

Movement Behaviors during COVID-19. A Survey among Children under Five Years of Latin American Origin or Descent from Chile, Mexico, and the US

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Abstract

Movement behaviors (physical activity, sedentary behavior (including screen time), and sleep) have been impacted by the COVID-19 pandemic. We aimed to report changes in and factors influencing movement behaviors during COVID-19 among Latin American/Latino children aged 1 to 5 years in Chile, Mexico, and the USA. We conducted a cross-sectional study between April and August 2020. Caregivers reported changes in movement behaviors and provided information about family and household characteristics. In total, 4,136 children (mean age [SD], 3.1 [1.4] years; 51% boys). The proportion of children who met the WHO Guidelines decreased significantly in all countries, with large declines in meeting the physical activity and screen time guidelines. Factors associated with changes were being an older child, unable to attend an early childhood education and care service, higher parental education levels, not having the opportunity to play with someone, and not having access to spaces to play. During COVID-19, Latino parents reported changes in physical activity, screen time, and sleep quality among their toddlers and preschoolers. The findings highlight the need to minimize disparities faced by families by providing access to early childhood education and care and safe places for children to play.

Introduction

The COVID-19 pandemic has changed how children, families, and communities conduct their daily lives. Latin America and the USA are an epicenter for the pandemic due to many factors, including widespread poverty and socioeconomic inequalities in the region. Despite comprising only 18% of the US population, Latino populations represent 30% of COVID-19 cases.^{1,2} Similarly, Latin America has accounted for around 30% of the total deaths globally due to COVID-19.³ Consequently, Latin Americans/Latinos face a disproportionate burden that is likely to last well beyond the post-vaccination period.

In 2019 the World Health Organization (WHO) released the first global guidelines for physical activity (PA), sedentary behavior, and sleep for children under five.⁴ These guidelines acknowledge the interrelationships between these three movement behaviors and reinforce that “the whole day matters” when promoting healthy levels of these behaviors. A recent systematic review found that only 10% of toddlers and 15% of preschoolers met the global guidelines for PA, sedentary behavior, and sleep.⁵

Studies have documented the impact of the pandemic on movement behaviors in adults⁶ and school-age children and youth⁷ in North America, but there is little empirical evidence of the impact on children under the age of 5, especially among Latin America/Latino populations. The closure of early childhood education and care services (ECEC), public spaces, parks and playgrounds, coupled with more parents/carers being unemployed or working from home, has likely impacted movement behaviors, and in turn the health, of young children. Understanding this impact and the contributing factors will provide important information on how to promote healthier levels of movement behaviors among children under 5 years. This study aimed to report the changes in movement behaviors (PA, sedentary behavior, and sleep) during COVID-19 among Latin American/Latino children aged 1 to 5 years in Chile, Mexico, and the USA. We were also interested in child, caregiver, and household factors associated with movement behaviors during COVID-19.

Methods

An online survey was conducted on main caregivers of 1- to 5-year-old children in Chile, Mexico, and the USA. The study was promoted through different online channels, including social media (Facebook, Twitter, Instagram), text

messages (i.e., WhatsApp and SMS), and emails. Potential participants accessed a personalized link for each study site to obtain details about the study and gave their online informed consent to participate.

The inclusion criteria were: 1) living in Chile, Mexico, or the USA, 2) being the main caregiver of a 1- to 5-year-old child, 3) living with the child most of the time before and during the COVID-19 pandemic, and 4) only in the USA, identifying as Latino/Hispanic (defined as being of Latin American origin or descend). The study was approved by the Scientific Ethics Committee for each study site independently (Universidad de La Frontera, Chile [ORD.: 009-2020], the National Institute of Public Health of Mexico [CI: 1661], and Washington University in St. Louis [IRB ID:202005074]), in accordance with of the Declaration of Helsinki.

The study data were collected and managed using REDCap (Research Electronic Data Capture)² in the three places.

Data collection occurred during the early stages of the pandemic, soon after the closure of educational centers (Chile: March 30th to April 27th, 2020; Mexico: April 30th to July 27th, 2020; USA: May 14th to August 30th, 2020). Schools were still closed in the three sites when data collection stopped.

Sociodemographic variables

Sociodemographic variables that may be potentially associated with movement behaviors were measured. Child characteristics included sex, age, enrolment in ECEC (yes/no), whether the child usually played with someone or alone, access to electronic devices (none, 1 to 2, 3 or more), electronic devices in the room where the child usually sleeps (yes/no), and parental restrictions in the use of electronic devices (yes/no). When the adult was the caregiver of more than one child aged 1-5 years, the participant was asked to answer for only one child. Caregiver characteristics included age, sex, and educational level. Household characteristics included housing type (house, condominium or apartment, or other), number of adults and number of children ≤ 18 years at home, available space to play (yes/no), available backyard (yes/no), squared meters per person at home, and income level. In Chile, households were classified into low (<530 USD), medium (≥ 530 -<1830 USD), and high (≥ 1830 USD) income. In the USA, households with an income <200% of the 2019 federal poverty levels were classified as low, those between 200-399% were classified as medium, and those >400% were classified as high. In Mexico, households were categorized as with high (A/B), medium (C+, C y C), or low (D+, D y E) income using a validated questionnaire.⁸ The area of residence (urban/rural) was also asked. Finally, caregivers reported whether they were in home confinement and the number of days they allowed their child to use electronic devices as an education means or to entertain or calm them before and during COVID-19.

Movement behaviors

Caregivers were asked to report on their child's time (in hours and minutes per day) spent in PA (total PA and moderate to vigorous PA or energetic play), sedentary behaviors (sitting time and screen time [ST]), and sleep in a typical week before and during COVID-19. The questions were based on the recommendations for each behavior⁴ and then extensively tested and refined as part of the SUNRISE pilot studies in 22 countries, ensuring feasibility and acceptability among participating populations.⁹⁻¹¹ We calculated the time (min/d) spent in each of these behaviors before and during COVID-19 and the difference between these two periods. We also estimated the proportion of children meeting WHO movement behavior guidelines for children under 5 in both periods.⁴

During both periods, sleep quality was assessed with the question “How would you rate your child’s sleep quality?”, with Likert scale response options (1 to 7, a higher score indicates better quality). Children with a sleep quality ≥ 4 were considered as with good sleep quality. We calculated the proportion of children with good sleep quality in both periods and the difference in sleep quality between them.

Statistical analysis

On each study site, means and standard deviations, and frequencies and percentages were used to describe the samples. For each country, total time in movement behaviors and movement behavior guidelines compliance before and during COVID-19 were compared using t-tests and proportion tests, respectively. Multiple linear regressions were used to assess the association between factors and changes in movement behaviors for each country, adjusting by all the factors. Logistic regressions were used to explore the association between factors and changes in movement behavior compliance (supplementary file). All data preparation and analysis were conducted with Stata 15.0 (College Station, TX: StataCorp LLC). The level of significance was $p < 0.05$, two-tailed.

Results

In total, 4,136 participants were included in the final analysis, 3,045 in Chile, 632 in Mexico, and 459 in the USA. Around half the sample was female, and the average age was 3.1 (1.4) years. A larger proportion of caregivers in Chile were younger. In Mexico, a larger proportion of caregivers had a university degree, households were bigger and from a high-income level. In the USA, fewer Latino children were enrolled in ECEC, more lived in apartments, from lower-income and located in rural areas (see Table 1).

Table 1
Sample characteristics across the three countries

	Chile (N = 3,045)	Mexico (N = 632)	US Latinos (N = 459)
Child characteristics			
Sex, n (%)			
Female	1498 (49.2)	297 (47.0)	236 (51.4)
Male	1547 (50.8)	335 (53.0)	223 (48.6)
Child's age, n (%)			
1–2 y	1198 (39.3)	215 (34.0)	145 (31.6)
3–4 y	1302 (42.8)	257 (40.7)	218 (47.5)
5 y	545 (17.9)	160 (25.3)	96 (20.9)
Children enrolled in early childcare centers, n (%)			
1–2 y	699 (56.2)	117 (50.9)	26 (12.4)
3–5 y	1786 (93.3)	386 (83.2)	200 (48.7)
Children usually plays with someone, n (%)			
Yes	2295 (75.4)	470 (74.4)	343 (74.7)
No	750 (24.6)	162 (25.6)	116 (25.3)
Access to electronic devices, n (%)			
None	33 (1.1)	13 (2.1)	30 (6.5)
1 to 2	2145 (70.4)	391 (61.9)	351 (76.5)
3 or more	867 (28.5)	228 (36.1)	78 (17.0)
Electronic device in child's room -Yes, n (%)	1598 (52.5)	289 (45.7)	197 (42.9)
Restrictions in the use of electronic devices, n (%)	1990 (65.4)	457 (72.3)	334 (72.8)
Caregiver characteristics			
Age, n (%)			
Less than 30 years	1353 (44.4)	199 (31.5)	140 (30.5)
31–40 years	1486 (48.8)	371 (58.7)	275 (59.9)
41 years or more	206 (6.8)	62 (9.8)	44 (9.6)
Sex, n (%)			
Female	2940 (96.6)	584 (92.4)	448 (97.6)

^a Sample size in the US, n = 416

	Chile (N = 3,045)	Mexico (N = 632)	US Latinos (N = 459)
Male	105 (3.4)	48 (7.6)	11 (2.4)
Education level, n (%)			
Incomplete high school or less	507 (16.7)	21 (3.3)	111 (24.2)
Complete high school or technical degree	2162 (71.0)	132 (20.9)	192 (41.8)
University degree	376 (12.4)	479 (75.8)	156 (34.0)
Household characteristics			
Housing type, n (%)			
House	2483 (81.5)	479 (75.8)	256 (55.8)
Condominium or Apartment	482 (15.8)	148 (23.4)	162 (35.3)
Other	80 (2.6)	5 (0.8)	41 (8.9)
Number of adults per home, mean (SD)	2.4 (1.1)	2.4 (1.1)	2.2 (0.9)
Number of children 18 years or younger per home, mean (SD)	1.7 (0.8)	1.6 (0.8)	2.3 (1.1)
Available space to play, n (%)	2971 (97.6)	601 (95.1)	414 (90.2)
Backyard, n (%)	2793 (91.7)	517 (81.8)	354 (77.1)
Squared meters per person at home, n (%) ^a			
< 11.7	974 (30.9)	161 (23.1)	250 (60.1)
≥ 11.7 to < 18.3	698 (22.1)	106 (15.2)	51 (12.3)
≥ 18.3 to < 25	603 (19.1)	109 (15.7)	52 (12.5)
≥ 25	882 (27.9)	320 (46.0)	63 (15.1)
Income level, n (%)			
Low	975 (32.0)	14 (2.2)	369 (80.4)
Medium	1493 (49.0)	325 (51.6)	78 (17.0)
High	577 (19.0)	292 (46.2)	12 (2.6)
Residence area, n (%)			
Urban	1692 (88.4)	622 (98.4)	336 (73.2)
Rural	353 (11.6)	10 (1.6)	123 (26.8)
Home Confinement - Yes, n (%)	2330 (76.5)	535 (84.7)	381 (83.0)
^a Sample size in the US, n = 416			

All movement behaviors changed across the three study sites during the early stages of the COVID-19 pandemic (Table 2). Overall, total PA decreased by about 20 percent, ST almost doubled, and sleep quality decreased between

14.0–17.0%. Sleeping duration decreased only in Chile in about 5 minutes per night. During COVID-19, about a third of children met PA recommendations (range 34.0-37.5%) and less than 10% met ST recommendations. No changes were observed in the proportion who met the sleep duration recommendations.

Table 2
Movement behaviors before and during COVID-19 in Chilean, Mexican and US Latino children (1–5 y).

	Chile			Mexico			US Latinos		
	Before	During	p value ^a	Before	During	p value ^a	Before	During	p value ^a
Physical Activity									
Minutes per day, mean (SD)	214.7 (118.7)	169.4 (128.7)	< 0.001	230.9 (144.0)	174.3 (147.6)	< 0.001	203.8 (144.0)	164.3 (152.5)	< 0.001
Meeting recommendations, n (%)	1734 (57.0)	1141 (37.5)	< 0.001	382 (60.4)	231 (36.6)	< 0.001	208 (45.3)	156 (34.0)	< 0.001
Screen time									
Minutes per day, mean (SD)	99.1 (68.9)	182.9 (115.4)	< 0.001	98.2 (74.8)	190.0 (115.3)	< 0.001	107.5 (101.0)	196.0 (166.7)	< 0.001
Meeting recommendations, n (%)	401 (13.2)	129 (4.2)	< 0.001	99 (15.7)	23 (3.6)	< 0.001	79 (17.2)	38 (8.3)	< 0.001
Sleep time									
Hours per day, mean (SD)	10.9 (1.8)	11.0 (1.9)	0.003	10.3 (2.7)	10.1 (2.7)	0.156	9.1 (3.7)	9.2 (3.9)	0.252
Meeting time recommendations, n (%)	2150 (70.6)	2187 (71.8)	0.295	402 (63.6)	396 (62.7)	0.727	245 (53.4)	244 (53.2)	0.947
Sleep quality^b									
Mean sleep quality, mean (SD)	5.7 (1.5)	4.9 (1.8)	< 0.001	5.9 (1.4)	4.9 (1.8)	< 0.001	5.5 (1.9)	4.6 (2.1)	< 0.001
Good sleep quality, n (%)	2706 (88.9)	2359 (77.5)	< 0.001	578 (91.5)	478 (75.6)	< 0.001	382 (83.2)	312 (68.0)	< 0.001
All recommendations, n (%)	145 (4.8)	32 (1.6)	< 0.001	36 (5.7)	10 (1.6)	< 0.001	15 (3.3)	2 (0.4)	< 0.001
^a p values indicate significant differences between the two measurement times (before and during the COVID-19 pandemic). Estimated using paired t-tests (for continuous variables) or proportion tests (for proportions).									
^b Measured with a Likert scale where “1” indicates difficulty to fall asleep, waking up several times throughout the night for long period and being restless (coughing and turning, moving and kicking the bedclothes off), whereas “7” indicates falling asleep easily and within few minutes, sleeping well through the night, breathing normally and sleeping deeply. Those answering 4–7 were classified as with “good sleep”.									

During COVID-19, more than half of caregivers permitted more frequent use of electronic devices as an education means (Chile = 51.5%, Mexico = 68.8%, and USA = 53.8%) compared with before this period. About 60% (Chile =

56.5%, Mexico = 66.3%, and USA = 59.9%) and around 40% of caregivers (Chile = 38.4%, Mexico = 45.9%, and USA = 51.6%) used the devices more frequently to entertain or calm their child, respectively (data not shown) during this period compared to before COVID-19.

Factors associated with changes in physical activity

In all countries, PA decreases were consistently associated with reductions in sleep quality, inability to play with someone else, and not having available space to play (Table 3). In Mexico and Chile, PA decreases were also associated with increases in ST, older children, living in an apartment or condominium, and not having an available backyard. In Chile and USA Latinos, decreases in this outcome were associated with having more educated caregivers. As for country-specific results, in Chile, decreases in PA were associated with being girl, being enrolled in an ECEC, having older caregivers, living with fewer children, and living in urban areas. In Mexico, PA reductions were more likely in children living in non-traditional residential structures (e.g., huts, motor homes, ranches) and those living with fewer adults at home.

Table 3

Factors associated with changes in physical activity and screen time during COVID-19 across the three countries.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
Associated factors	Physical activity (min/day)	Screen time (min/day)	Physical activity (min/day)	Screen time (min/day)	Physical activity (min/day)	Screen time (min/day)
	β (95% CI) a	β (95% CI) b	β (95% CI) ^a	β (95% CI) ^b	β (95% CI) a	β (95% CI) b
Changes in other movement behaviors						
Physical activity (min/day)	na	-0.2*** [-0.2,-0.2]	na	-0.2*** [-0.2,-0.1]	na	0.0 [-0.1,0.2]
Screen time (min/day)	-0.3*** [-0.3,-0.2]	na	-0.3*** [-0.4,-0.2]	na	0.0 [-0.1,0.2]	na
Sleep time (min/day)	-0.0 [-2.3,2.3]	-1.0 [-3.3,1.2]	-0.023 [-0.1,0.1]	-0.1 [-0.1,0.0]	0.0 [-0.1,0.1]	-0.0 [-0.2,0.1]
Sleep quality (1 point, 1 to 7 range)	2.0* [0.0,4.0]	-5.6*** [-7.5,-3.7]	9.9*** [4.5,15.3]	-4.1 [-8.9,0.8]	5.6 [-0.9,12.0]	-11.2*** [-17.3,-5.0]
Child characteristics						
Male sex, (Ref: Female)	3.3 [-3.1,9.7]	5.4 [-0.6,11.3]	7.3 [-9.2,23.9]	14.6* [1.8,27.4]	14.5 [-7.5,36.5]	1.5 [-21.8,24.7]
Age, (Ref: 1–2 y)						
3–4 y	-12.0** [-20.0,-3.9]	15.7*** [8.4,23.0]	-19.2 [-40.6,2.2]	27.8** [10.6,45.0]	-2.7 [-32.4,26.9]	5.7 [-24.3,35.8]
5 y	-18.4*** [-28.7,-8.0]	25.7*** [15.8,35.7]	-15.6 [-39.8,8.5]	19.0* [0.3,37.6]	-11.6 [-51.2,28.1]	19.0* [0.3,37.6]
Enrolled in early childcare center, (Ref: No)	-9.7* [-18.2,-1.3]	29.6*** [22.3,36.8]	-2.4 [-22.4,17.7]	25.6** [8.3,43.0]	-5.8 [-36.9,25.4]	-7.6 [-33.1,17.9]

*** p < 0.001, ** p < 0.01, *p < 0.05

^a Adjusted for the variables listed in the table plus physical activity before COVID-19 and region within the country.^b Adjusted for the variables listed in the table plus screen time before COVID-19 and region within the country.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
Children usually plays with someone, (Ref: No)	9.6* [1.7,17.5]	-26.3*** [-34.2,-18.5]	15.9 [-2.7,34.4]	-43.2*** [-62.3,-24.2]	30.3* [3.0,57.5]	-7.6 [-37.7,22.6]
Caregiver characteristics						
Age, (Ref: <30 years)						
31–40 years	-13.7*** [-21.1,-6.2]	5.5 [-1.3,12.4]	4.1 [-14.8,23.0]	-1.7 [-22.6,19.3]	20.4 [-6.9,47.7]	19.8 [-7.3,47.0]
41 years or more	-16.2** [-28.5,-4.0]	-9.5 [-21.4,2.4]	5.0 [-42.0,32.0]	-13.3 [-43.2,16.5]	-0.6 [-38.4,37.2]	-14.4 [-22.9,51.6]
Male sex, (Ref: Female)	20.4* [3.3,37.5]	-6.5 [-20.1,7.1]	1.0 [-31.5,33.4]	-1.8 [-24.8,21.1]	-6.1 [-43.8,31.4]	17.7 [-38.1,73.6]
Education level, (Ref: Incomplete high school or less)						
Complete high school or technical degree	-8.2 [-18.3,1.8]	11.9** [3.3,20.5]	-0.4 [-38.4,37.6]	-4.7 [-46.8,37.4]	-33.0* [-63.4,-2.5]	-13.8 [-52.3,24.8]
University degree	-14.8* [-28.3,-1.4]	16.8** [4.4,29.3]	-2.5 [-37.5,32.5]	1.1 [-43.0,45.1]	-32.0* [-62.0,-2.0]	-5.6 [-46.1,34.9]
Household characteristics						
Housing type, (Ref: House)						
Apartment or Condominium	-20.5*** [-29.9,-11.1]	5.4 [-4.0,14.7]	-19.9* [-39.7,-0.1]	6.8 [-11.8,25.3]	3.5 [-24.4,31.5]	11.0 [-20.7,42.7]
Other	12.2 [-12.2,36.6]	-17.5* [-31.8,-3.2]	-95.6*** [-144.0,-47.2]	1.4 [-55.5,58.3]	41.8 [-12.6,96.1]	13.2 [-47.5,73.9]
Number of adults per home, (n)	-0.4 [-3.6,2.8]	-3.0 [-6.2,0.2]	11.8** [4.0,19.6]	-5.6 [-15.8,4.5]	-7.4 [-20.2,5.4]	3.5 [-9.8,16.8]

*** p < 0.001, ** p < 0.01, *p < 0.05

^a Adjusted for the variables listed in the table plus physical activity before COVID-19 and region within the country.

^b Adjusted for the variables listed in the table plus screen time before COVID-19 and region within the country.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
Number of children < 18y in the household, (n)	4.3*	3.5	-9.7	-4.7	-0.6	-10.4
	[0.0,8.5]	[-0.3,7.3]	[-21.4,2.1]	[-14.6,5.1]	[-14.3,13.2]	[-24.0,3.2]
Access to electronic devices, (Ref: None)						
1 to 2	na	51.7*** [35.8,67.6]	na	80.2*** [33.3,127.2]	na	38.4 [-3.7,80.4]
3 or more	na	60.8*** [44.0,77.7]	na	91.3*** [42.8,139.8]	na	80.6** [31.8,129.5]
Electronic device in the room, (Ref: No)	na	4.2 [-2.0,10.3]	na	14.4 [-2.4,31.2]	na	-0.5 [-27.8,26.8]
Limits in the use of electronic devices, (Ref: No)	na	-39.1*** [-45.8,-32.5]	na	-31.8*** [-48.2,-15.3]	na	-30.3* [-59.5,-1.2]
Available space to play, (Ref: No)	27.4*** [13.3,41.5]	-14.0 [-28.3,0.3]	11.7 [-21.4,44.8]	-27.4 [-61.0,6.3]	40.3* [8.0,72.7]	-48.0* [-89.6,-6.3]
Available backyard, (Ref: No)	3.5 [-9.5,16.6]	-3.8 [-16.8,9.2]	-5.9 [-29.3,17.5]	-20.8 [-43.1,1.5]	5.9 [-25.3,37.0]	32.6 [-3.5,68.8]
Income level, (Ref: Low)						
Medium	1.9 [-6.2,10.0]	0.4 [-6.9,7.8]	28.7 [-20.3,77.7]	36.4 [-75.4,148.3]	9.9 [-21.6,41.3]	-15.8 [-43.8,12.2]

*** p < 0.001, ** p < 0.01, *p < 0.05

^a Adjusted for the variables listed in the table plus physical activity before COVID-19 and region within the country.

^b Adjusted for the variables listed in the table plus screen time before COVID-19 and region within the country.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
High	5.1 [-5.3,15.5]	1.5 [-8.0,10.9]	41.3 [-10.8,93.4]	45.9 [-70.7,162.5]	-9.4 [-50.0,31.1]	17.8 [-26.8,62.4]
Rural area, (Ref: Urban)	40.3*** [29.8,50.7]	-7.6 [-16.3,1.1]	26.7 [-32.3,85.6]	-3.1 [-78.9,72.6]	-4.1 [-27.2,19.0]	4.6 [-24.6,33.7]
Home confinement, (Ref: No)	-3.3 [-10.8,4.2]	1.8 [-5.5,9.1]	-7.5 [-33.0,17.9]	-6.0 [-25.9,13.9]	6.5 [-21.1,34.2]	4.9 [-40.3,50.2]
*** p < 0.001, ** p < 0.01, *p < 0.05						
^a Adjusted for the variables listed in the table plus physical activity before COVID-19 and region within the country.						
^b Adjusted for the variables listed in the table plus screen time before COVID-19 and region within the country.						

Factors associated with changes in screen-time

Across countries, ST increases were associated with reductions in sleep quality, being older, having great access to electronic devices, no parental-imposed restrictions in using such devices, and no available space to play (Table 3). In Chile and Mexico, increases in ST were also associated with reductions in PA, being older, being previously enrolled in ECEC, unable to play with someone else, and living in an apartment or condominium. In Chile, high parental education and residing in non-traditional homes (e.g., huts, motor homes, ranches) was associated with increased ST during COVID-19.

Factors associated with sleep duration and quality

Across sites, decreases in sleep duration were more likely among those living in apartments or condominiums (Table 4). In Mexico and Chile, decreases in sleep duration were also associated with reductions in sleep quality. In Chile, older children, those who were not previously enrolled in ECEC, and more educated caregivers had higher decreases in sleep duration. Being a boy was associated with decline in sleep duration in Mexico.

Table 4

Factors associated with changes in sleep duration and sleep quality during COVID-19 across the three countries.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
Associated factors	Sleep duration (min/day)	Sleep quality (1 to 7 score)	Sleep duration (min/day)	Sleep quality (1 to 7 score)	Sleep duration (min/day)	Sleep quality (1 to 7 score)
	β (95% CI) a	β (95% CI) b	β (95% CI) a	β (95% CI) b	β (95% CI) a	β (95% CI) b
Changes in other movement behaviors						
Physical activity, (min/day)	0.0 [-0.0,0.1]	0.0 [-0.0,0.0]	0.0 [-0.0,0.1]	0.0* [0.0,0.0]	-0.0 [-0.1,0.1]	0.0* [0.0,0.0]
Screen time, (min/day)	-0.0 [-0.1,0.0]	-0.0*** [-0.0,-0.0]	0.0 [-0.1,0.1]	-0.0* [-0.0,-0.0]	0.0 [-0.2,0.2]	-0.0* [-0.0,-0.0]
Sleep duration, (min/day)	na	0.0*** [0.0,0.0]	na	0.0*** [0.0,0.0]	na	-0.0 [-0.0,0.0]
Sleep quality, (1 point, 1 to 7 range)	9.4*** [7.1,11.7]	na	14.5*** [9.4,19.6]	na	-1.2 [-8.2,5.8]	na
Child characteristics						
Male sex, (Ref: Female)	-1.5 [-7.6,4.7]	0.0 [-0.1,0.1]	-19.2* [-33.9,-4.5]	0.2 [-0.0,0.4]	-3.4 [-28.8,22.1]	-0.0 [-0.3,0.3]
Age, (Ref: 1–2 y)						
3–4 y	-16.0*** [-24.8,-7.1]	0.2* [0.0,0.3]	-15.8 [-34.4,2.8]	0.3 [-0.0,0.6]	-8.0 [-37.2,21.1]	0.2 [-0.2,0.6]
5 y	-16.1** [-27.2,-5.1]	0.1 [-0.0,0.3]	2.4 [-19.7,24.6]	-0.1 [-0.4,0.3]	-15.3 [-53.5,22.9]	0.2 [-0.3,0.8]
Enrolled in early childcare center, (Ref: No)	10.4* [1.7, 19.1]	-0.0 [-0.2,0.1]	4.0 [-15.2,23.2]	-0.2 [-0.6,0.1]	20.6 [-9.2,50.4]	-0.3 [-0.7,0.1]

*** p < 0.001, ** p < 0.01, *p < 0.05

a Adjusted for the variables listed in the table plus sleep duration before COVID-19 and region within the country.

b Adjusted for the variables listed in the table plus sleep quality before COVID-19 and region within the country.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
Children usually plays with someone, (Ref: No)	2.9 [-5.0, 10.8]	-0.0 [-0.1,0.1]	0.6 [-19.1,20.4]	-0.0 [-0.3,0.2]	-13.8 [-44.8,17.3]	0.3 [-0.1,0.7]
Caregiver characteristics						
Age, (Ref: <30 years)						
31–40 years	-0.6 [-7.8, 6.5]	0.1 [-0.0,0.2]	4.0 [-16.3,24.2]	-0.0 [-0.3,0.3]	-1.8 [-28.6,25.1]	-0.1 [-0.4,0.3]
41 years or more	-10.1 [-24.5, 4.3]	0.2 [-0.0,0.4]	-14.7 [-41.4,12.0]	-0.2 [-0.6,0.3]	-19.9 [-63.7,24.0]	-0.0 [-0.7,0.7]
Male sex, (Ref: Female)	-3.6 [-18.2, 11.0]	0.3* [0.0,0.6]	19.3 [-8.7,47.4]	0.1 [-0.3,0.5]	-0.9 [-61.0,59.2]	0.9 [-0.5,2.3]
Education level, (Ref: Incomplete high school or less)						
Complete high school or technical degree	-11.8* [-22.4,-1.1]	0.1 [-0.1,0.3]	-15.0 [-58.9,28.9]	-0.0 [-0.7,0.7]	16.9 [-20.3,54.1]	-0.2 [-0.6,0.3]
University degree	-21.1** [-34.4,-7.8]	0.1 [-0.1,0.4]	-4.7 [-46.0,36.5]	0.3 [-0.4,0.9]	12.4 [-29.2,54.0]	0.1 [-0.5,0.6]
Household characteristics						
Housing type, (Ref: House)						
Apartment or Condominium	-4.0 [-13.3,5.3]	-0.0 [-0.2,0.2]	-9.3 [-29.3,10.7]	0.3 [-0.0,0.6]	-31.3* [-62.5,-0.2]	0.2 [-0.2,0.6]
Other	4.0 [-19.3, 27.4]	-0.0 [-0.4,0.3]	-0.5 [-80.5,79.5]	-0.0 [-1.5,1.4]	-5.5 [-47.3,36.3]	0.2 [-0.4,0.8]
Number of adults per home, mean (SD)	1.3 [-2.1,4.7]	-0.0 [-0.1,0.0]	-3.3 [-12.2,5.7]	0.0 [-0.1,0.2]	0.4 [-17.3,18.2]	0.0 [-0.2,0.2]
Number of children < 18y in the household, mean (SD)	0.6 [-3.6, 4.7]	-0.0 [-0.1,0.0]	-1.7 [-11.7,8.2]	0.0 [-0.1,0.2]	0.4 [-12.2,13.0]	-0.2 [-0.3,0.0]

*** p < 0.001, ** p < 0.01, *p < 0.05

^a Adjusted for the variables listed in the table plus sleep duration before COVID-19 and region within the country.

^b Adjusted for the variables listed in the table plus sleep quality before COVID-19 and region within the country.

	Chile (n = 3045)		Mexico (n = 632)		US Latinos (n = 459)	
Access to electronic devices, (Ref: None)						
1 to 2	-5.1 [-29.5,19.2]	0.1 [-0.4,0.6]	-32.0 [-78.3,14.3]	0.6 [-0.3,1.5]	-11.9 [-61.0,37.1]	-0.2 [-0.8,0.4]
3 or more	-5.2 [-30.3,19.8]	0.1 [-0.4,0.6]	-38.7 [-87.8,10.4]	0.5 [-0.5,1.4]	-45.4 [-99.8,8.9]	-0.2 [-1.0,0.5]
Electronic device in the room, (Ref: No)	-1.9 [-8.4,4.5]	-0.1 [-0.2,0.0]	6.9 [-8.2,22.0]	-0.2 [-0.4,0.1]	0.2 [-24.3,24.7]	-0.4* [-0.8,-0.0]
Limits in the use of electronic devices, (Ref: No)	-0.8 [-7.3,5.8]	-0.1 [-0.2,0.1]	-3.0 [-20.4,14.6]	0.1 [-0.1,0.4]	8.9 [-19.0,36.8]	0.1 [-0.5,0.3]
Available space to play, (Ref: No)	-13.3 [-28.1, 1.5]	0.6*** [0.3,0.8]	-30.5 [-65.7,4.6]	0.7** [0.1,1.2]	-20.1 [-57.2,17.1]	0.1 [-0.4,0.7]
Available backyard, (Ref: No)	9.1 [-4.2, 22.4]	-0.1 [-0.3,0.1]	6.9 [-17.9,31.6]	-0.2 [-0.6,0.2]	-7.2 [-44.0,29.6]	0.2 [-0.3,0.6]
Income level, (Ref: Low)						
Medium	3.6 [-4.6, 11.7]	0.1 [-0.1,0.2]	-46.9 [-125.7,31.9]	0.2 [-0.8,1.2]	-3.5 [-31.9,39.0]	0.0 [-0.5,0.5]
High	3.7 [-6.0, 13.3]	0.3** [0.1,0.5]	-42.9 [-123.8,38.0]	0.4 [-0.7,1.5]	-3.9 [-69.6,61.7]	0.6 [-0.4,1.6]
Rural area, (Ref: Urban)	5.1 [-4.5, 14.7]	0.1 [-0.1,0.2]	5.8 [-58.0,69.6]	0.2 [-0.7,1.0]	3.5 [-25.5,32.4]	-0.0 [-0.4,0.4]
Home confinement, (Ref: No)	-4.1 [-11.3, 3.2]	-0.1 [-0.2,0.0]	3.1 [-19.0,25.2]	-0.0 [-0.4,0.3]	6.5 [-32.6,45.5]	-0.1 [-0.5,0.3]
*** p < 0.001, ** p < 0.01, *p < 0.05						
^a Adjusted for the variables listed in the table plus sleep duration before COVID-19 and region within the country.						
^b Adjusted for the variables listed in the table plus sleep quality before COVID-19 and region within the country.						

In terms of sleep quality, increases in ST and decreases in PA were associated with decreases in this outcome across all sites (Table 4). In Chile and Mexico, increases in sleep quality were also associated with increases in sleep time and having available space to play at home. In Chile alone, male children and those in high SES families had better sleep quality. Meanwhile, in the USA, having electronic devices in the child's room was associated with worse sleep quality during the pandemic.

Discussion

Our study confirms strong interrelationships among changes in PA, ST and sleep quality among preschool Latin American/Latino children from Chile, Mexico and the USA.^{7,12,13} Several child, caregiver and household environment characteristics were consistently associated with unhealthy changes in all movement behaviors and across sites. For the child, these included being older, not being able to attend an ECEC. Higher parental education levels, not having the opportunity to play with someone, and not having access to spaces to play were important caregiver and household environment factors that negatively impacted movement behaviors among Latin American/Latino preschool children during the pandemic.

Some of our results are consistent with reports from other countries focused on children (versus preschool children). This includes a decline in PA^{7,12} and an increase in ST during COVID-19.^{7,13} This is likely due to children not being able to go outdoors, not attending their ECEC in-person (and often, switching to online educational activities),¹⁴ and having increased access to electronic media devices during COVID-19. It has been shown that children are more active and less sedentary the more time they spend outdoors,^{15–17} and are more active at ECEC than at home¹⁸. Outdoor play is also important in maximizing sleep quality, which can be explained by the effect of sunlight exposure on sleep and circadian rhythms.¹⁹ In our study, increases in ST and decreases in PA were much greater among preschoolers than toddlers, which is likely because children aged 3–5 had greater changes to their daily routines given the closure of ECEC services, and a greater proportion of them are enrolled than toddlers. Parents working from home may also be allowing their children greater access to electronic media devices to keep them from distracting them while the parent works. This could help explain why higher parental education was associated with more negative changes in movement behaviors in our study, as higher educated adults were most likely to have jobs allowing them to work from home during COVID-19.²⁰ This hypothesis warrants further exploration.

We found strong and consistent relationships across the three countries among PA, ST and sleep quality, but not sleep duration. As expected, PA increases were associated with positive changes in sleep quality and decreases in ST and vice versa.^{21–23} This reinforces that these behaviors are co-dependent and should be promoted in terms of what is a healthy movement pattern over 24 hours, as suggested by the WHO global guidelines.⁴ The null association for sleep duration with changes in PA and ST can be explained by the lack of change in sleep duration, unlike the difference in sleep quality, which was more profound and likely due to children going to bed and waking up later, a pattern of sleeping associated with poorer health outcomes.²⁴

Although most of our findings are not unexpected, documenting the adverse effects of COVID-19 on Latin American/Latino preschool children has added value beyond the description of temporary changes in movement behavior patterns during COVID-19. The impacts that COVID-19 might have on the health and wellbeing of people are expected to be long-lasting.^{25–27} Before the pandemic, Latin American countries already faced a disproportionate double burden of disease,^{28,29} which resulted from fast demographic and health transitions (including several large waves of migration to the USA),³⁰ in an environment with pervasive social and economic inequalities.^{31,32} Understanding if and how COVID-19 has contributed to widening the health disparities gap and identifying factors associated with worse or better outcomes can help provide critical information to develop tailored programs for promoting resilience and healthy movement behaviors during and after the pandemic. Our results suggest that such strategies must employ a multilevel, equity-driven approach.

One key finding of our study was the role of social and environmental opportunities to play in facilitating healthy movement behaviors during the pandemic. In line with other studies,^{15,16} opportunities for the child to play with other children or adults was an important factor associated with healthier levels of all three movement behaviors. Similarly, having a space for children to play was associated with more favorable changes in movement behaviors. It is possible that low-income families or those living in highly dense urban centers may be less likely to have designated “play spaces” in their private residences for their children to stay active and avoid sitting and screen-time. Usually, the lack of private space for play can be addressed by using public open recreation spaces such as parks, playgrounds or public squares. However, during COVID-19, many local governments have either limited or fully restricted access to these public facilities – a situation which has likely contributed to widening the gap of access to health-promoting spaces. Furthermore, the social isolation that results from lockdowns or stay-at-home orders is likely to impact Latin American/Latino children and families, especially given their strong collectivistic (community-oriented) identity. In fact, there is evidence that for adults, use and access to places that facilitate social interaction is a key driver of PA behaviors^{33,34}.

In contrast, we found that the level of access to electronic devices was associated with ST across all countries. A challenge faced by many caregivers is the ubiquity of screen devices. The mean number of connected devices owned by a USA household was 10.4 in 2020.³⁵ This provides children with more opportunities for ST, making it more challenging for caregivers to monitor the amount of ST for their child. However, we were encouraged that around two-thirds of caregivers set limits on the amount of time their child could use electronic devices and that setting limits effectively reduced their child’s ST. This strategy has been shown to be highly effective in lowering ST among children^{36,37} with the additional benefits of higher social interaction levels, mostly verbally,³⁸ which is important in language development.^{39,40}

The results of this study should be interpreted with consideration of its limitations. Although we asked caregivers to retrospectively report on their children’s patterns of movement behaviors before and during the pandemic, the cross-sectional survey design precludes us from inferring causality. Because all of our measures are based on self-report, and caregivers are reporting on behalf of their children, there may be some degree of information bias. Further, we recruited our sample using online social media outlets. Although the income and education distribution of participants in our sample broadly resembles those of the general population in Chile and among USA Latinos, there is potential for selection bias as respondents are most likely to be those with access to and frequent use of online media.

Our study also had many strengths. We used standardized methods to collect comparable data across three countries. This is the first study documenting movement behavior change patterns during COVID-19 among preschool children of Latin American origin or descent. We achieved robust sample sizes across all sites. Our results highlight consistent findings across countries, suggesting broad applicability of our results across Latin America, with potential for developing general joint-cross national recommendations. At the same time, we uncovered some country-specific results, which provide important information for developing locally tailored plans and actions to narrow the gap of healthy living opportunities during and after a major global crisis like COVID-19.

Conclusions

In this study of Latin American and Latino children during the first wave of the COVID-19 pandemic, fewer met the WHO global guidelines for PA and ST and sleep quality declined compared with pre-COVID-19. Parents with higher education levels and those with older children were more likely to report unhealthy movement behavior changes. We

found that not having access to an ECEC or to a space to play and not having the opportunity to play with someone were negatively associated with movement behaviors during the pandemic. This research provides further evidence on the impact the closure of pre-schools has had on children's physical and social health and some challenges parents found having their child at home during this pandemic stage, especially with managing a healthy level of screen time.

Declarations

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Authors contributions

AJ, DS and NAF conceived and executed the study. AJ analyzed the data. NAF, AJ, AO drafted the manuscript. All authors critically revised the manuscript for intellectual content and approved the final manuscript.

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Conflicts of Interest:

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Ethics

The study was approved by the Scientific Ethics Committee for each study site independently (Universidad de La Frontera, Chile [ORD.: 009-2020], the National Institute of Public Health of Mexico [Cl: 1661], and Washington University in St. Louis [IRB ID:202005074]).

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