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Prevalence and sociodemographic correlates of meeting the Canadian 24-hour movement guidelines among latin american adults: a multi-national cross-sectional study

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Abstract

Background: 24-hour movement behaviors, including moderate-to-vigorous physical activity (MVPA), sedentary time (ST), and sleep duration, have important implications for health across the lifespan. However, no studies exist that have examined the integration of these 24-hour movement behaviors in Latin America. The purpose of this study was to examine the prevalence of meeting the Canadian 24-Hour Movement Guideline recommendations and sociodemographic correlates of meeting the guidelines in adults from eight Latin American countries.

Methods: This was a multi-national cross-sectional study of 2338 adults aged 18 to 64 years from the Latin American Study of Nutrition and Health. MVPA and ST data were collected using accelerometers. Sleep duration was self-reported using a daily log. Socio-demographic correlates included sex, age, education level, and marital status. Meeting the 24-hour movement guidelines was defined as: $\geq$150 min/week of MVPA; $\leq$8 h/day of ST; and between 7 and 9 h/day of sleep. Logistic regression models were estimated on pooled data.

Results: The prevalence of adults who met the MVPA, ST, sleep duration, and integrated recommendations was 48.3, 22.0, 19.4, and 1.6%, respectively. Overall, being a woman (OR: 0.72; 95%CI: 0.55,0.93) and having a middle (0.63; 0.47,0.85) or high education level (0.31; 0.17,0.56) was associated with lower odds of meeting all three of the 24-hour movement guideline recommendations. Being married (1.70; 1.25,2.29) was associated with greater odds of meeting all three recommendations. Being a woman (0.46; 0.39,0.55), aged 50-64 years (0.77; 0.60,0.97), and married (0.79; 0.65,0.96) were associated with lower odds of meeting the MVPA recommendation. Having a middle (0.64; 0.50,0.80) or high (0.36; 0.23,0.55) education level was associated with lower odds and being married (1.86; 1.46,2.36) was associated with greater odds of meeting the ST recommendation. Being a woman (0.63; 0.51,0.78) was associated with lower odds; whereas being aged 50-64 years (1.40; 1.04,1.88) and having a middle education level (1.37; 1.09,1.73) were associated with greater odds of meeting the sleep duration recommendation.

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Conclusions: Overall, the proportion of Latin American adults achieving healthy levels of 24-hour movement behaviors was low. Further efforts are needed to promote more MVPA, less ST, and sufficient sleep in Latin American adults.

Trial registration: Clinical Trials NCT02226627. Retrospectively registered on August 27, 2014.

Keywords: 24-h movement behaviors, Physical activity, Sedentary time, Sleep duration, Epidemiology

Background

Engaging in satisfactory levels of physical activity, low levels of sedentary time, and getting sufficient sleep throughout the day is beneficial for health among children, adolescents, and adults [1–4]. Given that a 24-hour period consists of three types of movement behaviors (i.e., physical activity, sedentary behaviors, and sleep) [4], regularly monitoring the levels and patterns of these behaviors is essential for population health measurement and surveillance [5].

The World Health Organization (WHO) [6] and the National Sleep Foundation [7] offer recommendations for physical activity and sleep for different age groups. Although no time-specific benchmark is presented for sedentary time, it is usually advised to reduce time spent being sedentary [4, 6]. Based on the emerging evidence and a better understanding of the importance of considering all of the 24-hour movement behaviors, in an integrated fashion, several countries have developed and released public health guidelines that combine recommendations for physical activity, sedentary behavior, and sleep for children and youth [8–13]. Canada was among the first in the world to develop and release 24-hour movement guidelines for adults aged 18-64 years and adults aged 65 years or older, which included time-specific recommendations for physical activity, sedentary behaviours, and sleep. In doing so, Canada was first country to complete the 'family' of 24-hour movement recommendations for all age groups [8]. To date, there is no evidence offered to appreciate the levels of 24-hour movement behaviors among inhabitants from Latin American countries using globally recognized benchmarks such as international physical activity guidelines [6], sleep recommendations [7], or the recently released Canadian 24-Hour movement guidelines. Determining the frequency of individuals meeting these new public health guidelines is crucial to notify future health promotion and disease prevention policies and interventions. However, most previous investigation has been conducted in middle- and high- income countries [14–16].

Latin American countries are among the highest urbanized countries in the world with high population density and pronounced social inequality [17]. Furthermore, Latin America is characterized by high levels of diversity in terms of environment, access to health care, and population aging [18]; these factors inhibit healthy lifestyles, as well as increase the frequency of other risk factors for and prevalence or incidence of non-communicable diseases, such as obesity [19, 20]. Therefore, it is essential to examine the proportion of inhabitants within Latin American countries complying with established 24-hour movement guidelines to inform which percentage of adults engage in healthy levels of 24-hour movement behaviors across the day.

Previous studies have used differents methods to evaluate physical activity, sedentary time, and sleep in Latin America [20–26]. Much of this difference, however, may be elucidated by inconsistencies in the methodologies used to decrease, process, and analyze the data. This limitation can be overcome by combining and reprocessing individual level information from existing research in a harmonized and homogenous manner. This would provide a more consistent and comprehensive estimation of the levels of 24-hour movement behaviors in Latin America populations that could inform public health policy-makers across Latin America.

The Latin American Study of Nutrition and Health (Estudio Latinoamericano de Nutrición y Salud - ELANS) [27] has advanced standardized methods to create equivalent health measures across countries. Results from such a harmonized approach will provide more comparable estimates of 24-hour movement behaviors which can be used to inspire policy makers, governments, and local and national stakeholders to take action to facilitate structural changes designed at promoting increased physical activity, decreased sedentary time, and sufficient sleep duration. Therefore, the aims of this study were to (a) investigate the proportion of adults meeting the individual (moderate-to-vigorous physical activity, sedentary time, and sleep duration) and integrated Canadian 24-Hour Movement Guideline recommendations, and (b) examine sociodemographic correlates of adherence to the individual and integrated guidelines across eight Latin American countries [8]. In this manuscript, we used the Canadian 24-Hour Movement Guideline recommendations because these were the first in the world to provide time-specific recommendations for all three of the 24-hour movement behaviours.

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Methods

Study design

The data used in the present study were derived from the 2014-2015 cycle of the ELANS (https://es.elans study.com/) international database. The ELANS is an observational, epidemiological, cross-sectional study conducted in eight countries in Latin America (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela), that focuses on urban residents. More details about the methods and design of the ELANS are described elsewhere [27, 28]. The overarching ELANS protocol was approved by the Western Institutional Review Board (#20,140,605) and is registered at ClinicalTrials.gov (#NCT02226627). Ethical approval was obtained from each local institutional review board and participants' informed consent/assent was obtained.

Recruitment and participants

Participants were chosen using a random complex, multistage sampling frame with a random selection of Primary Sampling Units (PSUs) and Secondary Sampling Units (SSUs). The PSUs were areas (e.g. counties, municipalities, neighbourhoods, residential areas) within each selected city in each country. An "n" size relative to population weight was used for the selection of PSUs. In this instance, a simple random sampling of "n" with replacement was performed to adhere to the principle of statistical independence of the selection of the areas included in the PSU sample. For these random selections, the probability proportional to size method was applied. Thus, within each of the areas included in the PSU distribution, a representative sample of SSUs was randomly designated using the probability proportional to size method [20, 28].

For the selection of households within SSUs, we implemented a four-stage, systematic randomization by establishing a selection interval: (1) the total urban population was used to proportionally describe the main regions and to select cities representing each region; (2) the sampling points (survey tracts) of each city were randomly designated; (3) clusters of households were selected from each sampling unit; and (4) the designated respondent within each household was selected using the birthday method. In each country, stratified recruitment of participants was completed across sex, age, and socio-economic status. Sample size calculations considered a survey design effect of 1.75 with a maximum sampling error of 3.5% and $p < 0.05$, resulting in a required sample size of 9090. Details have been previously published [20, 28].

In total, 92 cities participated in the ELANS (7 to 23 cities from each country). A total sample of 10,134 people (aged 15.0–65.0 years) were invited to participate in the ELANS study. However, 9218 participants (4809 women) provided valid data and were included in the ELANS study (response rate: 91%). A subsample of 2732 participants aged 15 to 65 years were asked to provide accelerometer data, which represented 29.6% of the total ELANS sample (N = 9218) [29, 30]. The accelerometer subsample were randomly selected to fill quotas by sex, age, and socio-economic status. For logistical and financial reasons, efforts were made to ensure that a range of 23–34% of participants from each specific country each sample wore the accelerometer on all seven days [30, 31].

We excluded adolescents aged 15 to 17 years from the manuscript because the ELANS did not contain adolescents of younger ages. Further, adolescents may have limited independent mobility [32] when compared to adults. In addition, the existing 24-hour movement guideline recommendations are different for adolescents and adults [6, 8]. Furthermore, we also excluded participants aged 65 years based on the age range (i.e., 18-64 years) used in the Canadian guidelines to distinguish adults from older adults [8]. The current manuscript is based on a sample of 2338 participants aged 18 to 64 years with valid accelerometer data representing 25.4% of the total ELANS sample.

For the subsample of participants examined for this secondary data analysis, data was collected via two home visits. At the first visit, the designated respondents received instructions regarding the use of an accelerometer along with a diary to be filled out for seven consecutive days. The second visit which took place eight days later included the administration of the questionnaire and the retrieval of the accelerometer and diary.

24-hour movement behaviors

Mean min/day of moderate-to-vigorous physical activity and sedentary time were measured using the GT3X+ Actigraph (Fort Walton Beach, FL, United States), a triaxial accelerometer, that captures acceleration movements in three axes (Vertical, Horizontal, and Perpendicular) [33]. Prior studies have shown the GT3X+ Actigraph to have acceptable technical reliability for physical activity and sedentary behavior [33, 34].

Participants were instructed to wear the accelerometer attached to an elasticized belt at hip level (mid-axillary), from the time they woke up until bed time at night for 7 consecutive days and to remove the accelerometer any time they performed activities that involved the use of water such as bathing or swimming. Days with at least 10 h of recorded wear time were considered valid [35]. A participant was included in the analysis if they had at least five valid days of data, including at least one weekend day. After exclusion of the nocturnal sleep period time, periods with at least 60 min of consecutive zero accelerometer counts were categorized as non-wear time

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[36]. Details on accelerometer data have been published elsewhere [29, 30].

Data were processed using ActiLife software (V6.0; ActiGraph, Pensacola, FL). Data were collected at a sampling rate of 30 Hz and downloaded in epochs of 60 s [37]. Accelerometer counts were used to classify sedentary time (<100 activity counts/minute) and moderate-to-vigorous physical activity (≥1952 activity counts/minute) [38, 39]. Participants were instructed to complete a daily log, and to report the time they put the accelerometer belt on and the time when it was removed. Sleep duration was calculated by identifying non-wear time during valid accelerometer days, identifying the time between going to bed (removing device) and waking up (wearing the device) [40].

Sociodemographic characteristics

Sociodemographic correlates were selected a priori based on availability of data from the ELANS study and previous evidence of their associations with physical activity, sedentary time, and sleep in adults [14, 41]. The sociodemographic correlates were assessed using standard questionnaires during face-to-face interviews and included sex (women, men), age (18-34, 35-49, and 50-65 years), education level (low [basic or lower], middle [elementary], and high [university degree]), and marital status (single [not married, widowed, and divorced] or married). Further details can be found in a previous study [27, 29].

Statistical analysis

Weighting was done according to sociodemographic characteristics, sex, socioeconomic level, and country. Descriptive statistics, including mean, percentage, and 95% confidence intervals (95%CI) were calculated for the sociodemographic correlates and for moderate-to-vigorous physical activity, sedentary time, and sleep duration. Significant differences by sex and country were analyzed by overlapping 95%CI [42].

Each participant was categorized as either "meeting" or "not meeting" the time-specific recommendations outlined within the Canadian 24-Hour Movement Guidelines for adults aged 18-64 years. The recommendations were as follows: (1) engage in at least 150 min/week of moderate-to-vigorous physical activity; (2) spend ≤8 h/day in sedentary time; and (3) obtain between 7 and 9 h/day of sleep. The participants who met all three recommendations for moderate-to-vigorous physical activity, sedentary time, and sleep duration were categorized as meeting the integrated Canadian 24-Hour Movement Guidelines [8]. The proportion of participants meeting the physical activity, sedentary time, and sleep duration

recommendations by sex and by country were also calculated.

Logistic regression models (odds ratio: OR; 95%CI) with a binary dependent variable (0 = not meeting the moderate-to-vigorous physical activity, sedentary time and sleep duration recommendations, 1 = meeting the moderate-to-vigorous physical activity, sedentary time, and sleep duration recommendations) were performed to analyze the association between sociodemographic correlates and meeting vs. not meeting the individual and integrated guideline recommendations adjusted for city, region, and country. Data analysis was performed using IBM SPSS Statistics 22 (SPSS Inc., IBM Corp., Armonk, New York, NY, USA) with the level of significance set at $p < 0.05$.

Results

There were no significant differences ($p > 0.05$) between the participants who were asked to wear an accelerometer and those who did not by sex, socioeconomic level, educational level, and marital status. Participant

Table 1 Participant characteristics (mean or % [95%CI]). 2014-2015 Latin American Study of Nutrition and Health

Characteristics	Mean or % (95% CI) N = 2338
Sex	
Women	53.4 (51.4, 55.4)
Men	46.6 (44.6, 48.6)
Age (years)	38.2 (37.7, 38.7)
Age interval (years)	
18-34	44.7 (42.7, 46.7)
35-49	32.8 (30.9, 34.7)
50-64	22.5 (20.8, 24.2)
Educational Level	
Low	56.8 (54.7, 58.8)
Middle	32.2 (30.3, 34.1)
High	11.0 (9.8, 12.3)
Marital Status	
Single	47.5 (45.3, 49.7)
Married	52.5 (50.5, 54.5)
Country	
Argentina	11.2 (9.9, 12.5)
Brazil	19.5 (17.9, 21.1)
Chile	10.6 (9.3, 11.8)
Colombia	12.4 (11.1, 13.8)
Costa Rica	9.4 (8.2, 10.5)
Ecuador	10.7 (9.4, 11.9)
Peru	12.6 (11.2, 13.9)
Venezuela	13.8. (12.4, 15.2)

characteristics are presented in Table 1. Overall, 53.4% (95%CI: 51.4, 55.4) of the sample consisted of females and the mean age was 38.2 (95%CI: 37.7, 38.7) years. Overall, 44.7% (95%CI: 42.7, 46.7) of participants were aged <35 years, 56.8% (95%CI: 54.7, 58.8) had low education level, and 52.5% (95%CI: 50.5, 54.5) were married. The country with the highest proportion of participants was Brazil (19.5%; 95%CI: 17.9, 21.1) and the country with the lowest proportion was Costa Rica (9.4%; 95%CI: 8.2, 10.5).

Overall, mean values for moderate-to-vigorous physical activity, sedentary time, and sleep duration were 34.4 min/day (95%CI: 33.4, 35.4), 565.1 min/day (95%CI: 560.3, 569.4), and 10.3 h/day (95%CI: 10.2, 10.4), respectively. On average, men accumulated significantly more minutes of moderate-to-vigorous physical activity and sedentary time than women (mean difference: 12.3 and 15.2 min/day); however, no differences were observed in sleep duration between men and women (mean difference: 0.2 h/day) (Table 2).

Levels of moderate-to-vigorous physical activity were highest in Chile (mean: 39.7 min/day; 95%CI: 36.9, 42.7) and the lowest in Venezuela (mean: 30.5 min/day; 95%CI: 28.1, 33.0) and the mean difference between these two countries was 9.2 min/day. Sedentary time was the highest in Peru (mean: 592.8 min/day; 95%CI: 578.8, 606.5) and lowest in Brazil (mean: 549.4 min/day; 95%CI: 539.0, 560.2), with a mean difference of 43.4 min/day between these two countries. For sleep duration, the mean difference between Colombia (mean: 10.8 h/day; 95%CI: 10.6, 11.1; highest value) and Chile (mean: 9.7 h/day; 95%CI: 9.5, 10.0; lowest value) was 1.1 h/day (Table 2).

Table 2 Time spent (mean [95%CI]) in moderate-to-vigorous physical activity, sleep duration, and sedentary behavior. 2014-2015 Latin American Study of Nutrition and Health

|	MVPA (min/day)	Sedentary time (min/day)	Sleep duration (hours/day)
Overall	34.4 (33.4, 35.4)	565.1 (560.3, 569.4)	10.3 (10.2, 10.4)
Sex			
Women	28.7 (27.6, 29.8)	558.0 (552.1, 563.8)	10.4 (10.3, 10.5)
Men	41.0 (39.2, 42.9)	573.2 (566.2, 580.1)	10.2 (10.1, 10.3)
Country			
Argentina	32.3 (29.5, 35.4)	582.0 (567.0, 596.6)	10.1 (9.8, 10.3)
Brazil	33.4 (31.4, 35.7)	549.4 (539.0, 560.2)	10.6 (10.4, 10.8)
Chile	39.7 (36.9, 42.7)	548.6 (533.9, 561.8)	9.7 (9.5, 10.0)
Colombia	33.8 (31.1, 36.7)	563.8 (552.3, 577.4)	10.8 (10.6, 11.1)
Costa Rica	33.0 (29.6, 37.1)	555.9 (540.8, 570.6)	10.7 (10.4, 10.9)
Ecuador	38.9 (34.9, 42.9)	566.0 (549.8, 580.0)	10.0 (9.7, 10.2)
Peru	35.3 (32.5, 38.5)	592.8 (578.8, 606.5)	9.9 (9.7, 10.2)
Venezuela	30.5 (28.1, 33.0)	568.9 (556.2, 580.5)	10.6 (10.3, 10.8)

MVPA moderate-to-vigorous physical activity

Figure 1 shows the proportion of participants who met all three 24-hour movement guideline recommendations and each of the individual recommendations for moderate-to-vigorous physical activity, sedentary time, and sleep duration. Overall, the proportion of Latin American adults who met all three of the 24-hour movement guideline recommendations was only 1.6% (1.2% in women; 2.1% in men) (Fig. 1 A). A total of 48.3% of participants (39.4% in women; 58.7% in men) met the moderate-to-vigorous physical activity recommendation (Fig. 1B), whereas 22.0% met the sedentary time recommendation (22.7% in women; 21.2% in men) (Fig. 1 C), and 19.4% met the sleep duration recommendation (16.5% in women; 22.8% in men) (Fig. 1D).

Associations between sociodemographic correlates and meeting vs. not meeting the individual (moderate-to-vigorous physical activity, sedentary time, and sleep duration) and integrated recommendations are shown in Table 3. Being a woman (OR: 0.72; 95%CI: 0.55, 0.93), and having a middle (OR: 0.63; 95%CI: 0.47, 0.85) or high education level (OR: 0.31; 95%CI: 0.17, 0.56) were significantly associated with a lower likelihood of meeting the integrated guideline recommendations On the other hand, marital status (married; OR: 1.70; 95%CI: 1.25, 2.29) was significantly associated with a greater likelihood of meeting all three recommendations. Being a woman (OR: 0.46; 95%CI: 0.39, 0.55), aged 50-64 years (OR: 0.77; 95%CI: 0.60, 0.97), and married (OR: 0.79; 95%CI: 0.65, 0.96) were significantly associated with a lower likelihood of meeting the moderate-to-vigorous physical activity recommendation. Middle (OR: 0.64; 95%CI: 0.50, 0.80) and high (OR: 0.36; 95%CI: 0.23, 0.55) education level was significantly associated with a lower likelihood and being married (OR: 1.86; 95%CI: 1.46, 2.36) was significantly associated with a greater likelihood of meeting the sedentary time recommendation. Being a woman (OR: 0.63; 95%CI: 0.51, 0.78) was associated with lower odds and being aged 50-64 years (OR: 1.40; 1.04, 1.88) and having a middle education level (OR: 1.37; 95%CI: 1.09, 1.73) were associated with greater odds of meeting the sleep duration recommendation.

Discussion

The present study was the first to examine the prevalence and sociodemographic correlates of meeting vs. not meeting 24-hour movement guideline recommendations using Latin American data. From these data, we found that only 1.6% of Latin American adults met the integrated 24-hour movement guideline recommendations. However, nearly half of adults met the moderate-to-vigorous physical activity recommendation, and a fifth met the sedentary time and sleep duration recommendations. Being a woman, and having a middle or high education

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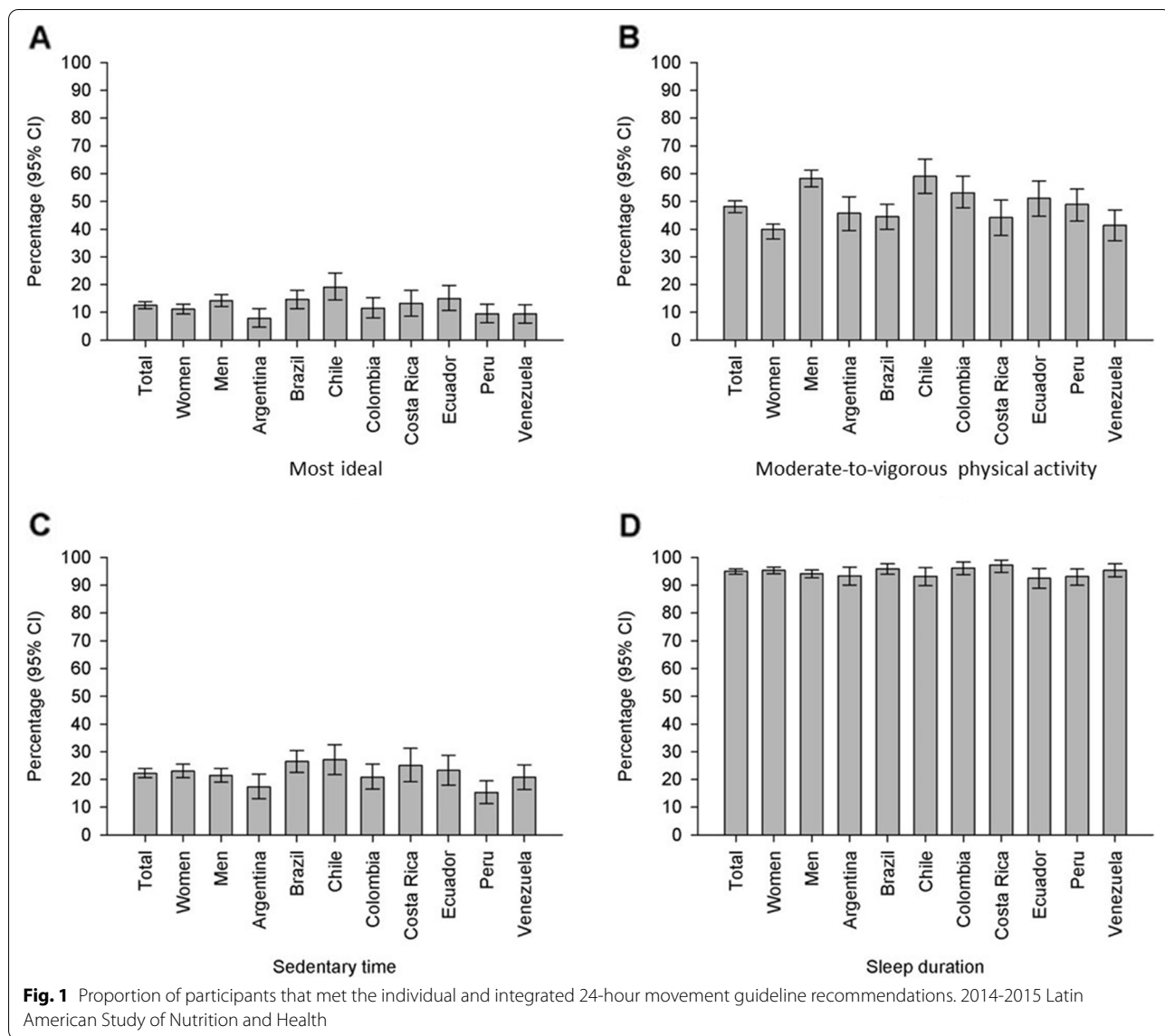
Fig. 1 Proportion of participants that met the individual and integrated 24-hour movement guideline recommendations. 2014-2015 Latin American Study of Nutrition and Health

level was associated with lower odds of meeting all three of the 24-hour movement guideline recommendations. Being married was associated with greater odds of meeting all three recommendations of the 24-hour movement guidelines. Being a woman, aged 50-64 years and married were associated with lower odds of meeting the MVPA recommendation. Having a middle or high education level was associated with lower odds and being married was associated with greater odds of meeting the ST recommendation. Being a woman was associated with lower odds; whereas being aged 50-64 years and having a middle education level were associated with greater odds of meeting the sleep duration recommendation.

The evidence presented herein on the proportion of Latin American adults who met the integrated 24-hour

movement behavior recommendations (i.e., combination of moderate-to-vigorous physical activity, sedentary time, and sleep recommendations) suggest that adherence to the recommendations, in their entirety, is low (1.6%). Liangruenrom et al. [14] found that around one in five Thai adults met the overall 24-hour movement guidelines in 2015. Another study found that in the same year only 0.4% of Korean adults met a similar 'most ideal' combination of movement behaviors [43]. However, a direct comparison between these findings is not possible, as there are differences in methodology used to assess movement behavior and categorise participants. For instance, both studies [14, 43] used different questionnaires to estimate daily physical activity, sedentary time and sleep duration, rather than a 24-hour time-use diary. Further, potential

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Table 3 Logistic regression models [OR (95% CI)] showing associations between sociodemographic correlates and meeting moderate-to-vigorous physical activity, sedentary time, sleep duration, and all three recommendations. 2014-2015 Latin American Study of Nutrition and Health

Sociodemographic correlates	Most ideal OR (95%CI)	MVPA[a] OR (95%CI)	Sedentary time[b] OR (95%CI)	Sleep duration[c] (95%CI)
Sex				
Men	Ref	Ref	Ref	Ref
Women	0.72 (0.55, 0.93)**	0.46 (0.39, 0.55)***	1.05 (0.85, 1.29)	0.63 (0.51, 0.78)*
Age interval (years)				
18-34	Ref	Ref	Ref	Ref
35-49	1.20 (0.88, 1.63)	1.00 (0.81, 1.23)	1.06 (0.83, 1.35)	1.21 (0.93, 1.57)
50-64	0.90 (0.63, 1.29)	0.77 (0.60, 0.97)*	0.92 (0.69, 1.21)	1.40 (1.04, 1.88)*
Educational level				
Low	Ref	Ref	Ref	Ref
Middle	0.63 (0.47, 0.85)**	1.20 (0.99, 1.45)	0.64 (0.50, 0.80)***	1.37 (1.09, 1.73)*
High	0.31 (0.17, 0.56)***	1.13 (0.86, 1.50)	0.36 (0.23, 0.55)***	1.31 (0.93, 1.83)
Marital Status				
Single	Ref	Ref	Ref	Ref
Married	1.70 (1.25, 2.29)**	0.79 (0.65, 0.96)**	1.86 (1.46, 2.36)***	0.86 (0.68, 1.10)

MVPA moderate-to-vigorous physical activity; *OR* odds ratio; *95%CI* 95% confidence interval

Models adjusted for city, region, and country

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$;

[a] 0 = <150 min/week; 1 = ≥150 min/week;

[b] 0 = ≤8 h/day; 1 = >8 h/day;

[c] 0 = <7 h/day; 1 = ≥ 7 h/day

comparisons are also limited due to cultural differences between countries and differences in the recommendations for the specific movement behaviours.

The current findings suggest that sex, education level, as well as marital status are associated with guideline adherence. Several studies have examined correlates associated with meeting the existing movement behavior recommendations, including sex, education level, and marital status [14, 43, 44]. Low adherence to the moderate-to-vigorous physical activity recommendation has been previously reported among women [45]. In particular, Latin American women seem to lag behind in moderate-to-vigorous physical activity compared with men in international studies [22, 29, 45]. Increasing moderate-to-vigorous physical activity levels would be beneficial for the population [3, 46] and would also increase the proportion of inhabitants meeting the integrated 24-hour movement recommendations. Intervention and public health promotion efforts to encourage moderate-to-vigorous physical activity and enhance compliance with the 24-hour movement guideline recommendations are necessary in this population subgroup.

This international study measured intensities and described patterns of moderate-to-vigorous physical activity and sedentary time in eight Latin American countries, using a comparable, reliable and validated device [33]. ELANS is the initial study to account for mean levels of physical activity and sedentary time using nationally-representative samples of urban inhabitants from Latin American countries based on objective methods. We found similar values for time spent in moderate-to-vigorous physical activity in adults from Latin America and high-income countries (34.4 min/day vs. 35.6 min/day) [45]. However, the percentage of adults that met the moderate-to-vigorous physical activity guidelines was lower in Latin America than high-income countries (48.3% vs. 68.2%), respectively [45].

Our results generally support the literature suggesting that education level and marital status are the key correlates of sedentary time among adults in high-income countries [47–49], however, no clear associations between sex and sedentary time appear to exist [49]. In this study, the proportion of the total sample with sedentary time >8 h/day was 78%, which far exceeded the corresponding proportions in specific Latin American countries (Brazil [2.6%], Colombia [5.4%], Argentina [16.3%] using self-reported overall sedentary time reported in a previous international study [50]. The use of objective measures to assess physical activity and sedentary time are more accurate than self-reported data and a study from Latin America found large differences between sedentary time values for self-report and

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accelerometer measurements [31]. We reinforce the need for additional studies that consider the cut-off point of 8 h/day in sedentary time or investigate different cut-off points to evaluate this behavior with objective methods in Latin America. We found that around one in five Latin American adults met the sedentary time recommendation. 20% of the adults from high-income countries (i.e., England [22%], Norway [11%], Portugal [33%], and Sweden [30%] spent ≤7.5 h/day in sedentary pursuits based on accelerometer data [45]. Development of intervention programs should inform policy and actions to reduce sedentary time among inhabitants from middle (i.e., Latin America countries) and high-income countries.

The average sleep duration was 10.3 h/day in our adult sample, which far exceeds the corresponding averages in low and middle-income countries [51]. A systematic review and meta-analysis showed mean 7.6 h/day of self-reported sleep duration in adults and older adults using data from 17 studies from these countries [51]. Self-report measures of sleep duration may considerably underestimate sleep time, when compared with objective measures [52]. Similar with other epidemiological studies, we found that sex, age, and education level were significantly associated with meeting vs. not meeting the sleep duration recommendation, such that middle education level were more likely to meet this recommendation [53]. Previous literature have demonstrated the benefits of sufficient sleep, both separately and in combinations with physical activity and sedentary time for health (i.e., adiposity level, HDL-cholesterol, and triglycerides) [54]. Given the links with poor health, the increasing prevalence of long sleep duration may be an early marker of declining public health [55]. Given the aforementioned, it is important to identify modifiable factors associated with sleep problems, which can be targeted via public prevention programs.

Latin American adults who were married were significantly less likely to meet the moderate-to-vigorous physical activity recommendation, but significantly more likely to meet the sedentary time recommendation compared to those who were single. In line with the findings of our analyses, Liangruenrom et al. reported a positive association (OR: 1.44; 95%IC: 1.37, 1.51) of married marital status with sedentary time recommendations (defined as interrupting sedentary time every 2 h) compared with never married marital status [14]. Considering the negative health effects of prolonged sedentary time and a low physical activity level [1, 3], it should be highlighted that married individuals may benefit from interventions aiming to decrease sedentary time and increase moderate-to-vigorous physical activity.

Reliable and valid data on daily movement behaviors are needed in order to enhance the understanding of dose-response relationships between movement behaviors and various health outcomes. Additionally, future research should consider the implementation of behavior-change interventions and counseling strategies to facilitate a sustainable healthy and active lifestyle. Such research could also provide viable information for the development of evidence-based 24-hour movement recommendations that include strategies to achieve them. At this time, there is, however, limited data on 24-hour movement behaviors in Latin American countries along with recommendations for strategies to enhance an active and healthy lifestyle. Such information is a critical contributor for strategic decisions regarding health policy, practice and overall health promotion among Latin American adults. Given the impact of movement behavior across the entire lifespan the promotion of physical activity is key to future public health.

This study was not without its limitations, including the cross-sectional design, which prevents conclusions regarding causality from being made. The temporality of when the data were collected (i.e., 2014-2015) relative to the release of the 24-Hour Movement Guidelines (i.e., 2020) is a limitation. It is possible that the movement behaviors of adult populations across Latin America have changed over this time period. Another potential limitation was that sleep duration was derived from non-wear time of valid days. Although participants were instructed to remove the device only to sleep and took notes in their daily logs, and these were matched to identify potential problems, there was no objective measure of sleep available. Furthermore, the ELANS study did not assess recreational screen time as suggested by the Canadian 24-Hour Movement Guidelines. There are no specific public health recommendations concerning 24-Hour Movement Guidelines for inhabitants from Latin America. On the other hand, there are several strengths of the present study. First, to the authors' knowledge, this was the first study to describe the levels and sociodemographic correlates of adherence to 24-hour movement guideline recommendations among Latin American adults. Second, the large sample size from eight Latin American countries using a standardized methodology across a consortium of participating countries was a strength. Third, objective measures were used to assess moderate-to-vigorous physical activity and sedentary time, which is rare in Latin American countries where the majority of previous research has relied on self-reported instruments [29, 31].

Conclusions
A large majority of Latin American adults do not meet the integrated 24-hour movement guideline recommendations. Further actions are needed to promote more

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moderate-to-vigorous physical activity, less sedentary time, and satisfactory sleep duration in Latin American adults from urban areas. Future studies should explore prevalence and correlates of moderate-to-vigorous physical activity, sedentary time, and sleep patterns (e.g., duration, quality, consistency) in Latin American inhabitants in greater detail. Moreover, currently 24-hour movement guideline recommendations do not exist in Latin America; it is important for countries to develop these to allow for greater measurement, surveillance and promotion of movement behaviors among Latin American adults. Our findings indicate that regional public health efforts are needed to promote more physical activity, less sedentary time, and adequate sleep among Latin American adults to increase the proportion of individuals meeting existing 24-hour movement guideline recommendations.

Availability of data and materials
The datasets generated and/or analyzed during this study are not publicly available due the terms of consent/assent to which the participants agreed but are available from the corresponding author upon reasonable request. Please contact the corresponding author to discuss availability of data and materials.

Declarations

Ethics approval and consent to participate
This study was conducted according to the guidelines laid down in the Declaration of Helsinki. All procedures involving human subjects/patients and each site specific protocol was also approved by the ethical review boards of the participating institutions. The overarching ELANS protocol was approved by the Western Institutional Review Board (#20140605) and is registered at Clinical Trials (#NCT02226627). Argentina: Comité de ética de la Asociación Médica Argentina; Brazil: Comité de ética do Instituto Pensi – Fundação José Luiz Setubal – Hospital Infantil Sabara; Chile: Comité de ético científico de la Facultad de Medicina de la Pontificia Universidad Católica de Chile; Colombia: Comité de Investigación y ética de la Faculdade de Ciencias de la Pontificia Universidad Javeriana; Costa Rica: Comité ético científico de la Vicerrectoría de Investigación de La Universidad de Costa Rica; Ecuador: Comité de Bioética Universidad de San Francisco de Quito; Peru: Comité Institucional de ética del Instituto de Investigación Nutricional; Venezuela: Comisión de Bioética de

la Escuela de Antropología de la Universidad Central de Venezuela. Written informed consent/assent was obtained from all individuals before commencement of the study.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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