

# Collaborative Outcomes Study on Health and Functioning During Infection Times (COH-FIT): Global and Risk-Group Stratified Course of Well-Being and Mental Health During the COVID-19 Pandemic in Adolescents

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**Objective:** To identify the COVID-19 pandemic impact on well-being/mental health, coping strategies, and risk factors in adolescents worldwide.

**Method:** This study was based on an anonymous online multi-national/multi-language survey in the general population (representative/weighted non-representative samples, 14-17 years of age), measuring change in well-being (World Health Organization–Five Well-Being Index [WHO-5]/range = 0-100) and psychopathology (validated composite P-score/range = 0-100), WHO-5 <50 and <29, pre- vs during COVID-19 pandemic (April 26, 2020-

June 26, 2022). Coping strategies and 9 *a priori*-defined individual/cumulative risk factors were measured. A  $\chi^2$ , penalized cubic splines, linear regression, and correlation analyses were conducted.

**Results:** Analyzing 8,115 of 8,762 initiated surveys (representative = 75.1%), the pre-pandemic WHO-5 and P-score remained stable during the study (excluding relevant recall bias/drift), but worsened during the pandemic by  $5.55 \pm 17.13$  (SD) and  $6.74 \pm 16.06$  points, respectively (effect size  $d = 0.27$  and  $d = 0.28$ ). The proportion of adolescents with WHO-5 scores suggesting depression screening ( $<50$ ) and major depression ( $<29$ ) increased from 9% to 17% and 2% to 6%. WHO-5 worsened (descending magnitude, with cumulative effect) in adolescents with a mental or physical disorder, female gender, and with school closure. Results were similar for the P-score, with the exception of school closure (not significant) and living in a low-income country, as well as not living in a large city (significant). Changes were significantly but minimally related to COVID-19 deaths/restrictions, returning to near-pre-pandemic values after  $>2$  years. The 3 most subjectively effective coping strategies were Internet use, exercise/walking, and social contacts.

**Conclusion:** Overall, well-being/mental health worsened (small effect sizes) during the early stages of the COVID-19 pandemic, especially in vulnerable subpopulations. Identified at-risk groups, association with pandemic-related measures, and coping strategies can inform individual behaviors and global public health strategies.

**Plain language summary:** The impact of COVID-19 and related restrictions on the mental health of children and adolescents remains unclear. This study conducted an anonymous online survey with over 8,100 adolescents aged 14 to 17 years worldwide. Results showed a significant decline in wellbeing, with depression rates increasing from 9% to 17% returning to near-pre-pandemic values after about 2 years. Adolescents with preexisting mental health conditions, female youth, and those affected by school closures were particularly vulnerable. Effective coping strategies included internet use, exercise, and social contacts, highlighting areas for public health focus to support youth during pandemics.

**Study preregistration information:** Physical and mental health impact of COVID-19 on children, adolescents, and their families: The Collaborative Outcomes study on Health and Functioning during Infection Times - Children and Adolescents (COH-FIT-C&A); <https://doi.org/10.1016/j.jad.2021.09.090>

**Diversity & Inclusion Statement:** We worked to ensure sex and gender balance in the recruitment of human participants. We worked to ensure race, ethnic, and/or other types of diversity in the recruitment of human participants. We worked to ensure that the study questionnaires were prepared in an inclusive way. The author list of this paper includes contributors from the location and/or community where the research was conducted who participated in the data collection, design, analysis, and/or interpretation of the work. We actively worked to promote inclusion of historically underrepresented racial and/or ethnic groups in science in our author group. We actively worked to promote sex and gender balance in our author group. One or more of the authors of this paper self-identifies as a member of one or more historically underrepresented racial and/or ethnic groups in science.

**Key words:** COVID-19; pandemic; survey; WHO-5; p-factor; well-being

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**S**ince the beginning of the COVID-19 pandemic, many studies have measured the impact of the pandemic and related restrictions on the mental health of children and adolescents.<sup>1</sup> Meta-analytic evidence shows overall a slight deterioration in some measures of psychopathology from the pre-pandemic to intra-pandemic times.<sup>2</sup> However, findings have been mixed, likely owing to high cross-study heterogeneity, without clear patterns across psychopathology measures.

Many studies of the COVID-19 impact on children and adolescents have multiple limitations: namely, focusing on the assessment of isolated domains of psychopathology, with an emphasis on internalizing behaviors; reliance on small samples, reflecting the practical challenges of recruiting larger samples during the pandemic; or restricting data collection to 1 country/location/language or population subgroup. Moreover, studies have considered only a single time point with a cross-sectional design, or did not account for variation in the death rate, the severity of the COVID-19 pandemic in specific geographic areas, and restriction measures over time. High cross-study heterogeneity, regarding design, setting, assessment tools, timing of baseline and follow-up assessment, and time between baseline and follow-up assessments,

limits the generalizability of findings of individual studies, posing methodological barriers to evidence synthesis efforts. Finally, studies have focused on psychopathology only, neglecting coping strategies.

The Collaborative Outcomes study on Health and Functioning during Infection Times (COH-FIT, [www.coh-fit.com](http://www.coh-fit.com)) is an international survey study conducted in 30 languages in representative/weighted non-representative samples, in adults, adolescents, and children.<sup>3,4</sup> COH-FIT has been measuring well-being and the psychopathology factor (P-score), a validated composite mental health measure,<sup>5</sup> in the general population across all continents since April 26, 2020, including a retrospectively recalled pre-pandemic assessment of comprehensive multidimensional factors relevant to well-being and mental health. Here, we report globally in adolescents findings of the 2 co-primary outcomes, well-being and the P-score, hypothesizing reduced well-being and increased psychopathology globally, with increased impairment in vulnerable subgroups and a relationship to death rates and stringency measures over time, and with cumulative effects across multiple risk factors. We also assessed subjectively the most effective coping strategies for dealing with the impact of the pandemic.

## METHOD

COH-FIT has been approved by local authors' institutional ethics committees, as per protocol.<sup>3,4</sup>

### Outcomes

The 2 co-primary outcomes were the pre- vs intra-pandemic change in well-being (World Health Organization–Five Well-Being Index [WHO-5]<sup>6</sup>) and the composite psychopathology “P-score,” a validated 5-dimensional measure composed of anxiety, depressive, post-traumatic, psychotic, and psychophysiologic (stress, sleep problems, and concentration problems) symptoms.<sup>5</sup> As in adults, in COH-FIT-Adolescents, anxiety items were extracted from the Generalized Anxiety Disorder 7 questionnaire (GAD-7)<sup>7</sup>; depression, sleep, and concentration items from the 9-item Patient Health Questionnaire (PHQ-9)<sup>8</sup>; post-traumatic items from the Post-Traumatic Stress Disorder (PTSD) Checklist for DSM-5 (PCL-5)<sup>9</sup>; stress items from the WHO-5 Well-Being Index<sup>6</sup>; and psychotic items from the 16-item Prodromal Questionnaire (PQ-16).<sup>10</sup> Obsessive-compulsive and manic symptoms did not meet our threshold for external validation in adults, and so were not included in the P-score (for either adults or adolescents).<sup>5</sup> Participants were asked to answer each item in relation to the period “during the last 2 weeks” and “during the last 2 weeks of your regular life” before the pandemic. Symptoms were rated on a visual analogue scale of 0 to 100 for both outcomes, with higher values indicating better well-being (WHO-5) and poorer mental health (P-score). We also computed the proportion of subjects with WHO-5 <50 (indication for testing for depression), and <29 (indicative of major depression),<sup>6</sup> before and during the pandemic.

We further asked participants to rate how important (“very,” “somewhat,” “not”) the following coping strategies were: exercise, Internet use, direct social contact, hobby, information about the COVID-19 pandemic, media, social media, work, studying/learning, pet, physical intimacy, prescribed medications, religion/meditation/spirituality, gaming, substance use, or other strategies. The list of coping strategies was identified *a priori* based on authors' clinical experience, diverse cultural backgrounds, and a targeted review of the literature.<sup>11–13</sup>

We tested for the presence of recall bias for retrospectively recalled pre-pandemic ratings over the time of data collection, performing polynomial regression analyses to assess linear or quadratic relationships.

### At-Risk Groups

We previously identified *a priori* 12 literature-based risk factors for poor well-being/mental health in adults: namely

present/past COVID-19 infection, age ≤30 years, female gender, employment, health care worker employment, mental disorder diagnosis, physical disorder diagnosis, first-generation immigrant status, large city location, low-income country location, obesity, and having lost someone because of COVID-19<sup>14,15</sup> (Table S1, available online). For adolescents, we used 9 risk factors, excluding 4 adult risk factors and including an additional one of school closures. We excluded age considering adolescents as 1 homogeneous age group, employment status, and being a health care worker, as minors typically do not work in developed countries, and being obese, as growth charts and not body mass index thresholds better describe overweight/underweight status in minors. In country-income analyses, we retained only data from those countries in which at least 100 analyzable surveys were available.

### COVID-19 Deaths and Restrictions

Time-/region-specific COVID-19 daily deaths were extracted from the Johns Hopkins University repository (<https://coronavirus.jhu.edu/data>). We also included the Oxford COVID-19 Stringency Index (<https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker>), which provides a daily rating for different countries indicating the severity of government-imposed restrictions (0–100) at the time of survey completion based on 9 comprehensive metrics, for example, school closures and facial coverings) (<https://covidtracker.bsg.ox.ac.uk/>). All reporting followed a Consensus-Based Checklist for Reporting of Survey Studies (CROSS)<sup>16</sup> (eChecklist).

### Translations and P-Score Validation

COH-FIT translations have been validated in adults.<sup>5</sup> The P-score in COH-FIT-Adolescents followed the same structure and was based on the same items as the validated P-score in adults. Because validated questionnaires in adults have not been validated in minors, any concurrent validation would not have been informative, because of the lack of validity of the external validator. Hence, we performed only internal psychometric validation of P-score in adolescents.

For internal validation, we performed confirmatory factor analysis (CFA) testing the fit of a model with the same second-order P-score and first-order depression, anxiety, post-traumatic, psychotic, and psycho-physiologic domains validated in adults.<sup>5</sup> In addition, we assessed the fit of 3 plausible alternative candidate models: (1) a unidimensional model; (2) a correlated 5-factor model; and (3) a bifactor model<sup>17</sup> with all factors uncorrelated. Criteria for adequate model fit were a comparative fit index (CFI) >0.95, root mean square error of approximation (RMSEA) <.06, and standardized root mean square



residual (SRMR)  $<.08$ .<sup>18</sup> We also computed the Bayesian Information Criterion (BIC), which is suitable for the direct comparison of non-nested models (eg, bifactor vs correlated factors), where lower BIC is indicative of better fit. Mean-adjusted maximum likelihood was used to estimate parameters with robust standard errors and Satorra–Bentler-scaled test statistics to account for any non-normality.<sup>19</sup> Sampling weights were applied to all CFA analyses. Overall and individual internal domain reliabilities were estimated with the coefficient omega.<sup>20</sup>

Equivalence of P-score measurement across different survey languages and countries, as well as across genders, was tested in a hierarchical manner,<sup>21</sup> assessing model fit after applying increasingly restrictive equality constraints across groups. Specifically, we modeled identical factor structures across groups (configural invariance), equal factor loadings (metric invariance), and equal item intercepts (scalar invariance), which is generally considered sufficient for valid measurement of latent means for any subsequent hypothesis testing.<sup>17</sup> To maximize the reliability of estimates, we excluded any subgroups with  $N < 200$  (eg, non-binary gender or countries with minimal survey administration). Using Chen's 2007<sup>22</sup> guidelines, a change in the following fit indices was used as indicative of nonvariance: CFI less than  $-0.01$  and either RMSEA  $>0.015$  or SRMR  $>0.03$  (loadings)/SRMR  $>0.01$  (intercepts). We did not use the  $\chi^2$  test to assess invariance, given that this is excessively sensitive to negligible changes in fit for large sample sizes.<sup>22</sup>

All analyses were conducted in  $R$ <sup>23</sup> using the *MICE*<sup>24</sup>, *ggplot2*<sup>25</sup>, *MVN*<sup>26</sup>, *psych*<sup>27</sup> and *lavaan*<sup>28</sup> packages.

## Data Analysis

COH-FIT-Adolescents items were identical to COH-FIT-Adult items.<sup>5</sup> Missing item data were imputed using multivariate chained equations, with predictive mean matching<sup>29</sup> for continuous and logistic regression for categorical values as described in Supplement 1, available online. Outliers were identified using a high threshold of  $|z| = 5.0$ , winsoring them to the next highest non-outlying value. Non-representative samples were weighted for gender according to representative distribution in each country.

To examine changes in outcomes across pre- vs intra-pandemic time periods, we performed mixed-effects linear regression with country as a random effect. We allowed regression slopes for time to vary across countries, given that the impact of time across different nations is likely varied. The McNemar  $\chi^2$  test was also used to compare change in the proportion of WHO-5  $<50$  and  $<29$  scores during pre- vs intra-pandemic time periods. Finally, we examined whether the presence of multiple concomitant risk factors was associated with worse outcomes by regression analyses

on WHO-5/P-score using a cumulative risk score (0-9). This risk score was derived by summing the number of at-risk groups to which each participant belonged as identified *a priori*.

Descriptive trends in the well-being and P-score changes over time were explored with cubic regression splines. This approach fits a series of smoothed local piecewise regression analyses across different time intervals,<sup>30</sup> and may be particularly sensitive to revealing sudden temporal changes that might occur with COVID-related events such as policy changes. These analyses were performed in the whole sample using 10 equally spaced spline intervals, together with COVID-19 deaths and restrictions. This analytic approach was applied to provide descriptive data on possible trends with no inferential analyses conducted.

We conducted a correlation analysis among co-primary outcomes. We conducted correlation and smoothed regression analyses to measure the association of outcomes with COVID-19 deaths, stringency, and time since the start of the pandemic. STATA<sup>31</sup> was used for regression analyses for cumulative risk factors and correlation analyses, and R for all other analyses.

## Sample Weights

Although the majority of the sample was obtained through representative sampling via survey organizations, around 25% of the data were acquired through non-probabilistic sampling. On average, this non-probabilistic subsample had a higher female-to-male respondent ratio (Table 1). Post-stratification adjustment weights were used to provide a representative distribution of gender within each country based on national population statistics. In the adult COHFIT survey population, we also weighted for age, education, and employment status (data under review). Here, we weighted only for gender, because employment and education classifications are not relevant to an adolescent sample, and because the age band used to define adolescents (14-17 years) is already narrow, and population figures frequently report age statistics using age bands that extend beyond the adolescent age range (commonly 15-19 years).

## RESULTS

### Survey Sample

Surveys were administered between April 27, 2020, and June 11, 2022, yielding 8,762 surveys. Excluding 642 participants completing  $<50\%$  of items and 5 respondents without obtainable Stringency Index information, data from 8,115 adolescents (representative = 75.1%, age = 15.6

**TABLE 1** Basic Participant Characteristics for Overall, Representative, and Non-Representative Samples

| Variable                                      | Overall   |         | Representative |         | Nonprobability |         |
|-----------------------------------------------|-----------|---------|----------------|---------|----------------|---------|
|                                               | Frequency | Percent | Frequency      | Percent | Frequency      | Percent |
| Representativeness of sample                  |           |         |                |         |                |         |
| Nonprobability                                | 2,019     | 24.9    | 0              | 0.0     | 2,019          | 100.0   |
| Representative                                | 6,096     | 75.1    | 6,096          | 100.0   | 0              | 0.0     |
| Age, y                                        |           |         |                |         |                |         |
| 14                                            | 1,669     | 20.6    | 1,332          | 21.9    | 337            | 16.7    |
| 15                                            | 2,196     | 27.1    | 1,689          | 27.7    | 507            | 25.1    |
| 16                                            | 1,977     | 24.4    | 1,404          | 23.0    | 573            | 28.4    |
| 17                                            | 2,273     | 28.0    | 1,671          | 27.4    | 602            | 29.8    |
| Gender                                        |           |         |                |         |                |         |
| Male                                          | 4,066     | 50.1    | 3,215          | 52.7    | 851            | 42.1    |
| Female                                        | 4,006     | 49.4    | 2,852          | 46.8    | 1,154          | 57.2    |
| Non-binary                                    | 32        | 0.4     | 24             | 0.4     | 8              | 0.4     |
| Transgender or intersex                       | 11        | 0.1     | 5              | 0.1     | 6              | 0.3     |
| Ethnicity                                     |           |         |                |         |                |         |
| White                                         | 5,782     | 71.3    | 5,121          | 84.0    | 661            | 32.7    |
| African/African descent                       | 420       | 5.2     | 128            | 2.1     | 292            | 14.5    |
| Hispanic                                      | 375       | 4.6     | 323            | 5.3     | 52             | 2.6     |
| Asian                                         | 1,002     | 12.3    | 117            | 1.9     | 885            | 43.8    |
| Mixed                                         | 465       | 5.7     | 370            | 6.1     | 95             | 4.7     |
| Other                                         | 71        | 0.9     | 37             | 0.6     | 34             | 1.7     |
| Country economy                               |           |         |                |         |                |         |
| High income                                   | 5,907     | 72.8    | 5,207          | 85.4    | 700            | 34.7    |
| Middle income                                 | 1,478     | 18.2    | 889            | 14.6    | 589            | 29.2    |
| Low income                                    | 730       | 9.0     | 0              | 0.0     | 730            | 36.2    |
| Stringency                                    |           |         |                |         |                |         |
| 0-24                                          | 726       | 8.9     | 456            | 7.5     | 270            | 13.4    |
| 25-49                                         | 1,932     | 23.8    | 1,591          | 26.1    | 341            | 16.9    |
| 50-74                                         | 3,803     | 46.9    | 2,944          | 48.3    | 859            | 42.5    |
| 75-100                                        | 1,654     | 20.4    | 1,105          | 18.1    | 549            | 27.2    |
| Migrant status                                |           |         |                |         |                |         |
| No                                            | 6,902     | 85.1    | 5,327          | 87.4    | 1,575          | 78.0    |
| Yes                                           | 521       | 6.4     | 481            | 7.9     | 40             | 2.0     |
| Not reported                                  | 692       | 8.5     | 288            | 4.7     | 404            | 20.0    |
| SES                                           |           |         |                |         |                |         |
| 0-24                                          | 399       | 4.9     | 168            | 2.8     | 231            | 11.4    |
| 25-49                                         | 1,012     | 12.5    | 615            | 10.1    | 397            | 19.7    |
| 50-74                                         | 4,643     | 57.2    | 3,576          | 58.7    | 1,067          | 52.8    |
| 75-100                                        | 2,061     | 25.4    | 1,737          | 28.5    | 324            | 16.0    |
| Urbanicity                                    |           |         |                |         |                |         |
| Village/rural                                 | 1,545     | 19.0    | 1,145          | 18.8    | 400            | 19.8    |
| Small city/town (10,000-100,000 population)   | 2,391     | 29.5    | 1,813          | 29.7    | 578            | 28.6    |
| Medium city/town (100,000-500,000 population) | 1,798     | 22.2    | 1,318          | 21.6    | 480            | 23.8    |
| Large city/town (> 500,000 population)        | 2,381     | 29.3    | 1,820          | 29.9    | 561            | 27.8    |
| COVID-19—related loss                         |           |         |                |         |                |         |
| No                                            | 7,431     | 91.6    | 5,540          | 90.9    | 1,891          | 93.7    |
| Yes                                           | 669       | 8.2     | 556            | 9.1     | 113            | 5.6     |
| Not reported                                  | 15        | 0.2     | 0              | 0.0     | 15             | 0.7     |

(continued)

TABLE 1 Continued

| Variable                 | Overall   |         | Representative |         | Nonprobability |         |
|--------------------------|-----------|---------|----------------|---------|----------------|---------|
|                          | Frequency | Percent | Frequency      | Percent | Frequency      | Percent |
| Month of data collection |           |         |                |         |                |         |
| Apr 2020                 | 130       | 1.6     | 2              | 0.0     | 128            | 6.3     |
| Jun 2020                 | 493       | 6.1     | 285            | 4.7     | 208            | 10.3    |
| Aug 2020                 | 432       | 5.3     | 5              | 0.1     | 427            | 21.1    |
| Oct 2020                 | 2,463     | 30.4    | 1,884          | 30.9    | 579            | 28.7    |
| Dec 2020                 | 431       | 5.3     | 365            | 6.0     | 66             | 3.3     |
| Feb 2021                 | 330       | 4.1     | 272            | 4.5     | 58             | 2.9     |
| Apr 2021                 | 519       | 6.4     | 428            | 7.0     | 91             | 4.5     |
| Jun 2021                 | 394       | 4.9     | 263            | 4.3     | 131            | 6.5     |
| Aug 2021                 | 434       | 5.3     | 284            | 4.7     | 150            | 7.4     |
| Oct 2021                 | 95        | 1.2     | 1              | 0.0     | 94             | 4.7     |
| Dec 2021                 | 39        | 0.5     | 0              | 0.0     | 39             | 1.9     |
| Feb 2022                 | 522       | 6.4     | 510            | 8.4     | 12             | 0.6     |
| Apr 2022                 | 1,648     | 20.3    | 1,612          | 26.4    | 36             | 1.8     |
| Jun 2022                 | 185       | 2.3     | 185            | 3.0     | 0              | 0.0     |

years (range = 14-17 years), female individuals = 49.4%, male individuals = 50.1%, non-binary = 0.4%, transgender/intersex = 0.1%) suitable for regression analyses were analyzed.

#### Data Screening

Missing data were  $\leq 1\%$  for all items except immigration status (9%), helping others (5%), and receiving a positive COVID test result (57%). Participant characteristics are detailed in Table 1. Patterns of missingness were explored across all included variables with the Anderson–Darling rank test.<sup>26</sup> This was significant (median  $T = 18.64$ , median  $p < .001$ ), suggesting that data were not “missing completely at random” but could be considered “missing at random” (ie, if missingness is contingent on the observed data), which means that imputation is supported (Supplement 1, available online). For the CFA, assessment of multivariate normality with the Mardia coefficient showed significant skew ( $z = 17398.01$ ,  $p < .001$ ) and kurtosis ( $z = 273.81$ ,  $p < .001$ ), so scaled CFA test statistics<sup>19</sup> and robust standard errors were used in parameter estimation to account for non-normality.

#### Recall Bias Analysis

A longer interval between the start of the pandemic and the completion of the survey was linearly associated with higher pre-pandemic well-being ratings ( $\beta = 0.077$ ,  $p < .001$ ) (Figure S1, available online). A quadratic association with P-scores was also observed ( $\beta = -0.02$ ,  $p < .001$ ), with

Figure S2 (available online) suggesting a general decrease in ratings across time but with a transient increase in January 2022. Variation in pre-pandemic scores across time nevertheless appeared to be minimal, suggesting little substantive recall bias/drift. Regression slopes estimating before vs during the pandemic are shown in Figure S3, available online.

#### P-Score Factor Structure

The second-order, bifactor, and correlated factors model all met established thresholds for model fit (Table S2, available online), and item-factor loadings were high, suggesting good convergent validity (Figure S4, available online). The unidimensional model did not demonstrate adequate fit (Table S2, available online) and is not considered further. A comparison of BIC values across the 3 adequately fitting models found that BIC was lowest (indicating a better fit) for the correlated factor model, and this model was therefore selected for further measurement invariance tests. Factor correlations for this model were high ( $r = 0.60$ - $0.84$ ), suggesting a strong degree of commonality across subdomains.

#### P-Score Reliability, Measurement Invariance, and Association With WHO-5

Reliability assessed with coefficient omega was high, both for an overall composite P-score ( $\omega = 0.96$ ) and for the five subdomains ( $\omega = 0.83$ - $0.93$ ). Measurement invariance results in Table S3 (available online) indicate that the

correlated factor model exhibits no meaningful decrement in model fit using Chen's criteria when factor structure, loadings, and intercepts were constrained to be equal across different countries, survey languages, and gender groups. Correlations of P-scores with the WHO-5 (Table S4, available online) showed significant associations for both the overall ( $r = -0.49$ ) and domain scores ( $r = -0.24$  to  $-0.53$ ).

### Change in Well-Being

Weighted mixed-effects regression analyses indicated an overall decrease (worsening) in WHO-5 well-being during the pandemic of 8.37 (95% CI = 6.50-10.23) points ( $t[16.79] = 8.83, p < .001$ ) from a pre-pandemic baseline of 75.78 (a standardized mean difference [SMD] of 0.40). The random-effects intercept term showed that there was considerable variation in the magnitude of well-being changes across countries (SD = 5.01) (Figure S3a, available online). Follow-up individual country-wide comparisons (Table 2) indicated significant worsening in all assessed countries except Canada, Russia, the United States, and Taiwan. The proportion of individuals scoring WHO-5 <50 increased from 9% before the pandemic to 17% during the pandemic (McNemar  $\chi^2 = 153.24, N = 8,115, p < .001$ ), with the proportion scoring WHO-5 <29 increasing from 2% before the pandemic to 6% during the pandemic (McNemar  $\chi^2 = 153.24, N = 8,115, p < .001$ ).

### Changes in P-Score

The P-score increased (ie, worsened) by 10.33 (95% CI = 8.05, 12.61) points ( $t[17.46] = 8.88, p < .001$ ) from the pre-pandemic baseline of 31.54 (SMD = 0.42), with notable variation in the size of P-score change (SD = 6.05) across countries (Figure S3b, available online). Individual country-wide comparisons (Table 2) indicated significant worsening of psychopathology in the majority of countries except in Canada and the United States. In addition, P-scores increased in 45% by  $\geq 20\%$ , 39% by  $\geq 30\%$ , 34% by  $\geq 40\%$ , and 30% by  $\geq 50\%$ .

Correlations of P-score total and domain scores with well-being can also be seen in Table S4 (available online).

### Change Trajectories in Well-Being, P-Score, COVID-19 Deaths, and Restrictions

Figure 1 shows regression splines fitted to WHO-5 scores ( $F_{8,3,8106} = 14.74, p < .001$ ) and P-scores ( $F_{8,9,8106} = 14.16, p < .001$ ) across time, along with stringency and death data rescaled to a similar metric to each outcome to facilitate visual comparison. Both outcomes appeared to worsen in the beginning stage of the survey collection

period early in the pandemic, returning to near-pre-pandemic levels over time, as evident from the shape of the cubic spline model (Figure 1). There was a significant, albeit very small, association between WHO-5 change and COVID pandemic-related deaths ( $r = -0.05, p < .001$ , and Stringency Index  $r = -0.09, p < .001$ ). P-score changes were significantly correlated, albeit with modest effect, with the Stringency Index ( $r = 0.04, p = .001$ ) but not with COVID pandemic-related deaths ( $r = -0.01, p = .299$ ).

### Risk Factors and Well-Being

The following risk factors were significantly associated with larger WHO-5 intra-pandemic worsening in adolescents: having a mental disorder, having a physical disorder, being female, and having school closures (Figure 2, Table S5, available online). Associations were non-significant for country income, immigrant status, COVID-19-related loss, COVID-19 infection, or urbanicity. The presence of more concomitant risk factors was associated with larger WHO-5 worsening ( $B = -0.79, SE = 0.18, p < .001$ ). Results from representative samples only are shown in Table S6, available online.

### Risk Factors and P-Score

The following risk factors were significantly associated with larger P-score worsening before vs during the pandemic in adolescents: having a mental disorder, having a physical disorder, being female, living in a low-income country, and not living in a large city (Figure 2, Table S5, available online). Associations were non-significant for school closure, immigrant status, COVID-19-related loss, or COVID-19 infection. A greater number of concomitant risk factors was associated with larger P-score worsening ( $B = 1.198, SE = 0.161, p < .001$ ). Results from representative samples only are provided in Table S6, available online.

### Coping Strategies

The coping strategies most frequently rated as "very important" were as follows: Internet use = 57.0%, exercise/walking = 51.4%, direct social contacts = 50.4%, followed by social media use/remote interactions = 49.8%, media use = 47.2%, having a hobby = 45.4%, gaming = 38.8%, receiving COVID-19 pandemic information = 38.8%, spending time with a pet = 38.3%, studying/learning = 37.3%, work = 24.5%, prescribed medications = 23.9%, physical intimacy = 21.8%, religion/meditation/spirituality = 21.2%, other strategies = 14.5%, and substance use = 9.6% (Figure 3, Table S7, available online).



**TABLE 2** Changes in Well-Being and Psychopathology Across Countries With More Than 100 Respondents, in Descending Order of Magnitude

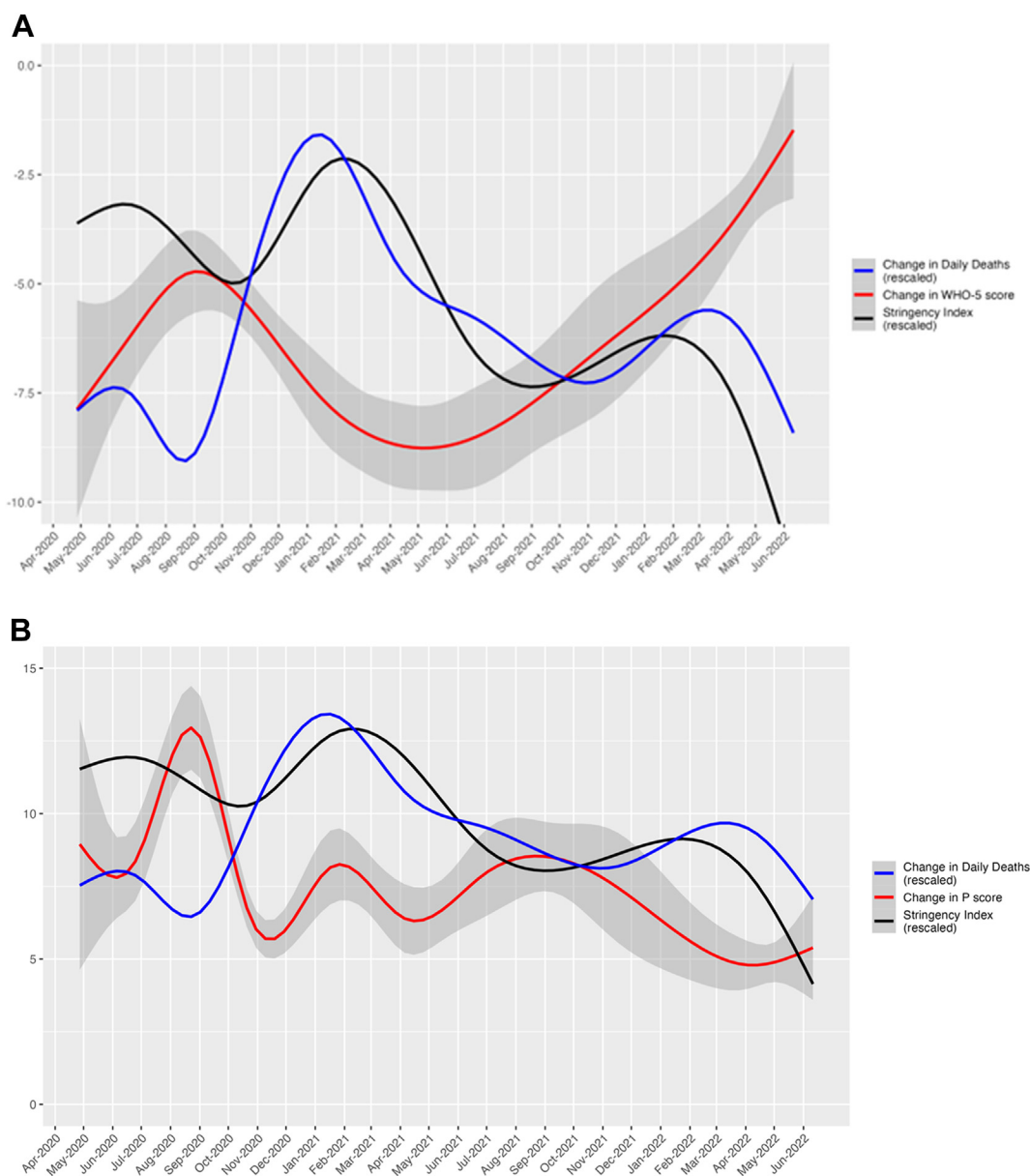
| Country        | N     | Before pandemic |       | During pandemic |       | Weighted change |       |
|----------------|-------|-----------------|-------|-----------------|-------|-----------------|-------|
|                |       | Mean            | SD    | Mean            | SD    | Mean            | p     |
| WHO-5          |       |                 |       |                 |       |                 |       |
| Uruguay        | 286   | 69.44           | 17.85 | 57.83           | 21.64 | 10.91           | <.001 |
| Uganda         | 320   | 57.47           | 18.08 | 48.32           | 17.27 | 9.13            | <.001 |
| Thailand       | 155   | 75.22           | 19.14 | 66.16           | 22.45 | 8.54            | <.001 |
| Germany        | 813   | 76.51           | 18.83 | 68.48           | 22.77 | 7.97            | <.001 |
| Czech Republic | 112   | 66.67           | 19.82 | 57.74           | 24.59 | 7.81            | 0.009 |
| Switzerland    | 133   | 69.67           | 19.18 | 61.56           | 21.77 | 7.64            | 0.003 |
| Poland         | 182   | 78.54           | 16.86 | 71.17           | 20.48 | 7.36            | <.001 |
| Greece         | 283   | 75.91           | 20.86 | 68.69           | 22.51 | 7.21            | <.001 |
| Austria        | 562   | 75.92           | 18.84 | 69.14           | 23.25 | 6.77            | <.001 |
| France         | 263   | 80.77           | 17.26 | 74.93           | 20.75 | 5.96            | <.001 |
| Brazil         | 632   | 78.37           | 18.57 | 72.70           | 21.20 | 5.70            | <.001 |
| United Kingdom | 467   | 76.24           | 19.11 | 70.55           | 22.19 | 5.63            | <.001 |
| Italy          | 625   | 79.02           | 16.38 | 74.20           | 19.18 | 4.83            | <.001 |
| Spain          | 1,358 | 79.99           | 16.39 | 75.43           | 18.62 | 4.60            | <.001 |
| Bangladesh     | 410   | 69.19           | 20.88 | 65.15           | 19.49 | 4.05            | 0.005 |
| Canada         | 225   | 75.45           | 17.35 | 73.06           | 19.88 | 2.40            | 0.174 |
| Russia         | 257   | 83.33           | 15.79 | 82.22           | 16.32 | 1.11            | 0.433 |
| United States  | 511   | 77.82           | 18.45 | 77.11           | 18.56 | 0.75            | 0.515 |
| Taiwan         | 340   | 72.85           | 22.09 | 72.48           | 22.20 | 0.02            | 0.993 |
| P-score        |       |                 |       |                 |       |                 |       |
| Uruguay        | 286   | 30.61           | 18.64 | 48.98           | 22.45 | -17.53          | <.001 |
| Bangladesh     | 410   | 36.41           | 21.03 | 50.44           | 22.88 | -14.88          | <.001 |
| Thailand       | 155   | 23.84           | 19.60 | 36.30           | 22.50 | -12.43          | <.001 |
| Switzerland    | 133   | 27.37           | 18.58 | 39.46           | 24.50 | -11.80          | <.001 |
| Czech Republic | 112   | 32.65           | 20.01 | 44.55           | 22.79 | -10.09          | <.001 |
| Austria        | 562   | 26.86           | 20.18 | 35.04           | 23.27 | -8.08           | <.001 |
| Uganda         | 320   | 32.87           | 20.14 | 40.45           | 19.40 | -7.56           | <.001 |
| Taiwan         | 340   | 17.87           | 17.65 | 25.54           | 20.89 | -7.47           | <.001 |
| Greece         | 283   | 33.27           | 22.49 | 40.48           | 22.61 | -7.21           | <.001 |
| Poland         | 182   | 31.66           | 20.94 | 38.77           | 23.78 | -7.11           | 0.003 |
| Germany        | 813   | 26.44           | 20.89 | 32.83           | 23.35 | -6.24           | <.001 |
| Italy          | 625   | 31.67           | 22.60 | 37.73           | 24.66 | -6.08           | <.001 |
| France         | 263   | 23.31           | 22.81 | 28.76           | 24.56 | -5.62           | 0.007 |
| Brazil         | 632   | 43.65           | 22.20 | 48.67           | 23.56 | -5.06           | <.001 |
| United Kingdom | 467   | 25.43           | 21.96 | 30.25           | 24.42 | -4.83           | 0.002 |
| Russia         | 257   | 21.37           | 20.03 | 26.09           | 22.04 | -4.72           | 0.011 |
| Spain          | 1,358 | 31.91           | 23.63 | 35.32           | 24.46 | -3.49           | <.001 |
| Canada         | 225   | 33.39           | 23.26 | 36.76           | 25.54 | -3.37           | 0.144 |
| United States  | 511   | 50.58           | 28.53 | 52.59           | 28.85 | -2.10           | 0.242 |

**Note:** WHO-5 = World Health Organization–Five Well-Being Index.

## DISCUSSION

To our knowledge, this is the first multi-language study to assess changes in well-being and overall psychopathology, as well as coping strategies, from before to during the COVID-19 pandemic in a transcontinental, predominantly

representative sample of adolescents. We found that during the COVID-19 pandemic, well-being and mental health of adolescents worsened, albeit with a small effect size, yet heterogeneously across one or multiple risk factor subgroups and countries. COVID-19–related deaths and restriction

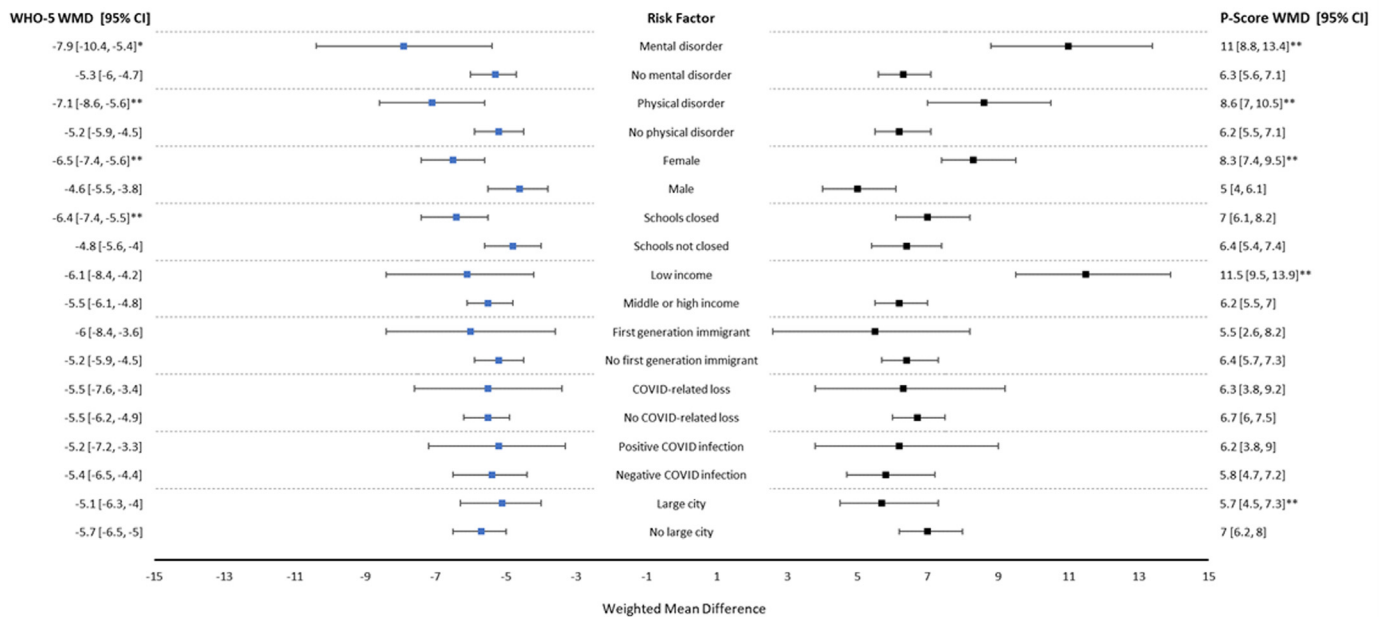
**FIGURE 1** Trajectory of Change in Outcomes of WHO-5 Well-Being Score (A) and Composite Psychopathology P-Score (B), Stringency, and Daily Death Rate

**Note:** Stringency and daily death rate rescaled to same metric as outcomes to facilitate comparison. WHO-5 = World Health Organization–Five Well-Being Index.

stringency association with well-being and psychopathology were statistically significant but negligible. The 3 most subjectively important coping strategies were Internet use, exercise/walking, and direct social contacts. Notably, well-being and composite psychopathology returned to near-pre-pandemic values after more than 2 years of the pandemic.

COH-FIT overcomes many limitations of previous studies on this topic, according to recent meta-analytic

evidence based on 51 studies.<sup>2</sup> First, previous studies were mostly (94%) based on convenience samples. Notably, early in the pandemic, Pierce *et al.* warned against the bias introduced by the exclusive use of convenience samples in mental health surveys. By contrast, COH-FIT relied mainly (75%) on representative sampling. Second, previous studies focused mainly on the assessment of isolated domains of psychopathology, with an emphasis on internalizing behaviors, whereas COH-FIT successfully assessed well-being

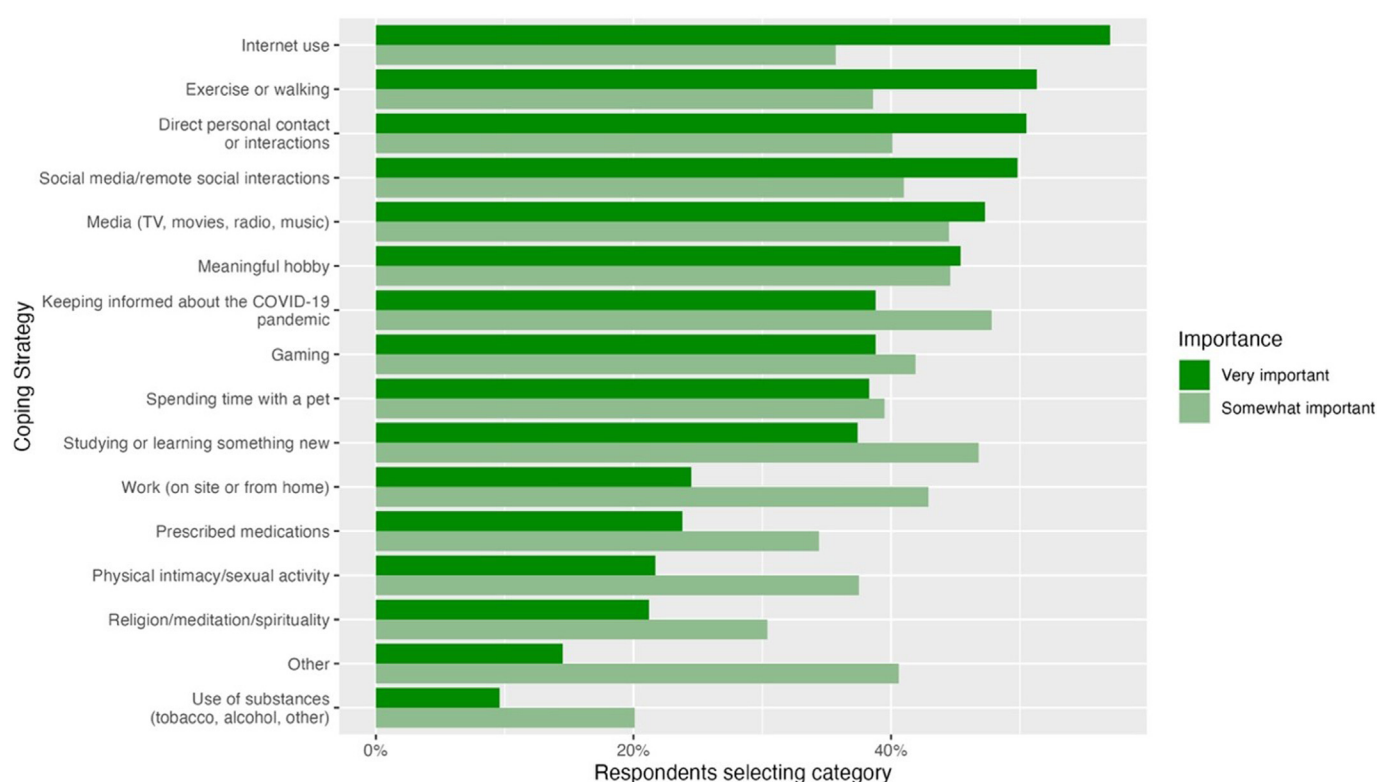
**FIGURE 2** Forest Plot of Changes in Well-Being and Psychopathology Across Risk Factors in Adolescents During vs Before COVID-19 Pandemic

**Note:** Although non-overlapping confidence lines (each corresponding to the group's standard error [SE]) are commonly used as a rough proxy for indicating significant differences across 2 groups, the precise 95% confidence interval relating to a comparison between 2 groups is actually  $\sqrt{2} \times SE$ , rather than  $2 \times SE$  (as suggested by the 2 drawn lines), being just under 30% smaller (eg, [https://www.jvascsurg.org/article/S0741-5214\(02\)00030-7/pdf](https://www.jvascsurg.org/article/S0741-5214(02)00030-7/pdf)). Visually reducing the SE lines by about 30% would give a better indicator of whether the difference between 2 groups has reached statistical significance.

\* $p < 0.05$ , Significant difference with vs without risk factor; \*\* $p < 0.001$ , significant difference with vs without risk factor.

as well as a composite index of general psychopathology. Third, previous studies were based mainly on one or a few countries. COH-FIT, being a multicontinental study, provides a unique overview of changes in well-being and psychopathology worldwide. Notably, we found an overall worsening of well-being and psychopathology across many countries, consistent with other data in adolescents and adults<sup>32</sup>; this was not the case for selected countries. Adolescents' well-being did not appear to worsen in Canada, Russia, the United States, or Taiwan, and no significant changes in general psychopathology were reported in Canada and the United States. Although it is possible that measures and policies applied in these countries were particularly effective in containing the impact of the pandemic in adolescents' well-being and mental health, it is also possible that other reasons were responsible for our not detecting significant changes in these countries, such as time of data collection or other unmeasured factors. Fourth, previous studies generally focused on psychopathology, whereas an important aim of COH-FIT was to also explore coping strategies, which is crucial to inform individual and mental health professional behaviors and public health policies on directly actionable measures, such as facilitating

Internet access, exercise/walking, and direct social contacts. The findings on physical exercise resonate with a large-scale umbrella review showing benefits of physical activity on psychosocial outcomes in youth.<sup>33</sup> Our findings underscore that, with cautions to restrict virus spread, (outdoor) exercise, safe direct social contact and Internet access should be facilitated, including for those adolescents unlikely to be able afford it. Fifth, previous evidence generally failed to account for variation in local death rates, severity of the COVID-19 pandemic, and governmental restrictions. We found that psychopathology and well-being were correlated with the Stringency Index, and well-being was also correlated with COVID-19-related deaths. However, these correlations were small, and we were likely limited by the small number of deaths in adolescents. Sixth, previous surveys investigated relatively small samples, or were set in one country, with sample sizes ranging, for instance, in studies reporting on anxiety symptoms from 184 to 11,774 (one country only). Overcoming the logistic challenges of initiating research studies and recruiting samples during the pandemic, our large sample size ( $N = 8,115$ ) collected as early as April 26, 2020, allowed us not only to detect average pre- to intra-pandemic group level changes, starting

**FIGURE 3** Most Important Coping Strategies in Adolescents During COVID-19 Pandemic

in the earliest pandemic times, but also to assess the impact on specific adolescent subgroups. Indeed, although the worsening, at the group level, in well-being and psychopathology is consistent with previous findings in youth, and although the small effect size would suggest that these changes were overall of limited clinical/public health importance, well-being and psychopathology worsened more substantially in specific subgroups. Having a mental health disorder, having a physical disorder, and female gender increased the negative impact of the pandemic both regarding well-being and psychopathology, consistent with effects in adults, and suggesting that these populations should be considered when allocating resources and initiatives to protect mental health and well-being by clinicians and governmental policies.<sup>34,35</sup> The timing and extent of school closures during the pandemic has been discussed controversially.<sup>36</sup> Our results suggest that school closures affect mainly well-being, but that effect may not be a strong risk factor for worsening of psychopathology. By contrast, not living in a big city was associated with worsening in psychopathology. Although worse housing conditions with less access to green areas, higher cost of living, and increasing job/financial insecurities might be expected to worsen psychopathology in adults, adolescents may

particularly value living in big cities in terms of peer support and social connectedness. Importantly, having multiple risk factors increased the pandemic's impact on well-being and mental health, suggesting that clinical care as well as public health prevention, promotion, and interventions should prioritize individuals with specific and, especially, multiple risk factors, aiming to provide targeted assistance and to reduce risk factors globally.

Although the duration of the studied effects of the pandemic on mental health in youth has been limited to a few months (eg, less than 1 year for studies of anxiety symptoms), our continuous data collection for more than 2 years allowed us to explore and assess temporal trends. Overall, our findings point to a return to near-pre-pandemic values after more than 2 years. As our findings are based on repeated cross-sectional rather than longitudinal data, they should be considered exploratory. Nevertheless, the pattern of change that we observed is consistent with longitudinal data from a large-scale meta-analysis pooling studies in adults and youth and showing a U-shaped relationship between time in the COVID-19 pandemic and anxiety/depressive symptom severity.<sup>32</sup> Overall, these data provide reassurance regarding the mental health impact of the pandemic, at least in the medium term and at the

general population level. Nevertheless, efforts are needed to identify less resilient/fortunate/resourceful subgroups and helping them to recover from the impact of the pandemic also.

Results from this study should be interpreted considering its limitations, including the cross-sectional design at the individual level, paired with retrospective recall to allow for calculation of pre- to intra-pandemic status. However, we did not detect a relevant drift in the retrospective recall of the pre-pandemic WHO-5 or P-factor during the study period. Moreover, accounting for severity of COVID-19 infections was not possible because we did not collect information on need for hospitalization for COVID-19, intensive care unit, intubation, or other proxy measures of severity. Also, country-level data were limited by small sample sizes that may have reduced the power to find significant differences between responses regarding pre-and intra-pandemic times in some isolated countries. With regard to the structure of the P-scale, although the correlated factors model had the most favorable fit indices, such indices can be biased by model features such as complexity, sample size, and other factors, and second-order and bifactor models should not be rejected. Nevertheless, all of these models commonly support the existence of 5 distinct but highly related dimensions (albeit with different inferences on how they are related), which supports the computation of either an overall P-score dimension or 5 separate subdomains. This P-score, however, did not measure externalizing symptoms. Finally, we did not conduct analyses on specific risk factors within each country, as dedicated reports will be focusing on them.

Despite these limitations, the COH-FIT study provides unique data to inform individuals, clinicians, and public health/intervention policies aimed at preventing/decreasing the impact of this and possible future pandemics on the well-being and mental health of adolescents.

### CRedit authorship contribution statement

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