

# The Influence of Family Adversities on Longitudinal Changes in Physical Inactivity Among Korean Adolescents During the COVID-19 Pandemic

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**Objectives:** Lack of physical activity has a critical effect on the physical and mental health of adolescents. This study examined the influence of family adversities on the longitudinal changes in physical inactivity among adolescents during the coronavirus disease 2019 (COVID-19) pandemic.

**Methods:** The study used multi-wave data from the Korean Children and Youth Panel Survey, including 2590 Korean adolescents aged 12-14 years. The longitudinal trajectory of physical inactivity among adolescents and the effects of related factors were estimated using a latent growth modeling method.

**Results:** Our results revealed a significant increase in physical inactivity among adolescents over time. At the onset of the pandemic, approximately one-seventh of Korean middle schoolers reported a lack of physical activity. However, 3 years later, during the quarantine, nearly one-fifth of these adolescents reported a significant increase in their physical inactivity. Initially, low level parental education was predictive of adolescents' physical inactivity, but this effect diminished over time, becoming statistically insignificant by the end of the 3-year period. Moreover, the increase in physical inactivity over the 3 years was significantly influenced by parental rejection.

**Conclusions:** These findings suggest that adolescents who experience parental rejection are more likely to report an increase in sedentary behaviors in contexts such as the COVID-19 pandemic.

**Key words:** Sedentary behavior, Longitudinal studies, Socioeconomic disadvantage, Parent-child relations, Adolescents, COVID-19

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## INTRODUCTION

Spread of the coronavirus disease 2019 (COVID-19) virus has slowed, and the emergency phase recently ended. It has been consistently reported that physical activity decreased, while sedentary activities such as internet use and TV watching increased among adolescents and younger populations across countries during the COVID-19 pandemic [1,2]. Physical inactivity among adolescents can be defined as the absence of engagement in physical activities, such as running or walking for exercise, for approximately 1 month [3]. In early adolescence,

it is especially important to maintain a balanced combination of exercise and nutrition for optimal physical development [4]. In recent years, the low level of physical activity among adolescents has been a concern for parents, educators, and health-care workers in Korea [2,5].

Adolescents who were previously physically active faced restrictions that limited exercising during the quarantine period of the pandemic [1]; thus, the level of physical activity at a single point in time may not accurately predict ongoing health risks later. Previous research on Korean adolescents found longitudinal increases in physical inactivity and lower exercise levels during the COVID-19 pandemic compared to the pre-pandemic period [5,6]. However, while the issue of adolescents' increased physical inactivity during the quarantine is well-documented, the influence of family environments on this increase has not been fully investigated.

It is important to note that adverse family variables can contribute to negative health outcomes in adolescents, including obesity and poor health conditions. Numerous studies have identified several socioeconomic variables, such as family income [7,8], parental education [7,8], residential environments [8], and marital status [9], as risk or protective indicators for adolescents' physical inactivity in their daily lives. For instance, adolescents from families with low socioeconomic status (SES) often face limitations in accessing sports or fitness clubs [10]. In addition, their families may lack insurance coverage and sufficient information on healthcare compared to families with high SES [9]. In other words, adolescents from low SES families were likely to experience environmental and financial barriers that restricted their active participation in physical activity, even prior to the pandemic.

Moreover, parents play a crucial role in monitoring their children's daily routines, including their eating habits, sleep patterns, exercise levels, and internet usage [11]. Given that most early adolescents in Korea live with their parents, the sedentary behaviors of adolescents are more likely to increase if parents overlook their children's sluggish lifestyles at home and fail to encourage physical exercise. Research has indicated that adolescents with uninvolved parents tend to report lower levels of physical activity than those with supportive parents [12]. However, the COVID-19 pandemic was an unprecedented and stressful crisis for both adolescents and their parents [13]. It raised the question of whether the effects of parental rejection and lack of parental involvement during the pandemic were similar to those observed before the outbreak of the vi-

rus. Therefore, we aimed to determine the extent to which parental rejection, as well as socioeconomic adversities, influenced changes in adolescents' physical inactivity during the pandemic.

In summary, this study investigated the longitudinal changes in physical inactivity among adolescents over a 3-year period, encompassing both the pre-pandemic phase and the quarantine period of the COVID-19 pandemic. Specifically, we employed latent growth modeling to assess and visualize the trajectory over the 3-year period. Subsequently, we examined the effects of various socioeconomic adversities and parental rejection on the trajectories of adolescents' physical inactivity. The hypothesized model is illustrated in Supplemental Material 1.

## METHODS

### Data Descriptions

This study used multi-wave data from the Korean Children and Youth Panel Survey (KCYPs), a longitudinal cohort study conducted by the National Youth Policy Institute. The initial cohort was selected using a multistage stratified cluster sampling process from 17 metropolitan cities and provinces. The survey was administered to adolescents and parents using the Tablet Assisted Personal Interview method. The KCYPs provided multidimensional data on the biological, psychological, and socioeconomic characteristics of the adolescents and their parents.

The study sample consisted of 2590 adolescents aged 12 years to 14 years who provided valid measurements of physical inactivity and family characteristics in 2018 (wave 1). Follow-up measurements were collected in 2019 (wave 2) and 2020 (wave 3), which coincided with the implementation of a nationwide quarantine. More information about the participants can be found in Table 1.

### Measures

#### *Physical inactivity*

In this study, participants were asked to report the number of hours they worked out until they started sweating, outside of schoolwork or daily life, such as running and walking, in 2018 (wave 1), 2019 (wave 2), and 2020 (wave 3). Physical activity was defined as undertaken for the purpose of exercise. This information was used to create a binary indicator for physical inactivity. A value of 1 was assigned to respondents

**Table 1.** Demographic information of the study participants (n=2590)

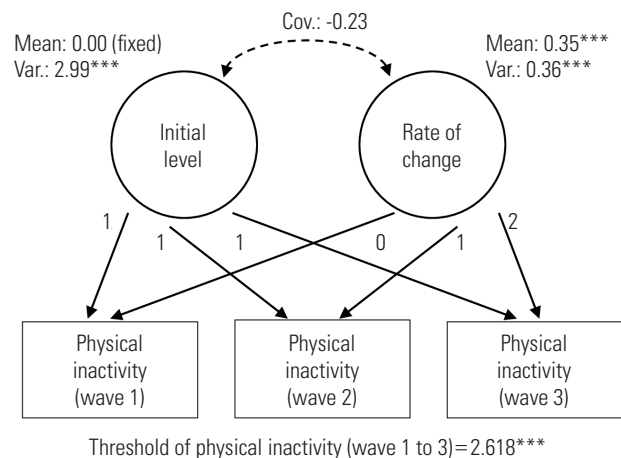
Variables	%
<b>Adolescents</b>	
Female	42.7
Age, mean ± SD [Min-Max] (y)	12.99 ± 0.12 [12.00-14.00]
<b>Parents</b>	
Relationship with adolescent	
Mother	88.0
Father	10.8
Education level (college or above)	
Mother	60.3
Father	64.3
Marital status	
Two parents	90.5
Single parents	8.8
Others	0.7
Family's monthly income (Korean won)	
≤ 1 999 999	6.1
2 000 000-2 999 999	8.6
3 000 000-3 999 999	16.5
4 000 000-4 999 999	20.7
5 000 000-5 999 999	18.6
6 000 000-6 999 999	10.0
≥ 7 000 000	19.5
Not provided	0.1

SD, standard deviation; Min, minimum; Max, maximum.

who reported no engagement in physical activities, while those who reported engaging in physical activity for more than 1 hour received a code of 0 to indicate their involvement in exercise.

### Socioeconomic adversities

Socioeconomic adversities in this study were measured by 3 main components: (1) parents with a low income, (2) parents with a low education level, and (3) single-parent households. Parents with a monthly household income below 50% of the median income in Korea (equivalent to 2 306 768 Korean won) in 2018 (wave 1) were coded as 1, indicating parents with a low income. Parents with a monthly household income above this threshold were coded as 0. Parental education level scores were calculated by considering the education levels of both fathers and mothers. A code of 1 was assigned if either parent had a high school diploma or lower education (i.e., a low education level). Parents who had education levels higher than high school were assigned a code of 0. Finally, parents who



**Figure 1.** Linear changes in physical inactivity among Korean adolescents during the coronavirus disease 2019 pandemic (categorical latent growth models). Unstandardized logistic coefficients are shown. Var., variance; Cov., covariance. The dotted double-headed arrow represents a non-significant path. \*\*\* $p < 0.001$ .

were single, widowed, divorced, or separated were coded as 1 to indicate single parenthood, while parents who were married were assigned a code of 0.

### Parental rejection

Parental rejection was assessed in 2018 (wave 1) using the Korean version of the Parents as Social Context Questionnaire for Korean Adolescents [14]. Adolescents completed a 24-item questionnaire using a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). In this study, parental rejection was defined as the opposite of parental warmth along the parenting behaviors spectrum. Therefore, scores for parental rejection were derived by summing the reverse-coded items of parental warmth, such as “My parents let me know they love me.” Cronbach’s alpha for the questionnaire was 0.85 in the current sample.

### Statistical Analysis

A linear latent growth model (LGM) was used to examine the longitudinal trajectories of physical inactivity in adolescents during the pandemic. The model included latent variables representing the initial level and the rate of change across the 3 time points, as depicted by the 2 circles in Figure 1. Since physical inactivity was measured as a binary variable, the logit link function was used [15]. Socioeconomic adversities and parental rejection, measured in wave 1, were included as predictors in the LGM. Effect sizes were reported as odds ratios

**Table 2.** Correlations, means, and standard deviations (SDs) among variables (n=2590)<sup>1</sup>

Variables	1	2	3	4	5	6	7	8
1. Physical inactivity (wave 1)	-							
2. Physical inactivity (wave 2)	0.26***	-						
3. Physical inactivity (wave 3)	0.20**	0.28***	-					
4. Female <sup>2</sup>	0.19***	0.22***	0.19***	-				
5. Low-income parents (wave 1)	0.07**	0.02	0.00	0.03	-			
6. Low parental education (wave 1)	0.03	0.09***	0.05*	-0.02	0.18***	-		
7. Single parent (wave 1)	0.03	0.02	0.05*	0.00	0.42***	0.09***	-	
8. Parental rejection (wave 1)	0.06	0.06	0.08***	-0.04	0.04	0.06**	0.08***	-
Mean ± SD or %	13.8	18.3	21.9	42.7	11.9	20.5	9.4	1.73 ± 0.55

<sup>1</sup>Point-biserial correlations were estimated when categorical variables were used; Multiwave data are from the Korean Children and Youth Panel Survey: wave 1 in 2018, wave 2 in 2019, wave 3 in 2020.

<sup>2</sup>Adolescent's sex.

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

(OR). All estimated effects were adjusted to control for sex.

The average rate of missing data among the 3 repeated measures of physical inactivity was 4.6%, ranging from 0.0% to 8.0%. Missing data were handled using Full Information Maximum Likelihood procedures. The analyses were conducted using Mplus version 8.0 (Muthen & Muthen, Los Angeles, CA, USA) and SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

### Ethics Statement

The study was exempted from human subject review by the Institutional Review Board of Sungkyunkwan University (IRB # SKKU-2022-08-029, 08/25/2022) because this study used completely anonymized data from the KCYPS for secondary data analysis.

## RESULTS

### Preliminary Analyses

The correlations and means (or proportions) of the study variables are displayed in Table 2. The proportions of adolescent physical inactivity increased from wave 1 to wave 3 (McNemar test  $p < 0.001$ ). In addition, low-level parental education in wave 1 had a positive correlation with adolescents' physical inactivity in waves 2 and 3. Similarly, parental rejection in wave 1 was positively correlated with physical inactivity in wave 3.

### Trajectories of Adolescents' Physical Inactivity

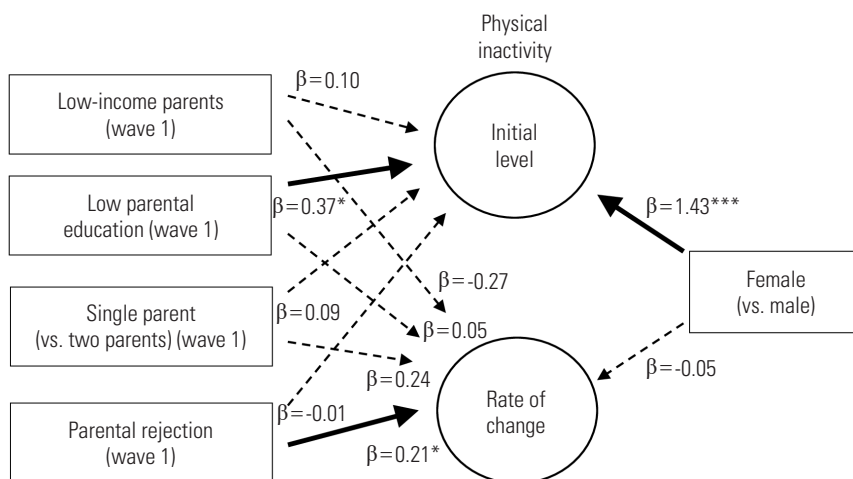
The results, as depicted in Figure 2, revealed that approximately 6.7% ( $100 \times 1/[1 + \exp 2.618]$ ) of the adolescents reported physical inactivity in wave 1. There was a 41.9% ( $100 \times [\exp 0.35] - 1$ ) increase in the odds of physical inactivity over a

1-year time change. This indicated that, on average, adolescents had a higher likelihood of being physically inactive throughout the pandemic. The results also reported significant variances in the initial levels and slopes (see  $p$ -values of the initial level and slope variances in Figure 1), suggesting that there were inter-individual differences in the intra-individual changes of physical inactivity among adolescents.

### Associations Between Socioeconomic Adversities, Parental Rejection, and the Trajectories of Adolescents' Physical Inactivity

The socioeconomic adversities and parental rejection were uniquely associated with the initial level and slope of adolescents' physical inactivity, as shown in Figure 2. A parental low education level was positively associated with the adolescents' initial level of physical inactivity ( $\beta = 0.37$ ,  $p < 0.05$ ; OR, 1.44; 95% confidence interval [CI], 0.03 to 0.71). However, there were no significant associations between the initial level and parents' low income ( $\beta = 0.10$ ,  $p = 0.67$ ; OR, 1.10; 95% CI, -0.39 to 0.61) or single-parent household ( $\beta = 0.09$ ,  $p = 0.81$ ; OR, 1.09; 95% CI, -0.67 to 0.86).

In particular, parental rejection did not show a significant association with the initial level ( $\beta = -0.01$ ,  $p = 0.97$ ; OR, 0.99; 95% CI, -0.25 to 0.25), but was positively associated with the slope (changes) of adolescents' physical inactivity ( $\beta = 0.21$ ,  $p < 0.05$ ; OR, 1.23; 95% CI, 0.04 to 0.37). Otherwise, none of the 3 socioeconomic adversities in this study showed a significant association with the slope (changes) of adolescents' physical inactivity: ( $\beta = -0.27$ ,  $p = 0.11$ ; OR, 0.76; 95% CI, -0.61 to 0.07) for low-income, ( $\beta = 0.05$ ,  $p = 0.64$ ; OR, 1.05; 95% CI, -0.17 to 0.27) for low education, and ( $\beta = 0.24$ ,  $p = 0.33$ ; OR, 1.27; 95%



**Figure 2.** Influence of socioeconomic adversities and parental rejection on physical inactivity among Korean adolescents during the coronavirus disease 2019 pandemic.  $\beta$ , logistic coefficients. Dotted paths represent non-significant paths. \* $p < 0.05$ , \*\*\* $p < 0.001$ .

CI, -0.25 to 0.74) for single-parent household. In terms of sex (control) effect, females had a higher initial level of physical inactivity than males ( $\beta = 1.43$ ,  $p < 0.001$ ; OR, 4.17; 95% CI, 1.14 to 1.73). However, there were no significant differences between the slopes for females and males ( $\beta = -0.05$ ,  $p = 0.61$ ; OR, 0.95; 95% CI, -0.24 to 0.14).

## DISCUSSION

The aim of the present study was to examine the change in adolescents' physical inactivity over a 3-year period that included the COVID-19 pandemic and to explore the impact of socioeconomic adversities and parental rejection on these changes. By analyzing panel data from Korean middle school adolescents and their parents using the LGM, this study contributed to the existing literature on family health concerns by providing additional evidence of a longitudinal increase in sedentary behaviors among Korean adolescents. In particular, it highlighted the impact of parental rejection on this increase during the pandemic. These findings suggest the importance of addressing negative family environments to improve adolescents' physical activity during challenging times such as the pandemic.

First, this study found that approximately one-seventh of Korean adolescents in our analysis reported a lack of physical activity in the initial wave. Subsequently, we observed trajectories of increasing physical inactivity among these adolescents over 3 years. By wave 3, nearly one-fifth of these adolescents reported a significant increase in physical inactivity. These

findings indicate a notable decrease in the number of adolescents engaging in regular exercise or physical activities after the onset of the quarantine period during the COVID-19 pandemic.

Consistent with previous research that documented increases in sedentary behaviors and decreases in physical activity among Korean adolescents during the pandemic [2,5], our results suggest that adolescents faced challenges in maintaining their usual level of physical activity during this period due to restricted mobility and limited access to outdoor activities. It is important to note that the World Health Organization recommends adolescents engage in at least 1 hour of intense physical exercise per day, including muscle training several times a week [16]. An unhealthy lifestyle during early adolescence can have long-term implications for future health [17]. Therefore, it is necessary to promote and increase healthy levels of physical activity regardless of daily circumstances or the presence of a pandemic. One potential way to address this issue would be the promotion of online exercise classes, where adolescents can watch at home and follow along [18]. This alternative allows adolescents to participate in physical activity in isolated environments.

However, use caution when interpreting these findings. The increased physical inactivity found among Korean adolescents should not be attributed solely to the physical restrictions in place during the COVID-19 pandemic. Physical inactivity can be a challenge during early adolescence, with reports suggesting a decline in physical activity, especially among girls [19]. Therefore, the observed increase in physical inactivity among

adolescents in this study was likely influenced by a combination of existing developmental factors and the additive impact of the pandemic-related restrictions. Further studies should consider exploring the interplay between developmental factors, contextual factors, and the effects of the pandemic.

Second, our study revealed a significant association between parental rejection and the increase in physical inactivity among adolescents during the COVID-19 pandemic. Adolescents who experienced parental rejection showed a greater increase in physical inactivity than those who had not experienced such rejection. This finding partially aligns with previous research, which found that uninvolved parenting and a lack of parental concern for their children were linked to health outcomes such as sedentary behaviors among adolescents [20-22]. Importantly, our study goes beyond the existing literature by suggesting that the impact of parental rejection on adolescents' physical inactivity intensifies over time, particularly in the context of a global health crisis.

During the quarantine period of the pandemic, the extended amount of time that children and adolescents spent at home with their parents raised concerns about family stress and potential abuse [23]. For Korean middle school adolescents, who typically live with their parents, the prolonged period of cohabitation during the pandemic may have increased the likelihood of experiencing parental rejection at home. Because supportive parenting is a positive predictor for a child's physical activity level [12], parents who show levels of rejection toward their children are less likely to monitor their child's obesogenic behaviors. Therefore, it becomes crucial to provide support to parents in managing their stress and to help them maintain a supportive parent-child relationship that promotes the physical and psychological well-being of both parents and adolescents [24]. By fostering parental interest and involvement in the adolescents' health, we can mitigate the potential negative impact of the pandemic and promote overall family health.

Third, this study found that parents' education level had a significant influence on adolescents' physical inactivity before the pandemic, but was not a significant influence on the subsequent increase in physical inactivity during the pandemic. Previous research has indicated that parents with higher levels of education tend to allocate more time to engaging in physical exercise with their families [7,8]. They also maintain healthier dietary habits, which can help prevent obesity [25]. Parents with lower levels of education may have limited access to in-

formational resources for physical health and may be less likely to recognize the benefits of regular physical activity [26]. In other words, adolescents can learn and model physical activity patterns from their parents through social learning processes.

However, the lack of significance in this study suggests that the influence of low parental education on the adolescents' physical inactivity was more pronounced at the initial stage, but diminished over time, becoming statistically insignificant in the final stage of our data. This can be attributed to the presence of other adverse variables, such as parental rejection. The impact of parental rejection may overshadow the influence of parental education. Therefore, it is important to consider that circumstances created by the pandemic may have overridden the traditional association between parental education and adolescents' physical health.

Finally, the results of this study revealed that parents' low income status and single-parent households did not have a significant influence on adolescents' physical inactivity during the pandemic. These findings suggest that, at least during this specific period, these socioeconomic variables may not directly affect adolescents' physical inactivity. However, it must be acknowledged that socioeconomic factors can have indirect or long-term effects on health behaviors [27] that have not been captured in this study. It may be that only low correlations with socioeconomic adversities were found because SES is determined by a variety of combinations of multiple indicators. Future research needs to consider examining various socioeconomic adversities to gain a comprehensive understanding of the broader social determinants of adolescents' health during pandemic situations. This knowledge can inform the development of targeted interventions and policies aimed at addressing health disparities and promoting physical activity among adolescents facing both pandemic-related and socioeconomic challenges.

This study acknowledges several limitations. First, the observed changes in adolescents' physical inactivity were captured over a relatively short 3-year period. Real-time information such as the COVID-19 prevalence rate and health status in the adolescent's residential area was also missed. Therefore, long-term follow-up studies are needed to gain a deeper understanding of how the physical inactivity of adolescents changed during the different phases of the pandemic and during the endemic COVID-19 period [28]. As mentioned earlier, it is crucial to interpret our findings in the context of adolescent development. In addition, some of the research vari-

ables in this study were coded as binary indicators, which may introduce measurement error or an under estimation or overestimation of the true relationship between family adversity and the physical inactivity of adolescents during the pandemic.

In conclusion, this study provided insights into the association between family adversities, such as parental rejection and parents' low education level, and increased physical inactivity among adolescents during the COVID-19 pandemic in Korea. The findings suggest the important role of promoting positive parent-child relationships and addressing socioeconomic disadvantages, particularly in times of crisis. By prioritizing the involvement of parents and identifying the socioeconomic risks of families, we can work together to reduce the negative impact of restricted mobility and promote healthier lifestyles for adolescents, both during the pandemic and in the long term.

## NOTES

### Supplemental Materials

Supplemental material is available at <https://doi.org/10.3961/jpmp.24.236>.

### Conflict of Interest

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

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### Author Contributions

Conceptualization: Song H, Pak TY, Lee TK. Data curation: Lee TK, Kim YM. Formal analysis: Lee TK. Funding acquisition: None. Methodology: Lee TK, Kim YM, Pak TY, Song H. Project administration: Song H, Pak TY. Visualization: Zhu J, Jiang ZK, Zhang M, Choi WH. Writing – original draft: Song H, Lee TK, Pak TY. Writing – review & editing: Kim YM, Zhu J, Jiang ZK, Zhang M, Choi WH, Song H.

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