the rest of the groups, which increases the need for establishing policies that facilitate the non-motorised access of the “young-seniors” to the weekly retail.

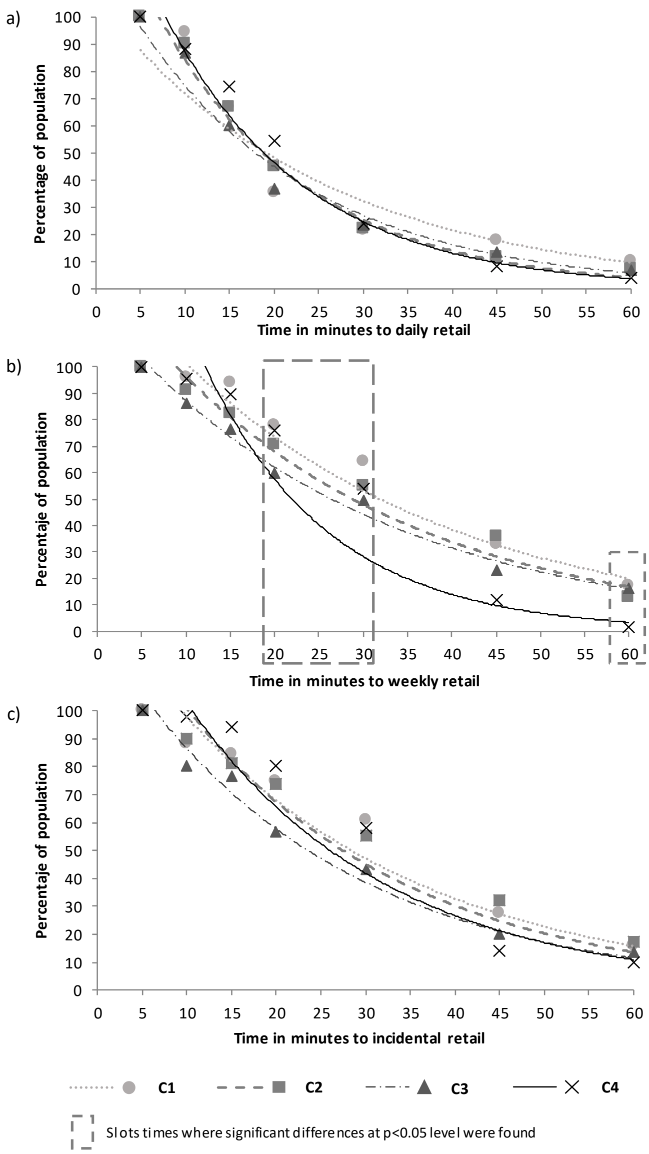

Figure 4: Time-willingness decay functions for daily (a), weekly (b), and incidental (c) retail.

5.2 Mapping relative accessibility

A gravity-based model was used to spatially show the accessibility to weekly retail, as statistical differences were found for this type of retail (Figure 5).

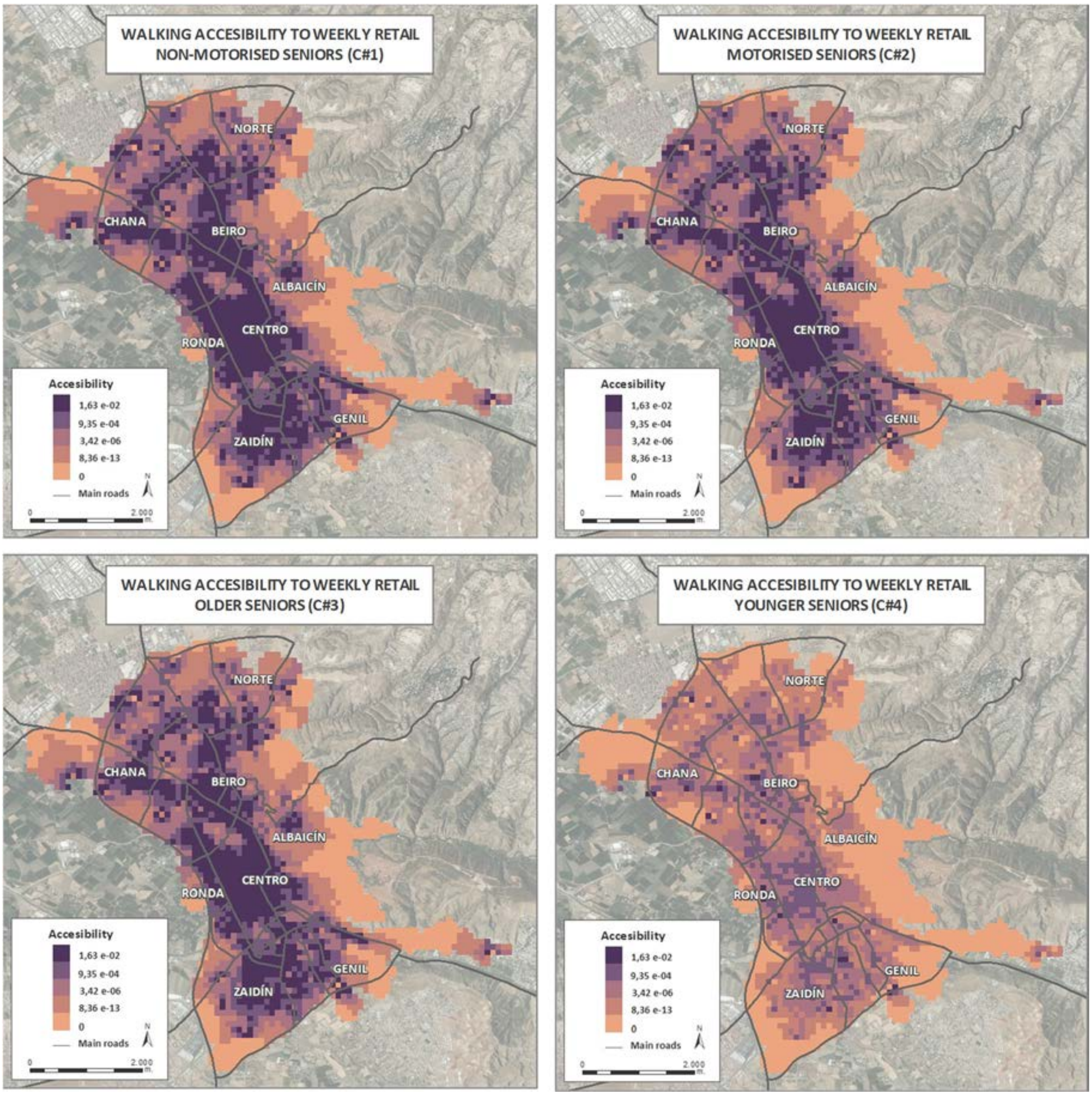

Figure 5: walking accessibility to weekly retail for the four clusters

Results show potential neighbourhoods with risk of presenting higher motorised rates to reach weekly retail, being geographical areas needed for the implementation of policies that foster a transition towards increasing walking accessibility levels to weekly retail. It was noticed that the less willingness to walk to the weekly retail of “younger-seniors” resulted in a loss of accessibility to weekly retail throughout the city. That is particularly relevant in the city centre, where “younger seniors” are less concentrated that the rest of ageing groups. However, weekly retail is highly present in that city centre, resulting in a strong increase of motorised trips from the “younger-seniors” to reach weekly retail.

Spatial analysis also identified places with low levels of walking accessibility to weekly retail for the four socio-economic clusters simultaneously. That is the case of the central-eastern zone. Those neighbourhoods have an important touristic activity and weekly retail does not predominate. However, such accessibility levels to weekly retail are also low in other residential neighbourhoods such as Genil, Chana, and Realejo. In those cases, the situation supposes a challenge for policy makers because of the ratio of senior population is high, leading a higher likelihood of weekly retail trips to the city centre. Policies that enhance the location of weekly retail in the mentioned neighbourhoods, as well as the promotion of pedestrian itineraries to the city centre would facilitate a reduction of traffic congestion in the city centre.

6. CONCLUSIONS AND DISCUSSION

The present research explored the following research questions: *to what extent is walking accessibility to retail activities similar for different socio-economic groups among the senior population?* Obtained results conclude that walking accessibility is significantly different for the case of weekly retail between the four studied clusters of seniors, while it is quite similar for both daily and incidental retail. In particular, it has been evidenced the existence of time-willingness thresholds in the slot between 20-30 minutes to access to weekly retail for the "younger seniors" in comparison with the rest of seniors, who have a significantly less willingness to go to this type of retail on foot for that time slot.

This research has revealed a strong preference between seniors for reaching different types of retail on foot in Granada, especially for "the motorized seniors", "the non-motorized seniors", and "the older seniors". A total of 88% of participants declared to walk to daily retail, 66% to weekly retail, and 44% to incidental retail. Those results diverge from other studies that highlight the high dependence of motorized accessibility to major locations among seniors (Ricciardi et al., 2015). On the contrary, it represents a strong basis for obtaining sustainable planning outcomes in the mid-term in the case study, assuming that around 30% of population in the south of Spain will be over 65 years old (Soria-Lara and Banister, 2017). For that reason, future urban designs should facilitate walking itineraries for seniors (fundamentally for people over 65 years old), avoiding obstacles, stairs, and any other physical barrier that can impede the walking transit. Mapping those physical barriers and designing policies to overcome them are key issues to foster an effective transition towards lower carbon mobility in the city of Granada.

As seen in previous studies, seniors located in peripheries of cities are under situations of disadvantage accessibility in comparison with seniors living in the city centre (Páez et al., 2010). That also happen for walking accessibility to retail in the case study analyzed. On the one hand, the group of "younger seniors" predominate in those locations and they are group with the lowest willingness to reach retail on foot. On the other hand, peripheries use to have a poor dotation of retail (especially weekly retail), which foster motorized trips between the external neighbourhoods of the city and its centre. Representative examples of that situation in Granada are the neighbourhood of Chana and Zaidin. The implementation of policies that encourage the location of new retail in peripheries could help to solve this situation (e.g., reduced taxes), as well as carrying out policies that restrict the access of motorized vehicles to the city centre triggering a higher number of local and short-distance trips.

It was seen how preferences to reach retail on foot was highly related to the presence of small and traditional stores across the city. All socio-economic clusters with the exception of the “younger seniors” declared its preferences for buying in traditional stores, while “younger seniors” preferred using private vehicles to travel to mall shopping centre for weekly retail in the peripheries of the city.

In this respect, legal regulations that protect the small and traditional stores should prevail because of they are one of the most important source of non-motorized trips in Granada. In this respect, e-commerce is also an on-going threat, but it is still unexplored its impact on the time-willingness of seniors to reach retail on foot.

The obtained findings also open new research horizons. For example, by comparing how relevant is the size of the city in the time-willingness of seniors to reach retail on foot, and by analysing how e-commerce can affect to the walking accessibility. Furthermore, the use of living labs by implementing track systems can be another important source of knowledge to understand more in-depth how the walking accessibility of seniors is different for other groups and what to do to foster it.

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REFERENCES

ALSNIH, R., HENSHER, D. A. (2003). The mobility and accessibility expectations of seniors in an aging population. Transportation Research Part A: Policy and Practice, 37(10), pp. 903-916.

ARRANZ-LÓPEZ, A., SORIA-LARA, J. A., LÓPEZ-ESCOLANO, C., PUEYO CAMPOS, Á. (2017). Retail mobility environments: A methodological framework for integrating retail activity and non-motorised accessibility in Zaragoza, Spain. Journal of Transport Geography, 58, pp. 92-103.

ARRANZ-LÓPEZ, A., SORIA-LARA, J. A., LÓPEZ-ESCOLANO, C., PUEYO CAMPOS, Á. (2017). Making ‘Retail Mobility Environments’ visible for collaborative transport planning. Journal of Maps, 13(1), pp. 90–100.

ARRANZ-LÓPEZ, A., SORIA-LARA, J. A., WITLOX, F., PÁEZ, A. (2018). Measuring relative non-motorized accessibility to retail activities. International Journal of Sustainable Transportation, 13(9), 639-651.

BERTOLINI, L. (2017). Planning the mobile metropolis. Transport for people, places and the planet. (Y. Rydin & A. Thornley, Eds.). Palgrave.

BOCAREJO S., J. P., OVIEDO H., D. R. (2012). Transport accessibility and social inequities: a tool for identification of mobility needs and evaluation of transport investments. Journal of Transport Geography, 24, pp. 142–154.

BÖCKER, L., VAN AMEN, P., HELBICH, M. (2017). Elderly travel frequencies and transport mode choices in Greater Rotterdam, the Netherlands. Transportation, 44(4), pp. 831–852.

CAO, X. J., MOKHTARIAN, P. L., HANDY, S. L. (2010). Neighborhood Design and the Accessibility of the Elderly : An Empirical Analysis in Northern California. International Journal of Sustainable Transportation, 4(December 2014), pp. 37–41.

CHANG, H. S., LIAO, C. H. (2011). Exploring an integrated method for measuring the relative spatial equity in public facilities in the context of urban parks. Cities, 28(5), pp. 361–371.

CHIA, J., LEE, J. (BRIAN), KAMRUZZAMAN, M. (2016). Walking to public transit: Exploring variations by socioeconomic status. International Journal of Sustainable Transportation, 10(9), pp. 805–814.

DELBOSC, A., CURRIE, G. (2011). Using Lorenz curves to assess public transport equity. Journal of Transport Geography, 19(6), pp. 1252–1259.

GEURS, K. T., VAN WEE, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. Journal of Transport Geography, 12(2), pp. 127–140.

HILDEBRAND, E. D. (2003). Dimensions in elderly travel behaviour: A simplified activity-based model using lifestyle clusters. Transportation, 30(3), pp. 285-306.

HESS, D. B. (2012). Walking to the bus: Perceived versus actual walking distance to bus stops for older adults. Transportation, 39(2), pp. 247–266.

LORD, S., DESPRÉS, C., RAMADIER, T. (2011). When mobility makes sense: A qualitative and longitudinal study of the daily mobility of the elderly. Journal of Environmental Psychology, 31(1), pp. 52–61.

MORENCY, C., PAEZ, A., ROORDA, M. J., MERCADO, R., FARBER, S. (2011). Distance traveled in three Canadian cities: Spatial analysis from the perspective of vulnerable population segments. Journal of Transport Geography, 19(1), pp. 39–50.

MONIRUZZAMAN, M., PÁEZ, A., NURUL HABIB, K. M., MORENCY, C. (2013). Mode use and trip length of seniors in Montreal. Journal of Transport Geography, 30, pp. 89-99.

NEGRON-POBLETE, P., SÉGUIN, A.-M., APPARICIO, P. (2016). Improving walkability for seniors through accessibility to food stores: a study of three areas of Greater Montreal. Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 9(1), pp. 51–72.

PÁEZ, A., GERTES MERCADO, R., FARBER, S., MORENCY, C., ROORDA, M. (2010). Relative Accessibility Deprivation Indicators for Urban Settings: Definitions and Application to Food Deserts in Montreal. Urban Studies, 47(7), pp. 1415–1438.

PÁEZ, A., MERCADO, R. G., FARBER, S., MORENCY, C., ROORDA, M. (2010). Accessibility to health care facilities in Montreal Island: an application of relative accessibility indicators from the perspective of senior and non-senior residents. International Journal of Health Geographics, 9(1), 52.

PÁEZ, A., NURUL, K. M., MORENCY, C. (2013). Mode use and trip length of seniors in Montreal. Journal of Transport Geography, 30, pp. 89–99.

RICCIARDI, A. M., XIA, J. C., CURRIE, G. (2015). Exploring public transport equity between separate disadvantaged cohorts: A case study in Perth, Australia. Journal of Transport Geography, 43, pp. 111–122.

SORIA-LARA, J.A, BANISTER, D. (2017). Dynamic participation processes for policy packaging in transport backcasting studies. Transport Policy, 58(1), pp. 19-30

STATISTIC NATIONAL INSTITUTE OF SPAIN (2016). Population projections 2016-2066. available at https://www.ine.es/prensa/np994.pdf

UNITED NATIONS (2014). World Urbanization Prospects. available at https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.pdf

VAN WEE, B. (2016). Accessible accessibility research challenges. Journal of Transport Geography, 51, pp. 9–16.

VAN WEE, B., HANDY, S. (2016). Key research themes on urban space, scale and sustainable urban mobility. International Journal of Sustainable Transportation, 10(1), pp. 18–24.