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# Socio-demographic patterns of public, private and active travel in Latin America: Cross-sectional findings from the ELANS study<sup>☆</sup>

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## ABSTRACT

**Background:** Active travel such as walking or cycling has been associated with more favorable health outcomes. However, evidence on patterns of transportation in Latin America is scarce. Therefore, the aim of this study was to quantify and characterise socio-demographic patterns of public, private and active travel in Latin American countries.

**Methods:** Data from the Latin American Study of Nutrition and Health, a population-based, cross-sectional survey conducted in eight Latin American countries including Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Venezuela (n = 9218; age range: 15–65 years). Transportation modes include public (bus, taxi, subway and train), private (car and motorcycle) and active (walking and/or cycling). Outcomes for this study include time spent in different modes of transportation. We performed overall and country-specific descriptive analyses to examine differences by sex, age, socioeconomic and education level.

**Results:** For the overall cohort, public transport represent 34.9% of the total travel time, whereas private, walking and cycling represent 48.2%, 10.6% and 6.3% of the total travel time. Time spent using public travel was highest in Venezuela (48.4%); Peru had the highest proportions of private travel (52.5%); Time spent walking and cycling was highest in Costa Rica (14.8% and 12.2%, respectively). The average travel time spent in public and private transport were 299.5 min/week (95% CI: 292.4307.0) and 379.6 min/week (95% CI: 368.0, 391.5) respectively; figures for walking and cycling were 186.9 min/week (95% CI: 181.8, 191.9) and 201.1 min/week (95% CI: 187.8, 216.9).

**Conclusions:** Public and private transport were the most common forms of travel in Latin America. Active travel (walking or cycling) represent 17% of total physical activity, therefore, promoting and providing the right infrastructure for active commuting could translate in increasing the population overall levels of physical activity in Latin America.

## RESUMEN

**Introducción:** Transporte activo como caminata o bicicleta ha sido asociado con una salud más favorable. Sin embargo, la evidencia en transporte activo en Latinoamérica es escasa. Por lo tanto, el objetivo de este estudio fue cuantificar y describir las características sociodemográficas del transporte público, privado y activo en países de Latinoamérica.

**Métodos:** Los datos provienen del “Estudio sobre Nutrición y Salud en Latinoamérica”, y fueron recogidos a través de encuestas nacionales en ocho países, incluyendo Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru y Venezuela (n = 9.218; edad: 15–65 años). Los modos de transportarse fueron, público (bus, taxi, metro y tren), privado (auto y motocicleta) y activo (caminar y/o bicicleta). Los resultados incluyeron el tiempo dedicado a los diferentes modos de transporte. Se realizó un análisis descriptivo de cada país para examinar las diferencias por sexo, edad, nivel socioeconómico y educativo.

**Resultados:** En general, el tiempo utilizado para transporte público representó el 34,9%, mientras que para el transporte privado, caminar y desplazarse en bicicleta representaron un 48,2%, 10,6% y 6,3%. El tiempo utilizado en viajes públicos fue más alto en Venezuela (48,4%); Perú tuvo la mayor cantidad de viajes privados (52,5%); el tiempo dedicado a caminar y bicicleta fue más alto en Costa Rica (14,8% y 12,2%). El tiempo de viaje en transporte público y privado fue de 299,5 min/semana (IC95%: 292,4–307,0) y 379,6 min/semana (IC95%: 368,0–391,5); las cifras de caminar y bicicleta fueron 186,9 min/semana (IC95%: 181,8–191,9) y 201,1 min/semana (IC95%: 187,8–216,9).

**Conclusiones:** El transporte público y privado fueron las formas de desplazamiento más comunes. Los viajes activos (caminada o bicicleta) representan el 17% de la actividad física total, por tanto, promover y proporcionar la infraestructura adecuada para los desplazamientos activos, podría traducirse en un aumento de los niveles generales de actividad física en América Latina.

## RESUMO

**Introdução:** O transporte ativo, como caminhada ou bicicleta, tem sido associado com uma saúde mais favorável. No entanto, as evidências do transporte ativo na América Latina são escassas. Portanto, o objetivo deste estudo foi quantificar e descrever as características sociodemográficas do transporte público, privado e ativo em países da América Latina.

**Métodos:** Os dados são provenientes do “Estudo sobre Nutrição e Saúde na América Latina” e foram coletados por meio de pesquisas nacionais em oito países, incluindo Argentina, Brasil, Chile, Colômbia, Costa Rica, Equador, Perú e Venezuela (n = 9218; Idade: 15 a 65 anos). Os modos de transporte foram: público (ônibus, táxi, metrô e trem), privado (carro e moto) e ativo (caminhada e/ou bicicleta). Os resultados incluíram o tempo dedicado aos diferentes modos de transporte. Uma análise descritiva de cada país foi realizada para examinar as diferenças por sexo, idade, nível socioeconômico e educacional.

**Resultados:** Em geral, o tempo utilizado no transporte público representou 34,9%, enquanto no transporte privado, caminhada e ciclismo foram 48,2%, 10,6% e 6,3%. O tempo gasto em

transporte público foi maior na Venezuela (48,4%); O Peru teve a maior quantidade de transporte privado (52,5%); o tempo gasto caminhando e andando de bicicleta foi maior na Costa Rica (14,8% e 12,2%). O tempo médio por transporte público e privado foi de 299,5 min/semana (IC95%: 292,4–307,0) e 379,6 min/semana (IC95%: 368,0–391,5); os números de caminhada e bicicleta foram 186,9 min/semana (IC 95%: 181,8–191,9) e 201,1 min/semana (IC 95%: 187,8–216,9).

**Conclusões:** O transporte público e privado foram as formas mais comuns de deslocamento. O transporte ativo (caminhada ou ciclismo) representam 17% da atividade física total, portanto, promover e fornecer infraestrutura adequada para o deslocamento ativo pode resultar em um aumento nos níveis gerais de atividade física da população em América Latina.

## 1. Introduction

Strong evidence supports that physical activity (PA) has substantial health benefits such as reducing premature mortality, cardiovascular disease incidence and some types of cancer (Piercy and Troiano, 2018; Physical Activity Guidelines Advisory Committee, 2018). These benefits can be obtained by performing structured PA (during leisure-time); but they can also be obtained through using walking or cycling as forms of transportation (hereafter ‘active travel’) (Celis-Morales et al., 2017; Step It Up, 2015). In fact, walking or cycling may also be a good way for people who are inactive to become active (Andersen, 2016).

Active travel is a key component for the development of healthy sustainable environments and provides health benefits as well as ancillary benefits related to greenhouse gas emissions (Dora et al., 2015; Haines et al., 2012). Moreover, increasing physical activity related to travel is an essential population-wide strategy which aims to reverse the burden of noncommunicable diseases (NCDs), given the substantial potential for tackling levels of physical inactivity through increasing overall PA levels (Celis-Morales et al., 2017; Pratt et al., 2012).

Latin America is the most urbanized region in the world (80% of Latin Americans live in cities) (United Nations, 2012), and the prevalence of obesity and chronic diseases has dramatically increased in the last 30 years (Ng et al., 2014; Rivera et al., 2014). Furthermore, high population density, disorganized transit systems, traffic congestion, air and noise pollution, rising crime rates, and pronounced income inequality are some of the characteristics of Latin American countries (United Nations, 2012; Barreto et al., 2012). In terms of PA and NCDs, Latin America has a high prevalence of physical inactivity (39.1%) (Guthold et al., 2018) and NCDs in comparison with other regions worldwide (World Health Organization, 2014). Therefore, there is an urgent need to look for different strategies aiming to increase the overall levels of physical activity in the Latin American population.

Evidence from a comprehensive review suggested that populations with higher levels of active travel tend also to have higher overall levels of PA than those populations who rely more on private transportation to get to and from places (Celis-Morales et al., 2017; Saunders et al., 2013; Hamer and Chida, 2008). In addition, evidence has shown that individuals who engage in active travel have lower risk of NCDs and all-cause mortality (Hamer and Chida, 2008; Saunders et al., 2013; Kelly et al., 2014). However, to date, evidence on the extent of active travel and its distribution across different groups (by sex, age, and socioeconomic level) in Latin America is limited. Filling this evidence gap could provide key information for informing national, regional and local transport and public-health policies aiming to increase active travel and therefore overall levels of PA in the population. Therefore, the aim of this study was to quantify and characterise socio-demographic patterns of public, private and active travel in Latin American countries.

## 2. Material and methods

### 2.1. Latin American study of nutrition and health

The Latin American Study of Nutrition and Health (*Estudio Latinoamericano de Nutrición y Salud*; ELANS) is a household-based cross-sectional survey aimed at investigating food and nutrient intake as well as nutritional and PA statuses of nationally representative samples from urban populations (Fisberg et al., 2016). The ELANS study includes data collected from eight Latin American countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela. Thus, a total sample of 9218 participants aged between 15 and 65 years was included in this study. The sampling size required for sufficient precision was calculated with a 95% confidence level of and a maximum error of 3.5% and a survey design effect of 1.75. The study was based on complex, multistage sample design, stratified by conglomerates, being all regions of each country represented, and random selection of main cities within each region according to probability proportional to size method. Sample was stratified by sex, age, and socioeconomic level. Socioeconomic levels was balanced based on national indexes used in each country (Fisberg et al., 2016) (Supplementary Table A1). For the selection of households within each secondary sampling unit, they were selected through systematic randomization. Considering quotas for the sex, age and socioeconomic level, the selection of the participant belonging to the domicile was made using 50% of the sample next birthday, and 50% last birthday. The rationale and design of the study are reported in more detail elsewhere (Fisberg et al., 2016).

All the study sites are academy based (universities and other academic institutions) and each site adhered to a common study protocol for interviewer training, implementation of fieldwork, data collection and management, and quality control procedures. Data collection for ELANS took place from September 2014 to February 2015. The ELANS protocol was approved by the Western Institutional Review Board (#20140605) and is registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (#NCT02226627). All participants of the ELANS study provided written consent to take part in the ELANS study.

## 2.2. Exclusion criteria

Participants were excluded from the study if at recruitment they were pregnant/lactating, had a major physical/mental impairment that impacted on food intake and PA levels, were  $\leq 15$  years old or  $\geq 65$  years old, if participants did not provide consent/consent from a legal guardian, or if participants could not read.

## 2.3. Survey measures

Measurements were collected according to standardized procedures in each country. Mode of transportation, its frequency and duration were collected using self-reported questionnaire. Participants were asked about what are the mode of transport generally used to move from one place to another (bus, taxi, subway, train, car and motorcycle), how frequent they use this mode of transport (number of days per week) and what is the average duration of travel (min/day). For the purpose of this study we generated two categories for non-active travel, public travel which included those participants who reported travelling by bus, taxi, subway and train; and private travel which include those participants reporting car and motorcycle transportation as main mode of travel. Time spent in public and private travel was expressed as minutes per week (min/week) – and calculated separately by multiplying the reported number of days per week by the reported duration on an average day.

We refer to the measures as overall travel rather than commuting as the questions captured overall travel rather than travel specifically undertaken to/from work. For active travel the following questions were asked: (i) “Do you walk or use a bicycle (pedal cycle) for at least 10 min continuously to get to and from places?” (Yes, No); (ii) “In a typical week, how many days do you walk or ride a bicycle for at least 10 min continuously to get to and from places?” and (iii) “How much time do you spend walking or bicycling for travel on a typical day?” These questions asked separately for walking and cycling. Time spent in active travel was expressed as min/week and calculated in the same way as described for non-active travel.

Self-reported PA and sitting time was assessed using the International Physical Activity Questionnaire (IPAQ) – long version, a validated self-report measurement tool in Latin America (Celis-Morales et al., 2012; Hallal et al., 2010; Salvo et al., 2014). An international group of experts developed this survey instrument to estimate PA patterns of populations from different countries and sociocultural contexts (Craig et al., 2003; Hallal et al., 2010). A Spanish version previously validated in Mexican adults was used in ELANS (Medina et al., 2013) and it was adapted for all eight participating ELANS countries, using culturally appropriate wording and examples (Salvo et al., 2014).

The total time spent in PA (min/day) was assessed using six items of the IPAQ, which asked about the frequency and duration of moderate- and vigorous-intensity PA as well as walking (Craig et al., 2003). We classed walking in this study as a moderately intensive activity. Data were analyzed in accordance with the IPAQ scoring protocol ([www.ipaq.ki.se](http://www.ipaq.ki.se)). Adolescents and adults were categorised physically inactive based on the WHO recommendations for moderate-to-vigorous physical activity (MVPA). For adolescents physical inactivity was defined as doing  $< 60$  min/day of MVPA. Whereas for adults, physical inactivity was defined as doing  $< 150$  min/week of moderate-intensity PA or its equivalent  $\geq 75$  min/week of vigorous-intensity PA or its metabolically equivalent  $< 600$  MET-min.week (World Health Organization, 2010).

Sitting time was used as a proxy of sedentary behaviour (Sedentary Behaviour Research Network, 2012). Participants were asked to report time spent in sitting time over the past 7 days, separately for a weekday and a weekend day. We calculated average daily sedentary time (min/day) as follows: [(weekday time\*5 + weekend time\*2)/7] (Bauman et al., 2011).

Information about socio-demographics such as age (expressed in years), sex, socioeconomic and educational level was collected using self-reported questionnaires. Socioeconomic data was divided into three categories (low, medium, high) based on the country-specific indices (Fisberg et al., 2016). Age was categorised into 3 groups (15–29, 30–59, and  $\geq 60$  years) and education level was presented as low (equivalent to non-formal education or primary school), middle (equivalent to secondary school), and high (equivalent to technical or university degree).

## 2.4. Statistical analyses

We performed data analyses with IBM SPSS, version 22 for Windows (SPSS Statistics for Windows, 2013). Descriptive statistics included the mean, frequency, percentage, and the associated 95% confidence interval (95% CI). The two main outcomes were the proportion of travel time spent by transport mode (public, private and active commuting (walking and cycling)), and the time spent in each transport mode. We present overall and country-specific estimates by sex, age group, socioeconomic level, and educational level. All our analyses were weighted for the survey design; with the weighting variable calculated according to the sex, socioeconomic level and region of each participating country (Fisberg et al., 2016).

## 3. Results

### 3.1. Cohort characteristics

The main characteristics of the overall cohort and of each country are shown in Table 1. Overall, the response rate was 99.4% and the mean age of the sample was 35.8 years. The proportion of women was slightly higher than for men (52.1% vs 47.9%), 52.0% of participants reported a low socioeconomic level and 61.2% had a low educational level. On average, the mean amount of time spent in total PA was 27.8 min/day. Over two-thirds of participants (68.8%; 83.1% in adolescents; 57.6% in adults, respectively) did not meet

**Table 1**

Baseline characteristics (mean or percentage and 95% confidence interval) of participants for each Latin America country.

Variables	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	Peru	Venezuela	Overall
N	1266	2000	877	1230	798	800	1113	1132	9218
Rate of response (%)	99.7	98.9	99.6	99.1	99.5	99.8	98.5	99.8	99.4
Sex <sup>a</sup>									
Men	45.3 (42.6–48.1)	47.2 (44.9–49.4)	48.2 (45.0–51.7)	49.1 (46.2–52.0)	49.4 (46.2–52.6)	49.7 (46.3–53.1)	47.2 (44.3–50.1)	48.7 (45.8–51.4)	47.9 (46.8–48.9)
Women	54.7 (51.9–57.4)	52.8 (50.6–55.1)	51.8 (48.3–55.0)	50.9 (48.0–53.8)	50.6 (47.4–53.8)	50.3 (46.9–53.7)	52.8 (49.9–55.7)	51.3 (48.6–54.2)	52.1 (51.1–53.2)
Age (years) <sup>b</sup>	36.7 (35.9–37.5)	36.5 (35.8–37.1)	36.4 (35.4–37.4)	36.9 (36.1–37.8)	35.2 (34.2–36.1)	34.3 (33.4–35.3)	34.1 (33.3–34.9)	34.9 (34.1–35.8)	35.8 (35.5–36.1)
Age group <sup>a</sup>									
15-29	38.7 (35.9–41.5)	38.1 (36.0–40.3)	40.1 (37.0–43.2)	41.4 (38.7–44.2)	44.1 (40.4–47.6)	45.2 (41.8–48.6)	46.7 (43.7–49.6)	44.1 (41.1–47.1)	41.7 (40.8–42.7)
30-59	55.3 (52.7–58.0)	56.3 (54.1–58.4)	54.5 (51.2–57.7)	52.1 (49.4–55.1)	52.0 (48.5–55.4)	49.7 (46.2–53.3)	49.3 (46.4–52.3)	55.1 (48.2–54.1)	53.0 (52.0–54.0)
≥60	6.0 (4.7–7.4)	5.6 (4.6–6.6)	5.4 (3.9–6.9)	6.5 (5.0–8.0)	3.9 (2.6–5.4)	5.1 (3.6–6.8)	4.0 (2.9–5.2)	4.8 (3.5–6.1)	5.3 (4.8–5.7)
SEL <sup>a</sup>									
Low	48.7 (45.8–51.5)	45.7 (43.7–47.9)	46.5 (42.8–49.8)	63.3 (60.7–66.0)	33.0 (29.6–36.3)	49.7 (46.3–52.9)	47.7 (44.9–50.7)	77.7 (75.1–80.4)	52.0 (51.0–53.0)
Medium	46.2 (43.2–48.9)	45.8 (43.6–47.9)	44.3 (41.1–47.8)	31.3 (28.6–34.0)	53.5 (50.3–56.9)	37.3 (34.0–40.7)	31.9 (29.0–34.4)	16.8 (14.8–19.1)	38.5 (37.5–39.5)
High	5.1 (3.9–6.6)	8.5 (7.4–9.7)	9.2 (7.2–11.3)	5.4 (4.2–6.7)	13.5 (11.1–15.9)	13.0 (10.8–15.4)	20.4 (17.9–22.8)	5.5 (4.2–6.8)	9.5 (8.9–10.1)
Education level <sup>a</sup>									
Low	75.5 (73.1–77.8)	48.4 (46.2–50.7)	65.1 (62.0–68.2)	64.9 (62.3–67.4)	81.6 (79.0–84.3)	82.9 (80.4–85.6)	23.0 (20.6–25.6)	68.7 (65.7–71.5)	61.2 (60.2–62.2)
Medium	20.3 (18.1–22.5)	43.1 (41.0–45.3)	23.5 (20.8–26.3)	24.0 (21.7–26.4)	12.7 (10.6–15.0)	10.5 (8.3–12.7)	67.2 (64.5–70.0)	12.5 (10.5–14.5)	29.2 (28.3–30.2)
High	4.3 (3.2–5.4)	8.4 (7.2–9.6)	11.4 (9.4–13.4)	11.2 (9.6–13.0)	5.7 (4.2–7.3)	6.5 (4.6–8.4)	9.8 (8.0–11.6)	18.8 (16.5–21.2)	9.5 (9.0–10.1)
Total PA (min/day) <sup>b</sup>	28.18 (26.4–26.9)	23.5 (22.2–24.7)	29.6 (27.3–31.9)	28.6 (26.9–30.3)	32.7 (30.4–34.9)	42.3 (39.8–44.8)	31.2 (29.4–33.0)	19.1 (17.5–20.7)	27.8 (27.2–28.5)
PA guidelines <sup>a</sup>									
Not meeting	64.2 (61.1–67.5)	72.0 (69.6–74.5)	71.6 (68.1–75.0)	66.7 (63.9–69.7)	60.6 (56.6–64.4)	66.2 (62.7–69.9)	70.6 (67.7–73.5)	76.7 (73.6–79.7)	68.8 (67.8–70.0)
Meeting	35.8 (32.5–38.9)	28.0 (25.5–30.4)	28.4 (25.0–31.9)	33.3 (30.3–36.1)	39.4 (35.6–43.4)	33.8 (30.1–37.3)	29.4 (26.5–32.3)	23.3 (20.3–26.4)	31.2 (30.0–32.2)
Sitting time (min/day) <sup>b</sup>	267.8 (258.8–276.2)	219.2 (212.5–226.9)	243.5 (233.6–254.1)	241.3 (231.9–250.9)	224.6 (214.2–236.6)	173.7 (163.9–182.8)	265.2 (256.2–273.9)	197.6 (188.9–205.5)	231.7 (228.5–234.9)

Analyses were weighted for the survey design.

SEL: socioeconomic level; PA: physical activity.

<sup>a</sup> Percentage and 95% confidence interval.<sup>b</sup> Mean and 95% confidence interval.

the WHO weekly guidelines for PA; this proportion was highest in Venezuela (76.7%) and was lowest in Costa Rica (60.6%). On average, the mean level of sedentary behaviour was 231.7 min/day, ranging from 173.7 min/day in Chile to 265.2 min/day in Peru (Table 1).

### 3.2. Proportions of travel time by sociodemographic factors

Fig. 1 shows the proportion of travel time spent in the four modes (public transport, private transport, walking and cycling) overall and by country. Overall, more than two thirds of travel time was spent in public and private transport (34.9% and 48.2%, respectively); less than one-fifth was spent in active travel (10.6% and 6.3% for walking and cycling respectively). The proportion of travel time spent in public transport was highest in Venezuela (48.4%) and Colombia (45.9%); this was more than double the equivalent proportion in Costa Rica (21.0%). The proportion of travel time spent in private transport also varied by country, ranging from 39.7% in Colombia to 52% in Costa Rica and 52.5% in Peru, respectively. Travel time varied to a lesser extent between countries. The proportions of walking travel ranged from 8.1% (in Colombia) to 14.8% in Costa Rica; the figures for cycling ranged from 1.0% in Venezuela to 12.2% in Costa Rica.

The overall and country-specific proportions of travel time by sex, age group, socioeconomic level, and educational level are available in Supplementary Fig. A1-A4 respectively. The proportions of time spent walking as part of travel was higher for women than for men overall (12.6% vs 9.8% respectively); this pattern was consistent across countries. The proportion for cycling was higher for men than for women overall (7.1% vs 3.1% respectively); but the pattern of sex differences varied across countries. Among men, the highest proportions of time spent walking was observed for Costa Rica (14.8% of travel time) whereas Brazil reported the higher proportion of time spent cycling as part of travel (11.0%). Among women, the proportion time spent walking ranged from 9.2% in Colombia to 18.9% in Costa Rica; the proportion of time spent cycling ranged from 0.1% in Venezuela to 6.8% in Chile (Supplementary Fig. A1).

Overall, the proportions of commuting time spent in public transportation were lower among participants aged 30–59 and  $\geq 60$  years. Costa Rica stood out in this regard: for those aged  $\geq 60$  years, the proportion of travel time in public transport was markedly lower than the other countries (7.5% Costa Rica; 34.6% overall) whilst time spent in private transport was higher (82.5% Costa Rica; 48% overall). The proportions of travel time spent walking was higher among those aged  $\geq 60$  years, whereas those for cycling were higher among those aged 15–29 years. The patterns in active travel by age varied across countries (Supplementary Fig. A2).

Overall, the proportions of travel time spent in public transport were higher among those in the lowest socioeconomic level, whereas the travel time in private transport was lower. With a few exceptions (e.g. public transport in Costa Rica), these patterns were consistent across countries. The proportions of travel time in walking and in cycling were higher in the lowest socioeconomic strata overall; however, the patterns varied across countries. Among participants in the lowest socioeconomic level, the highest proportions of travel time in walking and in cycling were in Costa Rica (18.4% and 14.6% respectively). Differences by socioeconomic level in the proportion of travel time spent walking were most pronounced in Brazil (11.5% and 7.8% in the lowest and highest socioeconomic levels respectively). Differences by socioeconomic level in cycling were sharpest in Costa Rica (14.6% and 5.9% of travel time in the lowest and highest socioeconomic levels respectively) and in Brazil (11.6% and 1.9% respectively) (Supplementary Fig. A3).

Overall, similar but smaller differences in the proportions of travel time in public- and private-transportation were observed by educational level. The proportion of travel time associated to walking was lower (9.4%) in the medium educational level than low (11.4%) and high level (11.6%), whereas travel time associated to cycling was higher in the lowest educational level. Patterns in active travel by educational level varied across countries. For example, the proportion of travel time in walking was highest in the lowest educational group in Argentina (11.4% low; 6.7% high); a reversed pattern was observed in Costa Rica (15.6% low vs 23.4% high) and in Ecuador (12.6% low vs 17.4% high) (Supplementary Fig. A4).

### 3.3. Time spent in different travel modes

Fig. 2 shows the mean time per week spent in each transport mode by country. Overall, the average travel time spent in public- and private-transportation were 299.5 min/week (95% CI: 292.4307.0) and 379.6 min/week (95% CI: 368.0, 391.5), respectively; equivalent figures for walking and cycling were 186.9 min/week (95% CI: 181.8, 191.9) and 201.1 min/week (95% CI: 187.8, 216.9), respectively.

Mean levels of time spent in non-active travel were lowest in Costa Rica (public transport: 241.0 min/week; 95% CI: 217.1, 266.0; private transport: 340.2 min/week; 95% CI: 301.0, 382.2). Mean levels of time spent in public transport was highest in Colombia (348.7 min/week; 95% CI: 320.7, 374.8); time spent in private transport was highest in Argentina (302.8 min/week; 95% CI: 281.4, 325.6). Mean levels of travel time spent walking were lowest in Brazil (168.7 min/week, 95% CI: 158.5, 178.2) and highest in Costa Rica (227.6 min/week; 95% CI: 208.9, 246.7); time spent cycling was on average lowest in Ecuador (116.8 min/week; 95% CI: 87.3, 150.5) and highest in Colombia (262.2 min/week; 95% CI: 218.7, 314.9) (Fig. 2).

Average levels of travel time in all four modes were generally higher for men than for women in all countries, with the differences most pronounced for private transport and for cycling. For the sex-specific, estimates (Supplementary Fig. A5), mean time spent in public transport was lowest in Costa Rica (men: 293.3 min/week; 95% CI: 250.8, 337.6; women: 203.7 min/week; 95% CI: 175.6, 231.9) and highest in Colombia (men: 385.1 min/week; 95% CI: 344.5, 426.0; women: 320.6 min/week; 95% CI: 289.9, 354.4). Among men, average levels of cycling was highest in Argentina (283.1 min/week; 95% CI: 222.9, 349.4); among women, average levels of cycling was lowest in Venezuela (72.4 min/week; 95% CI: 51.2, 90.3).

For the age-specific estimates (Supplementary Fig. A6), mean time spent in public transport was highest in Colombia (15–29 years:

370.7 min/week, 95% CI: 328.3, 415.5; 30–59 years: 339.7 min/week, 95% CI: 305.1, 373.9). Among those aged  $\geq 60$  years, the mean time spent in walking was highest in Peru (230.0 min/week; 95% CI: 161.2, 310.2) and in Argentina (229.1 min/week; 95% CI: 164.7, 301.7). On average, levels of time spent cycling among the lowest and middle socioeconomic and educational groups were lowest in Brazil (Supplementary Fig. A7-A8).

#### 4. Discussion

The aim of this study was to quantify and characterise socio-demographic patterns of transport and active travel in eight Latin American countries. Overall, four-fifths of travel time was spent in transport (34.9% and 48.2% for public and private transport, respectively); one-fifth was spent in active travel (10.6% and 6.3% for walking and cycling respectively). However, there were important differences across the countries. This multicountry study is the largest and more inclusive study to report patterns of travel using nationally representative samples from urban populations from eight Latin American countries.

Overall, the proportions of travel time spent walking and cycling in the Latin American region are low (10.6% for walking, and 6.3% for cycling). Compare to European countries such as Germany and Sweden who reported active travel prevalence on above 20% of the population, our estimates across Latin American countries shows a much lower prevalence (Hallal et al., 2012). In a systematic review, de Sá et al. (2017) showed that the prevalence of walking as part of travel was 15.5%, which differ considerably by country, ranging from 8.9% in Corrientes (Argentina) to 27.1% in Bogotá (Colombia). In the same study, the prevalence of cycling as part of travel was lower than the one reported in this study (3.2% vs. 6.3%), ranging from 1.3% in Argentina to 16.0% in Recife (Brazil). The authors found that 12.0% of the studied population reported active travel (combination of walking and cycling). Moreover, the proportion of individuals accumulating 30 min/day or more of active travel (walking and/or cycling) was 27.6% (95% CI: 26.5, 28.6) in São Paulo, Brazil (de Sá et al., 2015). Comparisons of information from other studies, regions, countries (de Sá et al., 2015; Dinu et al., 2018; Thern et al., 2015) and settings are challenging because there is no standardization of instruments used to report or assess levels of physical activity associated to travel.

In relation to sex, men had a higher prevalence of cycling compared to women and women had a higher prevalence of walking than men. These results can be explained in parts by the active commuting characteristics of these groups. Women are more likely to perform trips accompanied and with functional objectives (e.g. taking their children to school), which are more suitable activities for walking when compared to cycling that has a more individual and company-free profile. In addition, safety-related issues may explain this relationship, women may feel less secure in pedaling for both heavy traffic and crime safety (de Sá et al., 2017).

Older people ( $\geq 60$  years) do a little more walking as compared to younger ones (12.4% vs. 10.4%), which is expected to be a more common activity among the elderly. On the other hand, the prevalence of cycling decrease with increasing age (7.8% vs 5.0%) because older people are more vulnerable to falls and because they are exposed to less favorable environments. As probable, age group variations against the  $\geq 60$  years were found for cycling, hypothetically reflecting the effect of an environment less supportive for cycling among susceptible groups. On the other hand, sectors of the city with well overall openness show a positive association with cycling.

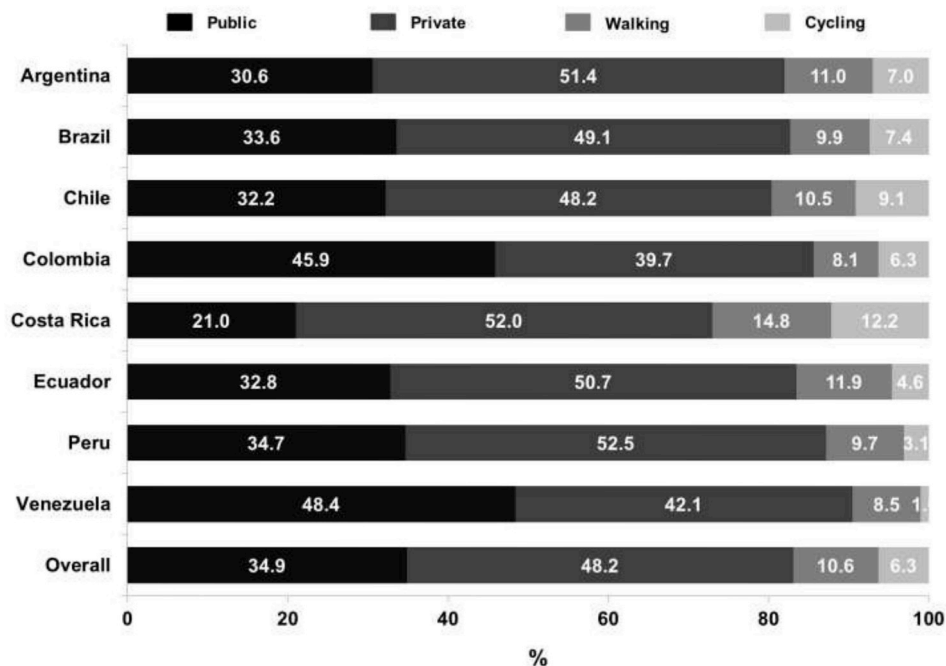


Fig. 1. Prevalence of public, private, walking and cycling for each Latin America country.

\*Public transport: bus, taxi, subway, and train; Private transport: car and motorcycle.

Also, areas with more intersections seem to encourage more cycling. This can be clarified because a more permeable urban form, or denser road network, allows elderly to find smaller routes, making this active travel more attractive (Oliva et al., 2018).

Although, active travel differs by socio-demographics factors in Latin American countries, as presented in this study, prevalence of active travel is relatively low compare to European countries (Hallal et al., 2012). However, there have been different initiatives aiming to increase active travel in different Latin American countries (Gomez et al., 2015; de Sá et al., 2017). A recent study in São Paulo city (Brazil) indicated that the presence of leisure or cycling lanes (also known as ‘ciclovias’ in Latin America) with less than 500 yards from home increased the participation of adults in walking (Florindo et al., 2017). Furthermore, some of the initiatives implemented in several Latin American cities include restricted car access to main streets, which are temporarily closed to private transport in order to create a safe environment for people to cycle, walk, run, and participate in social health promotion (Florindo et al., 2017). These initiatives have shown to be very successful programmes in engaging the community to take part in leisure PA (Florindo et al., 2017). For example, studies of such initiatives in Bogotá have shown that users of cycling lanes are more likely to comply with PA guidelines and have a higher quality of life (Sarmiento et al., 2010; Montes et al., 2012). Furthermore, the efficacy of Ciclovía programmes in Bogotá has led to an expansion of the initiative, and it now spans across 461 cities in Latin America (Pratt et al., 2015). Reflecting the potential of Ciclovías to promote PA while decreasing inequalities in access to facilities, >80% of the programs were connected with different income areas, parks, and promote sustainable modes of active commuting, such as cycling (Sarmiento et al., 2017). Cycle lanes are a promising way of increasing PA at the population level, and simultaneously addressing other important urban issues such as equity, quality of life, and the health physical environments (Sarmiento et al., 2017; Díaz del Castillo et al., 2016).

Despite the important environmental (Davis et al., 2005; Dinu et al., 2018) and health benefits (Garrido-Méndez et al., 2017; Rodríguez-Rodríguez et al., 2017; Steell et al., 2018), associated with active travel (Gomez et al., 2015) little research has been carried out in Latin America to date. To the authors’ knowledge, this is among the first studies to examine variations in active commuting

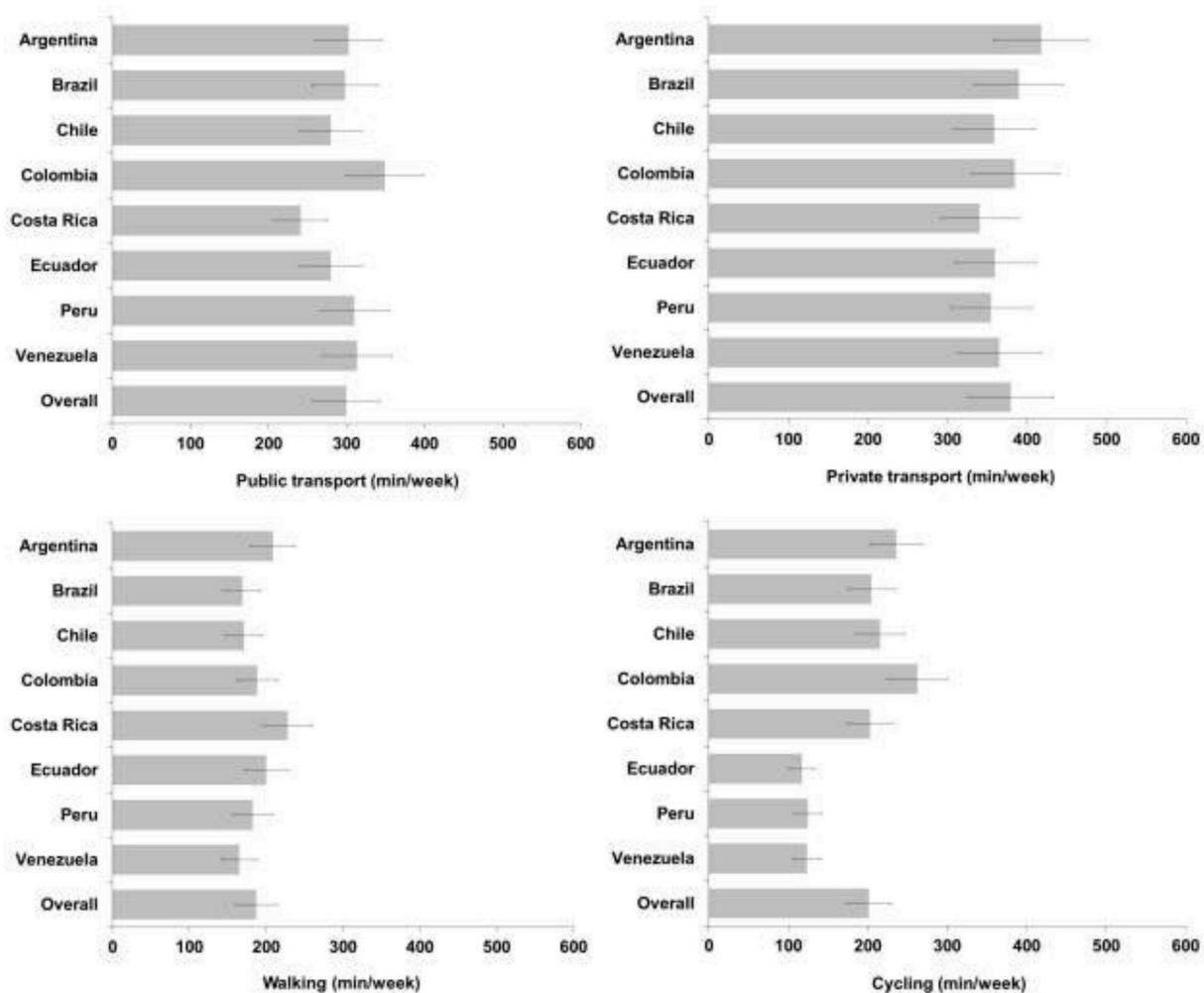


Fig. 2. Descriptive analysis (mean and 95% confidence interval) of public, private, walking and cycling of participants for each Latin America country.

\*Public transport: bus, taxi, subway, and train; Private transport: car and motorcycle.



across Latin American countries as a whole and its patterning by socio-demographic characteristics such as sex, age, and socioeconomic level. This study provides important descriptive data for the development and targeting of interventions and policies to promote active commuting and PA generally. Surveillance of current levels and patterning of motorized- and active forms of travel could provide key information for understanding cross-national differences in the Latin America region and, therefore, help in the design of informed policies for health promotion efforts to tackle physical inactivity levels in the region.

#### 4.1. Limitations and strengths

ELANS employed a cross-sectional design, precluding inferences about causality. The validity of cross-country comparisons may have been reduced to some extent by country-level variation in the questionnaire items on socioeconomic level (due to the legislative requirements or established local standard layouts). Latin American countries span a wide range of health, social and economic indicators; therefore, our results may not be directly generalizable to other countries. It is also well recognized that self-reported measures can overestimate PA (Celis-Morales, 2012; Sallis and Saelens, 2000), and IPAQ may do this more than other physical activity questionnaires (Dumith et al., 2011; Hallal et al., 2010). There is also the possibility of differential measurement error using IPAQ, with some countries or population subgroups potentially giving relatively accurate estimates of their behaviour, while other populations may over- or under-estimate their PA. This between-country variability appeared even greater in the World Health Survey, which was composed of mostly developing countries (Guthold et al., 2008). Among the strengths, the present study used large-scale population samples, so these prevalence estimates can be generalized to the country level. Only urban areas were included to maintain homogeneous populations in the research, considering that almost all countries have at least 80–90% of their population living in urban areas (Fisberg et al., 2016; Salvo et al., 2014). This study included standardized and comparable data collection protocols to facilitate comparisons across countries. Finally, compared with many current PA surveillance systems, IPAQ is a widely used instrument for measuring and tracking PA levels in Latin American populations.

#### 4.2. Conclusions

Based on the results of this study, prevalence and mean levels of public, private and active travel in Latin American countries varied widely across sociodemographic characteristics, suggesting that active forms of travel, especially cycling, should be encouraged to improve population and environmental health in Latin America.

Our findings could help to inform the planning of health policies and programmes designed to reduce levels of physical inactivity, as well as the local and cultural adaptation of these policies and programmes for successful implementation across Latin America. Additionally, future research is required to identify other practical key elements, such as legislation, policy, barriers and facilitators for promoting active travel in Latin America. This study and other similar future studies could help to promote active transport within Latin American communities and act as a key component in the fight against the burden of NCDs and climate change. Moreover, the two main health problems faced the high prevalence of NCDs and climate change, in Latin America may be ameliorated through the promotion of active travel, but further research is needed.

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#### Author contributions

G.L.M.F., J.R-S., and C.A.C-M., had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. The corresponding author and C.A.C.M had full access to all the data in the study and had final responsibility for the decision to submit for publication. Study concept and design: G.L.M.F., and C.A.C-M. Data collection: G.L.M.F., I. K, M.F, G.G.S, A.R, L.Y.C.S, M.C.Y.G, R.G.P.T, M.H-C, I.Z.Z, V.G, M.P, P.B.G, JR-S, J-PC, SS and DS. Statistical analysis: G.L.M.F., J. R-S., F.P-R and CACM. Drafting of the manuscript: G.L.M.F., J.R-S., HW, FPR, and C.A.C-M. All authors have provided a critical revision and final approval of the manuscript.

#### Declaration of competing interest

None to declare.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jth.2019.100788>.

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