

Article

Sociodemographic predictors of changes in physical activity, screen time, and sleep among toddlers and pre-schoolers in Chile during the COVID-19 pandemic

Nicolas Aguilar-Farias^{1,2*}, Marcelo Toledo-Vargas^{1,2}, Sebastian Miranda-Marquez^{1,2}, Andrea Cortinez-O’Ryan^{1,2}, Carlos Cristi-Montero³, Fernando Rodriguez-Rodriguez³, Pia Martino-Fuentealba^{1,2}, Anthony D. Okely⁴ and Borja del Pozo Cruz⁵

¹ Department of Physical Education, Sports and Recreation, Universidad de La Frontera, Chile. 4780000; nicolas.aguilar@ufrontera.cl (N.A.F.), marcelo.toledo@ufrontera.cl (M.T.V.), sebastian.miranda@ufrontera.cl (S.M.M.), andrea.cortinez@ufrontera.cl (A.C.O.), pia.martino@ufrontera.cl (P.M.F)

² UFRO Activate Research Group, Universidad de La Frontera, Chile. 4780000

³ IRyS Group, Physical Education School, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile; carlos.cristi@pucv.cl (C.C.M), fernando.rodriguez@pucv.cl (F.R.R)

⁴ Early Start, Faculty of Arts, Social Sciences and Humanities, University of Wollongong, Australia and Illawarra Health & Medical Research Institute, Wollongong, Australia; tokely@uow.edu.au (A.D.O.)

⁵ Institute for Positive Psychology and Education, Faculty of Health Sciences, Australian Catholic University, Sydney, Australia; borja.delpozocruz@auc.edu.au

* Correspondence: nicolas.aguilar@ufrontera.cl; Tel.: +56-45-2325209

Abstract: The aim was to examine the sociodemographic predictors associated with changes in movement behaviours (physical activity, screen time and sleep) among toddlers and pre-schoolers during the early stages of the coronavirus disease 2019 pandemic in Chile. Caregivers of 1- to 5-year-old children completed an online survey between March 30th and April 27th, 2020. Information about the child's movement behaviours before (retrospectively) and during the pandemic, as well as family characteristics were reported. In total, 3,157 participants provided complete data (mean children age: 3.1±1.38 years). During early stages of the pandemic, time spent in physical activity decreased, recreational screen time and sleep duration increased, and sleep quality declined. Toddlers and pre-schoolers with space to play at home and living in rural areas experienced an attenuated impact of the pandemic restrictions on their physical activity levels, screen time, and sleep quality. Older children, those whose caregivers had a higher educational level, and children living in apartments had greater changes, mainly a decrease in total physical activity and increase in screen time. This study has shown the significant impact of the pandemic restrictions on movement behaviours in toddlers and pre-schoolers in Chile.

Keywords: physical activity; sedentary behaviour; sleep; active play; outdoor time; movement behaviours; COVID-19

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has had a significant impact on everyday life worldwide. Since the declaration of the global pandemic and the first national cases, Chile has had a total of 462,991 infected and suffered 12,741 deaths (from March through September 2020).[1] During the pandemic, Chile has been in the top 10 countries with the highest ratio of deaths per 100k population (67.9 deaths/100k inhabitants by September 30th 2020).[2]

In response to this pandemic, the Chilean government implemented several approaches to reduce the health and economic impact of COVID-19. On March 16th, 2020, all schools were closed, and, in the same week, workplaces implemented work-from-home strategies. On March 17th, all national parks were closed, and on March 26th some districts enforced lockdowns and curfews.[3] These restrictions likely had a negative impact on young children's movement behaviours, (physical activity, sedentary behaviour – including screen time, and sleep).[4,5] Global guidelines recommend that children aged 1 to 5 should accumulate at least 180 min of physical activity, engage in no more than 1 h sedentary screen time (none for 1-year olds), and have between 11-14 h (1- to 2-year olds) and 10 to 13 h (3- to 5-year olds) good-quality sleep per night.[6,7] Limiting young children's ability to meet these recommendations may have long-term health consequences.[4,8] Studies conducted during the COVID-19 pandemic have shown that children and adolescents have decreased physical activity, increased screen time, and slightly increased sleep duration.[5] However, there is a lack of data regarding the impact of COVID-19 on movement behaviours in children under 5 years of age and from Latin-American countries.

Understanding the association between COVID-19 factors and young children's movement behaviours is important in guiding decision-making among policymakers, and in educating parents and health professionals. This information would be relevant not only during the pandemic but also when returning to a "new normal". The purpose of this study was to examine the early impact of COVID-19 restrictions implemented in Chile on levels of physical activity, screen time, and sleep among toddlers and pre-schoolers. In particular, we aimed to explore the sociodemographic factors associated with changes in these movement behaviours in this population group.

2. Materials and Methods

Main caregivers of 1- to 5-year old children living in Chile were invited to participate in an online survey from March 30th to April 27th, 2020. The study was promoted through social media (Facebook, Twitter, and Instagram) and emails from educational institutions. Potential participants accessed a personalized link to read more detailed information about the study and gave their online informed consent to participate in the study. The inclusion criteria were: 1) living in Chile, 2) being the main caregiver of a 1- to 5-year old child, and 3) living with the child most of the time before and during the COVID-19 pandemic. The study was approved by the Scientific Ethics Committee at Universidad de La Frontera, Chile (ORD.: 009-2020).

Data were collected and managed using REDCap (Research Electronic Data Capture)[9] hosted at Universidad de La Frontera. Data collection started two weeks after the government enforced educational centres to close in Chile (March 16th, 2020) due to COVID-19. At the end of the data collection, the education centres were still closed at a national level (April 27th, 2020).

Sociodemographic variables

The online survey included questions about the caregiver, family, and the child participating in the study. The sociodemographic and home characteristics section of the survey included questions

about educational level, family income, occupational situation, dwelling type and size, space to play at home, inhabitants per home, area of residence (urban/rural), city, and region. If there was more than one child at home between 1 to 5 years of age, the caregiver was asked to answer for only one of the children (freely chosen). Also, caregivers were asked about child sex, age, disability (yes/no and type), and enrolment in an early childhood education centre (ECEC; yes/no). Caregivers were also asked if they were in lockdown at home at the moment of the survey, and the number of days spent in lockdown.

Movement behaviours

A proxy-report from the main caregiver was used to assess children's movement behaviours (physical activity, screen time, and sleeping). Caregivers were asked to provide the time (in hours and minutes) spent by the child on each of the movement behaviours before and during the COVID-19 pandemic. Sleep quality was assessed with a Likert scale (1 to 7; a higher score indicated better quality). The survey was piloted in a small sample before the official launch to optimize readability, length, and pertinence of the questions. The questions regarding movement behaviours are included as a supplementary file 1.

Statistical analysis

Only participants with complete data for all sections were included in the analysis. Mean (standard deviation, SD), median (interquartile range, IQR), and proportions were used to describe participants on key characteristics and outcomes based on data distribution. Comparisons between sociodemographic characteristics were performed using parametric and non-parametric tests to compare behaviours before and during COVID-19. We used multiple linear regressions with a residualized change score approach [10,11] to investigate the sociodemographic predictors of changes in physical activity, recreational screen time, sleep duration, and sleep quality during the early stages of the pandemic in Chile. This approach provides robust estimates by eliminating auto-correlated errors and regression towards the mean, which often makes it preferable to the simple change score approach.[10] First, we regressed the standardized score during the COVID-19 pandemic on the standardized scores before the COVID-19 pandemic for each of the behaviours assessed in this study. The residualized change score (i.e., trend) for each behaviour was then estimated as the average of each participant's residual score (i.e., the difference between the estimated value and the observed value). A positive residualized change score indicates an increase in the specific behaviour from the time before COVID-19 and a negative score indicates a decrease. For each residualized change score, we explored the predictive role of a series of sociodemographic factors *a priori* thought to have influenced changes in the behaviours herein assessed after ECEC and school closures due to COVID-19. We adjusted all models for age and sex of the child, family income, geographic region, and presence of lockdown. Data preparation and validation was conducted with Stata 15.0 (College Station, TX: StataCorp LLC), while analyses were conducted in R (version 3.5.2). The level of significance was set at usual $p < 0.05$, two-tailed.

3. Results

In total, 5,505 individuals accessed the survey and 5,266 accepted participation and signed the consent form. We had participants from each of the 16 regions in Chile. A total of 2,109 (40.0%) participants were excluded from the analysis because they provided incomplete data (726 in

demographics and COVID-19 related questions and 1,383 for the movement behaviours). The final sample consisted of 3,157 participants with complete data. Participants that provided complete data were more likely to be older (31.4 [6.06] vs 30.3 [6.26], $p<0.001$) and more educated (52.4% vs 40.2% with university studies or more, $p<0.001$) than those with incomplete data. The caregivers' characteristics from those with complete data were comparable with those observed for the respective age group in the last National Census in terms of dwelling (81.6% vs 79.7% living in a house) and living area (11.4% vs 13.5% living in a rural area), but the current sample was more educated (65.7% vs 39.7% with more than 12 years of education).[12] The mean age of children was 3.1 (1.38) years. Children enrolled in ECEC or schools were 28.1% of 1- to 2-year olds and 71.9% of 3- to 5-year olds. Most participants lived in houses (81.6%). About 9 out of 10 caregivers reported space to play at home. A large proportion of participants resided in urban areas (88.6%), and 76.3% were under lockdown at the moment of the survey (mean duration 23.5 days [7.26]). No differences were observed between boys and girls in sociodemographic characteristics, except for the number of people (4.2 vs 4.1, $p=0.013$) and children (1.6 vs 1.7, $p=0.004$) per home (Table 1).

Table 1. Sample characteristics

	Total (n: 3157)	Boys (n: 1597)	Girls (n: 1560)	p^a
Children's age (mean years, SD)	3.1 (1.38)	3.1 (1.38)	3.1 (1.38)	0.459
Children's age (%)				
1y	17.9	18.15	17.59	0.364
2y	21.51	21.65	21.37	
3y	20.69	21.59	19.77	
4y	21.86	20.46	23.29	
5y	18.06	18.15	17.98	
Caregiver's age (SD)	31.4 (6.06)	31.2 (6.01)	31.6 (6.10)	0.098
Family's monthly income (%)				
<530 USD	32.30	31.54	33.08	0.597
≥530-<1830 USD	49.04	49.31	48.75	
≥1830 USD	18.66	19.15	18.17	
Main caregiver's level of education (%)				
Incomplete high school	3.23	3.07	3.39	0.705
Complete high school	31.07	31.23	30.90	
Technical degree	13.29	13.89	12.67	
University degree	52.42	51.81	53.04	
Children enrolled in ECEC (yes, %)				
1- to 2-year old	28.14	29.17	27.07	0.247
3- to 5-year old	71.86	70.83	72.93	
Dwelling type (%)				
House	81.59	82.04	81.13	0.678
Apartment	15.06	14.52	15.61	
Other	3.35	3.44	3.26	
Home size (%)				
<50 m ²	25.62	26.53	24.70	0.454
50 to <100 m ²	50.87	49.94	51.82	
≥100 m ²	23.51	23.53	23.48	
Number of people per home (mean, SD)	4.1 (1.40)	4.2 (1.48)	4.1 (1.31)	0.013
Number of children per home (mean, SD)	1.7 (0.82)	1.6 (0.76)	1.7 (0.88)	0.004
Children per home (%)				
1 child	47.9	48.7	47.0	0.027

2 children	37.7	38.5	36.9	
3 or more	14.4	12.8	16.1	
Squared metres per person at home (%)				
<11.7 m ² per person	25.37	24.59	26.17	0.534
≥11.7 to <18.3 m ² per person	22.90	23.34	22.46	
≥18.3 to <25 m ² per person	22.84	22.34	23.35	
≥25 m ² per person	28.88	29.72	28.02	
Available space to play (%)				
Yes	92.69	92.74	92.64	0.946
Living area (%)				
Urban	88.61	88.30	88.93	0.576
Rural	11.39	11.70	11.07	
Lockdown				
Yes (%)	76.3	75.8	76.8	0.530
Number of days (mean, SD)	23.5 (7.26)	23.267 (7.37)	23.2 (7.15)	0.786

Abbreviations: ECEC, early childhood care and education centres; USD, United States dollar

^a: significance when comparing characteristics between boys and girls.

Movement behaviours before and during the pandemic

Table 2 shows the changes in movement behaviours from before to during the COVID-19 pandemic by sex and age. Across all ages, mean time spent in physical activity decreased (-0.75 [CI 95% -0.81, -0.70] h/day), recreational screen time and sleep duration increased (1.4 [CI 95% 1.34, 1.45] h/day and 0.09 [CI 95% 0.04, 0.15] h/night, respectively) and sleep quality declined (-0.75 [CI 95% -0.81, -0.69] points). No differences by sex were observed for any of the movement behaviours before and during COVID-19. Older children were consistently less physically active, spent more time in screens, slept less and had better sleep quality before and during the pandemic. More details according to other sociodemographic factors are shown in supplementary table 1.

Table 2. Description of movement behaviours before and during the early stages of the COVID-19 pandemic in toddlers and pre-schoolers in Chile according to age and sex.

Characteristic	Physical activity (mean [SD], h/day)			Screen time (mean [SD], h/day)			Sleep duration (mean [SD], h/day)			Sleep quality (mean [SD], score 1 to 7)		
	Before COVID-19	During COVID-19	p	Before COVID-19	During COVID-19	p	Before COVID-19	During COVID-19	p	Before COVID-19	During COVID-19	p
Total	3.6 (1.97)	2.82 (2.15)	<0.001	1.66 (1.15)	3.05 (1.92)	<0.001	10.92 (1.80)	11.01 (1.86)	0.001	5.68 (1.54)	4.93 (1.77)	<0.001
Sex												
Girls	3.6 (2.00)	2.8 (2.14)	<0.001	1.65 (1.17)	3.00 (1.86)	<0.001	10.86 (1.75)	10.99 (1.82)	0.001	5.67 (1.56)	4.92 (1.79)	<0.001
Boys	3.6 (1.94)	2.9 (2.15)	<0.001	1.66 (1.13)	3.09 (1.98)	<0.001	10.97 (1.84)	11.02 (1.90)	0.214	5.69 (1.52)	4.93 (1.76)	<0.001
Age in years												
1	3.94 ^a (2.17)	3.65 ^b (2.42)	<0.001	1.33 ^a (1.03)	2.14 ^b (1.66)	<0.001	12.11 ^a (1.95)	11.96 ^b (2.03)	0.024	5.26 ^a (1.58)	4.58 ^b (1.76)	<0.001
2	3.92 (2.18)	3.14 (2.29)	<0.001	1.56 (1.12)	2.77 (1.73)	<0.001	11.35 (1.72)	11.38 (1.92)	0.710	5.54 (1.53)	4.83 (1.79)	<0.001
3	3.59 (1.96)	2.70 (2.01)	<0.001	1.77 (1.20)	3.29 (1.91)	<0.001	10.79 (1.61)	10.82 (1.70)	0.645	5.68 (1.57)	5.05 (1.69)	<0.001
4	3.22 (1.75)	2.42 (1.87)	<0.001	1.76 (1.13)	3.33 (1.98)	<0.001	10.33 (1.59)	10.57 (1.71)	<0.001	5.89 (1.49)	5.04 (1.81)	<0.001
5	3.23 (1.62)	2.25 (1.81)	<0.001	1.84 (1.21)	3.66 (1.97)	<0.001	10.07 (1.33)	10.38 (1.47)	<0.001	6.01 (1.42)	5.12 (1.76)	<0.001

Abbreviations: COVID-19, coronavirus disease 2019

^a: p-value <0.05 when comparing each behaviour between categories before COVID-19^b: p-value <0.05 when comparing each behaviour between categories during COVID-19

Predictors of change in movement behaviours

Table 3 shows the sociodemographic predictors of changes in movement behaviours due to the COVID-19 pandemic. Older children had greater reductions in physical activity and sleep duration, while they had more marked increase in their screen time. Children whose family had higher income had smaller decrease in sleep quality. Children whose main caregiver was more educated and those previously enrolled in an ECEC had greater reductions in their physical activity levels, and a greater increase in screen time. Toddlers and pre-schoolers living with five or more people had less marked decline in their physical activity, while those living with four or people had less marked increase in screen time. Children living with four people had greater reduction in sleep duration. Those living with more children had a less marked decline in their physical activity. Children who lived in apartment had greater reductions in physical activity and sleep quality, while they had a greater increase in screen time. Those living in a home different to a house or apartment had less marked increase in their screen time. Children who lived in homes with more square metres per person had a smaller decline in sleep quality. Children who had a space to play at home and those living in rural areas had smaller decline in physical activity and sleep quality, and less marked increase in screen time compared with their peers.

Table 3. Sociodemographic predictors of change in movement behaviours in toddlers and pre-schoolers during COVID-19 pandemic in Chile.

Characteristic	Residualized change score in physical activity (SD) (n=3157)	Residualized change score in screen time (SD) (n=3157)	Residualized change score in sleep duration (SD) (n=3157)	Residualized change score in sleep quality (SD) (n=3045)
Sex (ref: girls)	0.033 (0.035)	0.056 (0.035)	-0.032 (0.036)	-0.003 (0.036)
Age, y (ref: 1 year)	-0.121*** (0.013)	0.155*** (0.013)	-0.047*** (0.013)	0.019 (0.013)
Family income per month (ref: <530 USD)				
≥530-<1830 USD	-0.058 (0.040)	0.056 (0.039)	-0.016 (0.040)	0.109** (0.041)
≥1830 USD	-0.062 (0.040)	0.051 (0.051)	-0.010 (0.052)	0.294*** (0.053)
Main caregiver's level of education (%) (ref: Incomplete high school)				
Complete high school	-0.182 (0.102)	0.177 (0.102)	0.013 (0.104)	0.121 (0.107)
Technical degree	-0.300** (0.109)	0.282** (0.108)	-0.099 (0.111)	0.104 (0.114)
University degree	-0.371*** (0.104)	0.271** (0.103)	-0.093 (0.106)	0.122 (0.109)
Children enrolled in ECEC (ref: no)				
Yes	-0.195*** (0.048)	0.391*** (0.048)	0.078 (0.049)	-0.032 (0.050)
Dwelling type (ref: House)				
Apartment	-0.404*** (0.049)	0.226*** (0.049)	-0.089 (0.051)	-0.109* (0.051)
Other	0.114 (0.098)	-0.219* (0.098)	0.030 (0.100)	0.031 (0.101)

Number of people per home				
(ref: ≤3)				
4	0.058 (0.042)	-0.088* (0.042)	-0.085* (0.043)	-0.009 (0.044)
≥5	0.115** (0.043)	-0.112** (0.043)	0.004 (0.044)	-0.049 (0.045)
Children per home				
(ref: 1 child)				
2 children	0.112** (0.038)	-0.021 (0.038)	-0.015 (0.039)	-0.023 (0.040)
3 or more	0.124* (0.053)	-0.025 (0.053)	0.067 (0.054)	0.006 (0.055)
Squared metres per person at home				
(ref: <11.7 m² per person)				
≥11.7 - <18.3 m ² per person	-0.042 (0.052)	0.049 (0.051)	-0.074 (0.052)	0.051 (0.053)
≥18.3 - <25 m ² per person	-0.038 (0.053)	0.079 (0.053)	-0.025 (0.054)	0.087 (0.055)
≥25 m ² per person	0.053 (0.053)	-0.007 (0.053)	0.025 (0.054)	0.158** (0.055)
Available space to play (ref: no)				
Yes	0.546*** (0.067)	-0.398*** (0.067)	-0.057 (0.069)	0.396*** (0.070)
Living area (ref: urban)				
Rural	0.563*** (0.055)	-0.278*** (0.055)	0.102 (0.056)	0.120* (0.057)
Lockdown (ref: no)				
	-0.074 (0.042)	0.050 (0.041)	-0.076 (0.042)	-0.076 (0.043)

Abbreviations: COVID-19, corononavirus disease 2019; ECEC, early childhood care and education centres

Models adjusted by sex, age, family income, region and presence of lockdown.

Significance: *** = $p < 0.001$; ** = $p < 0.01$; * = $p < 0.05$

4. Discussion

To our knowledge, this is the first study examining the effects of COVID-19 on movement behaviours among children aged 1 to 5 years. We found that all movement behaviours changed across all ages, reflecting important secondary detrimental effects from this pandemic. The most common sociodemographic predictors of movement behaviours change during the COVID-19 pandemic were age, family income, previous enrolment in an ECEC, the main caregiver's education, dwelling type, available space to play, and type of residence area (urban/rural).

This is also the first known study in Chile that examined all three components of the 24-hour movement behaviours in toddlers and pre-schoolers. A novel finding was that children from poorer families were more physically active than those in more affluent or educated families during the pandemic. This finding is different from that commonly observed in Chilean children and adolescents.[13,14] It is plausible that those caregivers were less likely to work from home under lockdown and kept more "normal" routines with their families, at the same time that those children may have had more freedom to play indoors and less demand to stay quiet during working hours. Also, having space to play at home was consistently related to healthier levels in all movement behaviours both before and during the pandemic. This finding reinforces the need for ensuring spaces for children at home and surrounding areas to play as this is likely to promote these behaviours not only during the pandemic but also in the return to a "new normal". In Chile, specific content was developed for promoting physical activity through social media and national TV (since the April 27th 2020) as a response to the pandemic [15,16], and an expert committee on physical activity was installed by the Ministries of Sports, Health and Education to inform, adapt and add

physical activity content into the curriculum of the classes delivered remotely in this context [17]. Nevertheless, the lockdown measures did not allow people to participate in physical activity outdoors and most public parks were still closed during the period included in our study,[3] with few councils prioritizing pedestrian zones to favour physical distancing.[18] These opposing strategies where on one hand PA is promoted indoors while at the same time it is severely restricted outdoors need to be periodically revised and aligned with the latest evidence so health impairing over-restrictions are prevented.

Pre-schoolers were the most affected by the restrictions during the pandemic, particularly for physical activity and recreational screen time. This may be explained by pre-schoolers needing more space to play and having greater access to screen-based devices than toddlers. The reduction in physical activity and the increase in screen time have particularly affected those with previous enrolment in an ECEC. Schools would be in a better position to respond with specific actions to prevent physical inactivity during this period than ECECs, as children and adolescents are more likely to be connected to participate in their virtual school activities than toddlers and pre-schoolers. Therefore, governments, policymakers and professionals should devote particular attention to this age group.

Our results suggest that more educated parents tend to restrict their children's physical activity more, while at the same time may provide more opportunities to engage in screen-based behaviours. This is an interesting finding as, before the pandemic, children with more educated caregivers tended to engage less with screen-based devices than children with less-educated parents. This may be partially explained as more educated caregivers may have to work from home, and this, in turn, may require the caregiver to use screens to entertain their child while working from home. This may be even more complicated in families living in apartments, one of the strongest predictors of declines in physical activity and increases of screen time observed in this study during the pandemic. This finding has implications for urban planning. As the full impact of COVID-19 is uncertain and other pandemics may occur, upgrading substandard areas that are currently plenty of small social apartments with insufficient recreational public spaces should be considered, together with stronger regulation, as part of a plan to build healthier and more resilient cities. Undoubtedly, families and caregivers play a key role in facilitating movement behaviours of toddlers and pre-schoolers, but some political actions such as allowing specific time for those residing in apartments to go outside with their family may boost the process. The family composition (number of people and children per home) was also associated with changes in movement behaviours during the pandemic, so strategies should consider messages and actions for the entire family group, particularly small families.[19]

Overall, sleep quality worsened, but children with higher family income and less crowded homes showed less marked declines. This aspect may reflect other social issues that are not captured in this study that are related to the economic situation in Chile.[20] The decrease in sleep quality has also been described in a study conducted in Italy in children aged 3 to 6 during the early stages of the pandemic, however, after two weeks of follow up, this decline plateaued.[21] Some key messages to promote healthy sleep duration and quality, such as creating a bedtime routine and avoiding screens before sleep should be regularly disseminated and reinforced; and particularly tailored to low-income families.[4,6,22]

Having space to play at home was the most consistent factor in the home environment predicting changes in movement behaviours. A novel finding from our study is that the play space was not only important for physical activity and screen time but also had an impact on sleep quality. This is

particularly important as this association reinforces the call from the World Health Organization for focusing on the interaction of all three behaviours as they benefit each other.[6] Therefore, strategies originally thought for promoting active playing at home or surroundings may impact sleep, and this, in turn, may benefit the whole home environment. Another relevant factor that resulted in healthier changes in physical activity and screen time was living in a rural area. Recent studies conducted during the COVID-19 pandemic in children and adolescents have also reported that rurality is an important correlate of movement behaviours.[23,24] A study conducted in Croatia reported that the decrease in physical activity was more evident in adolescents living in urban areas than it was in those from rural areas.[23] For children living in Canada, factors such as living in an apartment and the proximity to major roads were barriers to engage in outdoor activities.[24] Also, adolescents spent more time outdoor if they lived in a low-density area and had access to parks in high-density neighbourhoods.[25] We acknowledge that one of the primary measures taken by countries to control the pandemic was the imposition of mobility restrictions. However, decision-makers should seek options to facilitate outdoor recreational activities for the population while preserving safety and physical distancing instructions. Outdoor time is not only relevant for all movement behaviours but also the lack of it may impact other areas such as mental health, vitamin D deficiency and myopia.[4] In our study, the region of residence and lockdown situation were not predictors of the movement behaviour changes suggesting that regardless of location and containment measures, movement behaviours, in both toddlers and pre-schoolers, were similarly affected during the pandemic in Chile.

The provision of safe spaces for physical activity is critical when physical distancing is required. As parks may be limited in space, availability and accessibility, programs such as open streets (e.g., Ciclovía) or play streets can be adapted and implemented while maintaining the physical distancing and other COVID-19-safe measures.[26-28] Thus, councils could provide additional safe spaces by closing lanes to cars, implementing complete streets schemes and transforming them into spaces for physical activity, play and recreation. Colombia has been highly innovative during the pandemic as they modified their current programs, usually delivered in parks or closed areas to face the needs of the population during the pandemic.[29] For example, in Bogotá, one of the first measures taken during the pandemic was the closure of lanes to private cars and the instalment of daily open streets.[30] Also, professionals from the Ministry of Sports Colombia have delivered their physical activity programs in the neighbourhoods while maintaining an appropriate physical distance.[29] These low-cost initiatives have been positively received by the general public and policymakers,[31,32] so once adapted to local needs they could be implemented in other contexts and countries, including Chile, and could help to alleviate the inactivity crisis.[3]

The detrimental effects of the COVID-19 pandemic in toddlers and pre-schoolers are still uncertain.[8] If sustained, the COVID-19 lockdown measures may have a serious impact on children, with a greater effect on those from a more deprived background, increasing the gap in other developmental outcomes such as motor development, cognition and literacy. Actions to prevent the adverse effects of the restriction measures due to COVID-19 are needed. As younger children are mostly dependant on adults, we should embrace this challenge and offer the best possible opportunities to promote a comprehensive development in the current context.[8] Messages and strategies should be respectful and appropriate for the families as many are suffering not only from the direct effects of the COVID-19 but also from economic and social hardships. These challenges are novel and highly demanding for governments and can only be successfully addressed if coordinated actions across sectors are undertaken. Cross-country collaborative efforts are needed to understand

further how the pandemic is affecting movement behaviours of people from other ages, locations and social groups. This may guide the allocation of resources where it is more critical. This study adds evidence that allows more balanced decision-making processes where not only the need to impose mobility restrictions to prevent contagion is taken into consideration but so is the need to avoid health impairments derived from extended confinements. Government departments are encouraged to develop and update their protocols in awareness of the multiple health impacts derived from the confinements.

Strengths and limitations

Strengths of this study include a large sample of participants from each of the Chilean regions. As recruitment was conducted online, voluntary response bias may have affected the sample composition with participants being more concerned regarding their children's health and having therefore higher chances to notice impairments in their movement behaviours. Besides this limitation, the respondents' characteristics were comparable from those observed in the last National Census for the respective age group in terms of dwelling type and living area, but the sample in our study was more educated.[12] Although our instrument was piloted before it was officially launched, we had a large percentage of incomplete questionnaires (40.0%). This could be explained since some people may be more reluctant to provide personal information through online platforms than in face-to-face modes. We acknowledge that self-report measures used in this study may have biased the results (e.g., social desirability and recall). The use of accelerometers was not possible as physical distancing was mandated at the national level, including for those studies that were not strictly related to COVID-19 in clinical settings during the early stages of the pandemic.[33] Considering this, we collected data only during four weeks to minimize the risk of recall bias regarding the retrospective nature of some assessments.

5. Conclusions

The COVID-19 lockdown measures have shown to have a serious impact on children's behaviours. This study has shown that all movement behaviours changed during the early stages of the COVID-19 pandemic in toddlers and pre-schoolers in Chile. The most common sociodemographic factors associated with these changes were age, family income, main caregiver's education, previous enrolment in an ECEC, dwelling type, space to play at home and type of residence area. Toddlers and pre-schoolers with space to play at home and living in rural areas had less marked impacts on physical activity, screen time and sleep quality due to the pandemic. In contrast, older children, those whose caregivers had higher educational level and children living in apartments had greater changes, decreasing the total physical activity and increasing screen time. Together, the information provided in this study may help professionals and decision-makers to balance more precisely the health risks and benefits of confinements, inform future strategies and focus resources to reduce the potential adverse effects of the pandemic, immediately, and in the long-term.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1, Table S1: title

Author Contributions: Conceptualization, N.A.F. and B.d.P.C.; methodology, N.A.F., P.M.F., M.T.V., S.M.M., C.C.M., F.R.R., and A.C.O.; software, M.T.V. and N.A.F.; validation, N.A.F. and M.T.V. ; formal analysis, N.A.F. and B.d.P.C.; investigation, N.A.F., P.M.F., M.T.V., S.M.M., C.C.M., F.R.R., and A.C.O.; resources, N.A.F. and P.M.F.; data curation, N.A.F.; writing—original draft preparation, N.A.F.; writing—review and editing, all

authors; visualization, N.A.F.; supervision, N.A.F., P.M.F, and A.D.O.; project administration, N.A.F. and P.M.F.; funding acquisition, N.A.F. and P.M.F. All authors have read and agreed to the published version of the manuscript.

Funding: The study was partially supported by the Research Office at the Universidad de La Frontera (DIUFRO DFP19-0012, Programa para grupos de alta productividad, apoyo a la inserción de estudiantes pre- y postgrado a la investigación DI20-2009, y apoyo a postulantes FONDECYT DI20-1002). ADO is supported by a NHMRC Investigator Grant.

Acknowledgments: The authors would like to thank all the participants of this study as they gave their time during the difficult period of COVID-19 pandemic in Chile.

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.

References

1. Ministerio de Salud Gobierno de Chile. Casos confirmados en Chile COVID-19. Available online: <https://www.minsal.cl/nuevo-coronavirus-2019-ncov/casos-confirmados-en-chile-covid-19/> (accessed on 30-09-2020).
2. Johns Hopkins University & Medicine. Coronavirus Resource Center. Mortality trends. Available online: <https://coronavirus.jhu.edu/data/mortality> (accessed on 27-10-2020).
3. Cortinez-O’Ryan, A.; Moran, M.R.; Rios, A.P.; Anza-Ramirez, C.; Slovic, A.D. Could severe mobility and park use restrictions during the COVID-19 pandemic aggravate health inequalities? Insights and challenges from Latin America. *Cad Saude Publica* **2020**, *10.1590/0102-311X00185820*, doi:10.1590/0102-311X00185820.
4. Guan, H.; Okely, A.D.; Aguilar-Farias, N.; Del Pozo Cruz, B.; Draper, C.E.; El Hamdouchi, A.; Florindo, A.A.; Jauregui, A.; Katzmarzyk, P.T.; Kontsevaya, A., et al. Promoting healthy movement behaviours among children during the COVID-19 pandemic. *Lancet Child Adolesc Health* **2020**, *4*, 416-418, doi:10.1016/S2352-4642(20)30131-0.
5. Bates, L.C.; Zieff, G.; Stanford, K.; Moore, J.B.; Kerr, Z.Y.; Hanson, E.D.; Barone Gibbs, B.; Kline, C.E.; Stoner, L. COVID-19 Impact on Behaviors across the 24-Hour Day in Children and Adolescents: Physical Activity, Sedentary Behavior, and Sleep. *Children (Basel)* **2020**, *7*, doi:10.3390/children7090138.
6. World Health Organization. *Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age.*; World Health Organization: 2019.
7. Okely, A.D.; Ghersi, D.; Hesketh, K.D.; Santos, R.; Loughran, S.P.; Cliff, D.P.; Shilton, T.; Grant, D.; Jones, R.A.; Stanley, R.M., et al. A collaborative approach to adopting/adapting guidelines - The Australian 24-Hour Movement Guidelines for the early years (Birth to 5 years): an integration of physical activity, sedentary behavior, and sleep. *BMC Public Health* **2017**, *17*, 869, doi:10.1186/s12889-017-4867-6.
8. Crawley, E.; Loades, M.; Feder, G.; Logan, S.; Redwood, S.; Macleod, J. Wider collateral damage to children in the UK because of the social distancing measures designed to reduce the impact of COVID-19 in adults. *BMJ Paediatr Open* **2020**, *4*, e000701, doi:10.1136/bmjpo-2020-000701.
9. Harris, P.A.; Taylor, R.; Minor, B.L.; Elliott, V.; Fernandez, M.; O’Neal, L.; McLeod, L.; Delacqua, G.; Delacqua, F.; Kirby, J. The REDCap consortium: Building an international community of software platform partners. *J Biomed Inform* **2019**, *95*, 103208.
10. Castro-Schilo, L.; Grimm, K.J. Using residualized change versus difference scores for longitudinal research. *J Soc Pers Relat* **2017**, *35*, 32-58, doi:10.1177/0265407517718387.
11. Dalecki, M.; Willits, F.K. Examining change using regression analysis: Three approaches compared. *Sociol Spectr* **1991**, *11*, 127-145, doi:10.1080/02732173.1991.9981960.

12. Instituto Nacional de Estadísticas - Chile. Censo de Población y Vivienda 2017. Available online: https://redatam-ine.ine.cl/redbin/RpWebEngine.exe/Portal?BASE=CENSO_2017&lang=esp (accessed on 30-09-2020).
13. Aguilar-Farias, N.; Miranda-Marquez, S.; Martino-Fuentealba, P.; Sadarangani, K.P.; Chandia-Poblete, D.; Mella-Garcia, C.; Carcamo-Oyarzun, J.; Cristi-Montero, C.; Rodriguez-Rodriguez, F.; Delgado-Floody, P., et al. 2018 Chilean Physical Activity Report Card for Children and Adolescents: Full Report and International Comparisons. *J Phys Act Health* **2020**, *17*, 807-815, doi:10.1123/jpah.2020-0120.
14. Aguilar-Farias, N.; Cortinez-O'Ryan, A.; Sadarangani, K.P.; Von Oetinger, A.; Leppe, J.; Valladares, M.; Balboa-Castillo, T.; Cobos, C.; Lemus, N.; Walbaum, M., et al. Results From Chile's 2016 Report Card on Physical Activity for Children and Youth. *J Phys Act Health* **2016**, *13*, S117-S123, doi:10.1123/jpah.2016-0314.
15. Elige Vivir Sano Ministerio de Desarrollo Social y Familia Gobierno de Chile. Vida saludable en casa. Available online: <http://eligevivirsano.gob.cl/vida-saludable-en-casa/> (accessed on 30-09-2020).
16. Ministerio de Educación Gobierno de Chile. Programación TV Educa Chile. Available online: <https://www.mineduc.cl/programacion-tv-educa-chile/> (accessed on 10-10-2020).
17. Ministerio de Educación Gobierno de Chile. Priorización curricular COVID-19 Educación Física y Salud. 1° Básico a 4° Medio. Available online: <https://bibliotecadigital.mineduc.cl/handle/20.500.12365/14466> (accessed on 30-09-2020).
18. Intendencia Región del Libertador General Bernardo O'Higgins. Covid-19: Autoridad adopta medida del cierre de calles en el centro de Rancagua. Available online: <http://www.intendenciabohiggins.gov.cl/noticias/covid-19-autoridad-adopta-medida-del-cierre-de-calles-en-el-centro-de-rancagua/> (accessed on 10-10-2020).
19. Ibarra-Mora, J.; Alvarez, C.; Aguilar-Farias, N.; Correa Escalona, P.; Cristi-Montero, C.; Delgado Arroyo, P.; Picasso, C.; Toledo Romero, C.; Smith Plaza, R. Guía de Actividad Física en Familia durante confinamiento. Mesa Técnica interministerial para la Educación Física, A.F.y.D.E.e.p.G.d.C., Ed. Santiago, Chile, 2020; 10.13140/RG.2.2.10468.81288.
20. Instituto Nacional de Estadísticas – Chile. Boletín estadístico: Empleo trimestral. Edición n° 263 / 30 de septiembre de 2020. Available online: https://www.ine.cl/docs/default-source/ocupacion-y-desocupacion/boletines/2020/pa%C3%ADs/bolet%C3%ADn-empleo-nacional-trimestre-m%C3%B3vil-junio-julio-agosto-2020.pdf?sfvrsn=1757d932_4 (accessed on 01-10-2020).
21. Dellagiulia, A.; Lionetti, F.; Fasolo, M.; Verderame, C.; Sperati, A.; Alessandri, G. Early impact of COVID-19 lockdown on children's sleep: a 4-week longitudinal study. *J Clin Sleep Med* **2020**, *16*, 1639-1640, doi:10.5664/jcsm.8648.
22. Chile Crece Contigo Gobierno de Chile. Chile Crece Contigo. Available online: <http://www.crececontigo.gob.cl/> (accessed on 30-09-2020).
23. Zenic, N.; Taiar, R.; Gilic, B.; Blazevic, M.; Maric, D.; Pojskic, H.; Sekulic, D. Levels and Changes of Physical Activity in Adolescents during the COVID-19 Pandemic: Contextualizing Urban vs. Rural Living Environment. *Applied Sciences* **2020**, *10*, doi:10.3390/app10113997.
24. Mitra, R.; Moore, S.A.; Gillespie, M.; Faulkner, G.; Vanderloo, L.M.; Chulak-Bozzer, T.; Rhodes, R.E.; Brussoni, M.; Tremblay, M.S. Healthy movement behaviours in children and youth during the COVID-19 pandemic: Exploring the role of the neighbourhood environment. *Health Place* **2020**, *65*, 102418, doi:10.1016/j.healthplace.2020.102418.
25. Moore, S.A.; Faulkner, G.; Rhodes, R.E.; Brussoni, M.; Chulak-Bozzer, T.; Ferguson, L.J.; Mitra, R.; O'Reilly, N.; Spence, J.C.; Vanderloo, L.M., et al. Impact of the COVID-19 virus outbreak on movement and play

- behaviours of Canadian children and youth: a national survey. *Int J Behav Nutr Phys Act* **2020**, *17*, 85, doi:10.1186/s12966-020-00987-8.
26. Triana, C.A.; Sarmiento, O.L.; Bravo-Balado, A.; Gonzalez, S.A.; Bolivar, M.A.; Lemoine, P.; Meisel, J.D.; Grijalba, C.; Katzmarzyk, P.T. Active streets for children: The case of the Bogota Ciclovía. *PLoS One* **2019**, *14*, e0207791, doi:10.1371/journal.pone.0207791.
 27. Torres, A.; Sarmiento, O.L.; Stauber, C.; Zarama, R. The Ciclovía and Cicloruta programs: promising interventions to promote physical activity and social capital in Bogota, Colombia. *Am J Public Health* **2013**, *103*, e23-30, doi:10.2105/AJPH.2012.301142.
 28. Cortinez-O’Ryan, A.; Albagli, A.; Sadarangani, K.P.; Aguilar-Farias, N. Reclaiming streets for outdoor play: A process and impact evaluation of "Juega en tu Barrio" (Play in your Neighborhood), an intervention to increase physical activity and opportunities for play. *PLoS One* **2017**, *12*, e0180172, doi:10.1371/journal.pone.0180172.
 29. O’Donovan, G.; Fajardo Ardila, K.; Hurtado Ramirez, H.; Mayorga Ramirez, H.; Ruiz Gomez, N.; Sarmiento, O.L. Community physical activity interventions during the COVID-19 pandemic: where there’s a will, there’s a way! In *British Journal of Sports Medicine Blog*, 2020; Vol. 2020.
 30. Alcaldía de Bogotá. Con 22 km. de ciclovía la alcaldía busca descongestionar TransMilenio. Available online: <https://bogota.gov.co/mi-ciudad/coronavirus-covid-19-con-ciclovía-se-descongestionara-transmilenio> (accessed on 30-09-2020).
 31. C40 Cities Climate Leadership Group. Prioritising cyclists and pedestrians for a safer, stronger recovery. Available online: https://www.c40knowledgehub.org/s/article/Prioritising-cyclists-and-pedestrians-for-a-safer-stronger-recovery?language=en_US (accessed on 30-09-2020).
 32. The New York Times. ‘Corona Cycleways’ Become the New Post-Confinement Commute. Available online: <https://www.nytimes.com/2020/06/12/business/paris-bicycles-commute-coronavirus.html> (accessed on 30-09-2020).
 33. Ministerio de Salud Gobierno de Chile. Recomendaciones de la CMEIS para los comités ético científicos (CECs) en la revisión de protocolos de investigación en contexto de pandemia por COVID-19. 6 junio 2020. Comisión Ministerial de Ética en Investigación en Salud, Ed. Santiago, Chile., 2020.