

## Transport and health: a look at three Latin American cities

Transporte y salud: una mirada a tres ciudades latinoamericanas

Transporte e saúde: um olhar sobre três cidades latino-americanas

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### Abstract

*Transport is associated with environmental problems, economic losses, health and social inequalities. A number of European and US cities have implemented initiatives to promote multimodal modes of transport. In Latin America changes are occurring in public transport systems and a number of projects aimed at stimulating non-motorized modes of transport (walking and cycling) have already been implemented. Based on articles from peer-reviewed academic journals, this paper examines experiences in Bogotá (Colombia), Curitiba (Brazil), and Santiago (Chile), and identifies how changes to the transport system contribute to encourage active transportation. Bus rapid transit, ciclovías, bike paths/lanes, and car use restriction are initiatives that contribute to promoting active transportation in these cities. Few studies have been carried out on the relationship between transport and physical activity. Car ownership continues to increase. The public health sector needs to be a stronger activist in the transport policy decision-making process to incorporate health issues into the transport agenda in Latin America.*

*Pendular Migration; Transportation; Bicycling; Walking*

### Resumen

*El transporte está asociado con problemas ambientales, pérdidas económicas, salud poblacional e inequidades sociales. En ciudades de Europa y Estados Unidos hay iniciativas para promover el transporte multimodal. En Latinoamérica hay proyectos en curso para cambiar los sistemas de transporte y estimular el transporte no motorizado (caminar y montar bicicleta). Basada en una revisión de artículos publicados en revistas académicas, se identifica de qué forma los cambios en el transporte en Bogotá (Colombia), Curitiba (Brasil) y Santiago (Chile) han contribuido a promover el transporte activo. A pesar que en estas tres ciudades se están implementando iniciativas para promover el transporte activo (sistema de autobuses articulados, ciclovías, ciclorutas, y restricciones para el uso del coche particular), pocos estudios han sido desarrollados sobre la relación entre el transporte y la actividad física utilitaria. La tenencia del coche particular continúa incrementándose. El sector de salud necesita ser un agente fuerte para incorporar la salud pública en la agenda de transporte en América Latina.*

*Migración Pendular; Transportes; Ciclismo; Caminata*

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## Background

An intensive and rapid worldwide process of urbanization over the last two centuries meant that by 2010 50% of the world's population was already living in urban areas. Although rates differ across regions, the United Nations calculates that on average 74% of the population of developed countries and 43% of the population of less developed countries live in urban areas<sup>1</sup>. Transport is a key aspect of urban life due to its impact on economic growth, social interaction and urban structure<sup>2</sup>. Although transport-related policies and projects are not, strictly speaking, health interventions, they have a potential impact on individual and collective health<sup>3,4,5,6</sup>. Therefore, urban transport policies and projects need to be monitored and evaluated to identify their social, economic and environmental costs and to define strategies to improve the public health benefits of such interventions<sup>7</sup>.

Transport is associated with environmental problems, economic losses and social inequalities and is a social and physical determinant of health. Motor vehicles are one of the main sources of environmental pollution. They produce 26% of carbon dioxide (CO<sub>2</sub>) emissions, one of the major causes of global warming<sup>8</sup>, which in turn is responsible for changes in worldwide distribution patterns of infectious diseases such as dengue fever and malaria<sup>9</sup>. In addition, the increased number of motor vehicles and associated increase in fuel consumption affects air, water and soil quality. Poor air quality is associated with respiratory disease<sup>10,11</sup>, cardiovascular morbidity, mortality<sup>12</sup>, premature deaths<sup>13</sup> and ocular irritation<sup>14</sup>, leading to an increase in the use of health services and out-of-pocket health care expenses<sup>15</sup>. Policy decisions regarding urban mobility affect exposure to motorized transport related injury<sup>16</sup> because the risk of injury is directly associated with the number of vehicles on the roads<sup>17,18</sup>. Furthermore, transport related injury is associated with mental health problems<sup>19</sup> and stress levels and mood are associated with commuter transportation choices<sup>20</sup>.

Transport is also related to other social determinants of health. Inadequate public transport infrastructure can exacerbate social segregation and restrict access to labor markets<sup>21</sup>. Furthermore, poor public transport can hinder access to educational institutions, health care services and cultural services<sup>22</sup>. A study carried out in England for example reported that people without a car face greater difficulties in finding employment, accessing supermarkets and seeking medical attention<sup>23</sup>. As a result, poor transport

infrastructure can accentuate social inequality. Poor transport facilities may have an impact on people's dietary patterns, particularly among minority and lower income groups that are more likely to face geographical barriers to accessing healthy food<sup>24,25</sup>.

In contrast, an affordable, efficient, multi-modal (combining different means of transport), accessible and interconnected public transport system stimulates interaction among people as well as a sense of belonging<sup>26</sup>. Additionally, a well-designed transport system facilitates the mobility of elderly people and enhances their autonomy<sup>27</sup>.

The relationship between transport and physical activity has been particularly well documented. Research has shown that transport infrastructure can have an effect on physical activity because transport systems can provide an incentive to use multimodal means of transport thus leading to an increase in the level of physical activity in urban areas. Public transport can also contribute to the practice of physical activity, because accessing transport services often requires walking<sup>28,29</sup>. Evidence also shows that car use and car dependence is a risk factor for obesity because excess driving leads to an imbalance between energy consumption and energy expenditure<sup>30</sup>. In fact, transport-related physical activity is a protective factor for chronic diseases, stress and obesity<sup>31,32</sup>.

Although the links between transport and health have been part of the academic and political agendas of Europe<sup>16,33</sup>, the USA<sup>34</sup> and Canada<sup>35</sup> for over two decades, the relationship between transport and health remains understudied in Latin America. There is limited literature available specifically on the influence of transport systems on physical activity (walking or cycling as a means of transport) in urban areas. A recent review of transport and its relation with physical activity (e.g. active commuting) by Bauman et al.<sup>36</sup> reported that there is practically no evidence for such an association. An increase in physical activity among the population of this region is crucial because between 30 and 69% of Latin Americans do not meet physical activity recommendations and between 50 and 60% of Latin American and Caribbean adults are overweight or obese<sup>37</sup>. Physical activity can help reduce the risk of cardiovascular diseases, the main cause of mortality (31%) and premature death in this region. Furthermore, transport-related physical activity is a practice that can be easily incorporated into people's daily lives.

This paper, based on articles from peer-reviewed academic journals from the HINARI (*Programa de Acceso a la Investigación en Salud*),

SciELO (Scientific Electronic Library Online) and LILACS (Literatura Latinoamericana y del Caribe en Ciencias de la Salud) databases, official reports, daily journals, and website pages, aims to analyze public transport initiatives and active modes of transport in three selected Latin American cities [Bogotá (Colombia), Santiago (Chile) and Curitiba (Brazil)] and their potential contribution to increasing physical activity (walking and cycling). The cities were selected because they all have large urban centers with high rates of urbanization (over 75%). Furthermore, the transport systems and urban mobility in Curitiba and Bogotá have been subject to wide changes over the last decades and both cities have been indicated as successful examples of urban transport <sup>38,39</sup>.

Firstly, a search of the following four transport strategies, each with potential to promote physical activity (walking and cycling), was carried out using gray literature and non-indexed documents (Google search) to characterize the initiatives in each city: Bus Rapid Transit (BRT) systems, car use restriction measures, Ciclovía-Recreativa programs, and the construction of cycle paths. Subsequently, a search of academic papers exploring the relationship between these initiatives and physical activity (walking and cycling) written up to 2011 was undertaken using the HINARI, SciELO and LILACS databases. These databases were used because they provide academic literature produced mainly in Latin American countries. Furthermore, HINARI offers free access and it includes important sources of health literature such as PubMed/MEDLINE.

The following combinations of key words in three languages (Spanish, Portuguese and English) were used together with the names of each city (Curitiba, Bogotá and Santiago): “transportation AND physical activity”, “Bus Rapid Transit AND physical activity”, “Ciclovías AND physical activity”, “cycle paths or bike lane AND physical activity”, “car free day AND physical activity” (i.e. transportation x physical activity x Curitiba). Only papers that explored the relationship between these initiatives and physical activity were selected for this review. In addition, two academic papers suggested by an expert were included in the study. The search was done between January 2011 and March 2011.

The peer-reviewed articles considered by this study are shown in Table 1.

## Transport and physical activity in Latin American cities

Today, around 75% of the Latin American population lives in urban areas. The pace of urbanization is more rapid in Latin America than in North America and Europe <sup>40</sup> and the rate is expected to increase to 82% by 2025. This process has contributed to a modified urban infrastructure in the region and, as a result of globalization, major cities have been important drivers of competitiveness (encouragement of international investment) since the 1980s <sup>41</sup>. Transport systems play an ever more important role in mobility and urban productivity and over the last 20 years a significant number of transport projects have been implemented in several Latin American cities.

One of the most important initiatives is the BRT system promoted by the World Bank <sup>42</sup> that has been offering loans aimed at implementing this system in cities around the world over the last three decades. BRT consists of a number of articulated buses each with capacity of more than 150 passengers that move along exclusive corridors using fixed stations to pick up and drop off passengers. BRT systems have been implemented in more than 70 cities worldwide, each with different characteristics with respect to infrastructure, costs, administration, speed, components, capacity and level of integration <sup>43</sup>. In Latin America, BRT systems have been implemented in Brazil (in Curitiba, Goiânia, Fortaleza, and Manaus), Ecuador (in Quito and Guayaquil), Peru (in Lima), Mexico (in Ciudad de México, Guadalajara and León), Colombia (in Cali, Pereira, Bogotá, Cartagena, Barranquilla, Medellín and Bucaramanga), where they are considered an efficient and cost-effective solution for urban mobility <sup>44</sup>.

Although the main objective of BRT is to increase urban mobility and reduce transport time, they also have the potential to stimulate the use of active modes of transport (cycling and walking) and reduce private car use, thus promoting physical activity <sup>34</sup>. The experience of implementing mass transportation systems such as BRT is a unique opportunity to evaluate the impact of transport on people's life in urban areas. However, evaluations using “natural” experiments with pre and post measures or prospective cohort studies remain scarce and to date only two studies are known to have evaluated the relationship between BRT and physical activity, both of which are cross-sectional studies: one carried out in Bogotá which is reviewed below <sup>45</sup>; and a pre-post study underway (not yet published) in Cali, which evaluates the impact of a BRT system

Table 1

Transport and physical activity (peer-reviewed articles included in this review).

Papers	Focus	Main findings	City
Reis et al. <sup>61</sup>	Participation and knowledge on community physical activity programs	Public transportation provides access to facilities where physical activity community programs are delivered	Curitiba, Brazil
Parra et al. <sup>62</sup>	Self-perception of environmental attributes and physical activity	Meeting recommendations of physical activity levels was associated with high perceptions of infrastructure accessibility (i.e. built bicycling and walking trails)	Curitiba, Brazil
Hino et al. <sup>22</sup>	Objective measures of the built environment and recreational physical activity	Density of bike paths was not associated with physical activity in leisure time	Curitiba, Brazil
Cervero et al. <sup>69</sup>	Built environment and physical activity (walking and bicycling)	BRT stations (TransMilenio) were associated with utilitarian walking. Living nearby to a Ciclovía increase Ciclovía usage. Density of bike paths was not associated with utilitarian bicycling	Bogotá, Colombia
Gomez et al. <sup>45</sup>	Built environment and physical activity in leisure time	BRT stations (TransMilenio) were associated with physical activity in leisure time. Existence of bike lanes was not associated with physical activity in leisure time	Bogotá, Colombia
Gomez et al. <sup>70</sup>	Built environment and walking patterns	Ciclovía was associated with walking at least 150 minutes per week	Bogotá, Colombia
Rodríguez et al. <sup>71</sup>	BRT stations (TransMilenio) and pedestrian activity	Friendly pedestrian environment around or along BRT stations (TransMilenio) incentive pedestrian activity	Bogotá, Colombia
Sarmiento et al. <sup>58</sup>	Ciclovía programs and physical activity	Ciclovía program has contributed to increasing levels of physical activity	Bogotá, Colombia

BRT: Bus Rapid Transit.

implemented in 2009 on physical activity and quality of life <sup>46</sup>.

Despite the health benefits of these systems implemented in Latin American cities, private car ownership in this region has been increasing steadily. Although rates do not yet match those of countries such as Luxembourg, which has the highest rate of car ownership in the world (647 cars per 1,000 population), New Zealand (607 cars per 1,000 population) <sup>47</sup>, or China, which became the world leader in domestic car sales in 2009 (13 million per year) <sup>48</sup>, private car ownership continues to rise in cities in Latin American countries such as Brazil, Argentina, Chile (97 per 1,000 population), Mexico (138 per 1,000 population) and Colombia (where car sales increased by approximately 50% between 2004 and 2005) <sup>49,50</sup>. A particularly striking case is Curitiba where, despite being a city with a public transport system that stands as an internationally recognized model, car ownership rates are one of the highest in Brazil <sup>51</sup>. Studies show that in some European, Canadian, Australian and U.S. cities, increas-

ing car ownership does not necessarily lead to an increase in car-usage <sup>52</sup>. However, in Latin American cities with lower use of non-motorized modes of transport, the higher social status offered by owning a car, irregular public transport systems and the trend of increasing car ownership is likely to have a negative impact on cycling and walking as means of transport.

A number of strategies aimed at restricting car use have been implemented to tackle the effects of traffic congestion on air quality. In 1989, for example, in Mexico City the program *Hoy no Circula* (No Circulation Today) was implemented which prohibited car owners and some public service vehicles (taxis and buses) from circulating between the hours of 5:00am and 10:00pm one day per week according to license plate number <sup>53</sup>. Similar programs have been implemented in other cities including São Paulo <sup>54</sup>, Cali <sup>55</sup>, Bogotá <sup>56</sup> and Santiago, where during rush hour or on certain days of the week drivers are prohibited from using their cars. Bike share programs, like the one implemented in Mexico City <sup>57</sup>, are also

being offered as alternatives to motor vehicle use. However, these strategies have not contributed to a reduction in car ownership.

Initiatives to promote cycling as a means of transport and leisure-time are also being implemented in several Latin American cities as independent projects or together with BRT systems. One example is the Ciclovía-Recreativas program, an open community program developed principally in Latin American cities where main streets are closed off to motorized traffic during certain periods of the week to allow people to use these areas for cycling, walking, running or skating. Sarmiento<sup>58</sup> found that 38 of these initiatives have been implemented in 11 countries and that 80% of Ciclovías were connected with parks. These initiatives involved the closure of between one to 121km of streets for between 18 and 64 days of the year. Pucher et al.<sup>59</sup> analyzed cycling infrastructure and highlighted a number of initiatives aimed at promoting cycling in Bogotá including the construction of separate bike paths connected with the public transport system, social and educational programs to encourage cycling and the definition of car-free areas.

In summary, four main transport strategies that have the potential to promote physical activity and improve people's health have been implemented recently in Latin American cities: BRT which has the potential to increase walking and cycling; car use restriction measures that promote the use of non-motorized means of transport; Ciclovías-Recreativas that promote physical activity on streets usually used by cars; and the construction of bike paths which allow cyclists and car drivers to share physical space and infrastructure. At the same time however, the number of privately-owned cars and motorcycles is also increasing in this region. The following section analyzes the experiences of successful initiatives to modify transport infrastructure in three Latin American cities to identify how these changes have influenced levels of physical activity and the main challenges facing these cities with respect to promoting transport-related physical activity. The socioeconomic characteristics of these cities are shown in Table 2.

## Transport and health in Curitiba, Bogotá and Santiago

### Curitiba

Curitiba is the capital city of the State of Paraná, located in the south of Brazil, and has 1,851,215 inhabitants. The city is home to the world's first BRT system, created in 1973 as part of the Ur-

ban Master Plan designed in 1966. The system carries around 1.5 million passengers daily and is widely recognized as a successful transport model in terms of efficiency, quality, capacity and cost<sup>60</sup>.

While a direct evaluation of the relationship between BRT and physical activity in Curitiba is yet to be carried out, three studies exist that indirectly analyze the relation between Curitiba's urban planning process, transportation system and physical activity among the population. Reis et al.<sup>61</sup> found that 5.6% of Curitiba's adult population participates in physical activity programs promoted by the city government and highlight that the integration between public transportation and land-use regulation facilitates access to several recreational facilities which involve physical activity programs. Such programs are generally developed in public spaces, "*including sports and leisure department units (that usually include a gymnasium, an exercise room and/or a pool), plazas, and cycling and walking paths*"<sup>61</sup> (p. 138).

In a study of environmental perception and transport-related physical activity and physical activity during leisure time, Parra et al.<sup>62</sup> showed that 55% of the population of Curitiba reported walking and 8% reported cycling as a means of transport; interestingly, a perception of traffic safety, measured as "*presence of traffic and drivers exceeding speed limits*"<sup>62</sup> (p. 236), was not associated with walking or cycling. However, moderate and high levels of perception of personal security, evaluated as "*perception of crime nearby and perceived safety when walking or cycling at night and during the day*"<sup>62</sup> (p. 236), were associated with both walking and cycling. The authors argued that a feeling of personal safety is more relevant than the urban physical environment as a factor that influences physical activity behavior. Finally, Hino et al.<sup>22</sup> found that there was no association between living close to bike paths and levels of physical activity in parks and plazas during leisure time. However, this study showed an association between living in an area with a high density of gyms and recreational centers and meeting physical activity recommendations during leisure time.

In summary, although Curitiba is considered a model city in terms of its transport system, there is no current evidence that shows an association between the BRT system and increased levels of physical activity among the population. Furthermore, according to Parra et al.<sup>62</sup>, apart from having a model BRT system, Curitiba has "*the highest public transportation ridership in Brazil (85%), the city also has the highest car/inhabitant ratio (1:2) in the country*"<sup>62</sup> (p. 235).

Table 2

Socio-economic characteristics of the selected cities.

City	Population *	Density (population/km <sup>2</sup> ) **	GINI ***	Human Development Index (by country-rank) #	% urban population ##
Bogotá	7,363,782	15.058	0.61	0,71 (87)	Colombia: 75.4
Curitiba	1,751,907	4.568	0.59	0,71 (84)	Brazil: 86.9
Santiago	4,668,473	2.896	0.55	0,80 (44)	Chile: 89.2

Sources:

\* Alcaldía Mayor de Bogotá D.C. <sup>78</sup>; Instituto Brasileiro de Geografia e Estatística (IBGE) <sup>79</sup>; and Instituto Nacional de Estadística de Chile (INE) <sup>80</sup>;

\*\* Hidalgo & Carrigan <sup>43</sup>;

\*\*\* United Nations Human Settlements Program (UN-HABITAT) <sup>81</sup>;

# United Nations Development Program (UNDP) <sup>82</sup>;

## United Nations Department of Economic and Social Affairs (UN-DESA) <sup>83</sup>.

Curitiba also has a network of more than 30km of bike lanes shared mainly with pedestrian walkways. However, a study of the general use of this system and the relation between the increase in the size of the bike lane network and prevalence of cycling as a means of transport is yet to be carried out. Also, Ciclovias-Recreativas in Curitiba are not common <sup>63</sup> and no data is available regarding the effects of car use restriction and car-free days in Curitiba on prevalence of physical activity (walking or cycling).

### **Bogotá**

Bogotá is the capital of Colombia and has 7,363,782 inhabitants. The city has been undergoing an important process of urban change since 1990 <sup>64</sup> and, as a result of a decentralization process that began in the mid-1980s, municipalities were granted new authority, including control over urban planning regulations. These changes included the implementation of a mass transport system based on the BRT system called TransMilenio which began operating in 2000 and is projected to cover 80% of the city by 2031. Each articulated bus has the capacity to carry 160 passengers (48 seated and the rest standing). In addition, the city is developing initiatives to promote cycling and reduce private car use.

To complement the TransMilenio, the city is creating a network of bike-paths covering more than 330km called Ciclorutas. This project encourages cycling as a means of transport to reduce air pollution, traffic congestion and automobile dependence. However, data reveals that, despite the significant investment in the development of the Ciclorutas network and the

implementation of cycle-friendly policies, a small number of people regularly use a bicycle in Bogotá: in 1995, only 0.6% of the population used a bicycle on a regular basis and this percentage increased to 2% in 1999 and peaked at 4.4% in 2003 <sup>65</sup>. Another study reported that only 3.3% of adults in Bogotá were sufficiently physically active through using a bicycle to meet health guidelines, and that 15.6% used a bicycle for at least 10 minutes a week <sup>66</sup>.

Bogotá is also experiencing a rapid increase in the number of motorcycles and private cars. Between 2004 and 2007, at least 74,108 new motorcycles were registered in the city and between 1995 and 2005 the number of cars per 1,000 inhabitants increased from 82.6 to 84.7 <sup>67</sup>. This trend has a potentially negative impact on cycling and walking as means of transport and Parra et al. <sup>68</sup> has shown a positive association between car and motorcycle ownership and excess weight, obesity and abdominal obesity among men.

Like Curitiba, Bogotá is widely recognized for its transport system and changes in its urban environment and several studies have evaluated the relationship between its transport system and physical activity. Cervero et al. <sup>69</sup> found an association between distance from the mode of transport, measured as “the number of TransMilenio (BRT) stations”, and utilitarian walking for 30 minutes or more per day. The authors also reported an association between proximity to a Ciclovía path and the use of the Ciclovía at least once a month. On the other hand, no association was found between utilitarian cycling and bike-lane density; however, authors explain that this contradictory finding should be confirmed using a larger sample. Finally, these authors also

reported that high volumes of traffic are an impediment to utilitarian cycling in Bogotá.

Gomez et al.<sup>45</sup> found that people who live in close proximity to a TransMilenio station are more likely to be irregularly active when compared with inactive people. The authors argue that urban changes related to pedestrian friendly initiatives together with the construction of the TransMilenio could explain why adult people living near TransMilenio stations are more physically active. However, the presence of bike lanes or Ciclovias was not associated with greater physical activity during leisure time. A study of the elderly by Gomez et al.<sup>70</sup> reported a slight association between the presence of Ciclovía-Recreativa and walking at least 150 minutes per week. Finally, Rodríguez et al.<sup>71</sup> supported the hypothesis that the friendly pedestrian environment and crossing aids built around BRT stations in Bogotá encourage walking and promote BRT use.

The literature also shows that Bogotá is recognized for its successful experience with the implementation of 121 km of ciclovias-recreativas that are open every Sunday and on public holidays between the hours of 7 am and 2 pm, and were used by 1,400,273 people per month in 2005, thus contributing to an increase in levels of physical activity<sup>57</sup>.

Car Free Days and car use restriction (known as “*Pico y Placa*” in Spanish) are other initiatives that stimulate the use of non-motorized transport in Bogotá; however, the impact of these initiatives on physical activity has yet to be reported.

### Santiago

Santiago is the capital of Chile and has a population of 4,668,473 distributed throughout a metropolitan area consisting of 34 *comunas*. The city has a combined transport system that includes a metro (subway system) and BRT system called Transantiago which is connected by feeder buses and began operating in 2007. Zegras<sup>72</sup> states that this system offers good quality buses, shorter routes, no competition between drivers to gain passengers, and uses an innovative card payment method which allows transfers without extra payment. The BRT system covers areas not served by the metro, aiming to reduce traffic congestion by discouraging private car use and encouraging the use of public transport. However, experts argue that the system has created other difficulties for citizens because it was implemented without initial testing.

Despite public efforts to increase ridership in Santiago, the number of private cars has increased sharply in recent years; between 1992 and 2002 car ownership increased from 24.3% to 36%<sup>73</sup>,

the number of vehicles per household increased from 0.32 in 1977 to 0.5 in 2001 and cars journeys increased from 12% in 1977 to 39.6% in 2001. Zegras<sup>72</sup> argues that having at least one vehicle per household is associated with increased family income. In a panel study carried out between December 2006 and October 2008, Yáñez et al.<sup>74</sup> analyzed the effects of the implementation of the Transantiago on different modes of travel. They reported an increment in the number of cars per household and argued that this increase may be the result of implementation problems. It is also interesting to note that 7% of individuals from the panel study bought a car and 2.3% acquired a driver's license for the first time after the system started operating. These findings illustrate the complexity of individual travel decisions and the importance of the quality of public transport systems. However, it is also necessary to consider the influence of changes in individual and family income on car ownership in Latin American cities. More research is necessary to determine the long-term effects of the Transantiago system on physical activity and health.

Other initiatives that aim to promote transport-related physical activity in Santiago are the CicloRecreoVia, a network of 7km of bike/walking paths created in 2006 used by around 3,000 people per event<sup>57</sup>, and a program to restrict private car use during rush hours and periods of high air pollution implemented in 1980.

Studies on the relationship between changes in Santiago's transport system and levels of physical activity (walking and cycling) were not found in the literature.

Table 3 shows a comparison of transportation patterns in Curitiba, Bogotá and Santiago.

### **Discussion**

Given the link between transport and health, it is imperative that individual and collective health issues are considered in designing urban transport policies and programs. Transport is a key social determinant of health, particularly in urban areas, which can help reduce social inequalities, improve people's mental and physical health, prevent injury and decrease environmental pollution<sup>19</sup>. Findings from studies in Europe, Canada, Australia and the USA show that transport has a potentially positive effect on physical activity behavior<sup>31</sup>; therefore, transport and health policies are indissociable. From the Latin American perspective, five main aspects of the relationship between transport and physical activity have been evaluated: (a) multimodal transport systems that incorporate

Table 3

Urban transport patterns by city.

City	Cycling for transport (%)	Walking for transport (%)	Cars per 1,000 inhabitants (year)	Motorcycles per 1,000 inhabitants	BRT-total passenger demand (million), 2009 #
Bogotá *	4.3	40.5	84.7 (2005)	NA	1.60
Curitiba **	8.0	55.0	556.4 (2010)	75.6 (2010)	2.26
Santiago ***	1.9	NA	129.0 (1998-2000)	NA	5.70

BRT: Bus Rapid Transit

Sources:

\* Biking and walking for transport: Instituto Colombiano de Bienestar Familiar <sup>49</sup>; Cars: Cámara de Comercio de Bogotá <sup>67</sup>;\*\* Biking and walking for transportation: Parra et al. <sup>62</sup>; Cars and motorcycles: Departamento de Tránsito do Paraná (Detran-PR) <sup>84</sup>;\*\*\* Biking for transportation: López-Barrera <sup>85</sup>; Cars: Sperling & Salon <sup>86</sup>;# Hidalgo & Carrigan <sup>43</sup>.

walking and cycling; (b) the potential of BRT to promote walking/cycling to access the system; (c) public transport systems as a disincentive to private car use associated with reduced physical activity and increased sitting time; (d) significant modifications of transport systems involving urban changes (i.e. recuperation of public spaces, mixed use, micro-design and security) which potentially reduce the physical barriers to the use of non-motorized means of transport; and (e) measures and programs to discourage private car use and support active transport (i.e. “Pico y placa”). Despite the rich source of information for potential study provided by the experiences in these cities, the impressive changes in transport systems and the implementation measures to stimulate non-motorized means of transport, little research on the relationship between transport and physical activity and health has been carried out in Latin America to date. The main focus of study has been the implementation of BRT based mass transport systems. In this respect, a limited number of studies carried out in Bogotá showed a positive association between BRT and physical activity, one study in Curitiba showed an indirect relationship and one study in Santiago showed that household car use increased after the implementation of the BRT system. The three cities have Ciclorutas and BRT systems, but only in Bogotá were these two systems implemented in conjunction. While Dill & Carr <sup>75</sup> report that physical infrastructure is an important factor *per se* that encourages bike use and bike commuting and studies of the Bogotá Ciclorutas found an association with physical activity during leisure time, no such association was found in the case of Curitiba. This suggests

that physical infrastructure alone might not be enough to encourage cycling in Latin American cities.

This preliminary review highlights several factors that may explain the lack of evidence regarding transport and health in these cities. First, most evaluations of BRT systems have focused on performance related to cost, travel time reduction, comfort, capacity and design <sup>76</sup> because health was not considered as one of the main objectives of this system. This may reflect a possible lack of integration between the public health and urban planning sectors in the transport policy and program decision-making process. As a result, evidence on the impacts of BRT systems on people’s health remains limited. Furthermore, differences in quality, design, costs and the implementation process potentially affect public acceptance and use of this mode of transport and may negatively impact its potential to encourage non-motorized means of transport. It is also necessary to investigate whether the BRT systems in these cities allow users to take bikes onto the buses and if the BRT system is integrated with the bike lane network. Answering these questions will help create a better understanding with respect to whether BRT prevents or encourages cycling (i.e. multimodal transport). In brief, in order to provide input into the policy decision-making process, more information is required on the impact of BRT and the cost-benefit of different policy scenarios that contemplate alternative urban transport strategies.

Second, urban physical infrastructure and people’s behavior is a relatively new research area and technical and methodological developments are needed, such as updated geographical infor-



mation systems. It is also important to create interdisciplinary teams and improve the availability of data from different sources, together with much needed financial resources which are limited in some Latin American cities. Research on transport and physical activity has been carried out largely in the USA and Europe. Studies in Latin America need take into account the specific characteristics of urbanization (land use and urban design) and motorization. Furthermore, in some cities car ownership has more social status than non-motorized means of transport (walking or cycling). Thus, while in the USA and Europe ample information exists on the factors that influence walking and cycling, in Latin America more research is necessary on the social and physical urban factors related to transport and physical activity.

Third, financial resource and time constraints are a limitation for studies on urban infrastructure and health. Cohort studies or “natural” experiments provide better scientific evidence but also require greater financial resources and support from research agencies. In this respect, local governments generally prefer to support short or medium-term research rather than long-term studies. Continued reviews of this nature are needed because transport affects many other health outcomes not included in this review such as, air quality, traffic injuries, social

inequalities (i.e. access to goods, places and resources), social integration, and family spending on transport. For instance, Bogotá’s experience in reducing traffic injuries deserves to be revisited<sup>77</sup>. It should also be emphasized that the role of the public health sector in the transport and urban land use sector is particularly important in Latin America due to the significant cross-cutting impacts on human health and well-being. From the social determinants of health perspective, public health researchers in Latin America should seek to influence the policy decision-making process to promote policies that positively impact active transport or non-motorized transportation; thus, contributing to an increase in levels of physical activity and a decrease in the risks of chronic diseases.

Finally, this narrative review has certain strengths and limitations. All academic papers published up to 2011 found in well recognized databases were included. A more comprehensive review was made possible by accessing wider sources of information by including additional databases (e.g. PubMed) and expanding each investigated topic as a separate item. Using other information sources and research techniques, such as interviews with key actors, could have contributed to elucidate why health (i.e. physical activity) has played such a limited role in public transport decision-making in the three cities.

## Resumo

*O transporte está associado a problemas ambientais, perdas econômicas, de saúde da população e as desigualdades sociais. Em cidades da Europa e da América existem esforços para promover o transporte multimodal. Na América Latina, há projetos em andamento para mudar os sistemas de transporte e incentivar o transporte não motorizado (caminhar e andar de bicicleta). Com base em uma revisão de artigos publicados em revistas acadêmicas identificou-se como as mudanças no transporte contribuíram para promover o transporte ativo em Bogotá (Colômbia), Curitiba (Brasil) e Santia-*

*go (Chile). Apesar de que nestas três cidades se estejam implementando iniciativas para promover o transporte ativo (sistema de ônibus articulado, ciclovias, pistas de ciclismo e restrições ao uso do automóvel particular), poucos estudos têm sido desenvolvidos sobre a relação entre transporte e atividade física utilitária. O uso de carro particular continua aumentando. O setor da saúde tem de ser um ativista forte para incorporar a saúde pública na agenda de transportes na América Latina.*

*Migração Pendular; Transportes; Ciclismo; Caminhada*

## Contributors

J. M. Becerra participated in study conception, data collection and analysis, elaboration of the first draft and review of successive drafts, and the approval of the final version of this article. C. M. Padin, L. Weigand, J. Dill, V. Dujon, C. Crespo, F. M. Paz, E. A. Cordero, B. Welle, F. A. Ramirez-Marrero, L. D. Frank, R. S. Reis, and E. Jacoby participated in data collection and data analysis, critical review of the content of successive drafts and in the approval of the final version of this article.

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