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Health-Related Quality of Life, Mental Health and Physical Activity in Iranian Students from Pandemic to Post-Pandemic: Intensification of Gender differences after Covid-19

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Abstract:

This study compared health-related quality of life (HRQOL)—including school, physical, emotional, and social functioning—body mass index (BMI), and physical activity (PA) levels among Iranian students (aged 6–18 years) during and after the COVID-19 pandemic, focusing on gender- and age-related differences. Two cross-sectional studies were conducted: the first (N = 1084) during the second year of the pandemic (post-Delta wave), and the second (N = 1602) in the post-pandemic period. Participants were selected using multistage cluster random sampling from urban and rural schools in Tehran Province. Data were collected online via standardized questionnaires, including the Pediatric Quality of Life Inventory (PedsQL) and the short form of the International Physical Activity Questionnaire (IPAQ-SF). In both studies, children reported higher HRQOL, BMI, and PA scores than adolescents, and boys outperformed girls across most HRQOL dimensions. These patterns remained consistent across both timepoints. Adolescent girls had the lowest scores in school, social functioning, and mental health. While gender differences in school performance diminished post-pandemic, mental health challenges among girls persisted.

During the COVID-19 crisis, age played a more decisive role in students' well-being, reflecting developmental sensitivity. In the post-pandemic period, gender became more influential, with long-term psychological and social impacts closely tied to gender differences. Gender disparities became more pronounced during adolescence, with adolescent girls consistently reporting the lowest HRQOL scores across domains.

These findings highlight the need for targeted, age- and gender-sensitive interventions to promote HRQOL, mental health and physical activity among at-risk youth populations.

***Keywords*:** BMI, Educational Wellbeing, HRQOL, Physical Health, School Functioning

Introduction:

The COVID-19 pandemic has profoundly affected individuals' lifestyles and health (Rawat et al., 2021) through intertwined psychological, social, and economic challenges (Yoosefi Lebni et al., 2021). Although children and adolescents exhibit the lowest physical susceptibility to COVID-19 (Tracker, 2022), the pandemic has profoundly affected their psychological and social well-being (Meherali et al., 2021) and health-related quality of life (HRQOL)(Ahn, 2022). HRQOL reflects individuals' perceptions of their health and life conditions shaped by cultural values, expectations, and priorities (Bonomi et al., 2000). and early-life behaviors during childhood and adolescence are known to influence future health risks (Neumark-Sztainer, 2006).

Studies indicated that life satisfaction in the present, current positive emotions, and positive emotions about future life (Wu et al., 2020) and wellbeing (Clarke, 2020) were positively associated with academic achievement. The experience of mandatory quarantine and the imposed social isolation—resulting from school closures, the suspension of recreational services, and restricted access to outdoor activities—posed significant pressures and challenges (Francisco et al., 2020). These disruptions have led to symptoms like anxiety, depression, sleep disturbances, cognitive impairments, and unhealthy lifestyle changes (Du et al., 2024; Ghosh et al., 2020). Hascher and Hagenauer (2011) described three distinct ways schools impact student wellbeing: first, through individual personality traits including students' emotional and cognitive readiness for learning; second, via the quality of teaching and social interactions within the classroom; and third, through the broader effects of the school system itself on students' wellbeing (Hascher & Hagenauer, 2011). Meanwhile, school closures and social quarantine during COVID, as well as changes in the education system and perspectives after the pandemic, can each directly and indirectly affect these factors.

In Iran, around 15 million students have been affected by school closures, which have disrupted education, daily routines, physical activity, social interactions, and mental well-being (Alizadeh et al., 2023; Chaturvedi et al., 2021; Ghosh et al., 2020). Additionally, the pandemic has widened the learning gap between low- and high-income families (Alizadeh et al., 2023; Tadesse & Muluye, 2020).

Understanding the trajectory of these effects over time is essential. While several studies have examined the immediate consequences of the pandemic on children's health and well-being conducted in the United States (McGuine et al., 2021), Croatia (Dragun et al., 2020), French (Bourion-Bédès et al., 2022) and Norway (Lehmann et al., 2023), fewer have explored whether these outcomes persisted, improved, or worsened after the return to normalcy. Some investigations in Switzerland (Roser et al., 2023), Germany (Ravens-Sieberer et al., 2022) and Spain (Vallejo-Slocker et al., 2020) compared HRQOL before, during or after the COVID-19 quarantine. A comparative approach that examines HRQOL during and after the pandemic offers valuable insights into the resilience and recovery patterns of different age and gender groups. These studies have revealed differences across age groups, gender disparities, functional limitations, emotional well-being, and social welfare among these populations (Orgilés et al., 2020; Ravens-Sieberer et al., 2022).

Given the limited research in both global and Iranian contexts, this study aims to compare the HRQOL, PA level, and BMI of different samples of Iranian students during and after the COVID-19 pandemic. By examining two distinct cross-sectional studies, the study seeks to identify patterns and disparities across time, age, and gender to inform future public health strategies.

Materials and Methods:

Study Design and Setting:

This research comprised two distinct cross-sectional studies. The first study was conducted during the COVID-19 pandemic, from October to December 2021, in the second year following the Delta wave. The second study was carried out from April to June 2023, nearing the official end of the pandemic. Both studies targeted students aged 6 to 18 years from Tehran province.

Participants:

A multi-stage cluster sampling method was used in both studies. The participant numbers were 1,084 students in the first study (356 children, 728 adolescents; 583 girls, 501 boys), and 1,602 students in the second study (709 children, 893 adolescents; 862 girls, 740 boys). All participants resided in Tehran Province, had parental consent, and were enrolled in school.

Research Instruments:

An online questionnaire was distributed to students via the Link school platform.

Individual Information Questionnaire: This collected demographic data such as age, gender, grade, height and weight.

Pediatric Quality of Life Questionnaire (PedsQL): Used to assess health-related quality of life (HRQOL), with 23 items. The parent-proxy version was used for elementary school students, and the self-report version for secondary school students. It includes scores for physical, emotional, social, and school functioning, along with composite scores for overall physical health, mental health and HRQOL. The physical functioning subscale constitutes the physical health score. International Physical Activity Questionnaire (IPAQ) – Short Form: This assesses the type and duration of physical activity performed, from which total metabolic equivalent (MET) values were calculated following the questionnaire's guidelines. The validity and reliability the Persian version of both questionnaires have been confirmed.

procedures:

To control social and economic variables, the study began by selecting educational zones in Tehran, including three districts within the city and five from suburban areas. In each area, one boy's and one girls' school from primary (first and second cycle), middle, and high school levels were chosen, totaling 64 schools. After obtaining the necessary permits, parental consent was acquired, and the study tools were introduced to participants via text and audio files. Questionnaires were distributed online. Parents filled out the forms for primary school students. For secondary school students, the students themselves completed the questionnaires.

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (2013), which emphasizes the protection of human dignity, the right to self-determination, and the prioritization of participants' well-being over scientific or societal interests. All participants were fully informed about the aims, procedures, potential risks, and their right to withdraw at any time without consequence. Written informed consent was obtained from all participants prior to their involvement in the study. Participant data were anonymized to ensure confidentiality.

Data Analysis:

Descriptive statistics (mean and standard deviation) were used to report demographic characteristics and research variables. A Two-Way Multivariate Analysis of Variance (Two-Way MANOVA) was conducted to examine the effects of gender (girls, boys) and age group

(children, adolescents) on multiple HRQOL dimensions, including physical, emotional, social, and school functioning. Since most of the data did not follow a normal distribution (Kolmogorov–Smirnov test), Bootstrapping with 100 resamples and the bias-corrected and accelerated (BCa) method was applied due to violations of multivariate normality assumptions. To address inconsistencies in the scales of MET and BMI compared to HRQOL, a Two-Way ANOVA was used with bootstrapping to handle normality violations. Data were analyzed using IBM SPSS Statistics version 27.

Findings:

In the first study, a total of 1,084 students participated, including 356 children (mean age = 10.55 ± 1.57 years) and 728 adolescents (mean age = 15.57 ± 1.68 years). Among them, 583 were girls and 501 were boys. In the second study, 1,602 participants were included, comprising 709 children (mean age = 10.13 ± 1.80 years) and 893 adolescents (mean age = 15.42 ± 1.71 years). Of these, 862 were girls and 740 were boys.

An initial step in the data analysis, descriptive statistics were calculated to summarize the characteristics of the study sample. To enhance the clarity of the findings and support interpretation, the descriptive data of research variable are also presented using bar charts (figure 1 and 2).

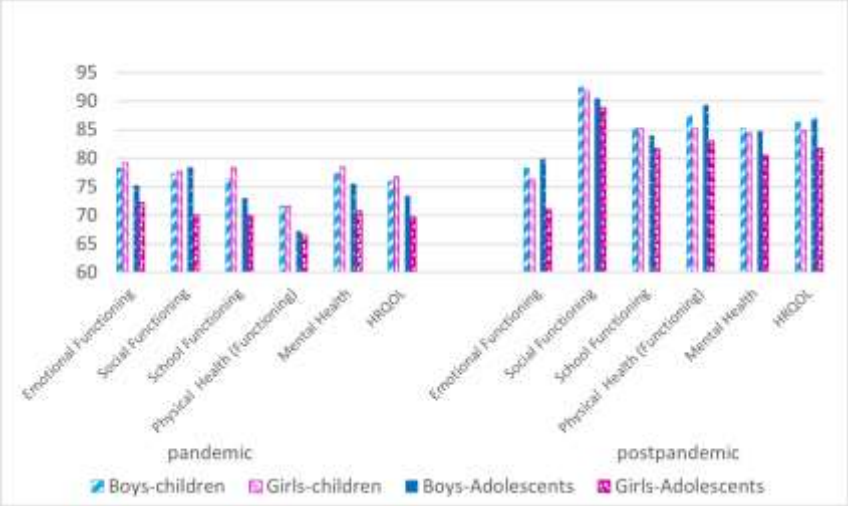

Figure 1- Health-Related Quality of Life (HRQOL) Dimensions by Age Group and Gender Across Two Studies

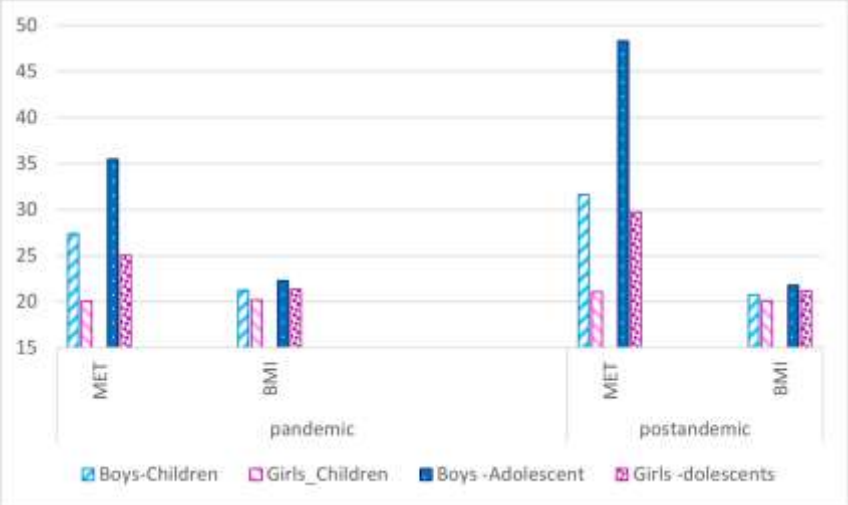

Figure 2- Body Mass Index (BMI) and Total Metabolic Equivalent (MET) by Age Group and Gender Across Two Studies

Note: For visualization purposes, physical activity scores (MET) were divided by 100 to align the scale with BMI values

Study 1 (During the Pandemic):

A Two-Way MANOVA was conducted to examine the effects of gender and age on HRQOL components. To enhance the robustness of the results, bootstrap resampling with 100 iterations using the bias-corrected and accelerated (BCa) method was applied. The analysis, based on Pillai's Trace, revealed the following significant multivariate effects:

Gender: Pillai's Trace = 0.01, F (4, 1077) = 4.22, p = 0.002, $\eta_p^2 = 0.01$

Age: Pillai's Trace = 0.04, F (4, 1077) = 13.37, p < 0.001, $\eta_p^2 = 0.04$

Gender × Age interaction: Pillai's Trace = 0.01, F (4, 1077) = 4.63, p = 0.001, $\eta_p^2 = 0.01$

Subsequent univariate ANOVAs indicated significant main effects of age across all HRQOL domains:

Physical functioning: F (1, 1080) = 27.36, p < 0.001, $\eta_p^2 = 0.02$,

Emotional functioning: F = 39.53, p < 0.001, $\eta_p^2 = 0.03$

Social functioning: F = 8.92, p = 0.003, $\eta_p^2 = 0.008$

School functioning: F = 39.75, p < 0.001, $\eta_p^2 = 0.03$

Mental health: F = 33.45, p < 0.001, $\eta_p^2 = 0.01$

Overall HRQOL: F = 38.58, p < 0.001, $\eta_p^2 = 0.03$

Significant gender effects were observed in:

Social functioning: F = 12.91, p < 0.001, $\eta_p^2 = 0.01$

Mental health: F = 5.08, p = 0.02, $\eta_p^2 = 0.005$

Overall HRQOL: F = 3.82, p = 0.05, $\eta_p^2 = 0.004$

Significant gender × age interactions were found in:

Emotional functioning: F = 5.62, p = 0.01, $\eta_p^2 = 0.005$

Social functioning: F = 16.15, p < 0.001, $\eta_p^2 = 0.01$

School functioning: F = 6.90, p = 0.009, $\eta_p^2 = 0.006$

Mental health: F = 12.76, p < 0.001, $\eta_p^2 = 0.01$

Overall HRQOL: F = 8.92, p = 0.003, $\eta_p^2 = 0.008$

Pairwise comparisons revealed that children consistently reported significantly higher HRQOL scores than adolescents across all components. Boys also reported significantly greater social functioning, mental health, and overall HRQOL compared to girls. Bonferroni post hoc tests clarified that girls in childhood outperformed adolescent girls in physical functioning, emotional functioning, mental health, and overall HRQOL. No significant gender differences were observed during childhood across any HRQOL domains; however, during adolescence, gender disparities became more pronounced across all domains, consistently favoring boys. These results suggest that gender differences in HRQOL emerge and intensify during adolescence. Bootstrap results fully corroborated the classical analyses, with 95% confidence intervals for all significant effects not crossing zero, confirming the stability and validity of the findings. Given inconsistencies in measurement scales of MET and BMI compared to HRQOL variables, Two-Way ANOVAs were employed. Significant main effects of age (F (1, 1080) = 26.07, p < 0.001, $\eta_p^2 = 0.02$) and gender (F (1, 1080) = 22.50, p < 0.001, $\eta_p^2 = 0.02$) were found on BMI, with boys and adolescents having higher BMI. In MET, Age (F (1, 1080) = 47.16, p < 0.001, $\eta_p^2 = 0.04$) and gender (F (1, 1080) = 64.58, p < 0.001, $\eta_p^2 = 0.05$) effects were also significant, with adolescents and boys reporting higher

levels of physical activity. Due to violations of normality, bootstrap analysis with 100 iterations was conducted. Bootstrap confidence intervals supported the classical test results.

Study 2 (post-pandemic):

Results of the Two-Way MANOVA using Pillai's Trace showed significant effects of:
Gender: Pillai's Trace = 0.03, F (6, 1593) = 8.84, $p < 0.001$, $\eta_p^2 = 0.03$
Age: Pillai's Trace = 0.01, F (6, 1593) = 3.51, $p = 0.002$, $\eta_p^2 = 0.01$
Gender × Age interaction: Pillai's Trace = 0.01, F (6, 1593) = 2.86, $p = 0.009$, $\eta_p^2 = 0.01$
Univariate ANOVAs revealed the following significant effects:
Gender:
Physical functioning: F (1, 1598) = 33.50, $p < 0.001$, $\eta_p^2 = 0.02$
Emotional functioning: F (1, 1598) = 28.88, $p < 0.001$, $\eta_p^2 = 0.01$
Mental health: F (1, 1598) = 13.91, $p < 0.001$, $\eta_p^2 = 0.009$
Overall HRQOL: F (1, 1598) = 28.29, $p < 0.001$, $\eta_p^2 = 0.01$
Age:
Social functioning: F (1, 1598) = 11.94, $p < 0.001$, $\eta_p^2 = 0.007$
School functioning: F (1, 1598) = 9.88, $p = 0.002$, $\eta_p^2 = 0.006$
Mental health: F (1, 1598) = 10.92, $p < 0.001$, $\eta_p^2 = 0.007$
Overall HRQOL: F (1, 1598) = 4.09, $p = 0.04$, $\eta_p^2 = 0.03$
Gender × Age interaction:
Physical functioning: F (1, 1598) = 7.63, $p = 0.006$, $\eta_p^2 = 0.005$
Emotional functioning: F (1, 1598) = 11.30, $p < 0.001$, $\eta_p^2 = 0.007$
Mental health: F (1, 1598) = 5.87, $p = 0.01$, $\eta_p^2 = 0.004$
Overall HRQOL: F (1, 1598) = 8.22, $p = 0.004$, $\eta_p^2 = 0.005$

Pairwise comparisons showed that boys scored significantly higher in physical functioning, emotional functioning, mental health, and overall HRQOL than girls. Children outperformed adolescents in school functioning, social functioning, mental health, and overall HRQOL. Bonferroni post hoc tests revealed that adolescent girls consistently scored lower than girls in childhood across all domains. Bootstrap 95% confidence intervals for all significant tests did not include zero, supporting the reliability of the findings. Given scale differences between MET and BMI compared to HRQOL variables, Two-Way ANOVAs were conducted. Bootstrap resampling with 100 iterations was used due to violations of normality. Significant effects of age (F (1, 1598) = 54.20, $p < 0.001$, $\eta_p^2 = 0.03$) and gender (F (1, 1598) = 19.50, $p < 0.001$, $\eta_p^2 = 0.01$) were observed on BMI (boys and adolescents showing higher BMI). Age (F (1, 1598) = 65.99, $p < 0.001$, $\eta_p^2 = 0.04$) and gender (F (1, 1598) = 106.91, $p < 0.001$, $\eta_p^2 = 0.06$) both had significant effects on MET, with adolescents and boys reporting higher physical activity. Bootstrap confidence intervals supported these results. The summary of the results of the two studies is presented in Figure 3.

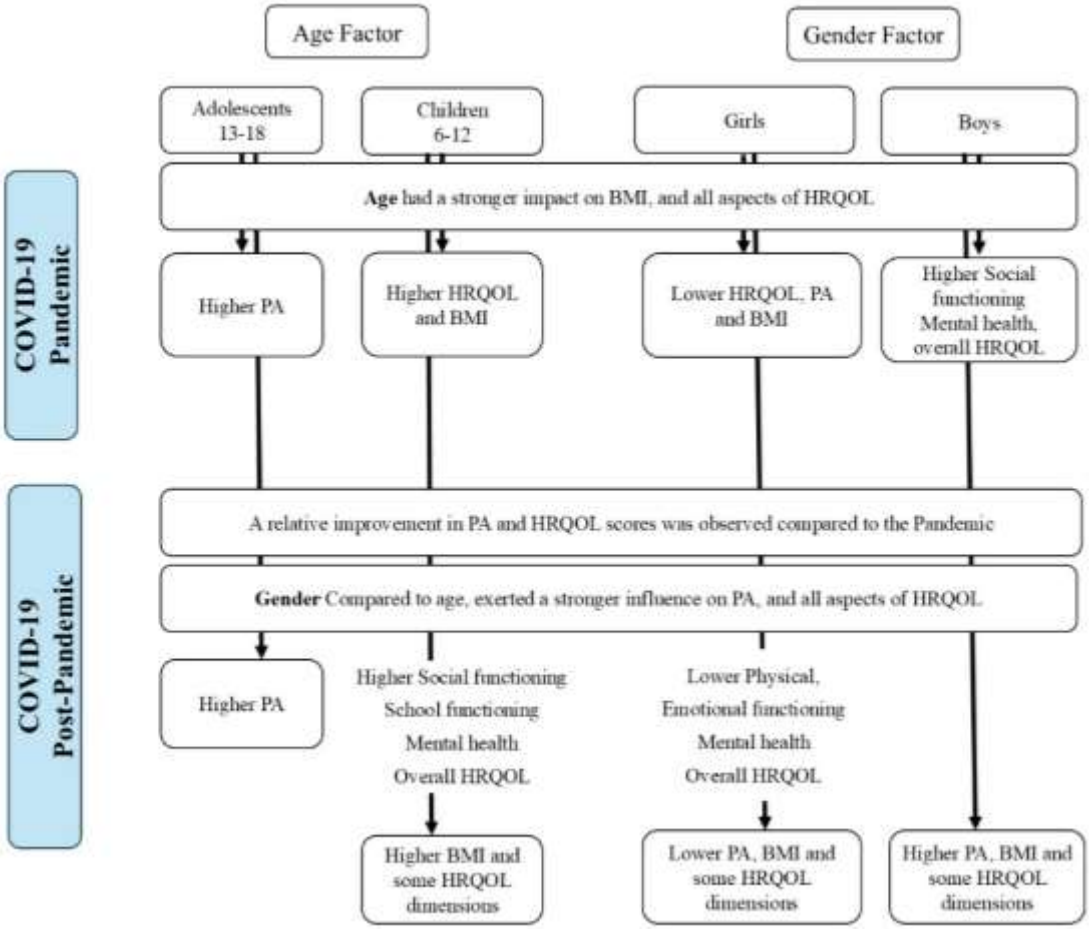

Figure 3- The summary of the results of the two studies

Discussion:

This study compared Health-Related Quality of Life (HRQOL), body mass index (BMI), and physical activity (PA) among Iranian children and adolescents during and after the COVID-19 pandemic, with a focus on gender and age differences. Although the samples were not identical in both cross-sectional studies, consistent trends emerged across age and gender. Adolescents consistently reported lower HRQOL scores than children across all domains, including emotional, social, school, and physical functioning, as well as mental health and overall HRQOL. These findings are in line with existing literature that identifies adolescence as a vulnerable period for mental health, particularly under stressors like the COVID-19 pandemic (Mikkelsen et al., 2022).

Adolescents face greater vulnerability to mental health challenges compared to children, partly due to their ongoing social development and identity formation (Jiao et al., 2020; Ravens-Sieberer et al., 2022). The COVID-19 pandemic intensified these difficulties through disruptions such as school closures, reduced peer interaction, and increased reliance on digital technology. In contrast, children generally exhibit higher health-related quality of life (HRQOL), which may reflect stronger emotional bonds with

caregivers (Masten & Barnes, 2018), greater developmental resilience, and fewer responsibilities such as lower academic stress and more parental support likely contributed to their greater emotional stability (Frosch et al., 2021; Lutin et al., 2023).
Gender differences were also consistent across both study phases. Boys reported higher HRQOL scores than girls in nearly all domains, with adolescent girls showing the lowest scores. These disparities intensified with age, particularly after the pandemic. Adolescent girls face additional challenges such as body dissatisfaction, reduced self-esteem, and increased emotional sensitivity, which can significantly impact their mental health (Fredrickson & Roberts, 1997; Nolen-Hoeksema & Hilt, 2016; Quittkat et al., 2019). Cultural norms and gender-based expectations likely exacerbate these issues. The main identified barriers include lack of time due to professional and domestic responsibilities, caregiving obligations, social and cultural expectations, financial limitations, low motivation, and safety concerns. Additionally, psychological factors such as low self-efficacy, body image concerns, and exercise-related anxiety also contribute to reduced participation. Media, policy interventions, and evolving gender dynamics play key roles in either reinforcing or challenging these barriers (Alyafei & Albaker, 2020). Addressing these constraints requires inclusive policies, increased awareness, and accessible fitness solutions to promote women's health, autonomy, and equal opportunities for exercise. Girls also report more negative emotional experiences, and their heightened concern about illness may lower their perceived health (Needham & Hill, 2010; Yoon et al., 2023). Interestingly, school functioning was the only HRQOL dimension without significant gender differences in either study. This could indicate that academic pressures affected both boys and girls similarly, or that the educational system offered a relatively gender-neutral experience during and after the pandemic.
Although, in general, school functioning tends to be better at younger (Panagouli et al., 2021), but the pandemic intensified age-related differences due to remote learning challenges, disrupted routines, and reduced peer interaction. Adolescents faced greater academic pressure from key milestones, along with hormonal changes, shifting priorities, and reduced motivation. Using HRQOL questionnaires to assess academic performance has limitations, and future research should include objective measures like test scores or teacher evaluations for more accurate insights. Children's better performance compared to adolescents may be due to closer teacher-student relationships, simpler curricula, and more individualized attention in elementary school—factors that also helped offset the weaknesses of online learning during COVID, which were harder to overcome in higher grades due to more complex and diverse subjects. In addition, Moreover, children's ongoing development of cognitive abilities, brain function, and knowledge base equips them to be more effective learners compared to others (Gualtieri & Finn, 2022).
A notable pattern was the shift in explanatory power from age to gender across the two points of time. During the pandemic, age had a stronger impact on HRQOL, likely because children and adolescents experienced and responded to the crisis differently. However, in the post-pandemic period, gender became a more significant factor, indicating that girls may have experienced prolonged psychological effects. As social and academic routines resumed, the gender gap in well-being became more evident. In both studies, adolescents and boys reported higher PA levels and BMI scores compared

to children and girls. These findings are expected given the natural increase in physical capacity with age (Kohl III et al., 2013) and the greater encouragement boys receive to engage in physical activities. Cultural norms sometimes restrict girls from active play and sports, especially in adolescence (Dennaoui et al., 2024). Concerns about body image, social judgment (Fredrickson & Roberts, 1997; Quittkat et al., 2019; Tiggemann & Slater, 2013), and limited gender-sensitive programs may discourage girls from participating in PA, which in turn affects their BMI and overall health. Gender disparities in physical activity and BMI highlight the need for supportive and inclusive environments that encourage girls' participation. Schools and communities should implement targeted, gender-sensitive programs that foster confidence, competence, and enjoyment in physical activities for girls.

The results of this study underscore the need for public health strategies that consider both age- and gender-specific vulnerabilities. Adolescents, particularly girls, emerged as the most affected group in terms of mental, social, and physical well-being. Interventions must be age-appropriate and designed to address the psychological and physical needs of each subgroup. For example, mental health support and body image education for adolescent girls, along with parental and school-based guidance, can help mitigate long-term effects of the pandemic. Future research should adopt longitudinal designs to trace the developmental trajectories of HRQOL, PA, and BMI over time, particularly focusing on adolescence as a critical period. Such studies could identify the long-term impact of the pandemic and evaluate the effectiveness of age- and gender-tailored interventions. In conclusion, this study confirms that age and gender play significant roles in shaping the health and well-being of children and adolescents, both during and after the COVID-19 pandemic. These findings can inform the development of targeted health promotion programs and educational policies to reduce disparities and promote well-being in youth populations.

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