The influence of urban greenspaces on people's physical activity: a population-based study in Spain

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Abstract

Past research has described positive associations between exposure to urban greenspaces and people's physical activity. However, there is variation in the relationship since it may differ according to the type of physical activity, socio-economic factors and use, as well as intrinsic characteristics of greenspaces. This study assesses the influence of urban greenspaces on distinct types of physical activity accounting for indicators such as vegetation quantity, tree cover density and green surface. The study combines data of a survey across Spain (n=2063) with data derived from satellite imagery – including normalized difference vegetation indexes (NDVI), tree cover density and land-use cover data. A generalized linear mixed model was used to evaluate the association between urban greenspaces and physical activity as well as to evaluate the effect of main socio-economic determinants. After adjustment for potential confounders, greater availability in greenspace was found to be related with decreased sedentary time and increased walking. Besides exposure to urban greenspaces, physical activity was found to be associated with household income, pro-environmental attitudes, lifestyles and eating habits. The results also showed that exposure to greenspaces in rural areas had considerably weaker effect than in urban areas. The results suggest that efforts should be made to provide access to new greenspaces where possible, in order to foster walking and improve population health.

Keywords: Physical activity, sedentary behaviour, Greenspace, NDVI, health

1. Introduction

The importance for greenspaces for health and wellbeing has gained increasing attention over recent years (Chiabai et al., 2018). Given the rising burden of non-communicable disease and pressure to develop on existing greenspaces to meet the demands for new properties, it is important we understand how important greenspaces are in encouraging improved health so we can optimise policy in this area. One important relationship is the link between greenspace and physical activity.

Physical activity can be defined as any bodily movement produced by skeletal muscles that requires energy expenditure including activities undertaken while working, playing, carrying out household chores, travelling, and engaging in recreational pursuits (WHO, 2018a). Independent of weight loss, physical activity can provide health benefits such as better physical functions. Past research has demonstrated the beneficial effect of physical activity on the prevention of cardiovascular disease, non-insulin dependent diabetes, obesity, strokes and some types of cancer, among other ailments, including mental struggles such as depression (Foster et al., 2008; WHO, 2018b). Being physically inactive has been shown to double health risks and also can contribute to the shortening of life spans if it persists into middle age (Lim et al., 2012). Approximately 3.2 million deaths per year are caused by physical inactivity (Lim et al., 2012), and globally there are many concerning trends – in England, 70% of adults are not active at recommended levels (Hillston et al., 2006).

Urban greenspaces are facing increasing pressure as a result of the increased population living in urban areas (from 46.6% in 2000 to 69.6% in 2050, see Lee and Maheswaran, 2011). Urban greenspaces can provide multiple benefits to human physical health by fostering an increase in physical activity (Persson et al., 2018; Pereira et al., 2013), improving air quality (García de Jalón et al., 2019), reducing noise pollution (Vivanco-Hidalgo et al., 2019), and protecting against heatwaves and extreme weather events (Li et al., 2019); and contribute to mental health by increasing recreation activities (Foster et al., 2008), reducing stress (Sugiyama et al., 2016) and stimulating societal cohesion (Kruize et al., 2019).

Previous studies have found that people's exposure to urban greenspaces have a positive influence on the amount of physical activity they regularly do (Persson et al., 2018; Gascon et al., 2015) and suggested that increased exposure to greenness is associated with better health such as lower levels of obesity (Pereira et al., 2013; Toftager et al., 2011). As well as providing open space for walking and jogging, urban greenspaces provide space for both formal and informal sporting activity. It is important to note that parks can also have an effect on certain sedentary activities through socialization while encouraging at the same time physical movement, and they at least provide a destination to walk to (García de Jalón et al., 2020).

To understand the relationship between how the existence of urban greenspaces can positively influence physical activity, it is important to first understand which factors influence physical activity. Cohen et al. (2007) conducted an experiment by observing frequency of use in 8 urban parks in the inner city Los Angeles, over the course of December 2003 to May 2004. Using both quantitative and qualitative methods, the authors found that age (being younger), gender (being male), and distance (living within 1 mile of park) were all positively correlated with park use and frequency of exercise. Those who lived within the one-mile radius were 4 times more likely to visit the park and had approximately 38% more exercise sessions per week than those who were living outside of this radius. Rather than focusing on determinants at the individual level, social and physical environments have been suggested to play a larger role. Giles-Corti & Donovan (2002) surveyed a community of 1803 individuals aged 18 to 59 living in a metropolitan area of Perth, Australia. The physical environment which influences physical activity was essentially defined as access to recreational facilities. Of the group of respondents, more than 59% were exercising at recommended levels and the physical environment was secondary to the individual and social environment. Existence of facilities or open spaces nearer to the home were used more often than those located further away. Social interaction and support was found to be quite important for sustaining physical activity amongst the respondents – for example, those with exercise partners or who participated in sporting clubs were more frequently achieving recommended levels of activity. People who had regularly exercised in the past were also found to exercise more than those who did not previously have that routine.

Urban greenspaces have a significant potential in improving public health with psychological, social, environmental and economic benefits (Hunter et al., 2015). Some of the benefits include improved general attitude, reduction of stress, better mental health, improved creativity, and higher social capital. Spending time in nature is proven to produce levels and patterns of chemicals in the brain associated with low stress and positive impacts on blood pressure (Astell-Burt et al., 2013). Pretty et al. (2005) analysed whether there is a positive correlation in taking up physical activity while also being directly exposed to nature, namely "green exercise". In their study, five groups of 20 people were tested running on treadmills while being exposed to different scenes – urban pleasant, urban unpleasant, rural pleasant, and rural unpleasant. The control group was tested on the treadmill with no use of imagery, and exercise mixed with the several different scenes had a clear and strong effect on blood pressure and mood. Although exercise alone had a significant effect in reducing blood pressure, increasing self-esteem, and positive effects on mood measures, exercise as well as exposure to pleasant green rural environments and pleasant green urban environments strengthened the positive effect of exercise on self-esteem relative to that of the control group. Greenspaces also promote social capital because their existence provides a pleasant space to share conversation and social interaction with neighbours and locals, which is especially important for older people.

A body of evidence highlights the connection between urban greenspace and physical activity – in that it supports an easy and cost-beneficial option for recreation or travel, with open paths for cycling, walking, and running. Hunter et. al (2015) conducted a review of interventions promoting physical activity in urban greenspaces, including twelve case studies. The case studies included had to be interventions encouraging physical activity that promoted use of greenspace through either a physical change to the greenspace or an intervention directly affecting physical activity, or both. The results showed that programmes which included a change to the built environment had a positive effect on physical activity. The authors identified certain gaps in the literature which included a need for longer term post intervention follow up, satisfactory control groups, and taking into account the social environment which has not been adequately utilised in this type of study thus far.

Despite the number of studies addressing the benefits of "green exposure" to the promotion of physical activity, there are still gaps in the literature that need to be properly addressed. First of all, studies have largely focused on specific areas and neighbourhoods, thus limiting the generalization of results. Also, they tend to focus on a specific type of activity. Given the fact that even mild levels of physical activity such as walking may be beneficial (WHO, 2018b; Pereira et al., 2013), it is important to explore these different modalities. Moreover, previous studies have found different levels of association between the exposure to greenspaces and physical activity (Bancroft et al., 2015; Hartig et al., 2014; Hunter et al., 2015; James et al., 2015; Lachowycz and Jones, 2011). This could be explained because of studies do not differentiate between the effects of distinct types of "urban green vegetation". Thus, since different traits of greenspaces are not considered when assessing the influence on physical activity, the comparison across studies is limited.

This study uses analysis of cross-sectional data to assess the influence of urban greenspaces exposure on people's physical activity exploring its main socio-economic determinants. The study contributes to the literature in two main ways: i) assessing the effect of greenspaces on a whole country by the use of a representative survey and ii) through the combination of a citizenship survey with vegetation indices from satellite imagery to evaluate the effect of different greenspace indicators such as vegetation quantity, tree cover density and green surface on walking, moderate and vigorous activity.

2. Materials and Methods

The methodology can be separated in three steps: *i)* design and implementation of the survey across Spain to assess people's physical activity, *ii)* estimation of the availability of urban green spaces through satellite imagery data and, *iii)* evaluation of the influence of urban greenspace and main socio-economic determinants on physical activity.

2.1. Citizen survey

The data on activity and socioeconomic factors used in this study were gathered from a survey conducted in Spain. in July–August 2018. A comprehensive one-on-one pretesting using semi-structured interviews in Spring 2018 and a pilot survey was carried out in June 2018. The survey formed part of a wider study across five countries on reaching a healthier and more sustainable society (Zvěřinová et al, 2020), as part of the European Commission funded INHERIT project (www.inherit.eu).

The final data for the sample consists in a total of 2063 observations. The sample is representative of national populations aged from 18 to 65 years in terms of gender, age, region, and education. Sample proportions deviated from few quotas set. Based on the population shares, we derived the weights to make the sample representative with respect to gender, age, education, and region. For data analysis the weights were used. Figure 1 shows those areas of zip codes included in the sample of the survey and compares them with main urban areas in Spain.

A web-based survey instrument was used. Data quality was monitored with regard to the length of the questionnaire in order to avoid those respondents who may flip through the questions without properly reading them in the self-administered mode. Thus we excluded those who sped through the survey – leaving a total of 2063 responses. According to the recommendation of Survey Sampling International (Mitchell, 2014), speeders are defined as those respondents who completed the questionnaire in 48% of the median time computed for their segment. After excluding the speeders, the median time to complete the questionnaire was 37 minutes in the main wave. Ethical approvals for the Spanish case were obtained from Institutional Review Board of Charles University Environment Centre and Ethics Committee of University of Alcalá.

The survey aimed to assess sustainable and healthy lifestyles in Spain. A section on physical activity was included at the beginning of the questionnaire, after providing consent and screening questions, while socio-demographic questions were placed at very end. Sections on dietary patterns and food consumption, experiments on changing respondent's lifestyle, future scenarios, and environmental concerns were placed in the middle (see Zvěřinová et al., 2020 for more details).

As a measure of physical activity, a standardized short-form version of the International Physical Activity Questionnaire (IPAQ-SF) (Craig et al., 2003; Lee et al., 2011) was used. The IPAQ-SF records the activity of four intensity levels – vigorous, moderate, walking and sitting – over the last 7 days. Due to time constraints, two questions related to sitting (the last in IPAQ-SF) were excluded. Based on the pre-survey results, we also slightly modified the wording of the questions concerning the length of time spent on the activities. The IPAQ scoring may be used to derive a Metabolic Equivalent of Task (MET) to measure the intensity of physical activity of each respondent to be potentially used in subsequent econometric modelling.

< INSERT FIGURE 1 >

2.2. Urban greenspaces

Urban greenspaces were evaluated based around satellite data using three different indicators: vegetation quantity, tree cover density and green surface. The quantity of vegetation was measured through the Normalized Difference Vegetation Index (NDVI). The satellite images were retrieved from the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite (Didan, 2015). NDVI is a vegetation indicator, typically utilised in remote sensing measurements, and assesses whether a particular area or pixel contains live green vegetation or not. Tree cover density data was obtained from the pre-processed multitemporal high resolution satellite image data from Tree Cover Density (TCD) 2015 (Sentinel-2, Landsat 8, https://land.copernicus.eu/). Tree cover canopy density represents the estimated percentage of an area that is covered by tree canopy, as determined from the analysis of satellite imagery. The data has a spatial resolution of 20m. The surface of urban greenspaces available for each survey respondent was measured through the land cover dataset CORINE Land Cover 2018, from the European Land Monitoring Service (http://land.copernicus.eu/). CORINE provides information of current land uses in Europe at 100m resolution.

In order to only consider urban areas and to exclude other land uses, a map indicating urban areas was generated (Figure 1, Map 1a). The urban areas map was utilized to overlay the maps of greenspace indicators (vegetation quantity, tree cover density and green surface) in order to only analyse greenspaces within urban areas. Through the map of zip code areas (Figure 1, Map 1b) the average of each indicator was calculated in every zip code area. Since the zip code information of each respondent was obtained in the survey the datasets on urban greenspaces could be merged with the database of the survey. Thus, the survey questions could be related to people's exposure to urban greenspaces in Spain at approximately at a neighbourhood level. The spatial analysis was done using R (R Core Team, 2020).

2.3. Assessing the influence of urban greenspaces on people's physical activity

A generalized linear mixed model was used to evaluate the association between urban greenspaces and different types of physical activity (walking, moderate and vigorous) as well as to evaluate the effect of main socio-economic determinants.

For the selection of the econometric model it is important to consider the nature of the dependent variable which was measured as the number of days a week and the number of minutes per day doing physical activity. Since the number of days is a count variable it is statistically inappropriate to analyse it through linear regression model, since the estimates would be inefficient, inconsistent, and biased (Long and Freese, 2014). Count data models are appropriate in this case since the variables of interest are non-negative integer-valued random variables. This type of distribution has been widely used in literature analysing product innovation and patents (Bronzini and Piselli, 2016; Siegel and Wessner, 2012), demand for health services (Elhay et al 2008; Winkelmann, 2004), tourism activities (Alén et al, 2014; Prebensen et al, 2015), and also physical activities (Downward and Rasciute, 2015; Jerrett, et al. 2013).

In the model, the number of days doing physical activity (y_i) represents count data. Here we examined and compared the Poisson regression model, the Negative Binomial (NB) regression model, the Zero Inflated Poisson (ZIP) and the Zero Inflated Negative Binomial (ZINB), to represent accurately the nature of the dependent variables in this study (see Green, 2018; Long and Freese, 2014).

The Poisson model assumes equi-dispersion, i.e. the mean and variance being equal. In our analysis, the expected value of days a week doing the different types of physical activity (μ) for each individual is:

$$\mu_i = exp(X_i\beta) \qquad \text{Eq. 1}$$

where X_i is the explanatory variables matrix including exposure to urban greenspaces, socio-economic factors, behaviours and personal norms. β is the vector of unknown parameters to be estimated. The Poisson model captures the discrete and non-negative nature of the dependent variable and allows drawing inference on the probability of a given individual behaviour.

When the model presents over-dispersion (the variance exceeds the mean) or under-dispersion (the variance is smaller than the mean), NB is more accurate since estimated parameters in the Poisson model are proved not being efficient and NB produces coefficients that are robust to distributional misspecification. The NB adds to the Poisson model the error term (ε) according to the following equation:

$$\mu_i = exp(X_i\beta + \varepsilon_i) \qquad \text{Eq. 2}$$

where $exp(\varepsilon_i)$ has a gamma distribution with mean 1 and variance α. We tested α significance in order to determine if the Poisson model or NB would be more appropriate.

The remaining two models, ZIP and ZINB, were mainly used to account for the frequency of zero counts, that is, in cases where regression structure allowed non-walkers ($y_i=0$) to be considered through a different data generation process to the walkers ($y_i>0$). These models simultaneously ran two equations: a binary equation to model the zeros in the dependent variables and a count data estimation (negative binomial or Poisson) to model the count data dependent variables. Here we tested the equality between conditional variance and conditional mean in the distribution of the dependent variable in order to determine the appropriateness of the model. A Vuong test was used to conclude if the zero inflated model was preferred to the zero non-inflated model (Vuong, 1989). For each situation, the more accurate model according to the described tests were used for the estimation.

3. Results

3.1. Availability of urban greenspaces in Spain

A map for each indicator of availability of urban greenspaces (excluding agricultural and forest land-uses) was generated (Figure 2): vegetation quantity (hereafter "NDVI", upper-left map), tree cover density (hereafter "TREE COVER", upper-right map) and surface of greenspaces (hereafter "CORINE", lower-left map). The maps show that small towns and villages tend to have lower values than cities in the three greenspace indicators. Despite the fact that small towns and villages in general have higher proportions of greenspaces than cities, cities tend to have higher proportions if only urban land uses are considered (as agricultural and forest land-uses are excluded). In this line, the metropolitan areas of Madrid and Barcelona are the ones with more urban greenspaces. In terms of regionals differences, it seems that urban areas in the Mediterranean coast and in the centre of Spain, i.e. Madrid, tend to have a higher proportion of urban greenspaces than in the rest of the country. Although different approaches were used to measure the three indicators the maps seem to show similar patterns of geographical distribution. The bottom-right boxplots show the dispersion of the values of the three greenspace indicators. NDVI had a distribution range wider than the other two urban greenspaces indicators.

< INSERT FIGURE 2 >

3.2. The effect of urban greenspace availability on physical activity

Walking was the type of physical activity most commonly done amongst the respondents. The average of the number of days a week doing walking activities (including walking at work and at home, walking to travel from place to place, and any other walking done for recreation, sport, exercise, or leisure for at least 10 minutes at a time) was around 4.7 days. The average frequency of moderate activities (those that take moderate physical effort, which makes someone breathe somewhat harder than normal, such as bicycling at a regular pace, gardening, or carrying light loads) was 2 days a week, and the average frequency of vigorous activities (those that take hard physical effort, which makes someone breathe much harder than normal, such as fast bicycling, aerobics, heavy lifting, or digging) was 1.6 days a week. Within those activities done seven days a week, walking represented 82% of the activities, followed by moderate (11%) and vigorous (7%) (Figure 3). Of all Spanish respondents only 44.5% reported zero days of vigorous physical activity (898 respondents), 35.5% zero days of moderate (716 resp.), and 7% zero days of walking (144 resp.).

< INSERT FIGURE 3 >

The results of the survey indicated that there was even number of males and females, with average age at 42 years (after weighting). There were 40 % respondents with primary and lower secondary education and 34 % with tertiary education. Average household net monthly income was 1,850 PPS EUR. About 0.62 children under the age of 18 lived with a respondent in her/his household and there were 41 % of respondents with no child under the age of 18 living with them. Table 1 provides a description of the survey variables used in the analysis and their scales used to assess the influence of the determinants of people's physical activity. "Do not know" responses were treated as missing values.

< INSERT TABLE 1 >

Figure 4 shows the relationship between the Pearson correlation coefficients of people's physical activity and the correlation coefficients of the determinants and vegetation quantity (NDVI) and the other determinants (see full Pearson correlation coefficient matrix in Table S.2). Older people, those who care more about being healthy, feel stronger moral obligations to protect environment (Stern et al. 1999; De Groot and Steg, 2007), and avoid using cars tend to do more walking activities (Panel 1 in Figure 4). The correlations of the determinants can be divided into two different groups, where one group mainly had positive correlations in both axes and the other had mainly the negative ones. Thus a relationship between the correlations of vegetation quantity and walking can be identified. In the case of moderate (Panel 2) and vigorous (Panel 3) activities, results show males and younger people tended to do these types of exercise more days a week than females and older people. Furthermore, those respondents with higher incomes and education tend to live in areas with higher vegetation quantity in urban spaces. In the case of income, it is worth highlighting that this variable has a positive correlation with the three types of physical activity.

< INSERT FIGURE 4 >

Table 2 presents the regression results of the zero non-inflated model for assessing the influence of the selected determinants on the number of days doing walking, moderate and vigorous physical activity. In each type of physical activity, three different regressions were conducted for each urban greenspace indicator: vegetation quantity (NDVI), green surface (CORINE) and tree cover density (TREECOV). Walking was the only type of physical activity that was significantly influenced by the availability of urban greenspaces. Within the walking regressions, only urban vegetation quantity had a positive and significant effect on increasing the number of days of physical activity *(β=0.45, $p < 0.01$)*. Green surface and tree cover density did not have a significant effect on people's physical activity *($p < 0.01$)*.

Overall, whilst males and younger people tend to do more moderate and vigorous activity, females and older people seem to walk more. Furthermore, we examined whether or not the relationship between age and physical activity differed by sex. In the three types of physical activity, we found out that the influence of age on physical activity was considerably higher in males than in females, suggesting that females are less affected by age on the amount physical activity they regularly do or suggesting that males gradually substitute vigorous for moderate and then for walking.

The results show that people that are highly concerned with the environment and have high income are more likely to spend more time walking. However, this effect was not found with the amount of moderate or vigorous activity.. Furthermore, those respondents who required higher thermal comfort at home were less likely to walk. The usage of cars to go hiking turned out to be inversely correlated with walking but directly correlated with doing vigorous activity.

We examined differences between respondents who stated that they used their own cars and those who walked in order to do different activities such as going to work, taking the children to school, going to school or university, and doing social activities, shopping, sport or leisure activities (see Figure S.1 in the Supplementary Material). In all activities, people who used more their own car then tend to walk less. Lind et al. (2015) and Abrahamse et al. (2009) found that people with stronger environmental personal norms were more prone to change from private car to more sustainable transport modes such as walking or cycling.

Respondents who value most being healthy tended to walk more than those ones who consider that being healthy is less important. Finally, respondents who lived in small cities (< 5,000 inhabitants) turned out to walk significantly less that people who lived in greater cities. This can be explained because in small villages people tend to use more their own car, as distances to shops, bars or restaurants, or cinema are often larger than in highly densely populated cities. Furthermore, when separately assessed, we found that the influence of urban greenspaces on physical activity increased as the population size of the city, town or village increased.

< INSERT TABLE 2 >

4. Discussion

It is well documented that physical activity has numerous positive effects on well-being. Although physical inactivity and living a sedentary lifestyle does not always directly contribute to health impediments, it affects long-term health through different channels such as the prevention of cardiovascular diseases, diabetes, obesity, strokes and some types of cancer (Penedo and Dahn, 2005). If greenspaces in urban zones can decrease the sedentary lifestyle by providing the opportunity to encourage people's use of their surroundings, there is significant incentive to encourage opening or enhancement of more urban greenspaces.

Our results suggest that the influence of urban greenspaces on the probability of people doing physical activity varies according to the type of activity. This could explain why some studies found that greenspaces reduced the likelihood of being overweight by offering suitable spaces that encourage physical activity (e.g. Hartig et al., 2014; Lee and Maheswaran, 2011) and others did not find a positive relation between greenness and physical activity or found an inverse relation (Persson et al., 2019). Reviews of epidemiological studies have found that exposure to greenspaces has been inconsistently associated with physical activity (Bancroft et al., 2015; Hartig et al., 2014; Hunter et al., 2015; James et al., 2015; Lachowycz and Jones, 2011). One reason of this inconsistent association could be due to studies widely differing in their definition of greenspace exposure (Klompmaker et al., 2018). This explanation is in line with our results as whilst vegetation quantity in urban areas had a significant effect on increasing walking, green surface did not have a significant effect and tree cover was only significant at $p < 0.1$. This could be explained because parks with limited vegetation areas are often classified as urban greenspaces, but probably they do not provide the same motivations described above for fostering physical activity. Thus urban parks with higher vegetation quantity including trees, shrubs and grasses seems to be higher incentive for physical activity than parks with lower vegetation density. Indeed, the quality of and distance to urban greenspaces was found to be related to increased frequency of physical activity. In this way, it was proposed that urban greenspaces should be clean and well-maintained (Duncan and Mummery, 2005; McCormack et al., 2010, Akpinar, 2016), more open, visible, as well as close to people's homes (Akpinar, 2016) to improve physical activity.

Compared with moderate and vigorous activity, walking was by far the activity most commonly done. In the case of walking, there was a positive relationship with age, indicating that older people were more likely to walk more than younger people. In fact, our results showed that people between 50 and 65 were the age group that walked the most. This finding confirms Buehler et al. (2020) as they found that people within the age group between 45 and 65 had the highest prevalence of walking. Urban greenspaces can be considered to promote the process of active ageing and healthy ageing among society. However, in the case of moderate and vigorous activity, there was a clear inverse relationship with age, indicating that older people were considerably less likely to do moderate and vigorous physical activity.

Past research has shown that the influence of the exposure to urban greenspaces on people's physical activity is different depending on the socioeconomic status of the area (Gordon-Larsen et al., 2000; Godbey et al., 2005; Chiabai et al. 2020). Our findings showed that people with higher incomes were more likely to do physical activity and this was accentuated in the case of walking. However, the influence of greenspaces on physical activity did not significantly vary amongst the different income groups of the survey. This could be due to instead of focusing on the association among poorer or richer neighbourhoods our study focused on household income among survey respondents without considering differences amongst the socioeconomic status of the area. Previous studies highlighted that urban greenspaces can play a key role on fostering physical activity in low-income communities (Bedimo-Rung et al., 2005; Godbey et al., 2005). A study by Gordon-Larsen et al. (2000) analysed environmental determinants as well as the impact of socio-demographics in physical activity patterns amongst U.S. adolescents. The authors found that physical activity was lower for non-Hispanic black and Hispanic teenagers, but participation in daily physical education or use of community recreation centres were positively associated with a higher probability of engaging in moderate to vigorous physical activity. The literature review conducted in Chiabai et al. (2020) found key patterns emerging throughout past research and identified main determinants affecting the relationship between urban greenspaces and health effects. Considering the correction for the publication bias, the study found that as a result of increased exposure to urban greenspaces health risks were reduced more in poorer neighbourhoods.

As shown in the results section, people living in cities greater than 5,000 inhabitants had higher likelihood to walk more than residents in small cities or towns. In fact, the influence of urban greenspaces on physical activity increased as the population size of the neighbourhood increased. Similar results were found in Whitfield et al. (2019). Through the U.S. 2015 National Health Interview Survey, Cancer Control Supplement (n = 29,925), the authors examined among U.S. adults two different types of walking, for leisure and transportation and found that urban residents in high-density neighbourhoods tended to walk more than rural residents. This could be due to perceived higher walkability (how friendly an area is to walking) in urban built environments with higher density of activity-friendly routes (e.g., footpaths) to everyday destinations in comparison to rural environments. Furthermore, perceived walkability has positively been associated with time walking and doing different physical activities (Nichani et al., 2019).

Typically, there is more greenspaces, including forests and agricultural land, in rural villages and low-density neighbourhoods than in high-density neighbourhoods. Nevertheless, our measurements showed higher values for the three indicators of urban greenspace in high-density neighbourhoods than in low-density neighbourhoods or in rural areas. This is due to our measurements only considered urban built environments and excluded those areas not classified in the CORINE LAND COVER layer as urban land-use, i.e., forests, grasslands and agricultural lands. The inclusion of these land-uses when assessing the relationship between greenness and physical activity could explain the inverse relationship found in previous studies (e.g. Persson et al., 2019) as despite having more greenspaces, walkability can be lower in rural areas (Whitfield et al., 2019). Moreover, the rurality effect could be an important moderator when evaluating the relationship between active commuting walking and environmental factors. Attention needs to be paid to rural-urban differences to avoid unintended consequences when assessing these relationships (Fan et al., 2017).

5. Conclusions

The findings in this study suggest a positive relationship between availability of urban greenspaces and walking – thus adding to the body of evidence showing an influence of greenspace on activity. This could be explained by perceived health benefits associated to the local environment such as protecting against extreme temperatures, improving air quality or reducing noise pollution and some benefits associated to mental health and to the stimulation of social contacts.

There are some nuances that are worth taking into account when assessing the influence of greenspaces on people's physical activity. Firstly, the influence of greenspace indicators on people's physical activity differ according to the type of physical activity. This study found that the availability of urban greenspaces only had a positive and significant influence on walking and did not have significant influence on moderate or vigorous activities. In regards to the effect of greenspace indicators such as vegetation quantity, tree cover density and green surface, we only found a significant effect *($p < 0.01$)* in the case of vegetation quantity which was measured through the NDVI index. Thus, the inconsistent association found in the literature between greenspace and physical activity could be due to the fact that studies differed in their definition of greenspace exposure.

The association between exposure to urban greenspaces and walking remains relevant even after controlling the effect of individual determinants, such household income, pro-environmental attitudes, lifestyles and eating habits. The analysis also revealed that exposure to greenspaces in rural areas had considerably weaker effect that in urban areas. Finally, the results seem to indicate that public interventions could aim to foster physical activity by promoting parks with high vegetation quantity and improving greenspace accessibility in densely populated areas since the influence of greenspaces on people's physical activity increased as population density increased.

References

Abrahamse, W., Steg, L., Gifford, R., Vlek, C., 2009. Factors influencing car use for commuting and the intention to reduce it: a question of self-interest and morality? Transp. Res. F Traffic Psychol. Behav. 12, 317–324.

Akpinar, A., 2016. How is quality of urban green spaces associated with physical activity and health? Urban Forestry & Urban Greening 16, 76–83.

Alén, E., Nicolau, J.L., Losada, N., Domínguez, T., 2014. Determinant factors of senior tourists' length of stay. Annals of Tourism Research, 49, 19-32.

Astell-Burt, T., Feng, X., Kolt G.S., 2013. Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: Evidence from 260,061 Australians. Preventive Medicine 57 (5), 601-606.

Bancroft, C., Joshi, S., Rundle, A., Hutson, M., Chong, C., Weiss, C.C., Genkinger, J., Neckerman, K., Lovasi, G., 2015. Association of proximity and density of parks and objectively measured physical activity in the United States: a systematic review. Soc. Sci. Med. 138, 22-30.

Bedimo-Rung, A.L., Mowen, A.J., Cohen, D.A., 2005. The significance of parks to physical activity and public health. A conceptual model. American Journal of Preventive Medicine 28 (2), 159-168.

Bronzini, R, Piselli, P, 2016. The impact of R&D subsidies on firm innovation. Research Policy, 4, 5442–457.

Buehler, R., Pucher, J., Bauman, A., 2020. Physical activity from walking and cycling for daily travel in the United States, 2001–2017: Demographic, socioeconomic, and geographic variation. Journal of Transport & Health 16, 100811.

Chiabai, A., Quiroga, S., Martinez Juarez, P., Suarez, C., García de Jalón, S., Taylor, T., 2020. Exposure to green areas: Modelling health benefits in a context of study heterogeneity. Ecological Economics 167, 106401.

Chiabai, A., Quiroga, S., Martinez-Juarez, P., Higgins, S., Taylor, T., 2018. The nexus between climate change, ecosystem services and human health: towards a conceptual framework. Sci. Total Environ. 635, 1191–1204.

Cohen, D.A., McKenzie, T.L., Sehgal, A.S., Williamson, S., Golinelli, D., Lurie, N., 2007. Contribution of Public Parks to Physical Activity. Am J Public Health 97, 509–514.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B.E., et al., 2003. International physical activity questionnaire: 12-Country reliability and validity. Medicine and Science in Sports and Exercise, 35(8), 1381–1395.

De Groot, J., Steg, L., 2007. Value Orientations and Environmental Beliefs in Five Countries: Validity of an Instrument to Measure Egoistic, Altruistic and Biospheric Value Orientations. Journal of Cross-Cultural Psychology 38(3), 318-332.

Didan, K., 2015. MOD13A1 MODIS/Terra Vegetation Indices 16-Day L3 Global 500m SIN Grid V006 [Data set]. NASA EOSDIS Land Processes DAAC. doi: 10.5067/MODIS/MOD13A1.006.

Downward, P., Rasciute, S., 2015. Assessing the impact of the National Cycle Network and physical activity lifestyle on cycling behaviour in England. Transportation Research Part A: Policy and Practice, 78, 425-437.

Duncan, M., Mummery, K., 2005. Psychosocial and environmental factors associated with physical activity among city dwellers in regional Queensland. *Preventive Medicine 40*(4), 363–372.

Elhai, J.D., Calhoun, P.S., Ford, J.D., 2009. Statistical procedures for analyzing mental health services data. Psychiatry Research, 160, 129-136

Fan, J.X., Wen, M., Wan, N., 2017. Built environment and active commuting: Rural-urban differences in the U.S. SSM - Population Health 3, 435-441.

Foster, G.D., Sherman, S., Borradaile, K.E., Grundy, K.M., Vander Veur, S.S., Nachmani, J., Karpyn, A., Kumanyika, S., Shults, J., 2008. A Policy-Based School Intervention to Prevent Overweight and Obesity. Pediatrics 121, 794–802.

García de Jalón, S., Burgess, P.J., Curiel Yuste, J., Moreno, G., Graves, A., Palma, J.H.N., Crous-Durán, J., Kay, S., Chiabai, A., 2019. Dry deposition of air pollutants on trees at regional scale: a case study in the Basque Country. Agricultural and Forest Meteorology 278, 107648.

García de Jalón, S., Chiabai, A., Mc Tague, A., Artaza, N., de Ayala, A., Quiroga, S., Kruize, H., Suárez, C., Bell, R., Taylor, T., 2020. Providing access to urban greenspaces: A participatory benefit-cost analysis in Spain. International Journal of Environmental Research and Public Health 17, 2818.

Gascon, M., Triguero-Mas, M., Martinez, D., Dadvand, P., Forns, J., Plasencia, A., et al., 2015. Mental health benefits of long-term exposure to residential green and blue spaces: a systematic review. Int. J. Environ. Res. Public Health 12, 4354–4379.

Giles-Corti, B. Donovan, R.J., 2002. The relative influence of individual, social and physical environment determinants of physical activity. Social science & medicine, 54(12), 1793-1812.

Godbey, G.C., Caldwell, L.L., Floyd, M., Payne, L.L., 2005. Contributions of leisure studies and recreation and park management research to the active living agenda. American journal of preventive medicine 28 (2), 150-158.

Gordon-Larsen, P., McMurray, R.G. and Popkin, B.M., 2000. Determinants of adolescent physical activity and inactivity patterns. Pediatrics, 105(6), 83-83.

Greene, W., 2018, Econometric Analysis, New York: Pearson, 8thed.

Hartig, T., Mitchell, R., de Vries, S., Frumkin, H., 2014. Nature and health. Annu Rev. Public Health 35, 207-228.

Hillsdon, M., Panter, J., Foster, C. and Jones, A., 2006. The relationship between access and quality of urban greenspace with population physical activity. Public health, 120(12), 1127-1132.

Hunter, R.F., Christian, H., Veitch, J., Astell-Burt, T., Hipp, J.A., Schipperijn, J., 2015.The impact of interventions to promote physical activity in urban green space: a systematic review and recommendations for future research. Soc. Sci. Med. 124, 246-256.

James, P., Banay, R.F., Hart, J.E., Laden, F., 2015. A review of the health benefits of greenness. Curr. Epidemiol. Rep., 2, 131-142

Jerrett, M., Almanza, E., Davies, M., Wolch, J., Dunton, G., Spruitj-Metz, D., Pentz, M.A., 2013. Smart growth community design and physical activity in children, American Journal of Preventive Medicine, 45. 386-392

Klompmaker, J.O., Hoek G., Bloemsma, L.D., Gehring, U., Strak, M., Wijga, A.H., van den Brink, C., Brunekreef, B., Lebret, E., Janssen, N.A.H., 2018. Green space definition affects associations of green space with overweightand physical activity. Environmental Research 160, 531-540.

Kruize, H., van der Vliet, N., Staatsen, B., Bell, R., Chiabai, A., Muiños, G., Higgins, S., Quiroga, S., Martinez-Juarez, P., Aberg Yngwe, M., Tsichlas, F., Karnaki, P., Lima, M.L., García de Jalón, S., Khan, M., Morris, G., Stegeman, I., 2019. Urban Green Space: Creating a Triple Win for Environmental Sustainability, Health, and Health Equity through Behavior Change. Int. J. Environ. Res. Public Health 16, 4403.

Lachowycz, K., Jones, A.P., 2011. Greenspace and obesity: a systematic review of the evidence. Obes. Rev. 12, 183-189.

Lee, A.C. Maheswaran, R., 2011. The health benefits of urban green spaces: a review of the evidence. Journal of public health, 33(2), 212-222.

Lee, P.H., Macfarlane, D.J., Lam, T., Stewart, S.M., 2011. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. International Journal of Behavioral Nutrition and Physical Activity 8(1), 115.

Li, Z., Chow, D.H.C., Yao, J., Zheng, X., Zhao, W., 2019. The effectiveness of adding horizontal greening and vertical greening to courtyard areas of existing buildings in the hot summer cold winter region of China: A case study for Ningbo. Energy and Buildings 1961, 227-239.

Lim, S.S., Vos, T., Flaxman, A.D., et al., 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 380, 2224-2260.

Lind, H.B., Nordfjærn, T., Jørgensen, S.H., Rundmo, T., 2015. The value-belief-norm theory, personal norms and sustainable travel mode choice in urban areas Journal of Environmental Psychology 44, 119-125.

Long, J. S., Freese, J., 2014. Regression Models for Categorical Dependent Variables Using Stata. 3rd ed. College Station, TX: Stata Press.

Li, L., Uyttenhove, P., Van Eetvelde, V., 2020. Planning green infrastructure to mitigate urban surface water flooding risk – A methodology to identify priority areas applied in the city of Ghent. Landscape and Urban Planning 194, 103703.

Mccormack, G.R., Rock, M., Toohey, A.M., Hignell, D., 2010. Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health & Place 16*(4), 712–726.

Mitchell, N., 2014. The Changing Landscape of Technology and Its Effect on Online Survey Data Collection. Survey Sampling International website. Retrieved from: https://www.surveysampling.com/site/assets/files/1583/the-changing-landscape-of-technology-and-its-effect-on-online-survey-data-collection.pdf.

Nichani, V., Vena, J.E., Friedenreich, C.M., Christie, C., McCormack, G.R., 2019. A population-based study of the associations between neighbourhood walkability and different types of physical activity in Canadian men and women. Preventive Medicine 129, 105864.

Penedo, F.J. and Dahn, J.R., 2005. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. Current opinion in psychiatry, 18(2), 189-193.

Pereira, G., Christian, H., Foster, S., Boruff, B.J., Bull, F., Knuiman, M., et al., 2013. The association between neighborhood greenness and weight status: an observational study in Perth Western Australia. Environ. Health 12, 49.

Persson, Å., Pyko, A., Lind, T., Bellander, T., Östenson, C.-G., Pershagen, G., Eriksson, C., Lõhmusa, M., 2018. Urban residential greenness and adiposity: A cohort study in Stockholm County. Environment International 121 (1), 832-841.

Prebensen, N.K., Altin, M., Uysal, M., 2015. Length of stay: A case of northern Norway. Scandinavian Journal of Hospitality and Tourism, 15, 28-47.

Pretty, J., Peacock, J., Sellens, M. and Griffin, M., 2005. The mental and physical health outcomes of green exercise. International journal of environmental health research, 15(5), 319-337.

R Core Team, 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from: https://www.R-project.org/.

Siegel, D., Wessner, C., 2012. Universities and the success of entrepreneurial ventures: evidence from the small business innovation research program. Journal of Technology Transfer, 37, 404–415.

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., Kalof, L., 1999. A value-belief-norm theory of support for social movements: The case of environmentalism. Human ecology review, 81-97.

Sugiyama, T., Villanueva, K., Knuiman, M., Francis, J., Foster, S., Wood, L., Giles-Corti, B., 2016. Can neighborhood green space mitigate health inequalities? A study of socio-economic status and mental health. Health & Place 38, 16-21.

Toftager, M., Ekholm, O., Schipperijn, J., Stigsdotter, U., Bentsen, P., Gronbaek, M., et al., 2011. Distance to greenspace and physical activity: a Danish national representative survey. J. Phys. Act. Health 8, 741–749.

Vivanco-Hidalgo, R.M., Avellaneda-Gómeza, C., Dadvand, P., Cirach, M., Oisa, Á., Gómez González, A., Rodriguez-Campello, A., de Ceballos, P., Basagaña, X., Zabalza, A., Cuadrado-Godia, E., Sunyer, J., Roquer, J., Wellenius, G.A., 2019. Association of residential air pollution, noise, and greenspace with initial ischemic stroke severity. Environmental Research 179, 108725.

Vuong, Q.H., 1989. Likelihood Ratio Tests for Model Selection and non-nested Hypotheses. Econometrica. 57 (2), 307–333.

Whitfield, G.P., Carlson, S.A., Ussery, E.N., Watson, K.B., Berrigan, D., Fulton, J.E., 2019. National-level environmental perceptions and walking among urban and rural residents: Informing surveillance of walkability. Preventive Medicine 123, 101-108.

WHO, 2018a. Fact Sheet of Physical Activity. World Health Organization. Retrieved from: https://www.who.int/news-room/fact-sheets/detail/physical-activity.

WHO, 2018b. Global action plan on physical activity 2018–2030: more active people for a healthier world. World Health Organization. Retrieved from: https://www.who.int/publications-detail/global-action-plan-on-physical-activity-2018%E2%80%932030.

Winkelmann, R., 2004. Health Care Reform and the Number of Doctor Visits - an Econometric Analysis, Journal of Applied Econometrics 19, 455-472.

Zvěřinová, I., Máca, V., Ščasný, M., Strube, R., Marques, S., Dubová, D., Kryl, M., Craveiro, D., Taylor, T., Chiabai, A., García de Jalón, S., 2020. How to Achieve a Healthier and More Sustainable Europe by 2040 According to the Public? Results of a Five-Country Questionnaire Survey. International Journal of Environmental Research and Public Health 17 (17), 6071.

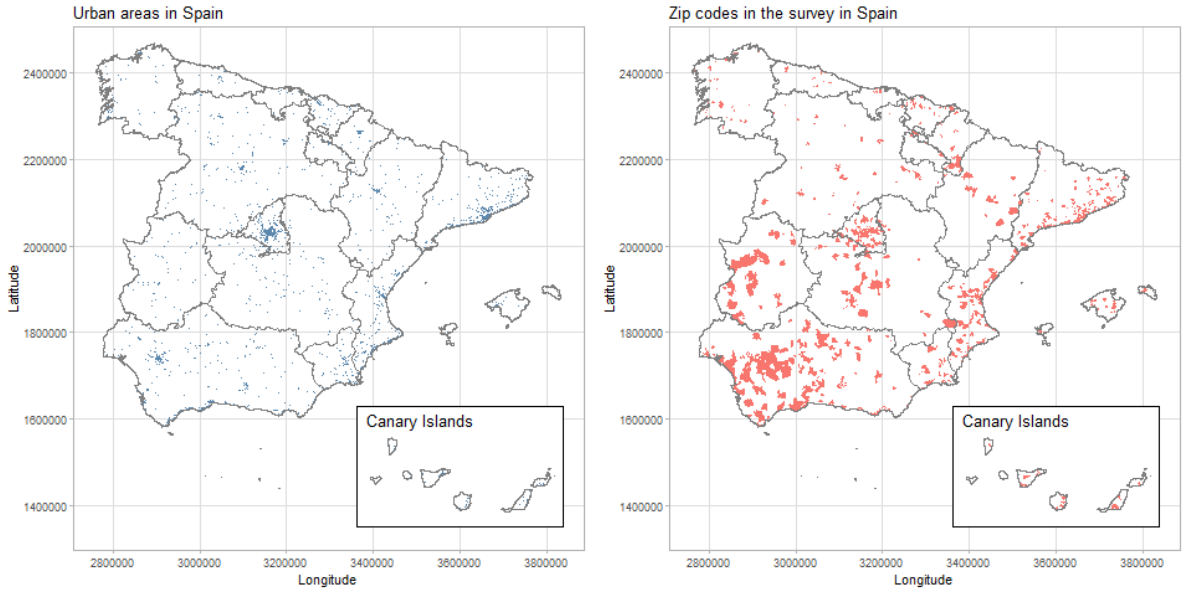

Figure 1. Urban areas and zip code areas in Spain included in the sample of the survey. Map 1a: Urban areas in Spain. Map 1b: Zip codes included in the citizen survey.

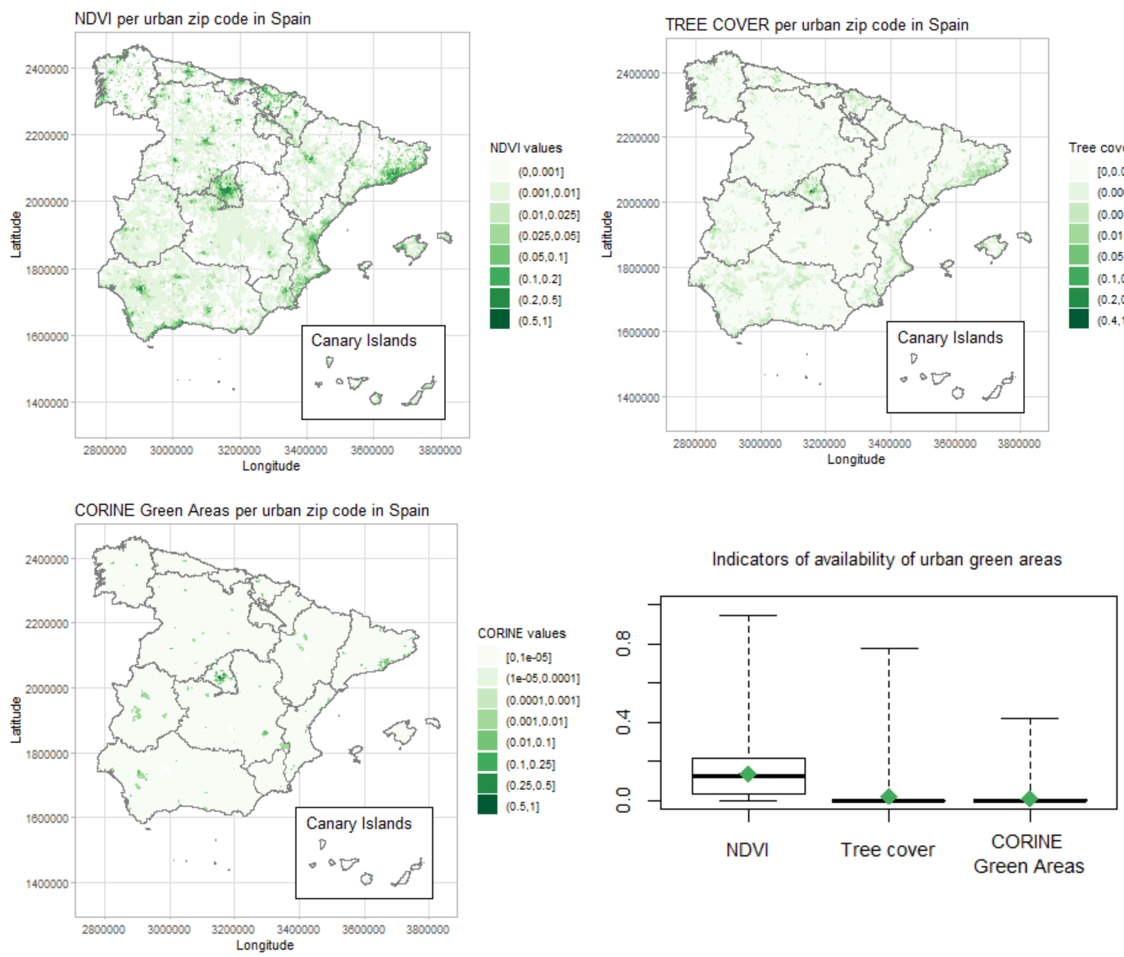

Figure 2. Indicators of greenspaces in urban areas in Spain. Upper-left map shows NDVI index, upper-right map shows tree cover density and bottom-left map shows green areas identified by CORINE land cover. Bottom-right boxplots show the distribution of the values in the maps. The band inside the box indicates the median value, box limits indicate percentile 25 and 75 and whiskers are calculated as 1.5 times the interquartile range (Q3 – Q1).

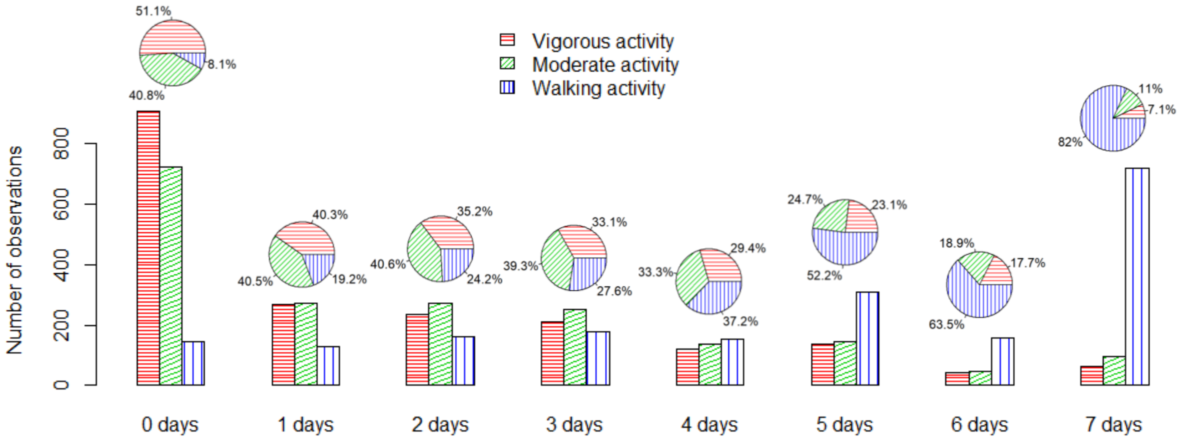

Figure 3. Number of days per week that people in Spain do physical activity. Bars show the frequency (number of observations) and pie charts show percentage estimates. See survey responses in Table S.1.

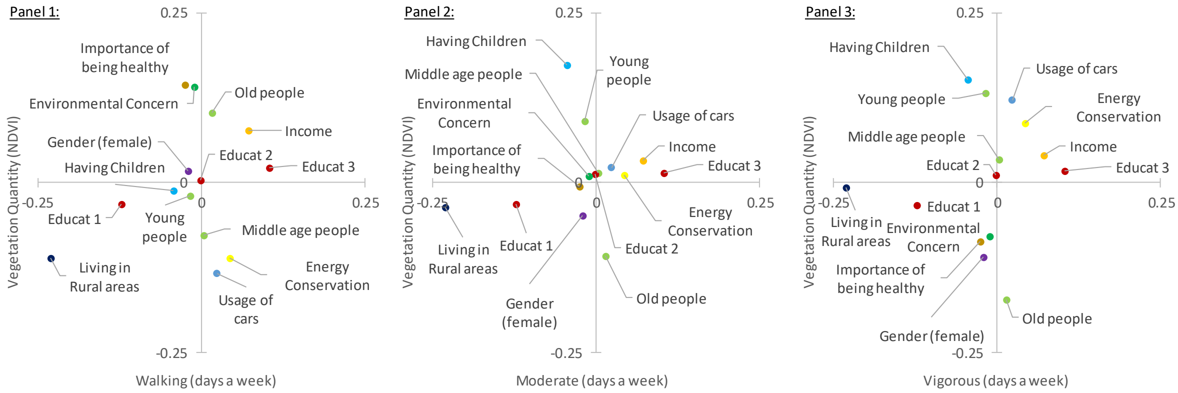

Figure 4. Correlation coefficients between the determinants and vegetation quantity and the number of days doing physical activity. Panel 1, 2 and 3 indicate walking, moderate and vigorous activities, respectively. See full Pearson correlation coefficient matrix in Table S.2.

Table 1. Description of the survey results on people's physical activity and their determinants.

Variables	Description and scales	Min.	Max.	Mean	Standard deviation
Walking	Walking activity (8 categories from 0 to 7 days a week)	0	7	4.68	2.35
Moderate	Moderate activity (8 categories from 0 to 7 days a week)	0	7	1.96	2.08
Vigorous	Vigorous activity (8 categories from 0 to 7 days a week)	0	7	1.63	1.98
Age	3 levels (1 = Younger people (18-34 years old, 30%); 2 = Middle aged people (35-50 years old, 42%); Older people (> 50 years old, 28%)	-	-	41.8 years	12.0 years
Female	2 categories (1 = female; 0 = male)	0.00	1.00	0.50	0.50
Environmental personal norms[1]	7 levels (1 = strongly disagree; 7 = strongly agree)	1.00	7.00	5.90	1.10
Income	3 levels of household's net monthly income (1 = less than €1900; 2 = between €1900 and €3300; 3 = more than €3,300)	1.00	3.00	€1,851[2]	€1145
High thermal comfort	3 levels (1 = never (35%); 2 = occasionally (46%); 3 = often and/or always (19%)). "In the winter, I keep the heat on so that I do not have to wear a jumper."	-	-	-	-
Usage of cars to go hiking	3 levels (1 = never (40%); 2 = occasionally (38%); 3 = often and/or always (22%)). "I drive to where I want to start my hikes."	-	-	-	-
Importance of being healthy	8 levels (-1 = Opposed to my values; 7 = Of supreme Importance) "How important each of these is as a guiding principle in your life"	-1.00	7.00	5.52	1.65
Living in rural areas	2 levels (0 = living in town or city with more than 5,000 inhabitants; 1 = otherwise)	0.00	1.00	0.13	0.33
Having children	2 levels (0 = without children; 1 = with children)	0.00	1.00	0.42	0.49

Note:

1) The variable was calculated as the average of five statements: "We have a moral obligation to future generations to do whatever we can to prevent damage to the environment."; "I feel morally obliged to bear in mind the environment and nature in my everyday behaviour."; "Business and industry should take strong action to prevent damage to the environment."; "The government should take strong action to prevent damage to the environment."; "The European Union should take the most responsibility acting to prevent damage to the environment.". Cronbach's alpha = 0.91.
2) The mean was computed as the midpoint of each interval.

Table 2. The influence of the determinants of people's physical activity. Figures show the estimated coefficients of negative-binomial regressions.

	Walking						**Moderate activity**						**Vigorous activity**					
Vegetation quantity (NDVI)	**0.45**	**					-0.27						-0.35					
Green surface (CORINE)			**0.42**	.					0.61						-0.42			
Tree cover density (TREECOV)					0.41						-0.77						-1.74	
Middle aged people (35-50 years old)	**-0.07**	*	**-0.07**	*	**-0.07**	*	**-0.17**	*	**-0.17**	*	**-0.18**	*	**-0.18**	*	**-0.19**	*	**-0.19**	*
Older people (> 50 years old)	0.05		0.05		0.05		**-0.25**	**	**-0.25**	**	**-0.25**	**	**-0.50**	***	**-0.50**	***	**-0.51**	***
Female	0.01		0.01		0.01		-0.11	.	-0.10	.	-0.10		**-0.28**	***	**-0.28**	***	**-0.28**	***
Environmental personal norms	**0.03**	*	**0.03**	*	**0.03**	*	0.02		0.02		0.02		-0.01		-0.01		-0.01	
Income (between €1900 and €3300)	**0.09**	**	**0.09**	**	**0.09**	**	0.05		0.05		0.05		-0.08		-0.08		-0.07	
Income (more than €3,300)	**0.09**	*	**0.09**	*	**0.09**	*	0.04		0.03		0.02		0.06		0.06		0.06	
High thermal comfort (occasionally)	-0.04		-0.04		-0.03		-0.05		-0.06		-0.06		0.04		0.03		0.03	
High thermal comfort (often and/or always)	**-0.13**	**	**-0.13**	**	**-0.13**	**	-0.08		-0.09		-0.08		0.05		0.05		0.05	
Usage of cars to go hiking (occasionally)	**-0.07**	*	**-0.07**	*	**-0.07**	*	-0.02		-0.02		-0.02		0.11		0.11		0.11	
Usage of cars to go hiking (often and/or always)	**-0.10**	*	**-0.10**	*	**-0.09**	*	-0.01		-0.01		-0.02		**0.22**	*	**0.21**	*	**0.21**	*
Importance of being healthy	**0.02**	*	**0.02**	*	**0.02**	*	-0.01		-0.01		-0.01		-0.02		-0.02		-0.02	
Living in rural areas	**-0.15**	**	**-0.16**	***	**-0.17**	***	-0.13		-0.09		-0.11		0.04		0.06		0.06	
Having children	**0.09**	*	0.03		0.03		**0.32**	**	**0.32**	***	**0.29**	***	**0.24**	*	**0.23**	**	**0.23**	**
Interaction effect[1]: Urban greenspace indicator and Having children	**-0.44**	.	0.05		-0.45		-0.08		0.02		2.59		0.04		0.90		2.74	
Constant	**1.20**	***	**1.25**	***	**1.26**	***	**0.74**	***	**0.69**	***	**0.70**	***	**0.87**	***	**0.83**	***	**0.83**	***
Likelihood-ratio test of alpha=0	**3.23**	*	**3.5**	*	**3.89**	*	**419.78**	***	**417.88**	***	**418.45**	***	**482.63**	***	**482.66**	***	**481.35**	***

(*) "." Indicates significant at 10%; "*" significant at 5%; "**" significant at 1%; "***" significant at 0.1%. N=1262.

1) Interaction effect between the evaluated urban greenspace indicator (Vegetation quantity (NDVI), Green surface (CORINE), Tree cover density (TREECOV)) and the variable Having Children

1