# Abstract

The area of an individual’s daily activity space may be limited by the difficulty of traveling long distances or by the density of destinations, which limits the need for traveling far from home. In this study, we analyze data from a travel diary survey for 327 individuals in Granada Spain for both a weekday and a weekend to determine the relationship between activity space areas and destination accessibility by car and non-car modes. We find that lower accessibility is associated with larger activity spaces on weekdays, while weekend activity space areas are better predicted by the availability of household resources.

# Questions (200 words)

Activity spaces represent the area within which an individual completes their routine activities (Cagney et al. 2020). The size of an individual’s activity space can inform an understanding of their well-being, but it has limited usefulness as a stand-alone measure of welfare without an understanding of its causes. On the one hand, there is a constraints-based narrative: the idea that a person’s activity space is constrained by the difficulty of travel. On the other hand is a freedom-based narrative: the idea that better access to more proximate destinations gives people the freedom to fully participate in community life without traveling over a wide area. The constraints-based narrative would suggest that larger activity spaces are associated greater well-being, while the freedom-based narrative would suggest that smaller activity spaces are associated with greater well-being.

Destination accessibility offers a useful construct for evaluating the relative merits of the freedom-based narrative and the constraints-based narrative. If small activity spaces are associated with lower accessibility, this would be consistent with a constraint-based narrative. If smaller activity spaces are associated with higher accessibility, this would be consistent with a freedom-based narrative. This study seeks to address the question of whether there is a positive or negative relationship between the destination accessibility of individuals’ home and the areas of their activity spaces.

# Methods

This study draws on data that was collected ….. (describe survey methodology).

For purposes of this study, an individual’s activity space was defined as (describe method for calculating activity space).

One individual’s weekday activity space and three individuals weekend activity spaces were more than eight standard deviations from the mean. These were removed from the sample.

To calculate destination accessibility, we drew on parcel-level land-use data for the province of Granada (describe dataset). We classified parcel land uses into six categories categories: leisure (retail, restaurants, and indoor culture and recreation), other services (including ….), outdoor recreation (including ….), residential, agricultural, and industrial.

The size of the land use at each location was defined as the gross floor area for leisure, other services, and industrial land uses, as the total land area for outdoor recreation and agricultural land uses, and as the estimated population for residential uses, where the estimated population of a parcel was calculated as shown in Equation 1.

(1)

where *Pparcel* = The estimate population of the parcel,

*Ptract* = The population of the census tract, from ,

*GFAparcel* = The total gross floor area of all residential buildings on the parcel, and

*GFAtract* = The total gross floor area of all residential buildings in the tract.

We used the r5r package (Pereira et al. 2021) to calculate twelve different accessibility metrics for the home location of each survey respondent: Accessibility by car for each of the four destination types and accessibility without a car (e.g. by walking and transit) for each of the four destination types. Accessibility was calculated as the sum of all parcels in the province of Granada. weighted by size (as defined above) and by travel time from the home location using a logistic decay function with an inflection point at thirty minutes and a standard deviation of five minutes, as shown in Equation 2.

(2)

where *A* = the accessibility of a respondent’s home to a particular destination type,

*Sd* = the size of destination *d*, and

*ttd* = the travel time from the respondent’s home to destination *d*.

All accessibility metrics were centered to have a mean of zero and scaled to have a standard deviation of one. The correlations among the measures for access by car to leisure, other service, residential, and outdoor recreation land uses were greater than 0.94, as were the correlations among car-free access to those four destination types. These highly-correlated metrics were averaged to produce a single measure of general access by car and a single measure of general car-free access.

We estimated an ordinary-least squares linear regression model predicting the log-transformed area of the activity space for both the weekday and the weekend. Table 1 shows the independent variables included in the two models with some descriptive statistics. As Table 1 shows, some observations were removed from the sample due to missing values for car ownership, income, and employment status, in addition to the four observations that were removed due to exceptionally high values of weekday or weekend activity spaces. The final sample included 327 individuals.

Table . Variables included in regression analyses.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable name** | **Description** | **Mean or proportion** | **Standard deviation** | **Effect on sample (number of observations removed due to missingness or outliers)** |
| Outcome variables |  |  |  |  |
| Weekday activity space | Area (km2) of convex hull around home and destination buffers (log transformed in models) | 8.4 | 26.6 | 1 |
| Weekend activity space | 17.3 | 51.1 | 3 |
| Predictor variables |  |  |  |  |
| No vehicles | In zero-vehicle household | 28% | - | 12 |
| General access by car | Standard deviations from the mean for access by car from home | 0.00 | 0.99 |  |
| Industrial access by car | 0.00 | 1.00 |  |
| Agricultural access by car | 0.00 | 1.00 |  |
| General car-free access | Standard deviations from mean for transit/walk access from home | 0.00 | 0.99 |  |
| Industrial car-free access | 0.00 | 1.00 |  |
| Agricultural car-free access | 0.00 | 1.00 |  |
| *Work status* |  |  |  | 2 |
| Not in labor force | Not in a category below | 27% | - |  |
| Student | Attends school | 13% | - |  |
| Unemployed | Seeking work | 11% | - |  |
| Part-time | Employed part time | 11% | - |  |
| Full-time | Full time or self-employed | 37% | - |  |
| Age | Age in years | 48.4 | 19.0 |  |
| Female | Identifies as female | 53% | - |  |
| Lives with children | Lives with children | 31% | - |  |
| Lives with spouse/partner | Lives with spouse/partner | 46% | - |  |
| Lives with parent(s) | Lives with own parent(s) | 13% | - |  |
| *Household Income (Euros per month)* | |  |  | 35 |
| Low income | Less than 1,100 | 24% | - |  |
| Low middle | Between 1,100 and 1,800 | 26% | - |  |
| Middle income | Between 1,801 and 2,700 | 28% | - |  |
| High middle income | Between 2,701 and 3,900 | 14% | - |  |
| High income | Greater than 3,900 | 8% | - |  |

# Findings (~300 words)

Table 2 shows the results of the regression models for the areas of weekday and weekend activity spaces. The weekday model predicts about 24 percent of the variation in activity space areas, and the weekend model predicts about 17 percent.

On weekdays, younger people tend to have larger activity spaces and those who live with their parents tend to have smaller activity spaces. Controlling for these and other predictors, greater accessibility by transit and walking to the set of leisure, recreational, service, and residential destinations is associated with smaller activity spaces, which is consistent with the freedom-based narrative: people have smaller activity spaces on weekdays when they don’t have to travel as far to meet their daily needs.

Table . Results of regression models

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Weekday activity-space area (log-transformed)** | | | | | **Weekend activity space area (log-transformed)** | | |
| R2 = 0.24 | | | | | R2 = 0.17 | | |
| Estimate | | Standard Error | | p-value | Estimate | Standard Error | p-value |
| Intercept | **0.96** | | **0.20** | | **< 0.001** | **3.03** | **0.64** | **< 0.001** |
| No vehicles | -0.31 | | 0.17 | | 0.063 | **-0.53** | **0.23** | **0.023** |
| Industrial access by car | 0.19 | | 0.15 | | 0.204 | 0.08 | 0.21 | 0.714 |
| Car-free industrial access | 0.16 | | 0.08 | | 0.051 | 0.18 | 0.11 | 0.101 |
| Agricultural access by car | -0.02 | | 0.12 | | 0.847 | -0.32 | 0.17 | 0.060 |
| Car-free agricultural access | 0.07 | | 0.10 | | 0.483 | 0.06 | 0.14 | 0.662 |
| General access by car | -0.19 | | 0.10 | | 0.072 | 0.07 | 0.14 | 0.621 |
| General car-free access | **-0.29** | | **0.10** | | **0.005** | -0.14 | 0.14 | 0.303 |
| Access by car : no vehicles | -0.11 | | 0.30 | | 0.717 | 0.31 | 0.42 | 0.463 |
| Car-free access : no vehicles | 0.19 | | 0.17 | | 0.266 | 0.17 | 0.24 | 0.467 |
| *Work status (relative to not in labor force)* | | | | | | | | |
| Student | -0.53 | | 0.37 | | 0.151 | -0.90 | 0.51 | 0.082 |
| Unemployed | 0.09 | | 0.29 | | 0.759 | -0.14 | 0.40 | 0.738 |
| Part-time | -0.31 | | 0.31 | | 0.314 | 0.10 | 0.43 | 0.820 |
| Full-time | 0.04 | | 0.23 | | 0.875 | 0.24 | 0.32 | 0.467 |
| Age | **-0.02** | | **0.01** | | **0.015** | **-0.02** | **0.01** | **0.008** |
| Female | -0.17 | | 0.13 | | 0.173 | 0.24 | 0.18 | 0.161 |
| Lives with children | 0.08 | | 0.16 | | 0.597 | **-0.70** | **0.22** | **0.002** |
| Lives with spouse/partner | 0.09 | | 0.16 | | 0.579 | -0.04 | 0.22 | 0.839 |
| Lives with parent(s) | **-0.51** | | **0.23** | | **0.028** | -0.55 | 0.32 | 0.088 |
| *Household income (relative to middle income)* | | | | | | | | |
| Low income | -0.35 | 0.20 | | 0.080 | | **-0.78** | **0.28** | **0.006** |
| Low middle income | -0.19 | 0.17 | | 0.281 | | **-0.54** | **0.24** | **0.024** |
| High middle income | 0.03 | 0.21 | | 0.884 | | **-0.64** | **0.29** | **0.025** |
| High income | 0.16 | 0.25 | | 0.521 | | **-0.86** | **0.35** | **0.014** |
| Note: **Bold text** indicates 95% confidence, gray text indicates less than 90% confidence. | | | | | | | | |

Access to destinations is not a significant predictor (at a 90-percent confidence level) of weekend activity spaces. The significant predictors of weekend activity space areas are generally more related to household resources, which is more consistent with a constraints-based narrative. Individuals in households without a vehicle have smaller weekend activity spaces, as do those living in households with children, which may be a result of care-giving related constraints. Relative to those in the middle income category, individuals in the low and low-middle income categories have smaller weekend activity spaces, which is consistent with a constraints-based narrative for understanding activity spaces. However, individuals in the high-middle and high income categories also have smaller activity spaces than those in the middle income category also have smaller activity spaces than those in the middle income category. This suggests that rising incomes are associated with increased weekend activity spaces up to a particular income threshold, beyond which weekend activity spaces begin to shrink, perhaps because individuals spend their additional income on meeting their weekend needs without travel.