Mix Of Destinations And Sedentary Behavior Among Brazilian Adults

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Abstract

Background: Sedentary behavior is influenced by contextual, social and individual factors, including the built environment. However, the associations between the built environment and sitting time have not been extensively investigated in countries with economies in transition such as Brazil. The objective of this study is to examine the relationship between sitting-time and access to a mix of destinations for adults from Sao Paulo city, Brazil.

Methods: This study uses data from the Sao Paulo Health Survey (n=3,145). Sedentary behavior was assessed by questionnaire using two questions: total sitting time in minutes on a usual weekday; and on a usual weekend day. Mix of destinations was measured by summing the number of facilities (comprising bus stops, train/subway stations, parks, squares, public recreation centres, bike paths, primary health care units, supermarkets, food stores, bakeries, and coffee-shops) within 500m of each participant's residence. Linear and categorical (<4, ≥4 hours/day) measures of sitting time were derived and analyzed using linear and logistic multilevel regression. Models accounted for clustering within census-tracts and households, were stratified by gender, and adjusted for environmental, sociodemographic, and health-related factors.

Results: Average minutes of sitting, and the likelihood of sitting for more than four hours, were significantly higher among males, younger people, the more educated, single persons, smokers, those who engaged in low levels of physical activity, the obese and those with chronic disease, and those who owned a private motor vehicle. Among females, mix of destinations was inversely related with minutes of sitting time on a weekday (β= -11 minutes; p=0.001) and weekend day (β= -8 minutes; p=0.012). Females who had a higher mix of destinations within their residential catchment had a significantly lower likelihood of sitting for four hours or more on weekdays (OR=0.66 IC95%0.47-0.94). No significant associations were found for males.

Conclusion: This is the first-known study to examine the relationship between mix of destinations and sedentary behavior among adults in Sao Paulo City, Brazil. Our results suggest that health promotion and policy should focus on reducing sedentary behavior in the whole population, and especially those groups who engage in higher-levels of sitting time.

Background

Sedentary behavior - i.e. extended periods of uninterrupted sitting with low energy expenditure - is a significant public health problem: it accounts for 3.8% of all-cause mortality [1], and increases the risk of cardiovascular disease and diabetes and premature mortality[2–4]. In addition, sedentary behavior is associated with loss of functional capacity and daily life activities and poorer quality of life in elderly people[5], with weight gain from childhood to adulthood[6] and with unhealthy diet and food consumption[7].

The social-ecological model proposed by Owen et al. [8] and systematic reviews to explain sedentary behavior posit that this behavior is present in leisure time, in the household, during transportation and in work time, and is a multifactorial variable associated with individual and social variables like gender, age, education and income, health variables like low physical activity levels, high body mass index, worse self-related health conditions, and diseases, and with built environment and policies[8–13].

Early studies examining relationships between the built environment and sedentary behavior show that low walkability was associated with more television viewing in Australian females[14], and with more driving time and television viewing in North American adults[15]. A study conducted in 11 cities with 5.712 adults which measured sedentary behavior using accelerometers found that higher street connectivity and a more diverse land use mix were associated with fewer minutes per day of sedentary time on average; and higher residential density, and pedestrian infrastructure were associated with more minutes per day of sedentary time[16]. A systematic review showed that access and proximity to general services and facilities and recreation facilities were inversely associated with total sitting time[11]. Another cross-sectional study showed that the walkability index was associated positively with sedentary behavior in Belgian adults[17]. Overall, studies examining the association between the built environment and sedentary behavior have produced inconsistent and inconclusive evidence, and relationships might differ depending on the domain of sedentary behavior being investigated[10].

With the exception of the Owen et al.[16], study that involved adults from Curitiba, Brazil, and Bogota, Colombia, there are no other known studies of the relationship between the objective built environment and sedentary behavior in middle-to-high income countries such as Brazil. In addition, systematic reviews of sedentary behavior indicate further research is needed to better clarify associations between this behavior and the built environment [8, 10, 20–22]. Therefore, the objective of this study is to examine the relationship between mix of destinations and total sitting time in adults from Sao Paulo city, Brazil.

Methods

Sao Paulo Health Survey (ISA)

This study used data from the Sao Paulo Health Survey. Data collection was completed in 2015, with 4,043 adult participants who lived in five health administrative areas in Sao Paulo city. The sampling process has been described in more detail elsewhere[23]. Georeferencing resulted in 3,145 participants having their residential address geocoded: [18]. More details can be obtained from other publications[18, 19, 24]. This dataset will be used such as the baseline of the longitudinal study denominated of “ISA: Physical Activity and Environment” that will have such as objective to verify the relationship between the built environment and physical activity in adults from Sao Paulo city, Brazil.

Sedentary Behavior

Sedentary behavior data were collected using the International Physical Activity Questionnaire (IPAQ)[25] and measured on the basis of two questions: 1) Total sitting time on a usual weekday; 2)

Total sitting time on a usual weekend day. The questions asked about minutes per day that people spent sitting in all domains of life (work, leisure, transportation, and household). For analysis, two types of outcomes were used: 1) Continuous measures of minutes of sitting time in a typical weekday and in a typical weekend day; and 2) categorical measures which employed a cut-off point of four hours per day to classify sedentary behavior in a typical weekday and in a weekend day. The basis for this cut-off point was a meta-analysis of the relationship between sedentary behavior, physical activity, and mortality in more than one million people in a second Lancet series about physical activity and health[4].

Mix of Destinations

Walkable destinations within each participant's residential catchment were captured using georeferencing procedures [18, 19] applied to publicly available datasets, and included: transportation (bus stops, train and subway stations), green areas (parks, squares), public recreation centres, bike paths, and primary health care units. The dataset for these items pertain to places in 2016 and were obtained mainly from the open site GEOSAMPA <http://geosampa.prefeitura.sp.gov.br/PaginasPublicas/_SBC.aspx>. In addition, we captured supermarkets, food stores, bakeries and coffee shops using the Health Surveillance Registration database from Sao Paulo city associated with National Economic Activity Classification in November 2016. We calculated the number of these destinations within a 500m radial buffer of each participant's home address: we used this distance because previous studies conducted in Sau Paulo city with the same sample found significant associations between the built environment and walking [18, 19].

The eight destination-types were operationalized in two ways. First, we calculated the median number of destinations for the sample [median=3 and range 0 to 8] and grouped participants into two categories using a median-split (1=above median, 0=at or below median). Second, the distribution of destinations was divided into tertiles (high, medium, low): a similar measure using data from the Sao Paulo Health Survey found that participants who lived in areas with a greater mix of destinations were significantly more likely to walk for transport [19].

Covariates

We used age (18-29 years, 30-39 years, 40-49 years, 50-59 years, 60 years or more), education (in four categories for logistic models: incomplete elementary school, incomplete high school, complete high school, incomplete undergraduate or above), marital status (singles, married/with partners, separated/widowers), obesity (in two categories: BMI <30 kg/m^2: no or yes ≥ 30 kg/m^2), physical activity (evaluated by IPAQ and we used the cut-off point of 150 minutes per week: yes or no according to work, household, leisure, and transportation activities), diseases (self-report of diseases diagnosed by physicians - arterial hypertension; diabetes; myocardial infarction; cardiac arrhythmia; other heart disease; cancer; arthritis, rheumatism or arthrosis; osteoporosis; asthma or asthmatic bronchitis; emphysema, chronic bronchitis or chronical obstructive pulmonary diseases; rhinitis; chronic sinusitis; other lung disease; tendonitis, repetitive strain injury or work-related musculoskeletal disorders; cerebral vascular

accident or stroke; spine disease or spine problem: presence or not of diseases), smoking (yes or no), car or motorcycle ownership (yes or no); time living in the same residence (in three levels : <1 year, ≥1 year and <5 years, >5 years), and place where people living in Sao Paulo city (North, South, Midwest, Southeast, and East). These variables were selected based on the findings of systematic reviews [9, 12, 13], and also because they were found to be important variables in other studies that examined the relationship between the built environment and physical activity in the same sample [22-24].

Statistical Analysis

The analysis uses four outcomes variables: 1) sitting time during a typical weekday in minutes; 2) sitting time during a typical weekend day in minutes; 3) four hours or more of sedentary behavior in a typical weekday (yes or not); and 4) four hours or more of sedentary behavior in a typical weekend day (yes or not). We used bivariate descriptive analyses to examine how sitting time was distributed by each of the environmental, sociodemographic, and health-related variables. Sample weights were calculated considering the survey design effect, post-stratification by sex and age, and the non-response rate. We used the chi-square (Wald test p-value) to identify associations between categorical variables, and linear regression to identify differences between quantitative variables.

Linear and logistic multilevel analysis of the association between mix of destinations and sitting time were conducted in two stages, firstly without adjustment, and secondly, with adjustment for those factors found to be statistically significant in the bivariate analysis: the covariates used for the adjusted models are shown in Table 1. The multilevel analysis accounted for clustering within census-tract and household.

For multilevel analysis, we examined the relationship between the outcomes with the mix of destinations scores. Firstly, we examined the relationship without adjustment. Secondly, we added demographics, social, health, and environmental variables that had significant association in bivariate analysis. The places where people lived and time living in the same residence were added regardless of statistical significance because these variables are important for adjusting the analysis between environmental and behavior variables. We used both linear and logistic regression models. We used age, education, marital status , obesity , physical activity , diseases

We opted to run separate models for males and females [9, 13]. We used the xtmixed command for linear models and the results are presented as beta coefficients (β) with 95% confidence intervals, and the xtmelogit command for logistic models and the results are presented as odds ratios (OR) with 95% confidence intervals. All analyses were conducted in Stata software (Stata version SE 12.1, StataCorp).

Ethics Approval

The Ethics Committee of the School of Arts, Sciences, and Humanities at the University of Sao Paulo approved the study (process number 55846116.6.0000.5390).

Results

Approximately 50% of participants engaged in four or more hours of sedentary behavior on both weekdays and weekend days (Table 1).

Table 1. Descriptive variables for sitting time in a typical week day and weekend day according to social, demographics, health, and environmental variables, Sao Paulo city, 2015.

	Sitting time in a typical day							
	Week days minutes	p	Weekend days minutes	p	Week days ≥4 hours	p	Weekend days ≥4 hours	p
	mean (se)		mean (se)		% (IC95%)		% (IC95%)	
Overall	286.8 (5.8)		263.7 (6.0)		55.1 (52.5 – 57.8)		51.6 (48.5 – 54.6)	
Sex		0.003		0.001		<0.001		0.011
Male	301.9 (7.7)		279.5 (8.4)		59.2 (55.9 – 62.5)		54.5 (50.7 – 58.2)	
Female	273.7 (7.3)		249.7 (6.4)		51.6 (48.1 – 55.2)		49.0 (45.3 – 52.7)	
Age						<0.001		0.098
18-29	351.0 (10.2)	Ref.	286.9 (10.8)	Ref.	66.4 (62.0 – 70.9)		54.8 (49.7 – 59.8)	
30-39	286.7 (11.1)	<0.001	262.8 (9.7)	0.032	55.3 (50.4 – 60.2)		52.9 (47.9 – 57.9)	
40-49	257.5 (9.3)	<0.001	246.5 (9.3)	0.002	49.8 (44.5 – 55.1)		47.8 (42.7 – 52.9)	
50-59	245.4 (10.1)	<0.001	240.3 (9.2)	<0.001	48.1 (42.5 – 53.7)		47.5 (41.6 – 53.3)	
60 or more	264.8 (7.3)	<0.001	270.3 (7.8)	0.157	51.0 (47.4 – 54.6)		52.8 (48.6 – 56.9)	
Education						<0.001		<0.001
Incomplete elementary school	232.4 (8.8)	Ref.	250.8 (9.3)	Ref.	41.1 (36.7 – 45.5)		44.8 (40.3 – 49.4)	
Until incomplete high school	243.3 (8.9)	0.311	243.8 (7.9)	0.486	44.8 (40.4 – 49.1)		47.2 (42.9 – 51.6)	
Until complete high school	280.5 (8.5)	<0.001	255.5 (7.6)	0.642	54.5 (50.2 – 58.8)		52.1 (47.8 – 56.4)	
Undergraduate incomplete or +	361.7 (10.8)	<0.001	295.7 (11.1)	0.001	73.3 (69.3 – 77.4)		58.9 (54.4 – 63.5)	
Physical activity		<0.001		<0.001		0.078		<0.001
≥ 150 minutes per week	272.9 (6.4)		250.2 (6.4)		53.5 (50.5 – 56.5)		49.1 (45.8 – 52.5)	
<150 minutes per week	350.5 (12.0)		318.3 (10.8)		62.3 (56.4 – 68.3)		60.9 (56.0 – 65.9)	
Body Mass Index (kg/m^2)		0.047		0.001		0.027		0.004
Obesity (≥30 kg/m^2)	306.5(13.0)		294.4(13.4)		59.7 (54.7 – 64.8)		57.6 (52.5 – 62.8)	
Not obesity (<30 kg/m^2)	281.6(6.3)		254.7(6.3)		54.1 (51.4 – 56.9)		50.2 (47.0 – 53.4)	
Presence of diseases		0.102		0.002		0.047		0.008
Yes	292.6 (7.6)		274.3 (7.8)		56.9 (53.6-60.1)		53.5 (49.8-57.2)	
Not	276.8 (7.3)		246.4 (6.8)		52.6 (49.0-56.2)		48.1 (44.6-51.6)	
Smoking		0.316		0.202		0.516		0.833
Yes	298.8 (13.4)		277.5 (13.1)		56.8 (51.2-62.5)		52.0 (47.0-57.0)	

Not	284.4 (6.1)		260.7 (6.1)		54.8 (51.9-57.7)		51.4 (48.1-54.7)	
Marital Status						<0.001		0.228
Married, or with partners	271.2 (6.8)	Ref.	256.7 (7.7)	Ref.	52.2 (49.0-55.4)		50.2 (46.3-54.1)	
Singles	326.3 (8.6)	<0.001	279.4 (8.5)	0.019	63.3 (59.3-67.4)		54.8 (50.2-59.3)	
Separated, or widowers	271.8 (10.8)	0.955	259.9 (9.3)	0.774	51.2 (45.5-56.9)		50.7 (45.4-56.0)	
Car or motorcycle ownership		0.001		0.531		<0.001		0.007
Yes	299.2 (6.1)		266.2 (6.8)		59.0 (55.8 – 62.2)		54.5 (50.6 – 58.4)	
Not	269.9 (8.4)		260.3 (8.6)		49.9 (46.4 – 53.4)		47.7 (43.8 – 51.5)	
Place where people living						<0.001		0.249
North	286.5 (12.9)	Ref.	259.4 (11.6)	Ref.	52.8 (46.9 – 58.6)		49.8 (44.2 – 55.4)	
South	271.5 (12.7)	0.409	244.5 (13.9)	0.412	55.6 (47.4 – 63.8)		48.7 (41.7 – 55.6)	
Midwest	320.9 (14.5)	0.078	286.1 (14.6)	0.155	64.8 (59.6 – 70.0)		58.2 (51.2 – 65.1)	
Southeast	263.3 (11.5)	0.181	249.7 (11.7)	0.556	48.7 (43.1 – 54.5)		47.6 (41.5 – 53.7)	
East	277.3 (9.2)	0.560	267.4 (12.2)	0.639	51.1 (46.1 – 56.1)		50.9 (43.6 – 58.3)	
Time living in the residence						0.660		0.140
<1 year	297.4 (15.1)	Ref.	282.2 (14.8)	Ref.	57.2 (49.6 – 64.9)		57.2 (50.2 – 64.2)	
>1 year and <5 years	295.0 (10.5)	0.891	248.6 (9.6)	0.049	56.0 (51.4 – 60.7)		48.9 (43.6 – 54.1)	
>5 years	282.4 (6.2)	0.349	264.8 (6.6)	0.223	54.6 (51.7 – 57.4)		51.1 (47.9 – 54.3)	

Ref. (category of reference for comparison)

Average minutes of sitting, and the likelihood of sitting for more than four hours, were significantly higher among males, younger people, the more educated, single persons, smokers, those who engaged in low levels of physical activity, the obese and those with chronic disease, and those who owned a private motor vehicle (Table 1).

Insert Table 1

Buffers with highest of concentration of destinations were found in the central areas of the city (Fig. 1) and mix of destinations scores were significantly higher in Midwest than other regions in Sao Paulo city ($p < 0.001$).

Insert Fig. 1

On a typical weekday and weekend-day, females residing in buffers with a greater mix of walkable destinations engaged in significantly fewer minutes of sitting-time: these associations were observed before and after adjustment for the covariates. There were no associations found between mix of destinations and minutes of sitting-time for men. (Table 2).

Table 2
Multilevel linear regression results explaining the influence of mix destinations score in the minutes per day of sitting time in adults from Sao Paulo city, Brazil, 2015.

Sex	Typical day	Model	Mix of destinations score				
			β(minutes)	IC95% (minutes)			p value
500 m buffers							
Female	Typical week day	1 (unadjusted)	-7.57	(-14.04	;	-1.10)	0.002
		2 (adjusted)*	-11.45	(-18.22	;	-4.68)	0.001
	Typical weekend day	1 (unadjusted)	-6.26	(-12.19	;	-0.33)	0.039
		2 (adjusted)*	-8.09	(-14.42	;	-1.76)	0.012
Male	Typical week day	1 (unadjusted)	0.59	(-7.05	;	8.23)	0.880
		2 (adjusted)*	-5.34	(-12.79	;	2.09)	0.159
	Typical weekend day	1 (unadjusted)	-2.65	(-9.97	;	4.66)	0.477
		2 (adjusted)*	-6.66	(-13.92	;	0.61)	0.072

*Adjusted by age, education, marital status, obesity, physical activity, smoking, diseases presence, car or motorcycle ownership, place where people living in Sao Paulo, and time living in the same residence

Insert Table 2

The results of the logistic models showed that females who lived in buffers with more access to a mix of destinations had 34% lower odds of engaging in more than four hours per day of sedentary behavior than their counterparts with access to fewer destinations (Table 3). However, the results were not statistically significant for a typical weekend day, and for males.

Table 3
Results of multilevel model for the association between ≥ 4 hours per day (vs. < 4 hours per day) of sitting time and tertiles of the mix of destinations, Sao Paulo city, Brazil, 2015.

Mix of Destinations Scores	Sedentary Behavior in week		Sedentary Behavior in weekend	
	Model 1	Model 2*	Model 1	Model 2*
	OR (IC95%)	OR (IC95%)	OR (IC95%)	OR (IC95%)
500 m buffers				
Female				
Lowest	1		1	
Middle	0.77 (0.57–1.04)	0.71 (0.50–1.01)	0.77 (0.54–1.08)	0.75 (0.51–1.08)
Highest	0.79 (0.59–1.05)	0.66 (0.47–0.94)**	0.79 (0.56–1.09)	0.72 (0.49–1.04)
Male				
Lowest	1		1	
Middle	0.74 (0.52–1.05)	0.69 (0.47–1.01)	0.80 (0.56–1.15)	0.75 (0.53–1.06)
Highest	1.11 (0.80–1.54)	0.94 (0.66–1.36)	0.84 (0.60–1.18)	0.78 (0.56–1.10)

*Adjusted by age, education, marital status, obesity, physical activity, smoking, presence of diseases, car or motorcycle ownership, place where people living in Sao Paulo, and time living in the same residence; **p < 0.05

Insert Table 3

Discussion

The main results of this study showed that the females who lived in buffers with better access to a mix of destinations engaged in fewer minutes of sitting time. Males, people with more education, young people, singles, smokers, people with low level of physical activity, with obesity and diseases, people with a car or motorcycle ownership in families, and who lived in Midwest Sao Paulo engaged in more sitting time.

When compared with the results of a recent systematic review [26], our findings show that the prevalence of sedentary behavior in Sao Paulo city is lower than in many high-income countries, and is similar to rates observed in eastern European countries.

Further, the results of our descriptive analysis show that in megalopolis in middle-high income countries such as Brazil, sedentary behavior is associated with many of the same environmental, sociodemographic, and health-related factors that been reported in studies conducted in high-income countries [9].

We showed that better access to a mix of destinations was inversely associated with sedentary behavior in females. The mix of destinations involved access to green areas, physical activity and transportation facilities, primary health care units, supermarkets and food facilities in 500 m buffers of participant's residences and higher levels of this score was associated with more likelihood for walking in another study in this same sample[19].

Other studies have shown results of the inverse association between destinations mix and sedentary behavior. A systematic review showed that access to destinations was inversely associated with sitting time, particularly access to leisure and transportation destinations[10]. A cross-sectional study conducted with Japanese adults living in Tokyo found that access to 30 or more different types of destinations stayed in the limit of statistical significance for inverse association with sitting time in transportation for leisure activities[27]. However, longitudinal study with adults from Nerima and Kanuma cities, in Japan, did not find association between screen time and access to different types of destinations[28]. In addition, studies conducted with adults from high-income countries like New Zealand, Belgian, and Netherlands that evaluated sedentary behavior by accelerometers did not find significant association with built environment variables [29, 30] or found positive association, showing that people who lived in places with better walkability, for example, had more minutes of sitting time, a result that not was expected[17].

The results for the inverse association between sedentary behavior and mix of destinations for females was independent of education, age, and of other health variables like physical activity level and obesity, and environmental factors like the place where they lived, car or motorcycle ownership, and length of time living in the same residence. Thus, for females at least, neighbourhood environments with a greater mix of walkable destinations might promote or facilitate lower levels of sedentary behavior among this group. We did not find a significant association between the mix of destinations and sedentary behavior for males. Similarly, an Australian study of adults from Adelaide city Australia showed that walkability was inversely associated with television viewing among females, but not males[14].

This study had a number of limitations which should be considered when interpreting the results. Firstly, sedentary behavior was measured by self-report. Sitting time is a very complex behavior for people to recall accurately, because it is necessary to think in all domains of life (work, household, leisure, and transportation). In this case, underestimation due to measurement error can be present in these results [8, 13]. Secondly, it is important to verify possible longitudinal changes to decrease the self-selection of neighborhoods, because people can choose places with an environment more suitable for their lifestyle. For example, a recent systematic review showed that obesity was inversely associated with walkability index in cross-sectional studies, but not in the longitudinal studies [31].

Conclusion

This was the first-known study with a sample exclusively from Sao Paulo city, Brazil that examined the relationship between mix of destinations and sitting time in adults. Our results suggest that health promotion and policy should focus on reducing sedentary behavior in the whole population, and especially in those sub-groups who engage in higher-levels of sitting time and whose health is therefore at greater risk.

Abbreviations

International Physical Activity Questionnaire (IPAQ); Sao Paulo Health Survey (ISA); CI Confidence interval; OR (Odds Ratio).

Declarations

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Authors' contributions

AAF had the idea of this study. AAF, GT, LMTG, JPASB, and MSC contributed to data statistical analysis. AAF, GT, JPASB, MSC, LVG, and MG contributed to interpretation and drafted the manuscript. LVG, MAF, BSA contributed to georeferencing of built environment variables. All authors contributed to drafting, critically revising and approved the final manuscript.

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Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The Ethics Committee of the School of Arts, Sciences, and Humanities at the University of Sao Paulo approved the study (process number 55846116.6.0000.5390).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

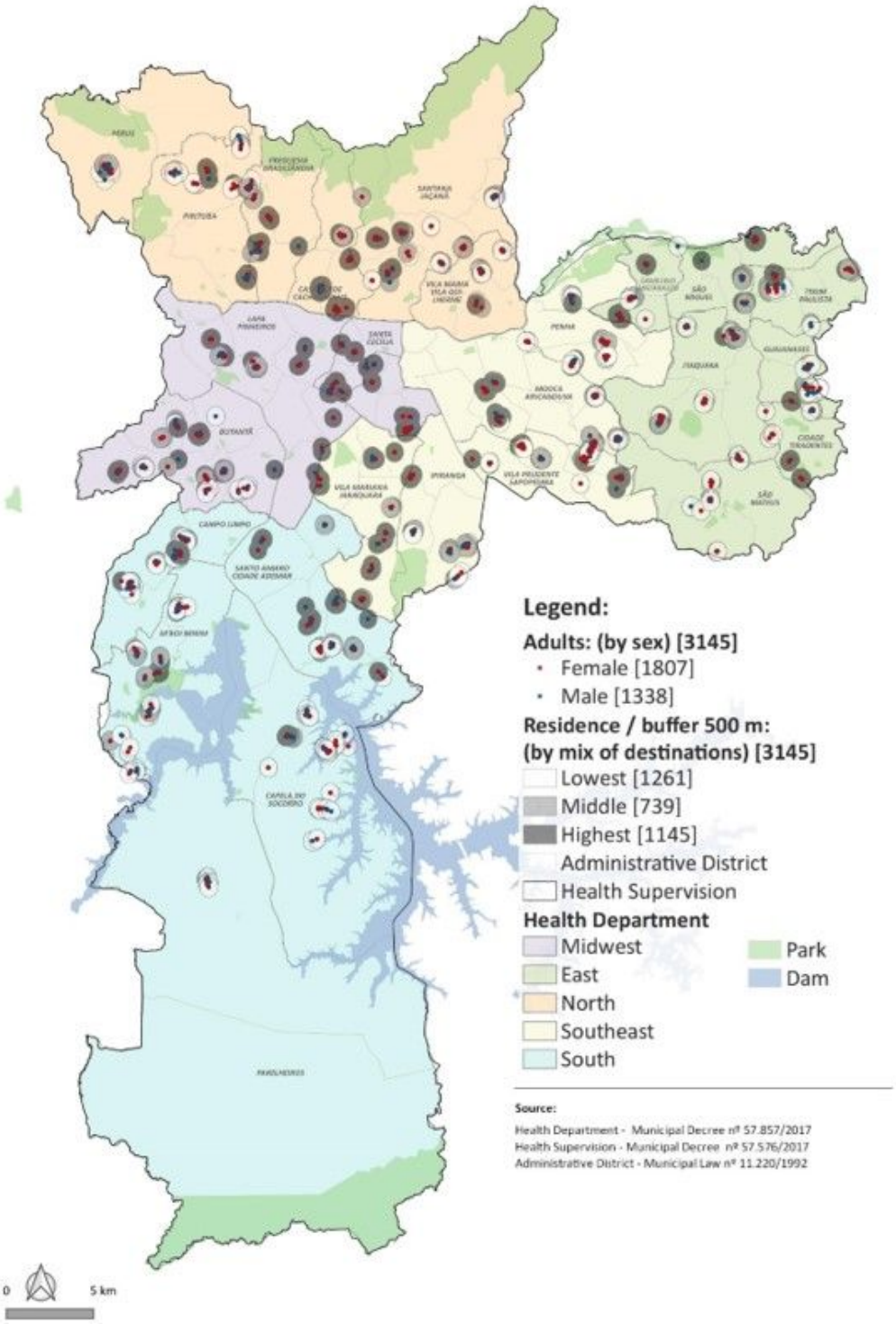

Figure 1

Destinations mix according to sex and health administration area where people reside in Sao Paulo city, Brazil, 2016