



Associations of Sex and Household Area With Physical Activity and Sedentary Behavior During Total and Partial COVID-19 Lockdowns in Chile: A Study in Adults Aged 18-44 Years

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Objectives: The coronavirus disease 2019 pandemic led to various intensities of lockdowns, affecting lifestyles globally. This study investigates the impact of partial lockdown versus total lockdown on adult physical activity (PA) and sedentary behavior.

Methods: A cross-sectional online survey was conducted from April 2020 to October 2020, with 493 participants included in the analysis.

Results: The analysis revealed no significant differences in total PA or total sitting time between partial lockdown and total lockdown scenarios. However, moderate physical activity (MPA) significantly decreased during total lockdowns, with more pronounced reductions among females than males. Notably, a positive correlation was found between household area and MPA, suggesting that larger living spaces may encourage more PA. A negative correlation was observed between sitting time and MPA during both types of lockdown.

Conclusions: Total lockdown conditions were associated with a significant decrease in MPA, highlighting sex disparities in PA responses. Living space size emerged as a crucial factor in maintaining PA levels during restricted conditions. This study emphasizes the need to consider environmental and demographic factors in public health strategies during prolonged periods of restricted movement.

Key words: Physical activity, Sedentary behavior, COVID-19, Quarantine

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INTRODUCTION

The advent of the coronavirus disease 2019 (COVID-19) pandemic prompted unprecedented public health responses worldwide, with lockdowns serving as a primary strategy to contain virus transmission [1,2]. While necessary, these measures have disrupted normal life, influencing various health behaviors, particularly physical activity (PA) and sedentary habits [3-5]. Given the varying intensities and durations of lockdowns across

different regions, evaluating their specific impacts on physical and sedentary activities is essential. This study seeks to fill this gap by analyzing and comparing the effects of partial and total lockdowns on these behaviors among a cohort in Chile.

The COVID-19 pandemic has necessitated varying degrees of lockdown measures globally, significantly altering daily routines and PA patterns [6]. This study primarily focuses on comparing PA levels and sedentary behavior under partial lockdown and total lockdown conditions. Understanding these dynamics is crucial since the characteristics of lockdown restrictions can affect mental and physical health outcomes differently [7-9].

Research has demonstrated that the reduction in PA during the COVID-19 pandemic significantly increased the risk of developing non-communicable diseases such as cardiovascular disease, obesity, and type 2 diabetes [10]. Furthermore, prolonged physical inactivity has also contributed to mental health issues such as elevated stress, anxiety, and depression [11]. These negative trends were compounded by lifestyle disruptions, leading to poorer cardiovascular health behaviors, such as increased sedentary behavior and unhealthy dietary patterns [12,13]. By examining how moderate, vigorous, transport, and total PAs, as well as sedentary times, vary between these two distinct lockdown scenarios, this research aims to shed light on the broader implications of prolonged home confinement on lifestyle behaviors. Such insights are vital for developing targeted interventions aimed at promoting PA and reducing sedentary behavior in the face of potential future lockdowns.

Comparing total and partial lockdowns during the COVID-19 pandemic provides a unique window into understanding how different levels of movement and activity restrictions influence human behavior during health crises. Analyzing these differences is crucial for assessing the effectiveness of implemented control measures and refining decision-making in response to future public health emergencies. Understanding the direct impact of these measures not only helps identify strategies that effectively reduce virus spread but also minimizes adverse impacts on PA and the overall well-being of the population.

Moreover, the results of these comparisons can provide crucial empirical evidence for formulating specific policies and recommendations to enhance the management of health crises. This includes determining the optimal duration, scope of restrictions and developing adaptive and flexible action plans that consider local characteristics, and needs.

The contrast between total lockdown, which imposed severe restrictions on almost all aspects of daily life, and partial lockdown, which allowed some flexibility with limited movements within neighborhoods, illustrates the importance of considering both the direct impacts on virus containment and the secondary effects on society [14,15]. This analysis must also integrate ethical and social considerations, addressing how measures disproportionately affect different groups and seeking a better balance between protecting public health and preserving individual freedoms and quality of life.

The objective of this study is to examine the impact of household area, demographic factors, and sex differences on PA levels and sedentary behavior during partial lockdown and total lockdown scenarios. The variables selected for this study—sex, household area, and different types of PA (moderate, vigorous, transport-related)—were chosen due to their documented influence on PA and sedentary behavior. Previous research has shown that sex differences significantly affect sedentary patterns, with females more likely to adapt their PA habits during lockdowns compared to males [16,17]. Additionally, individuals living in urban areas tend to reduce PA due to spatial constraints, while rural environments offer greater opportunities for maintaining activity [17]. Understanding these variables is essential for accurately assessing the diverse impacts of lockdowns on PA and sedentary behavior. By identifying key factors influencing these behaviors, the study seeks to develop targeted strategies to enhance PA and reduce sedentary time, thereby improving health outcomes during extended lockdown periods.

METHODS

Study Design and Subjects

This cross-sectional study was conducted using an anonymous online survey. Six hundred sixty-four adults agreed to participate, with 493 completing the survey correctly which means a 74.3% response rate. Of the total group, 78.3% were university students, and the remainder were direct relatives, all aged between 18 years and 44 years. The study was carried out from April 2020 to October 2020. Information about the study was distributed via social media platforms and through the email accounts of students from the participating universities, with links to a Google Form questionnaire. Participants were recruited from databases of seven universities located in the northern, central, and southern regions of Chile. Invita-

tions to participate, along with informed consent and an acceptance statement, were sent via email. A key question used to classify participants into groups was whether they had been under quarantine in the previous week, based on official government records. According to the 'Paso a Paso' plan outlined by the Chilean Ministry of Health, total lockdown was defined as strict confinement with restrictions on movement outside the home, except for essential activities such as healthcare and food supply (Resolución Exenta No. 591, 2020) [18].

Power and Sample Size Calculation

The total population of adults aged 18-44 years was 7 071 181 according to the 2017 Chilean census. The sample size was calculated to achieve a statistical power of 95% confidence interval with a 5% margin of error, requiring a sample size of 385 subjects for this study.

Data Collection

Participants spent approximately 10 minutes completing an online questionnaire that included questions on PA, sedentary time, and other socio-demographic variables that included age, sex, weight, height, educational level, area of residence (north, central, or south), per capita income, and household area. PA levels were assessed using the Spanish self-administered version of the Global Physical Activity Questionnaire (GPAQ). The GPAQ encompasses sedentary behavior and three domains of PA: work, transport, and leisure-time, which can be grouped into total, moderate, vigorous, and transport-related activities [19]. PA was reported in metabolic equivalent of task (MET)-min/wk, a commonly used measure based on energy expenditure, where 1 MET represents the energy cost of resting. Additional information on the assessment and categorization of sedentary behavior and PA levels can be found in the GPAQ Analysis Guide [20].

Participants were classified based on whether they were under partial lockdown or total lockdown in the week prior to data collection. This classification ensures that subjects did not experience both types of lockdown simultaneously, eliminating the possibility of overlap between partial and total lockdowns.

Validity of the Measurement Instrument

Although the GPAQ has shown a moderate-to-weak correlation with accelerometry data in prior studies, with correlation coefficients ranging from 0.17 to 0.34 for moderate physical

activity (MPA) and from 0.10 to 0.64 for vigorous PA [21], it is a validated instrument in Chile and other countries [22,23].

Statistical Analysis

The dataset was analyzed as follows: Categorical variables were summarized using frequencies and percentages, while continuous variables were reported using means and standard deviations (SDs). The data distribution underwent evaluation via normality and equal variance tests (Shapiro-Wilk and Levene tests). Variations in means among six distinct groups—stratified by different lockdown conditions (partial and total) and by sex—were examined using the non-parametric Kruskal-Wallis test, followed by Dunn's multiple comparison test to identify groups with statistically significant differences. Effect sizes, calculated using Hedges's g , where $g = (x_1 - x_2) / \sqrt{((n_1 - 1)s_1^2 + (n_2 - 1)s_2^2) / (n_1 + n_2 - 2)}$, were qualitatively classified as trivial (0.00-0.19), small (0.20-0.49), medium (0.50-0.79), or large (0.80 and above). Correlation analyses between PA, sitting time (ST), and other variables were conducted using the Spearman correlation coefficient. Multiple linear regression analysis was employed to identify predictors influencing total and MPA, as well as ST, under both total lockdown and partial lockdown conditions. To ensure the comparability of the groups, we performed a chi-square analysis on the distribution of subjects across different categories (e.g., education, household income, etc.). Except for geographical location, no significant differences were found in the distribution of participants between the total lockdown and partial lockdown groups. This indicates that the two groups are largely comparable, and any observed differences in PA can be attributed more confidently to the effects of the lockdown conditions rather than demographic discrepancies. A p -value of ≤ 0.05 was considered statistically significant.

Ethics Statement

All protocols involving human subjects in this study complied with the ethical guidelines of the institutional and national research committees, consistent with the 1964 Declaration of Helsinki and its subsequent amendments. Informed consent was obtained from all engaged participants. The study received approval from the Ethics Committees of Universidad de Santiago de Chile (protocol code 122/2020, approval date: 20 April 2020) and Universidad de los Andes (protocol code CEC202036, approval date: 30 April 2020).

Table 1 Participant characteristics

Characteristics	All (n=493)	Partial lockdown (n=164)		Total lockdown (n=329)	
		Male	Female	Male	Female
Age (y)	24.97 ± 5.27*	26.36 ± 5.51*	23.60 ± 4.00*	25.27 ± 5.10*	25.35 ± 5.82*
Body mass index (kg/m ²)	24.26 ± 3.82*	25.95 ± 3.93*	24.17 ± 4.13*	24.44 ± 3.15*	23.89 ± 3.88*
Total	493 (100)	40 (8.1)	124 (25.2)	117 (23.7)	212 (43.0)
Education					
Primary	44 (8.9)	4 (0.8)	16 (3.2)	13 (2.6)	11 (2.2)
Secondary	386 (78.3)	27 (5.5)	102 (20.7)	86 (17.4)	171 (34.7)
Tertiary	63 (12.8)	9 (1.8)	6 (1.2)	18 (3.6)	30 (6.1)
Age (y)					
18-24	300 (60.8)	20 (4.1)	90 (18.2)	62 (12.6)	128 (26.0)
24-34	160 (32.4)	16 (3.2)	30 (6.1)	48 (9.7)	66 (13.4)
35-44	33 (6.7)	4 (0.8)	4 (0.8)	7 (1.4)	18 (3.6)
Area of residence					
North	75 (15.2)		13 (2.6)		62 (12.6)
Center	292 (59.2)		89 (18.0)		203 (41.2)
South	126 (25.6)		62 (12.6)		64 (13.0)
Household per capita income quintiles					
Q1	49 (9.9)		24 (4.9)		25 (5.1)
Q2	91 (18.5)		30 (6.1)		61 (12.4)
Q3	53 (10.7)		15 (3.0)		38 (7.7)
Q4	99 (20.1)		37 (7.5)		62 (12.6)
Q5	201 (40.8)		58 (11.8)		143 (29.0)
Household area (m ²)					
< 40	19 (3.8)		6 (1.2)		13 (2.6)
40-59	51 (10.3)		17 (3.4)		34 (6.9)
60-99	126 (25.6)		34 (6.9)		92 (18.7)
100-149	142 (28.8)		53 (10.7)		89 (18.0)
≥ 150	155 (31.4)		54 (10.9)		101 (20.5)

Values are presented as mean ± standard deviation or number (%).

* $p < 0.05$.

RESULTS

Table 1 presents the characteristics of the 493 participants included in the study. The mean age was 24.97 ± 5.27 years, and the mean body mass index (BMI) was 24.26 ± 3.82 kg/m². Characteristics are further detailed by lockdown type (partial or total) and sex. During partial lockdown, males had a mean age of 26.36 ± 5.51 years and a mean BMI of 25.95 ± 3.93 kg/m², while females had a mean age of 23.60 ± 4.00 years and a mean BMI of 24.17 ± 4.13 kg/m². During total lockdown, males had a mean age of 25.27 ± 5.10 years and a mean BMI of 24.44 ± 3.15 kg/m², whereas females exhibited a mean age of 25.35 ± 5.82 years and a mean BMI of 23.89 ± 3.88 kg/m².

The majority of participants (78.3%) had secondary educa-

tion, followed by tertiary (12.8%) and primary education (8.9%). Sixty-one percent of the participants were aged between 18-24 years. Most resided in the central area (59.2%), followed by the south (25.6%) and the north (15.2%) of Chile. Participants predominantly belonged to the highest household per capita income quintile (Q5, 40.8%), with 31.4% living in homes of 150 m² or larger. Statistically significant differences ($p < 0.05$) in age and BMI were observed across the groups.

Table 2 outlines differences in PA and ST during partial and total lockdowns, as reported by participants according to sex. Data are presented as mean ± SD for each activity type. The Kruskal-Wallis test was initially used to compare baseline values across the six groups, followed by Dunn's test for post hoc comparisons where significant differences were detected. For

Table 2. Physical activity and sitting time during total and partial lockdown reported by participants according to sex¹

Variables	Partial lockdown	Total lockdown	ES	Differences between groups
	$\bar{x} \pm SD$	$\bar{x} \pm SD$	Hedges' <i>g</i>	<i>p</i> -value ²
All				
GPAQ physical activity (MET-min/wk)				
Total physical activities	3153 ± 2443	3125 ± 2416	-0.01	NS
Moderate activities	1121 ± 1339	837 ± 1043	-0.24	<0.05
Vigorous activities	1502 ± 1626	1746 ± 1819	0.13	NS
Transport activities	531 ± 800	541 ± 771	0.01	NS
GPAQ sedentary behavior (min/day)				
Sitting time	368 ± 186	395 ± 175	0.15	NS
Male				
GPAQ physical activity (MET-min/wk)				
Total physical activities	3278 ± 2469*	3674 ± 2475*	0.16	NS
Moderate activities	913 ± 984	912 ± 1140	-0.00	NS
Vigorous activities	1871 ± 1899*	2115 ± 1963*	0.12	NS
Transport activities	493 ± 748	646 ± 807	0.19	NS
GPAQ sedentary behavior (min/day)				
Sitting time	382 ± 213	376 ± 192	-0.02	NS
Female				
GPAQ physical activity (MET-min/wk)				
Total physical activities	3113 ± 2443*	2821 ± 2333*	-0.12	NS
Moderate activities	1187 ± 1432	795 ± 985	-0.33	<0.05
Vigorous activities	1383 ± 1518*	1542 ± 1705*	0.09	NS
Transport activities	543 ± 819	483 ± 746	-0.07	NS
GPAQ sedentary behavior (min/day)				
Sitting time	363 ± 177	391 ± 190	0.14	NS

SD, standard deviation; ES, effect size; GPAQ, Global Physical Activity Questionnaire; MET, metabolic equivalent of task; NS, not significant.

¹Statistical analysis was performed using the Kruskal-Wallis test for the six groups.

²Using Dunn's test.

**p* < 0.05.

all participants, total PAs showed similar levels between partial (3153 ± 2443 MET-min/wk) and total lockdown (3125 ± 2416 MET-min/wk). However, moderate activities were significantly lower during total lockdown (837 ± 1043 MET-min/wk) compared to partial lockdown (1121 ± 1339 MET-min/wk), with a small effect size (-0.24). Both vigorous and transport activities remained similar across conditions. On the other hand, ST was slightly lower in partial lockdown (368 ± 186 min/day) compared to total lockdown (395 ± 175 min/day), but this difference was not statistically significant.

Among male participants, total PAs during total lockdown (3674 ± 2475 MET-min/wk) compared to partial lockdown (3278 ± 2469 MET-min/wk) were not statistically significant. Moderate, vigorous, and transport activities remained similar across lockdown conditions, with no significant differences found. For female participants, total PAs were significantly lower

during total lockdown (2821 ± 2333 MET-min/wk) compared to partial lockdown (3113 ± 2443 MET-min/wk) with a small effect size (-0.12). Moderate activities were also lower during total lockdown (795 ± 985 MET-min/wk) compared to partial lockdown (1187 ± 1432 MET-min/wk), with a medium effect size (-0.33). Vigorous and transport activities remained similar across lockdown conditions. ST did not show significant differences between partial lockdown (363 ± 177 min/day) and total lockdown (391 ± 190 min/day).

Table 2 also shows total and vigorous PAs during total and partial lockdowns, reported by participants according to sex, as measured in MET-min/wk. The data suggest that for total PAs during the total lockdown, activity levels were lower in females (2821 ± 2333 MET-min/wk) compared to males (3674 ± 2475 MET-min/wk). This difference was statistically significant (*p* < 0.05) according to Dunn's test, indicating a notable sex

Table 3. Relationship between age, BMI, sitting time, income, household area, and sex with moderate physical activity, and regression analysis for predicting moderate physical activity during partial and total lockdown

Variables ¹	<i>r</i>	<i>p</i> -value ²	95% CI		B	SD	β	<i>p</i> -value ³
			LL	UL				
Partial lockdown								
Moderate physical activity	-	-	-	-	1122.68	834.05	-	0.180
Age	0.082	0.297	-0.076	0.236	4.07	25.67	0.03	0.874
BMI	-0.002	0.977	-0.159	0.155	32.46	27.13	0.29	0.233
Sitting time	-0.192	0.014	-0.339	-0.034	-0.97	0.58	-0.01	0.098
Income	0.090	0.250	-0.068	0.244	41.87	39.77	0.35	0.294
Household area	-0.023	0.768	-0.180	0.135	-3.93	2.75	-0.03	0.156
Sex	-0.028	0.718	-0.185	0.129	-342.45	252.98	-3.15	0.178
Total lockdown								
Moderate physical activity	-	-	-	-	152.75	485.25	-	0.025 ²
Age	0.057	0.306	-0.055	0.166	0.36	11.12	0.01	0.975
BMI	-0.037	0.509	-0.147	0.075	18.88	16.30	0.32	0.248
Sitting time	-0.131	0.018	-0.238	-0.019	-0.81	0.33	-0.01	0.013
Income	0.075	0.175	-0.036	0.184	1.17	23.09	0.02	0.960
Household area	0.173	0.002	0.063	0.279	3.94	1.50	0.06	0.009
Sex	0.047	0.391	-0.064	0.158	116.98	119.42	2.05	0.328

BMI, body mass index; *r*, Spearman correlation coefficient; CI, confidence interval; LL, lower limit; UL, upper limit; B, unstandardized regression coefficient; SD, standard deviation; β , standardized regression coefficient (beta).

¹Dependent variable: moderate physical activity partial and total lockdown levels are adjusted $R^2=0.013$ and adjusted $R^2=0.03$, respectively.

²Using Spearman's correlation test.

³Using analysis of variance.

disparity in response to total lockdown conditions for this variable.

In vigorous PAs, males exhibited a higher value during total lockdown (2115 ± 1963 MET-min/wk) compared to females during partial lockdown (1871 ± 1899 MET-min/wk), which was statistically significant ($p < 0.05$). No other differences were observed between the groups.

During partial lockdown conditions, the correlation between MPA and various demographic and behavioral variables from Table 3 shows mostly non-significant results. Age and BMI have negligible correlations with PA, indicated by their respective correlation coefficients and high *p*-values (age: $r=0.082$, $p=0.297$; BMI: $r=-0.002$, $p=0.977$). ST is the only variable that exhibits a statistically significant negative correlation with MPA ($r=-0.192$, $p=0.014$), suggesting that more time spent sitting is associated with less MPA. Income, household area, and sex, however, do not show significant associations with MPA levels during this period.

In the total lockdown scenario, as depicted in Table 3, the patterns change slightly. Individuals with smaller household areas engaged in less MPA, as indicated by a significant positive correlation between household area and MPA ($r=0.173$,

$p=0.002$). ST retains a significant negative correlation, though it is less strong than in partial lockdown ($r=-0.131$, $p=0.018$). Age, BMI, income, and sex continue to show no significant correlation with MPA levels during total lockdown.

Table 3 also presents a regression analysis summarizing how different variables predict MPA during both partial and total lockdowns, with the adjusted R^2 values being 0.013 and 0.030, respectively. This analysis, in conjunction with the correlations observed in Table 3, offers a nuanced view of factors influencing PA levels. During the partial lockdown, none of the variables such as age, BMI, income, household area, or sex demonstrated a statistically significant impact on MPA. ST, although not statistically significant ($p=0.098$), negatively influenced MPA ($\beta=-0.01$), aligning with the findings shown in Table 3 where a similar negative correlation with activity levels was observed.

In contrast, during the total lockdown, while age, BMI, income, and sex still show no significant effects, household area emerges as a significant predictor ($p=0.009$, $\beta=0.06$). This demonstrates that individuals with larger household areas engage in more MPA, while those with smaller household areas engage in less. Additionally, ST again shows a significant

negative impact on MPA ($p=0.013$, $\beta=-0.01$), emphasizing its consistent influence on PA across different lockdown conditions.

DISCUSSION

This study highlights significant variations in PA under different lockdown conditions, emphasizing how varying levels of restrictions affect individual health behaviors. While ST did not significantly differ between partial and total lockdowns, the decrease in MPAs during stricter lockdowns is concerning, as it may pose health risks even without increased sedentary behavior. This discussion explores the implications of these findings and strategies to mitigate reduced PA during extended lockdowns.

Differences in age and BMI across groups highlight the study population's heterogeneity, which may influence PA behaviors during lockdown. Age and BMI are known to affect activity levels [24,25]. However, the variability in these factors across the groups might reflect genuine population diversity rather than sampling errors, providing valuable insights into how different subgroups respond to lockdown measures.

Global trends show decreased PA and increased sedentary time during the COVID-19 pandemic [3,6,26-28]. Although our study lacks direct pre-pandemic data, we can infer the pandemic's impact by comparing our findings with pre-pandemic levels in similar populations in Chile [29-31].

Compared to previous findings, our study reports lower levels of total PA during both partial and total lockdowns. Specifically, Díaz-Martínez et al. [29] reported average PA levels of 150.9 ± 170.4 MET-hr/wk for male and 95.2 ± 117.5 MET-hr/wk for female, based on data from the Chilean National Health Survey 2009-2010. When converted to MET-min/wk (150.9 MET-hr/wk $\times 60 = 9054$ MET-min/wk for male and 95.2 MET-hr/wk $\times 60 = 5712$ MET-min/wk for female), these values are substantially higher than those observed in our study (3153 ± 2443 MET-min/wk for partial lockdown and 3125 ± 2416 MET-min/wk for total lockdown). This discrepancy suggests that the restrictions imposed by lockdowns lead to a decrease in the levels of total PA in the Chilean population compared to before the pandemic, aligning with reports from several studies, both in Chile and globally. Díaz-Martínez et al. [29] also reported an average daily ST of 3.72 hours for male and 3.38 hours for female. In comparison, our findings indicate an average ST closer to 6.4 hr/day during lockdowns, meaning participants in

our study spent more time in sedentary behavior compared to historical data. In our study, this represents approximately 72% and 85% greater ST for male and female, respectively, compared to pre-pandemic levels, consistent with multiple other studies. Similar data are reported by Concha-Cisternas et al. [32]. During the pandemic, Sadarangani et al. [26] reported similar MPA and vigorous PA levels to those in our study but noted higher STs, possibly due to an older population.

When comparing PA and ST between subjects in partial lockdown versus total lockdown, we observed lower MPA during total lockdown, especially in females. These findings suggest different lockdown types generate significant effects on activity levels depending on sex, with no differences in ST. Similar results were reported by Parada-Flores et al. [9], who also observed lower MPA during total lockdown compared to partial lockdown, despite using a different measurement tool.

Previous studies found that males were less affected than females during the lockdown period. Factors such as lower pre-existing social support for PAs, increased time demands from simultaneously managing work and household chores, and a rise in mental health issues related to social isolation could have contributed to this [33]. Nienhuis et al. [34] reported that females were significantly less physically active than males and experienced significantly more generalized anxiety than males in the context of COVID-19. These findings are similar to those found by us (Table 2). The observed sex differences in PA levels during lockdowns can be explained by several socio-demographic factors that disproportionately affect female in the Chilean context. Previous research has shown that females are more likely to face barriers to engaging in PA, such as increased household responsibilities, caregiving duties, and limited access to outdoor spaces [35,36]. These challenges were exacerbated during the COVID-19 lockdowns, where restricted movement further limited female's opportunities for PA [37]. Moreover, cultural expectations in Latin America often position female in caregiving roles, reducing the time available for leisure and exercise. These findings suggest that sex-sensitive public health interventions are necessary to promote PA among female, particularly in urban areas with limited access to safe outdoor spaces.

Correlation analysis reveals that during partial lockdown, there is a negative correlation between ST and MPA ($r=-0.192$, $p=0.014$), suggesting increased sedentary behavior is associated with decreased PA. In total lockdown, household area positively correlates with MPA ($r=0.173$, $p=0.002$), indicating that

individuals with larger living spaces engage in more moderate activity. This correlation persists, although weaker, highlighting the consistent impact of sedentary behavior on activity levels across different lockdowns (Table 3).

The non-significant correlations with age, BMI, income, and sex in both lockdown conditions suggest these factors might not be crucial in determining moderate activity levels during restricted periods. Interventions to increase PA during lockdowns should focus on environmental factors, like available space, and reducing ST, rather than on demographic characteristics.

In a review, Mansoubi et al. [38] showed that the associations between sedentary behavior and PA are generally weak to moderate. Studies utilizing objective monitoring have revealed stronger negative correlations specifically between sedentary behavior and light intensity activities. Although the evidence is still limited, it supports the notion that engaging in sedentary behavior tends to displace light intensity activities. Epidemiological research corroborates this, indicating that individuals with higher sedentary time generally exhibit lower PA levels [39]. This relationship is clinically significant, as increased sedentary behavior is associated with heightened risks of health issues like cardiovascular disease, obesity, and type 2 diabetes, which can be mitigated through more active lifestyles [40].

The regression analysis provides insights into the determinants of MPA during both partial lockdown and total lockdown conditions, emphasizing household area and sedentary behavior rather than demographic factors (Table 3).

During partial lockdowns, although not statistically significant, ST tended to negatively affect MPA ($\beta = -0.01$). In total lockdowns, household area emerged as a significant predictor of moderate activity ($p = 0.009$, $\beta = 0.06$), indicating that larger living spaces facilitate more MPA. Conversely, smaller living areas may challenge maintaining an active lifestyle under strict lockdown measures. The persistent negative impact of ST on moderate activity ($p = 0.013$, $\beta = -0.01$) across both lockdown scenarios further emphasizes the need for strategies to reduce sedentary time, particularly considering the physical environment, such as the size of the living area.

While this study provides valuable insights into the effects of lockdown on PA and sedentary behavior, it is important to note that the findings are based on a convenience sample primarily composed of university students and their relatives. Therefore, caution should be taken when generalizing these results to the broader population. The sample reflects specific demographic and socioeconomic characteristics, which may

not be representative of other groups, and this could influence the observed outcomes.

The consistent negative impact of sedentary behavior on MPA across different lockdown scenarios underscores the need for effective public health strategies during movement restrictions. Given the role of household area in facilitating PA, urban planning and housing policies should ensure that even smaller living spaces are designed to encourage PA. This could include multi-functional furniture or dedicated exercise zones within homes adaptable for use by individuals and families. Public health initiatives could promote indoor exercise programs tailored for small spaces, like online fitness classes, virtual reality exercise games, and app-based workouts that encourage movement. Education campaigns emphasizing regular movement breaks can help maintain physical health during extended periods of home confinement.

In conclusion, reduced PA levels during total lockdown are significantly influenced by household area, with smaller spaces associated with markedly lower levels of moderate activity. This emphasizes the impact of limited living areas on maintaining PA during stringent lockdowns. The data also show a significant decrease in both total PA and MPA, particularly affecting females more than males. While demographic factors like age, BMI, income, and sex do not significantly affect activity levels, sedentary behavior consistently correlates negatively with activity across different lockdown scenarios. These insights underscore the need for strategies that promote PA and reduce sedentary time, particularly in environments with restricted space, to preserve health during prolonged lockdowns. Household size has emerged as a key factor in this study. Future research should adopt an ecological approach that takes into account not only the household and work environments but also transportation settings and the broader built environment. Such an approach would provide a more comprehensive understanding of the factors that influence PA, inactivity, and sedentary behavior.

This study has several limitations that should be considered when interpreting the findings. First, the sampling method was not random, which may limit the generalizability of the results. Participants were recruited through social media and university networks, which does not necessarily represent all university students in Chile, nor the broader population aged between 18 years and 44 years. Additionally, the use of the GPAQ to assess PA levels and sedentary time poses another limitation. While the GPAQ is a widely used tool, it has been

shown to overestimate PA levels and underestimate sedentary time. These factors suggest that the results should be approached with caution, as they may not fully reflect the true behaviors of the wider Chilean population within this age group.

Another limitation of this study is the potential bias introduced by recruiting participants from the same household. Although shared characteristics, such as income level and household area, may have influenced group-level analyses, it is unlikely that these factors had a significant impact on the overall results. However, this should still be considered when interpreting the findings.

NOTES

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

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