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Changes in travel to school patterns among children and adolescents in the São Paulo Metropolitan Area, Brazil, 1997–2007

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ABSTRACT

This paper describes the changes in how children and adolescents travel to school in the São Paulo Metropolitan Area (SPMA), Brazil. Data were from children (6–11 year) and adolescents (12–17 year) who reported at least one trip to school at the SPMA Household Travel Survey for the years 1997 (15,491 people; 31,909 trips) and 2007 (11,992 people; 24,428 trips). We estimated: the proportion and respective 95% confidence interval, median interquartile range, and total trip time in each mode of travel (active, private, public transport) according to sex and quintiles of family income. The analysis was stratified by age group and weighted to make the sample representative of the studied population. Results suggest that the use of public transport and active transport in school travel decreased between 1997 and 2007, whereas the use of private transport increased, especially among children. An inverse relationship between median time in private transport and income was also observed for both children and adolescents. Median time of transport to school remained stable in the study period. This scenario suggests that little effort was put into improving independent mobility of children and adolescents to school by the local authorities. Policies focused on facilitating the acquisition of private vehicles implemented in the study period might have contributed to worsen the situation. Remodeling local environments (both built and social) to make them more suitable for children and adolescents' mobility might be part of a broader, long-term policy destined to enhancing the use and share of the cities' streets in a sustainable, equitable, and healthy way.

1. Introduction

Modes of travel have a crucial importance in the way cities and societies are organized and in people's quality of life and health. Despite this importance, few studies are investigating changes in modes of travel. Studies in high-income countries have shown a decrease in active transport in the last few years (Grize et al., 2010; van der Ploeg et al., 2008). However, extrapolation of the results from high-income countries to other contexts should be made with caution. For example, in Brazil there was a rapid change in the socioeconomic context, with direct consequences to the transport system. From 2000 to 2010, there was a 12% increase of the Brazilian population (Brazilian Institute of Geography and Statistics, 2014a), while in the same period there was an increase of around 140% in the number of vehicles in cities (Brazilian National Department of Transportation, 2014). Moreover, a 2006 federal policy stimulating vehicle purchases through tax reductions combined with an increase in the population's purchasing power help to explain the increase in car use.

A review study from de Nazelle et al. (2011) concluded that active travel policies have the potential to generate large population health benefits through increasing population physical activity levels, and smaller health benefits through reductions in exposures to air pollution in the general population. In this light, encouraging active transport is a potential method not only to improve health (Hamer and Chida, 2008; Saunders et al., 2013; Schoeppe et al., 2013), but also to improve traffic, social and ecological aspects (Hamer and Chida, 2008; Stone et al., 2014). Moreover, fostering active commuting of children and adolescents could promote empowerment through

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independent mobility and reinforce the role of streets as public spaces and drivers of health and prosperity in a city (United Nations Human Settlements Programme, 2013; Weiler et al., 2014).

Notwithstanding the well-recognized benefits of active transport, this practice consistently declined in the last decades among children and adolescents. Recently, a review reported data showing decline of active transport per decade in Australia (5–9 percentage points – p.p.), Brazil (16 p.p.), Canada (5 p.p.), China (11 p.p.), Switzerland (6 p.p.), and USA (9 p.p.) (Booth et al., 2014). Despite methodological differences among studies, patterns of consistent decline can be observed, probably due to car ownership and distance from home to school (Booth et al., 2014). Particularly in Brazil, data regarding modes of travel are scarce, especially time trends, being worse when the focus is children and adolescents. In addition to the data from Florianópolis (Costa et al., 2012) included in the review, in Pelotas, also located in the South of Brazil, adolescents that reported walking or cycling to school decreased from 69% in 2005 to 56% in 2012 (16 p.p.) (Coll et al., 2014). There is no nationally representative time trend data of active travel to school in Brazil yet – in 2012, a National Adolescents School-based Survey showed that 38% of adolescents do not walk or cycle to or from school (Rezende et al., 2014).

Previous studies on transportation to school mainly have investigated only active transport (Coll et al., 2014; van der Ploeg et al., 2008). Despite its importance to public interventions and urban planning, we should understand transportation in a wider view. For example, active transport to school time could be decreasing because of better distribution of schools throughout neighborhoods or of improvements in the public transportation systems, which are desirable ameliorations. Therefore, while active transport has decreased, we should learn how other forms of commuting are changing in order to improve the organization of the city and its transport system. Thus, the purpose of the present study is to describe changes in travel to school patterns among children and adolescents between 1997 and 2007, living in the São Paulo Metropolitan Area, Brazil.

2. Material and methods

We used data collected for the São Paulo Metropolitan Area Household Travel Survey (HTS), an on-going household travel survey carried out by the transport sector (*Companhia do Metropolitano de São Paulo – Metro*) every ten years since 1967. The past two HTS (1997 and 2007) comprised the 39 cities of the São Paulo Metropolitan Area (from now on, we will refer to the whole metropolitan area as São Paulo), the largest metropolitan area in South America, home to almost 21 million people, that comprises an area of 8500 km^2 (Brazilian Institute of Geography and Statistics, 2014b). The proportion of people aged 5–19 years old in the São Paulo population in 1997 and 2007 were 28% and 24%, respectively (Seade Foundation, 2014). The education component of the Human Development Index increased in the region between 1991 and 2010 (from 0.421 to 0.725), resulting in a high proportion of people aged 6–14 years old attending school in 2010 (around 96%) (United Nations Development Programme, 2014).

For both surveys, the sampling plan followed a complex and stratified design to produce estimates representative of the São Paulo population. Sampling strategy was based on the roll of electricity consumers of the city electricity companies, which covers 98% of the area's population (Brazilian Institute of Geography and Statistics, 2014b). As part of the sampling process, São Paulo was divided in contiguous zones. Each zone was used to randomly select, with replacement, the primary study units (households) according to three levels of energy consumption – used as a proxy for household number of individuals and income. For both years, each zone had its sample size calculation, with the total sample size target for São Paulo of 30,000 households. In case of a not valid household (refusal to participate, without information from all residents, closed, empty or not found household), another household from the same zone and level of energy consumption would be randomly selected.

Data were collected for every household member using a face-to-face interview. In case of children younger than 10 years old who would not go alone to school, information was provided by the parents. Data collection took place in various days of the week to have all weekdays represented in the sample. Household-level data included the number of families and residential location. Several information from family and individuals was collected, including the number of members in the family, home ownership, family and individual income, age, gender, and education. Travel-level data was related to one-way trips undertaken on the day before the interview and included origin and destination, mode of travel, the number of times one changed the mode of travel, purpose and time of departure and arrival. Data were collected for the 1997 HTS from August 1997 to November 1997 from 98,780 people in 26,278 households, and include 163,541 trips. The 2007 HTS was conducted from August 2007 to April 2008 and contains data of 91,405 people in 29,957 households, and 169,665 trips.

In both years (1997 and 2007), we used information of children aged from 6 to 11 years old and adolescents aged from 12 to 17 years old (Centers for Disease Control and Prevention, 2014) who traveled to and from school at least once in the reference day. Trips originating in the school had the purpose defined as 'school'. Modes of travel were grouped into three categories: active transport (walking or cycling), private transport (car, motorcycle, taxi, school van, and charter bus) and public transport (public bus, public van, subway and train). In order to obtain individual-level information of travel patterns, we aggregated travel-level data for each individual, estimating the person/day cumulative minutes spent on total travel, active, private, and public transport. We also classified subjects according to their mode of travel use: private transport users were those traveling by any private mode to school at least once on the reference day – same as for public transport users (the proportion of those who used both modes of travel were not presented due to low frequency – less than 1% in almost all cases). Active traveler was defined as those exclusively walking or cycling to school on the reference day.

2.1. Statistical analysis

Our entire analysis was stratified by age group (children and adolescents). For 1997 and 2007, we estimated the proportion and its respective 95% confidence interval as well as the median and interquartile range time of trips to school in each mode of travel (active, private, public transport) and in total according to sex and quintiles of family income. We considered population relevant estimate changes greater than 5% in the study period. Given the large sample size, all changes observed were statistically significant at a significance level of 0.05. Data were weighted to adjust for the selection probabilities at the individual level and to make the sample representative of the studied area. Analyses were conducted in 2014 using Stata 12.1 (StataCorp LP, College Station, TX, USA). The Institutional Ethics in Research Committee at the University of São Paulo, School of Public Health approved the study.

3. Results

For 1997 we used data from 7604 children (15,395 trips) and 7887 adolescents (16,514 trips). For 2007 we used data from 5795 children (11,662 trips) and 6127 adolescents (12,766 trips). In 1997, the proportion of boys among children and adolescents was 53% (95% CI: 51–54) and 49% (95% CI: 48–50), respectively. In 2007, the proportion of boys was 52% (95% CI: 50–53) among children and 50% (95% CI: 49–51) among adolescents. The proportion of children and adolescents living in families with ≤ 2 minimum wages were 24% (95% CI: 23–25) in 1997 and 4% (95% CI: 3–5) in 2007. The minimum wage in 1997 and 2007 were R$120 (US$ 115) and R$ 380 (US$ 195), respectively.

3.1. General trends in transport patterns among children

Proportion of private transport increased between 1997 and 2007 due to a reduction in active and public transport trips (Fig. 1).

The proportion of active transport decreased similarly among sex between 1997 and 2007. Among all income strata, the proportion of active transport decreased between 1997 and 2007, except in the lowest income quintile (Table 1). Between 1997 and 2007, the proportion of private transport increased for both sexes and income strata, except in the lowest income quintile (Table 1). Proportion of public transport decreased among in all quintiles of income and in boys and girls, although the reduction was more pronounced among the latter (Table 1).

In total, median time of transport to school remained stable between 1997 (median=25 min, IQR: 20–40) and 2007 (median=30 min, IQR: 20–50). The median time in private transport increased between 1997 and 2007, especially in boys and in the lowest and middle income quintiles (Table 2). Time spent in public transport remained similar between 1997 and 2007, except the second lowest quintile that increased in around 20 min (34%) (Table 2).

3.2. General trends in transport patterns among adolescents

Proportion of private transport increased between 1997 and 2007 due to a reduction in active and public transport trips (Fig. 1).

The proportion of active transport slightly decreased among boys and reduced among higher income strata between 1997 and 2007 (Table 3). The proportion of private transport increased among both boys and girls, whereas a sharp decrease in the lowest income quintile was observed (Table 3). The proportion of public transport slightly decreased among boys and in the lowest income quintile, with an increase in the middle income quintile (Table 3).

In total, median time of transport to school increased 10 min between 1997 (median=30 min, IQR: 20–55) and 2007 (median=40 min, IQR: 20–60). Among boys and the lowest income quintile, the median time of active transport increased 30% between 1997 and 2007 (Table 4). The median time spent in private transport increased 33% between 1997 and 2007 and this increase was higher among girls and in the lowest and second highest income quintiles. Time spent in public transport increased between 1997 (median=44 min, IQR: 26–73) and 2007 (median=55 min, IQR: 34–90). Median time of public transport was similar among sex in 1997, with a higher increase among boys from 1997 to 2007. Similarly, only in 2007, a negative relationship between time spent in public transport and income level was found (Table 4).

Fig. 2 presents the graphical distribution (histograms) of total median time spent in active, private and public transport for 1997 and 2007, for both children and adolescents.

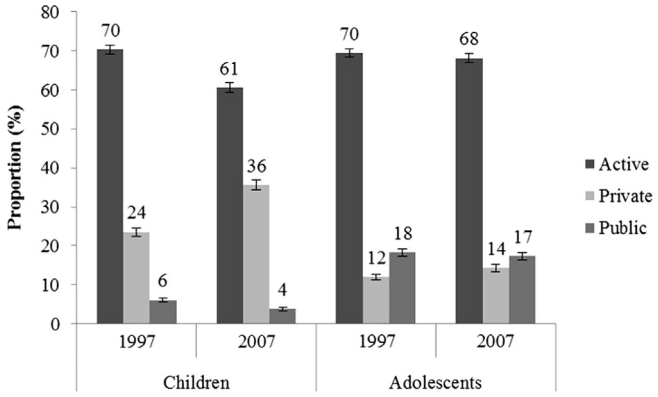

Fig. 1. Proportion of children and adolescents going to school according to mode of travel. São Paulo, Brazil, 1997–2007.

Table 1
Proportion of children going to school according to mode of travel, sex, and income level. São Paulo, Brazil, 1997–2007.

Variables	Active traveler[a]						Private transport user[b]						Public transport user[c]					
	1997 (*n*=4999)			2007 (*n*=2999)			1997 (*n*=2061)			2007 (*n*=2636)			1997 (*n*=642)			2007 (*n*=222)		
	%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI	
Sex																		
Girls	69	67	71	59	57	61	25	23	26	38	36	40	6	5	7	3	2	4
Boys	72	70	73	62	61	64	23	21	24	33	32	35	6	5	7	5	4	6
Income quintile																		
1° (Lowest)	70	68	73	76	74	78	24	22	27	21	18	23	6	4	7	3	2	5
2°	85	84	87	72	69	74	8	7	10	24	22	27	6	5	7	4	3	5
3°	79	76	81	62	59	65	15	13	17	34	31	37	6	5	8	4	3	5
4°	70	68	73	40	37	43	23	21	26	56	53	60	6	5	7	3	2	5
5° (Highest)	40	37	43	22	19	25	54	51	57	74	71	78	6	5	7	4	2	5

Notes:
n: number of trips considered in each mode and year; %: proportion; 95% CI: 95% confidence interval.
Some categories do not sum 100% because of the omission of the mixed user (those children who used both private and public transports).

[a] Those performing trips to school exclusively by walking and bicycle.
[b] Those performing at least one trip to school by private transport (car, motorcycle, taxi, school transport and charter bus).
[c] Those performing at least one trip to school by public transport (public bus or micro-bus, subway or train).

4. Discussion

This study found that compared with the São Paulo travel to school patterns in 1997, the use of public and active transports decreased in 2007, whereas the use of private transport increased, especially among children. There was a slight increase in the median time of travel to school, which was more pronounced in trips made by private transport. Some disparities according to family income groups exist among both children and adolescents, such as an inverse relationship between median time in private transport and income. Finally, while the proportion of active travelers reduced – sharply among children – during the decade, the median time spent on active transport remained relatively stable.

The reduction in active transport to school due to increased private transport found in our study is a trend in several countries (Cui et al., 2011; Fyhri et al., 2011; Grize et al., 2010), and in other Brazilian cities (Costa et al., 2012). The substantial increase in the use of private transport might reflect what happened in Brazil in recent decades regarding economic growth and urban development. Concerning to the former, Brazilian purchasing power has been increasing in all socioeconomic strata, allowing more people to possess and use desired goods and services, including cars and motorcycles. As in other countries, in Brazil, the combination between individual's new economic capability and old desires play an important role in the private transport acquisition, not just for its instrumental value, but also for status symbol and affective factors (Steg, 2005). In addition, some federal government decisions fostered the automobile industry development, such as supporting tax exemptions and facilitating loans for private vehicles purchase.

The way urban sprawl took place in regions such as the São Paulo Metropolitan Area also helps to explain why active transport to school has become less attractive recently. The region has grown in an unplanned manner, with people settling down intensively and disorderly in peripheral areas before the needed infrastructure had arrived. For instance, between 1997 and 2007 the demographic density increased 28% in the periphery of the metropolitan area (*i.e.*, not considering São Paulo city) compared to 11% in São Paulo city (Department of Planning and Expansion of Metropolitan Transports, 2008). However, the density of jobs (Department of Planning and Expansion of Metropolitan Transports, 2008) and schools[1] did not follow the same trend. Particularly for schools, density increased 35% in the center against 6% in the other regions, shrinking in some areas.[1]

It is plausible that this macro-environmental scenario has influenced meso- and micro-environmental aspects and, ultimately, the transport-related behavior. For instance, the quantity of cars in São Paulo state increased 31% from 1997 to 2007 (Brazilian National Department of Transportation, 2014) and, in the São Paulo Metropolitan Area, motorized trips increased 23% in the same period (Department of Planning and Expansion of Metropolitan Transports, 2008). Moreover, for decades transport policies focused on facilitating motorized traffic, thinking streets as roads instead of social places, trying to speed up traffic and minimize travel time (Banister, 2008; United Nations Human Settlements Programme, 2013). Evidence suggests that the number of cars in the household (Bringolf-Isler et al., 2008; Gropp et al., 2012) and pedestrian safety concerns (Bringolf-Isler et al., 2008; Carlson et al., 2014; Larouche et al., 2014; Pont et al., 2013) are strong correlates of non-active travel to school among children and adolescents. Regarding the unorganized urban sprawl patterns, consistent results indicate distance to school as an important barrier to active travel in this age (Carlson et al., 2014; Pont et al., 2013; Wong et al., 2011). Unfortunately, the available data does not allow us to analyze whether the distance to school increased in the period. Carver et al. (2014b) found that the territorial range among children residing in disadvantaged areas is generally restricted in less than 15 min when they are out alone, and is positively associated with the number of accessible destination types in the neighborhood. Recent evidences also suggest that community design and street network configuration can affect health (Marshall et al., 2014). Furthermore, other built environmental characteristics such as better walkability, street connectivity around home, residential density around home and school, percentage of streets with sidewalks, and total length of roads have showed to be important correlates of active commuting among children and adolescents living in high-income countries (Carlson et al., 2014; Gropp et al., 2012).

Children and adolescent's active commuting is also related to their parents' behaviors, attitudes, and perceptions (Babey et al., 2009; Bringolf-Isler et al., 2008; Carlson et al., 2014). Parent's habitual active commuting can influence their children to actively travel to school (Carlson et al., 2014). Those aspects related to parents might also be viewed as intermediate variables in a framework that links macro-environmental scenario, such as the unorganized urban sprawl patterns, to active commuting. For instance, since school trips are commonly interlinked with parent's trips to work, an increase in private mode use in trips to work, due to increased distance from home, might also contribute to an increase in private mode use in their children's commute to school. Additionally, adolescents who frequently do not have an adult present after school and whose parents know little about their whereabouts after school are more likely to commute actively (Babey et al., 2009), which might help to explain why the decrease in active travel to school was not so strong when compared to children.

Other aspect is the parental safety concerns related to active transport to school, which decreases the probability of children using active commuting to go to school (Bringolf-Isler et al., 2008; Carlson et al., 2014). Regarding safety issues, a study conducted with Brazilian adolescents found that traffic and crime safety concerns were associated with non-active transport to school (Silva et al., 2011). A nationwide survey conducted in 2012 showed that 9% of students did not go to school in the 30 days preceding the survey because they did not feel safe on the way between home and school. This percentage was higher among public school students (10%), who are poorer than those from private schools (5%). In Brazil's Southeast region, where our study population is located, this proportion was 10% (Brazilian Institute of Geography and Statistics, 2013).

Policies that encourage active and safe transport to school, as well as polices aimed to inclusion of children in public and active transport, are of great importance to promote empowerment and independent mobility of children and adolescents. One public health effort that has been getting attention in this area is the Safe Routes to School program, initiated in Denmark in the late 1970s and that today is developed throughout Europe, United States, Australia, New Zealand, and Canada (National Center for Safe Routes to School, 2014). In the United States, where the program provides grants to local projects that support safe modes of active transport to school, a study found an increase of 37% in active transport after a 5-year period (Stewart et al., 2014). Unfortunately, programs of this type are scarce and not well documented in Brazil, where this kind of action could bring great benefits stimulating safe and active transport to

[1] Calculated by the authors using educational census datasets freely provided by the Brazilian National Institute of Educational Studies and Researches at < http://portal.inep.gov.br/basica-levantamentos-acessar > .

school. However, the imminent launch of the United Nations' Sustainable Development Goals brings new opportunities to discuss mobility-related topics, and to foster and implement programs that promote active transport to school and independent mobility for youth in several countries, including Brazil. Such discussions and programs have the potential to pervade several Sustainable Development Goals issues, like provision of safe, affordable, accessible and sustainable transport for connected and healthy communities; reduction of the environmental impact of cities; support of positive economic, social and environmental links within urban areas; reduction of road traffic deaths, and so on (United Nations, 2014).

Given the important impacts of active transport on health (Hamer and Chida, 2008; Schoeppe et al., 2013), the reduction of active transport observed among children and adolescents might have contributed to the increase of obesity and overweight rates both among these groups and adults (Conde and Monteiro, 2014). It also might help to explain the increase in the occurrence of asthma in the region (Solé et al., 2015). Beyond the potential direct health effects, active transport to school by young people also reflects the empowerment and possibilities of street use, independent mobility, financial capacity, and other political and sociogeographic factors (Carver et al., 2014a; Fyhri et al., 2011; Schoeppe et al., 2014; Weiler et al., 2014). Indeed, according to the City Prosperity Index, developed by the United Nations Human Settlements Programme (2013), equity and social inclusion, including the promotion of street used by young people, especially through active modes of transport, are key aspects for the development of a more livable, healthy and prosperous São Paulo in the future (United Nations Human Settlements Programme, 2013).

Our study has some limitations. First, we were unable to evaluate whether trip duration increased due to a concomitant increase in the distance traveled since trip distance information was available only at the 2007 HTS. Additionally, HTS from both years suffer from the common limitations of self-reported data, which in this case tends to overestimate trip duration (Kelly et al., 2013). The rounding that occurs in self-reports of duration may also introduce additional measurement error (Yang and Diez-Roux, 2012). Nevertheless, the use of a unique and everyday trip purpose in this study (going to school) might have helped to reduce this error. Lastly, different data collection strategies among children according to their habit of going alone to school could have introduced some report bias, unless we assume that the report from children going alone to school is as accurate as that of parents taking their children to school.

5. Conclusion

The results of this study suggest that from 1997 to 2007, São Paulo failed to improve independent mobility of children and adolescents to school, resulting in a reduction of public and active transport. In fact, it appears that policies focused on facilitating the acquisition and use of private transports made the present scenario worse for all, whereas the proportion and time use of private modes increased in the period. Remodeling local environments (both built and social) to make them more suitable for children and adolescents' mobility might be part of a broader, long-term policy destined to enhancing the use and share of the cities' streets in a sustainable, equitable, and healthy way. In this sense, São Paulo's most recent strategic urban plan – approved on June 30, 2014 – has goals related to reducing sociogeographic disparities, fostering urban life on neighborhood level, and reorganizing the transport system (São Paulo Department of Urban Development, 2014), which can change the city's current mobility scenario. Now it is necessary to turn intention into action.

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