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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 scores than adolescents, whereas adolescents had higher BMI and PA levels. Boys generally reported higher scores than girls on several HRQOL dimensions, particularly social functioning and mental health. The age-related pattern was broadly consistent across both timepoints, whereas the pattern of gender differences appeared more pronounced in the post-pandemic sample. Adolescent girls generally showed the least favorable HRQOL profile, particularly in school, social, and mental health domains. While gender differences in school functioning appeared less pronounced post-pandemic, differences in mental health persisted. During the COVID-19 crisis, age played a more decisive role in students' well-being, reflecting developmental sensitivity. The pattern of gender differences appeared more evident in the post-pandemic sample, although the cross-sectional design does not permit direct inference about changes over time. 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 Function

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

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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 HRQOL, PA level, and BMI among 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 study periods, 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 of the Persian versions of both questionnaires have been established.

Procedures:

A cluster sampling method was used to recruit students from primary, middle, and high schools in Tehran. 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 (MANOVA) was conducted to examine the effects of gender (girls, boys) and age group (children,

adolescents) on HRQOL. The analysis included physical, emotional, social, and school functioning, together with the corresponding mental health and overall HRQOL composite scores. Because these PedsQL domain and composite scores are mathematically related, they were interpreted as related HRQOL dimensions rather than as fully independent outcomes. Because most variables did not meet the normality assumption, bootstrap resampling with 100 samples using the bias-corrected and accelerated (BCa) method was applied. For BMI and physical activity (MET), separate two-way ANOVAs were conducted because these variables represented distinct continuous outcomes rather than components of the HRQOL multivariate outcome set.

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).

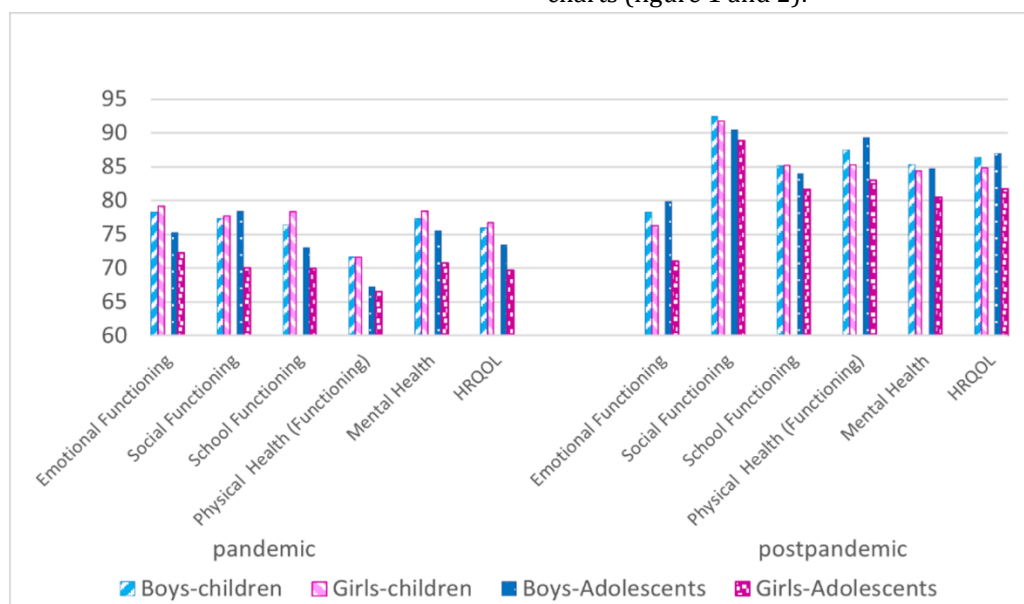


Figure 1- Health-Related Quality of Life (HRQOL) Dimensions by Age Group and Gender Across Two Studies

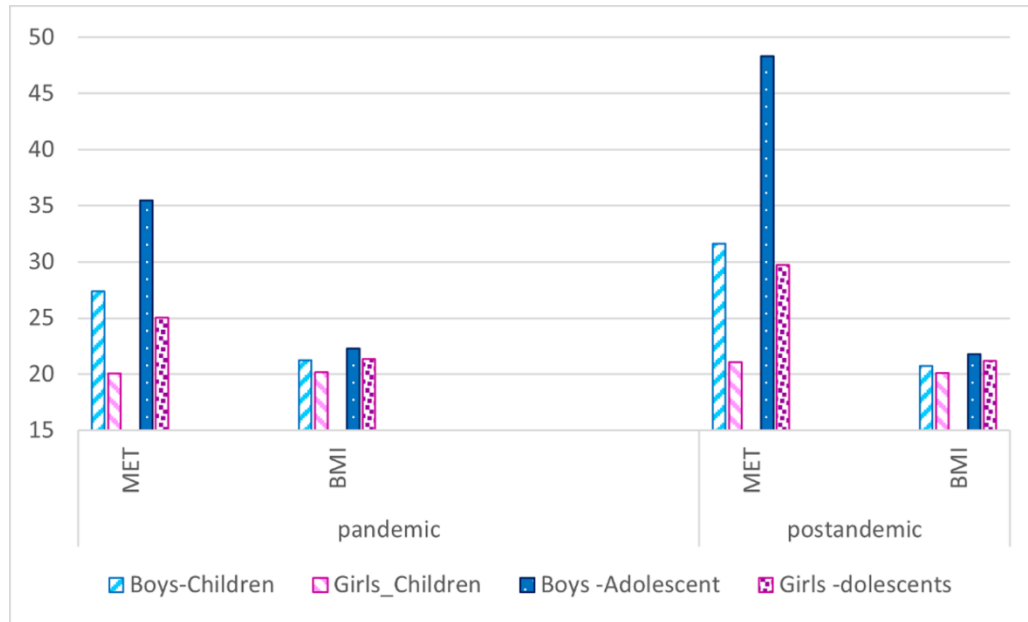


Figure 2- Body Mass Index (BMI) and Total Metabolic Equivalent (MET) by Age Group and Gender Across Two Studies

Note: For visualization purposes only, physical activity scores (MET) were divided by 100 to align the scale with BMI values; the original MET values were used in the statistical analyses.

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 $\times$ 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: $F(1, 1080) = 39.53$, $p < 0.001$, $\eta_p^2 = 0.03$

Social functioning: $F(1, 1080) = 8.92$, $p = 0.003$, $\eta_p^2 = 0.008$

School functioning: $F(1, 1080) = 39.75$, $p < 0.001$, $\eta_p^2 = 0.03$

Mental health: $F(1, 1080) = 33.45$, $p < 0.001$, $\eta_p^2 = 0.03$

Overall HRQOL: $F(1, 1080) = 38.58$, $p < 0.001$, $\eta_p^2 = 0.03$

Gender effects were observed for:

Social functioning: $F(1, 1080) = 12.91$, $p < 0.001$, $\eta_p^2 = 0.01$

Mental health: $F(1, 1080) = 5.08$, $p = 0.024$, $\eta_p^2 = 0.005$

Overall HRQOL: $F(1, 1080) = 3.82$, $p = 0.051$, $\eta_p^2 = 0.004$. This gender effect did not reach statistical

significance.

Significant gender $\times$ age interactions were found in:

Emotional functioning: $F(1, 1080) = 5.62$, $p = 0.018$, $\eta_p^2 = 0.005$

Social functioning: $F(1, 1080) = 16.16$, $p < 0.001$, $\eta_p^2 = 0.01$

School functioning: $F(1, 1080) = 6.91$, $p = 0.009$, $\eta_p^2 = 0.006$

Mental health: $F(1, 1080) = 12.76$, $p < 0.001$, $\eta_p^2 = 0.01$

Overall HRQOL: $F(1, 1080) = 8.93$, $p = 0.003$, $\eta_p^2 = 0.008$

Pairwise comparisons revealed that children consistently reported significantly higher HRQOL scores than adolescents across all components. Boys also reported significantly greater social functioning and

mental health compared with girls; the overall HRQOL gender difference did not reach statistical significance ($p = 0.051$). Bonferroni post hoc tests clarified that girls in the child age group had higher scores than adolescent girls in physical functioning, emotional functioning, mental health, and overall HRQOL. No significant gender differences were observed in the child age group across the HRQOL domains; however, in the adolescent group, gender differences were more pronounced in several HRQOL domains, particularly emotional, social, school, and mental health functioning, with higher scores generally observed among boys. These findings indicate that the pattern of gender differences was more pronounced among adolescents, but the cross-sectional design does not permit inference about within-person changes over time. Bootstrap results were consistent with the classical analyses, with 95% confidence intervals for significant effects not crossing zero, supporting the robustness of the findings. 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. Because normality assumptions were not consistently met, bootstrap resampling with 100 iterations was used. The bootstrap confidence intervals were generally consistent with the corresponding classical analyses.

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 $\times$ 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: $F(1, 1598) = 28.88, p < 0.001, \eta_p^2 = 0.02$

Mental health: $F(1, 1598) = 13.91, p < 0.001, \eta_p^2 = 0.009$

Overall HRQOL: $F(1, 1598) = 28.29, p < 0.001, \eta_p^2 = 0.02$

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: $F(1, 1598) = 4.09, p = 0.04, \eta_p^2 = 0.003$

Gender $\times$ 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-adjusted comparisons indicated that adolescent girls had lower scores than girls in the child age group on the HRQOL dimensions showing significant age-related differences. Bootstrap 95% confidence intervals for all significant tests did not include zero, supporting the reliability of the findings. Because BMI and physical activity (MET) were distinct continuous outcomes rather than components of the HRQOL multivariate outcome set, separate 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.

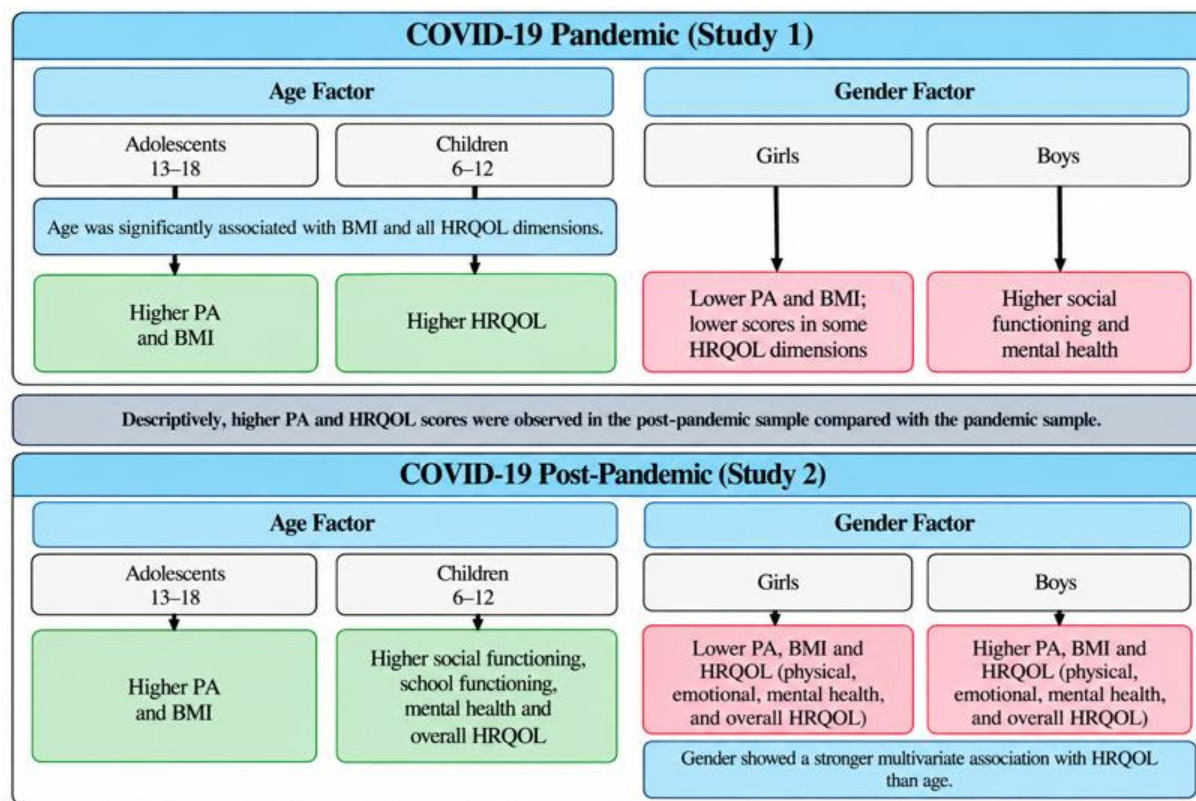


Figure 3- The summary of the results of the two studies

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 observed across both study phases. Boys reported higher HRQOL scores than girls in several domains, with adolescent girls showing the least favorable HRQOL profile. The pattern of gender differences appeared more pronounced in several domains among adolescents, particularly in the post-pandemic sample. Several psychosocial and sociocultural factors may contribute to these gender differences, including body-image concerns, social expectations, and differences in opportunities for physical activity. However, these mechanisms were not directly measured in the present study. Girls may also report more negative emotional experiences, which could contribute to lower perceived health (Needham & Hill, 2010; Yoon et al., 2023). Interestingly, school functioning was the only HRQOL dimension without a significant main effect of gender in either study. This pattern may indicate that gender differences in school functioning were less

pronounced than those observed in other HRQOL dimensions; however, the present data do not allow the mechanisms underlying this pattern to be determined.

Although school functioning tends to be better at younger ages (Panagouli et al., 2021), age-related differences may reflect differences in remote learning experiences, disrupted routines, and reduced peer interaction during the pandemic. Adolescents also faced greater academic pressure associated with key educational milestones, along with developmental changes, shifting priorities, and reduced motivation. Using HRQOL questionnaires to assess academic functioning has limitations, and future research should include objective measures such as test scores or teacher evaluations. Children's better scores compared with adolescents may be related to closer teacher-student relationships, simpler curricula, and more individualized attention in elementary school—factors that may also have helped offset some weaknesses of online learning during COVID-19.

A notable difference was observed in the pattern of age- and gender-related effects across the two study periods. During the pandemic, age showed a stronger multivariate association with HRQOL, whereas in the post-pandemic period, gender-related differences were more evident in several domains. This pattern may indicate that the relative distribution of age- and gender-related differences varied across the two study periods; however, the cross-sectional design does not permit direct inference about changes over time or prolonged psychological effects. In both studies, adolescents and boys reported higher PA levels and BMI scores compared with children and girls. These findings may partly reflect age-related changes in physical capacity and gender-related differences in opportunities and social encouragement for physical activity (Kohl III et al., 2013; Dennaoui et al., 2024). Concerns about body image and social judgment may also contribute to lower physical activity among some girls (Fredrickson & Roberts, 1997; Quittkat et al., 2019; Tiggemann & Slater, 2013). These interpretations should be considered as possible explanations because the relevant mechanisms were not directly measured in this study. Schools and communities may benefit from supportive and inclusive environments that encourage girls' participation in physical activity.

The results of this study underscore the need for public health strategies that consider both age- and gender-specific vulnerabilities. Adolescents, particularly girls, showed a less favorable profile across several mental, social, and physical well-being indicators. Interventions should 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, may help address identified vulnerabilities. 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 investigate the longer-term consequences of the pandemic and evaluate the effectiveness of age- and gender-tailored interventions. In conclusion, this study indicates that age and gender are associated with differences in health and well-being among Iranian children and adolescents during and after the COVID-19 pandemic. These findings may 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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