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# Global and risk-group stratified well-being and mental health during the COVID-19 pandemic in adults: Results from the international COH-FIT Study

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ABSTRACT

International studies measuring wellbeing/multidimensional mental health before/ during the COVID-19 pandemic, including representative samples for >2 years, identifying risk groups and coping strategies are lacking. COH-FIT is an online, international, anonymous survey measuring changes in well-being (WHO-5) and a composite psychopathology P-score, and their associations with COVID-19 deaths/restrictions, 12 a-priori defined risk individual/cumulative factors, and coping strategies during COVID-19 pandemic (26/04/2020-26/06/2022) in 30 languages (representative, weighted non-representative, adults). T-test, $\chi^2$, penalized cubic splines, linear regression, correlation analyses were conducted. Analyzing 121,066/142,364 initiated surveys, WHO-5/P-score worsened intra-pandemic by 11.1±21.1/13.2±17.9 points (effect size d=0.50/0.60) (comparable results in representative/weighted non-probability samples). Persons with WHO-5 scores indicative of depression screening (<50, 13% to 32%) and major depression (<29, 3% to 12%) significantly increased. WHO-5 worsened from those with mental disorders, female sex, COVID-19-related loss, low-income country location, physical disorders, healthcare worker occupations, large city location, COVID-19 infection, unemployment, first-generation immigration, to age=18-29 with a cumulative effect. Similar findings emerged for P-score. Changes were significantly but minimally related to COVID-19 deaths, returning to near-pre-pandemic values after >2 years. The most subjectively effective coping strategies were exercise and walking, internet use, social contacts. Identified risk groups, coping strategies and outcome trajectories can inform global public health strategies.

## 1. Introduction

Until June-7-2023 >767,750,000 persons have been infected with COVID-19, and >6,941,000 died (World Health Organization, 2020). The pandemic also worsened mental health of the general population (Clift et al., 2022), as measured in cohort studies and surveys in individual countries. Several non-COVID-19-related cohort studies had a pre-pandemic mental health assessment (Ahrens et al., 2021), but most did not, retrospectively assessing pre-pandemic mental health (Huang et al., 2022). Also, to avoid in-person visits, both cohort studies and surveys assessed mental health with questionnaires (Lu et al., 2022). Many surveys have reported alarming rates of anxiety, depression, and post-traumatic symptoms during COVID-19 (Dragioti et al., 2022). However, most studies were affected by methodological limitations limiting the impact, representativeness, and generalizability of findings (e.g., assessing one intra-pandemic time-point only). Also, studies were set in at most two countries, used questionnaires in one language only

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(neglecting linguistic/ethnic minorities), focused on one or few mental health domains, in non-representative samples, or in specific population subgroups, collecting few candidate risk/mitigating factors for mental health, without concurrently assessing physical health outcomes (Dragioti et al., 2022). Such limitations impede a comprehensive understanding of the health impact COVID-19. For instance, previous reports from individual countries showed that general population mental health is closely related with COVID-19 infection (Abel et al., 2021) and restrictions (Fancourt et al., 2021), but such associations at the global level remain unclear. Moreover, no study has assessed whether risk factors for poor mental health identified in individual countries, like younger and older age (Patel et al., 2022), female sex (Patel et al., 2022), or pre-existing physical and mental disorders (Dragioti et al., 2022), replicate globally.

The Collaborative Outcomes study on Health and Functioning during Infection Times (COH-FIT, www.coh-fit.com) (Solmi et al., 2022a, b) is an international survey study, conducted in 30 languages in representative/weighted non-representative samples. COH-FIT has been measuring well-being and the psychopathology factor (P-score), a composite mental health measure (Solmi et al., 2022a), in the general population across all continents since April-26-2020, including a retrospectively recalled pre-pandemic assessment, comprehensive multidimensional factors relevant for well-being and mental health. Here, we report globally in adults, findings of the two co-primary COH-FIT outcomes, well-being and the P-score, hypothesizing reduced well-being and increased psychopathology globally, with increased impairment in vulnerable subgroups and related to death rates and stringency measures over time, and with cumulative effects across multiple risk factors. We also assessed subjectively most effective coping strategies for dealing with the impact of the pandemic.

## 2. Methods

COH-FIT was approved by institutional ethics committees in study investigators' countries (published protocol (Solmi et al., 2022a, b)). COH-FIT translations and the P-score have been validated (Solmi et al., 2022a). For detailed methods and data dictionary with items' text and response values, see supplementary material. Below, we report methods and results following A Consensus-Based Checklist for Reporting of Survey Studies (CROSS) (Sharma et al., 2021) (eChecklist).

### 2.1. Outcomes

The two co-primary outcomes were intra- vs. pre-pandemic changes in the WHO-5 well-being score (Topp et al., 2015), and the "P-score", a 5-dimensional measure composed of anxiety, depression, post-traumatic symptoms, psychotic symptoms, and psychophysiologic parameters (stress, sleep problems, and concentration problems). Participants rated symptoms "during the last two weeks", and "during the last two weeks of their regular life" before the pandemic (visual analogue scale, 0-100 range WHO-5=0-100, P-score=0-100, higher scores better and worse status, respectively). Additionally, we calculated the proportion of subjects with WHO-5 <50 (indication for testing for depression), and <29 (indicative of major depression) (Topp et al., 2015), pre- and intra-pandemic.

We examined possible recall bias for WHO-5 and P-score performing polynomial regression analyses using linear or quadratic relationships.

Additionally, respondents rated how important ("very", "somewhat", "not") the following coping strategies were for dealing effectively with the pandemic: exercise or walking, 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.

### 2.2. At-risk groups

Based on previous literature (Dragioti et al., 2022; Salazar de Pablo et al., 2020) we *a priori* identified 12 risk factors for poor well-being/mental health, namely having had COVID-19 infection, age ≤30, female sex, being unemployed, healthcare worker employment, having a mental disorder, having a physical disorder, first-generation immigrant status, large city location, low-income country location, obesity, and having lost someone due to COVID-19.

### 2.3. COVID-19 deaths and restrictions

Time- and region-specific COVID-19 daily deaths, and stringency index were extracted from Johns Hopkins University repository (https://coronavirus.jhu.edu/data), and University of Oxford stringency metric (0-100) (https://covidtracker.bsg.ox.ac.uk/) (eMethods).

### 2.4. Data analysis

The missing item data were imputed using multivariate chained equations, using predictive mean matching (van Buuren and Groothuis-Oudshoorn, 2011) to impute missing continuous values, and logistic regression for categorical variables (eMethods). Two iterations of outlier screening were undertaken, using a relatively high threshold of |z|=5.0, and winsoring them to the next highest non-outlying value. Details on survey weighting are available in eMethods. WHO-5 and P-score values and proportion of WHO-5 <50 and <29 pre- vs during pandemic were compared with paired t-test and $\chi^2$ test. Changes in the co-primary outcomes were compared in subjects with vs. without each risk factor for poor well-being/high P-score during the pandemic, using independent t-tests. Both weighted t-tests, using calibration weights, and unweighted t-tests with the original unweighted data were conducted. All tests of primary outcomes were evaluated for significance using an alpha threshold of α=.01.

We also explored a cumulative effect of multiple risk factors on outcomes by testing a linear regression model between number of concomitant risk factors and co-primary outcomes. As the trajectory of intra-pandemic changes in WHO-5 and P-score could not be realistically predicted *a priori*, we conducted exploratory modelling of the course of outcomes using penalised cubic splines, plotting them together with COVID-19 deaths and restrictions. To quantify the association of outcomes with COVID-19 deaths, stringency, stringency/death ratio, and time, we conducted correlation and smoothed regression analyses. All analyses were performed in R, except for regression analyses for cumulative risk factors and correlation analyses, which were conducted with STATA.

## 3. Results

### 3.1. Survey sample

Overall, from 142,364 initiated surveys, 121,066 adults (age=42.0 ±15.9 (*range*=18-100); male=35.4%, female=64%, non-binary=0.4%, transgender/intersex=0.2%) provided analyzable data between 26-Apr-2020/19-Jun-2022. (participant flow in eFig. 1).

Baseline characteristics (see Table 1, and eTable 2 comparing included/excluded samples), indicated over-representation of females, younger adults, and those with higher education vs. national population statistics (eFig. 2).

A longer interval between survey completion and pandemic start was related to both pre-pandemic well-being scores (linear β=-0.03, quadratic β=-0.03, p<.001) and P scores (linear β=-0.01, quadratic β=-0.07, p<.001), yet with a negligible effect size (see eFigs. 3 and 4/), reflecting absence of substantial recall bias/drift.

**Table 1**
Basic participant characteristics for overall, representative and non-probability samples.

| | Overall | | Representative | | Non-probability | |
|---|---|---|---|---|---|---|
| | N | Percent | N | Percent | N | Percent |
| **Representative sample** | | | | | | |
| non-probability | 86017 | 71.0 | 0 | 0 | 86017 | 100 |
| representative | 35049 | 29.0 | 35049 | 100 | 0 | 0 |
| **Age** | | | | | | |
| 18-34 | 46159 | 38.1 | 10216 | 29.1 | 35943 | 41.8 |
| 35-49 | 33947 | 28.0 | 9829 | 28.0 | 24118 | 28.0 |
| 50-64 | 28769 | 23.8 | 10058 | 28.7 | 18711 | 21.8 |
| 65+ | 12191 | 10.1 | 4946 | 14.1 | 7245 | 8.4 |
| **Gender** | | | | | | |
| Male | 42891 | 35.4 | 17242 | 49.2 | 25649 | 29.8 |
| Female | 77487 | 64.0 | 17696 | 50.5 | 59791 | 69.5 |
| Non-binary | 462 | 0.4 | 67 | 0.2 | 395 | 0.5 |
| Transgender or intersex | 226 | 0.2 | 44 | 0.1 | 182 | 0.2 |
| **Ethnicity** | | | | | | |
| White | 83498 | 69.0 | 28641 | 81.7 | 54857 | 63.8 |
| African/African-descent | 3375 | 2.8 | 632 | 1.8 | 2743 | 3.2 |
| Hispanic | 3366 | 2.8 | 884 | 2.5 | 2482 | 2.9 |
| Asian | 23795 | 19.7 | 2765 | 7.9 | 21030 | 24.4 |
| Mixed | 5121 | 4.2 | 1561 | 4.5 | 3560 | 4.1 |
| Other | 1403 | 1.2 | 449 | 1.3 | 954 | 1.1 |
| Prefer not to answer | 508 | 0.4 | 117 | 0.3 | 391 | 0.5 |
| **First-generation immigrant** | | | | | | |
| No | 73346 | 92.6 | 26480 | 92.2 | 46866 | 92.8 |
| Yes | 5897 | 7.4 | 2253 | 7.8 | 3644 | 7.2 |
| **Education** | | | | | | |
| None | 671 | 0.6 | 196 | 0.6 | 475 | 0.6 |
| Primary school | 3401 | 2.8 | 2018 | 5.8 | 1383 | 1.6 |
| High school | 38726 | 32.0 | 18706 | 53.4 | 20020 | 23.3 |
| College/university degree | 68335 | 56.4 | 12986 | 37.1 | 55349 | 64.3 |
| PhD | 9933 | 8.2 | 1143 | 3.3 | 8790 | 10.2 |
| **Socio-economic status** | | | | | | |
| 0-24 | 7104 | 5.9 | 2298 | 6.6 | 4806 | 5.6 |
| 25-49 | 23091 | 19.1 | 7253 | 20.7 | 15838 | 18.4 |
| 50-74 | 71109 | 58.7 | 21148 | 60.3 | 49961 | 58.1 |
| 75-100 | 19762 | 16.3 | 4350 | 12.4 | 15412 | 17.9 |
| **Employment** | | | | | | |
| No | 46890 | 38.7 | 13909 | 39.7 | 32981 | 38.3 |
| Yes | 74176 | 61.3 | 21140 | 60.3 | 53036 | 61.7 |
| **Healthcare worker** | | | | | | |
| No | 56004 | 76.1 | 18864 | 89.4 | 37140 | 70.7 |
| Yes | 17606 | 23.9 | 2239 | 10.6 | 15367 | 29.3 |
| **Mental health diagnosis** | | | | | | |
| No | 101325 | 83.7 | 30523 | 87.1 | 70802 | 82.3 |
| Yes | 19741 | 16.3 | 4526 | 12.9 | 15215 | 17.7 |
| **Physical disease diagnosis** | | | | | | |
| No | 66840 | 55.2 | 20404 | 58.2 | 46436 | 54.0 |
| Yes | 54226 | 44.8 | 14645 | 41.8 | 39581 | 46.0 |
| **COVID-19 infection** | | | | | | |
| No | 27989 | 82.8 | 10874 | 77.6 | 17115 | 86.6 |
| Yes | 5805 | 17.2 | 3147 | 22.4 | 2658 | 13.4 |
| **Urbanicity** | | | | | | |
| Village/rural | 21415 | 17.7 | 8459 | 24.1 | 12956 | 15.1 |
| Small city/town (10,000-100.000 population) | 30037 | 24.8 | 10199 | 29.1 | 19838 | 23.1 |
| Medium city/town (100,000-500.000 population) | 27312 | 22.6 | 7186 | 20.5 | 20126 | 23.4 |
| Large city/town (over 500.000 population) | 42302 | 34.9 | 9205 | 26.3 | 33097 | 38.5 |
| **Restrictions (Oxford Stringency Index)** | | | | | | |
| 0-24 | 4578 | 3.8 | 3446 | 9.8 | 1132 | 1.3 |
| 25-49 | 24754 | 20.4 | 10270 | 29.3 | 14484 | 16.8 |
| 50-74 | 61978 | 51.2 | 17914 | 51.1 | 44064 | 51.2 |
| 75-100 | 29756 | 24.6 | 3419 | 9.8 | 26337 | 30.6 |
| **Country income** | | | | | | |
| High income | 83214 | 68.7 | 29492 | 84.1 | 53722 | 62.5 |
| Middle income | 32517 | 26.9 | 5557 | 15.9 | 26960 | 31.3 |
| Low income | 5335 | 4.4 | 0 | 0 | 5335 | 6.2 |
| **Obesity** | | | | | | |
| No (BMI < 30) | 98291 | 85.0 | 26998 | 79.1 | 71293 | 87.4 |
| Yes (BMI 30+) | 17371 | 15.0 | 7113 | 20.9 | 10258 | 12.6 |
| **COVID-19-related loss** | | | | | | |
| No | 114424 | 94.8 | 32684 | 93.3 | 81740 | 95.4 |
| Yes | 6329 | 5.2 | 2347 | 6.7 | 3982 | 4.6 |

### 3.2. Well-being

The WHO-5 score decreased by 11.1±21.1 points from pre- (71.5 ±19.3) to intra-pandemic (60.4±24.5) (paired t=183.68, $p$<.001, moderate effect size of d=.50). The proportion of individuals scoring <50 increased from 13% pre-pandemic to 32% intra-pandemic (McNemar's $\chi^2$=17637.38, p<.001), with the proportion scoring <29 increasing from 3% pre-pandemic to 12% intra-pandemic (McNemar's $\chi^2$=9103.50, p<.001).

A world map of WHO-5 changes shows that worsening varied across countries, but with a general pattern of global deterioration (Figs. 1A, 2A, and B, eTable 3).

Compared with those without each risk factor, larger decreases in WHO-5 score emerged for those, in descending order, with a mental disorder, females, COVID-related loss, living in low-income countries, with a physical disorder, healthcare workers, living in a large city, with prior COVID-19 infection, unemployment, and age 18-29 years old, but not for first-generation immigrants. Obesity was associated with smaller decline of WHO-5 (Fig. 3A, eTable 4). Multiple concomitant risk factors cumulatively increased WHO-5 worsening (1.95 WHO-5 score worsening for each risk factor, standard error/SE=0.070, p<0.01).

### 3.3. P-score

The P-scores increased by 13.2±17.9 points from pre-pandemic 27.5 ±19.9 to intra-pandemic 40.7±23.6 (paired t=256.23, p<.001, moderate effect size d=.60). Additionally, 63% experienced a P-score increase by ≥20%, 57% by ≥30%, 52% by ≥40%, and 47% by ≥50%.

A world map of P-score changes shows that P-score worsening varied across countries, but with a general pattern of global increase (Fig. 1B, eTable 3).

Compared with those without each risk factor, larger increases in P-score emerged for those, in descending order, with a mental disorder, living in low-income countries, females, age 18-29 years old, a physical disorder, COVID-related loss, healthcare workers, unemployment, living in a large city, first-generation immigrants, with history of COVID-19 infection, but without any difference for obesity (Fig. 3A, eTable 4). Multiple concomitant risk factors increased P-score worsening (2.03 P-score worsening for each risk factor, SE=0.06, p<0.01)

### 3.4. Coping strategies

The coping strategies most frequently rated as "very important" were

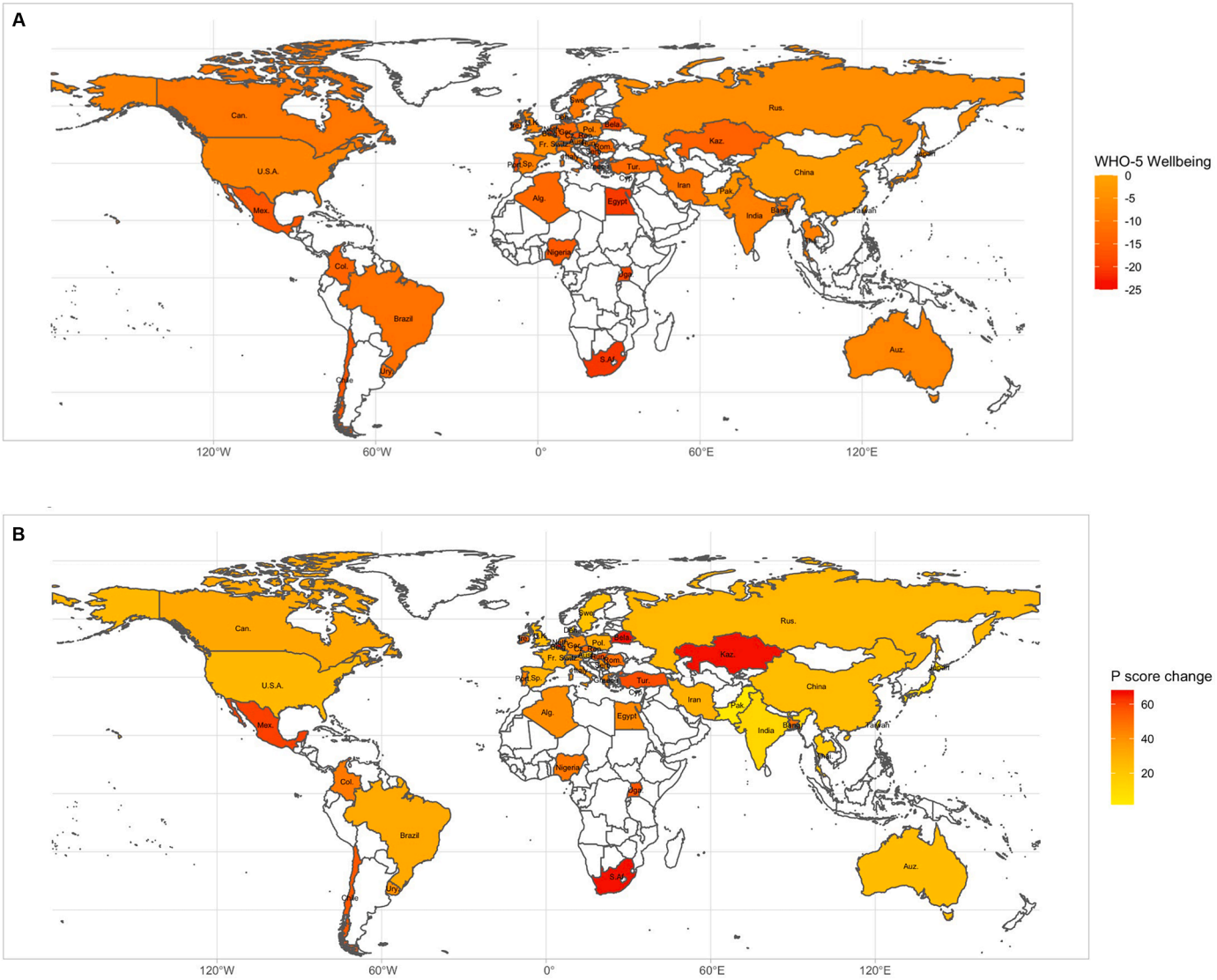


**Fig. 1.** Global change in WHO-5 well-being score (1A) and the composite psychopathology P-score (1B) in the general population during COVID-19 pandemic in COH-FIT. Legend Fig. 1.: COH-FIT, Collaborative Outcomes study on Health and Functioning during Infection Times, WHO, World Health Organization; larger negative and positive values indicate worsening of WHO-5, and P-score, respectively.

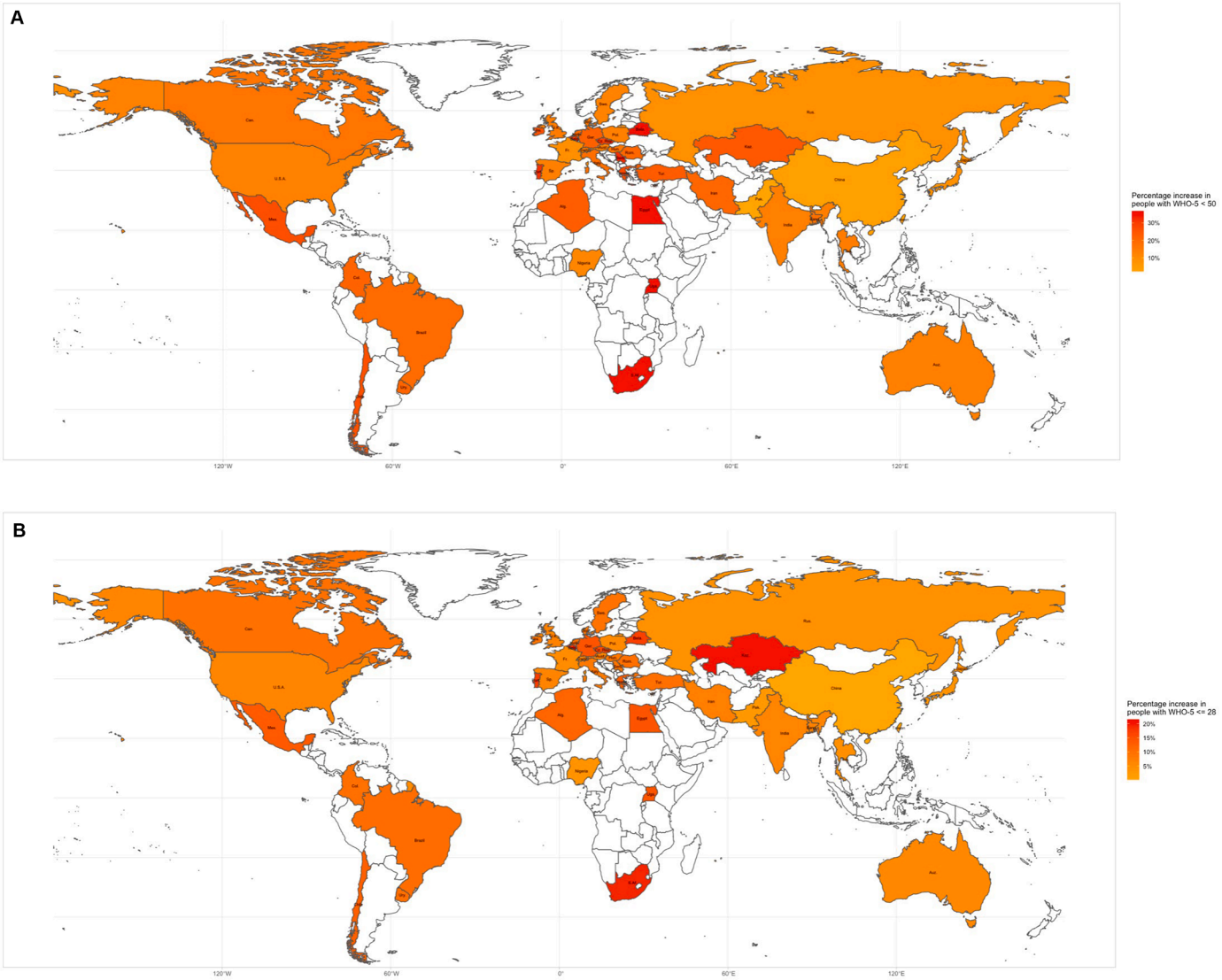


**Fig. 2.** Proportion of subjects with a WHO-5 well-being score < 50 (2A) and <29 (2B) in the general population during COVID-19 pandemic in COH-FIT.

exercise or walking=56.0%, internet use=55.3%, direct social contacts=52.7%, followed by hobby=48.8%, COVID-19 pandemic information=44%, media use=43.9%, social media use/remote interactions=39.4%, work=37.5%, studying/learning=31.6%, spending time with a pet=31.4%, physical intimacy=27.4%, prescribed medications=26.7%, religion/meditation/spirituality=20.9%, gaming=18.0%, other strategies=12.9%, and substance use=7.8% (Fig. 3B, eTable 5).

### *3.5. Change trajectories in well-being, P-score, COVID-19 deaths and restrictions in the overall sample, and across risk factors*

The smoothed trajectories of changes in well-being suggested a worsening of WHO-5 until May-June 2021, when well-being returned to early intra-pandemic levels (Fig. 4A and eFig. 17).

P-score peak worsening overall preceded WHO-5 oscillations by 1-2 months (Fig. 4B).

The course of well-being and P-score, together with the course with COVID-19 deaths and restrictions during the pandemic across risk factors, are visualized in eFigs. 5–16.

Exploratory correlation analyses showed that in the whole sample and across risk factors, both co-primary outcomes were significantly associated with COVID-19 deaths, restrictions stringency, and with stringency/death ratio, yet with very small effect sizes (eTable 6).

WHO-5 and P-score worsening returned towards near-pre-pandemic values over time (F=116.20, p<0.001, F=83.38, p<0.001).

## 4. Discussion

This transcontinental study shows that during the COVID-19 pandemic well-being and mental health worsened in the general population, with a medium effect size, heterogeneously across one or multiple risk factors, countries, and time. COVID-19-related deaths, restriction stringency, and their ratio were significantly yet only minimally associated with worsening of well-being and psychopathology. Most effective coping strategies were identified. Well-being and composite psychopathology returned to near-pre-pandemic values after >2 years of the pandemic.

Results of COH-FIT confirm, though transcontinentally, findings from a systematic review that pooled 177 European studies, reporting a significant negative impact of COVID-19 on mental health, followed by a trending towards pre-pandemic levels over time (Ahmed et al., 2023). Also, COH-FIT results should be interpreted in comparison with findings of a well-conducted recent meta-analysis of cohort studies, which concluded that no/minimal mental health changes occurred during COVID-19 (Sun et al., 2023). Despite the methodological rigor of that

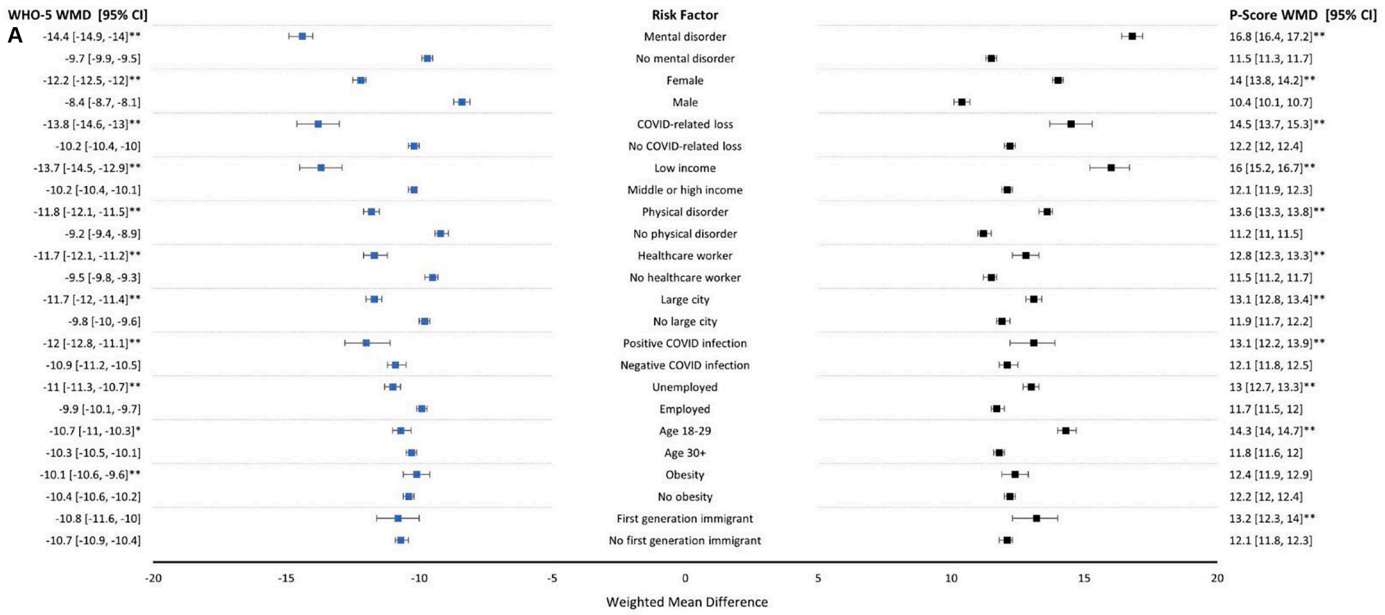


**Fig. 3.** Forest plot of changes in well-being and P-score (3A) across risk factors in adults during versus before COVID-19 pandemic, and coping strategies (3B). Legend Fig. 3A.: Risk factors are ordered by WHO-5 score difference between groups with and without risk factor; **, p value <0.05

meta-analysis, the included cohort studies had several limitations. First, 97% of response came from high/upper-middle-income countries. In COH-FIT, 31% of responses came from low/middle-income countries, which had the largest worsening. Second, only 23% of the studies recruited representative samples. In COH-FIT, 29% were representative samples, and results did not differ between representative and weighted non-probability samples. Third, only 31% of included cohorts followed up with ≥75% participants, with selective retaining of persons that were doing well enough no to drop from the study. COH-FIT kept collecting responses longitudinally at the population level, and the retrospective assessment of pre-pandemic well-being and mental health did not show an upward or downward (idealization or contamination) drift. Fourth, the outcomes included general mental health, depressive, and anxiety symptoms, taken individually, and only one study included WHO-5. COH-FIT also measured a psychopathology P-score, integrating five different domains into one validated score (Solmi et al., 2022a), and used WHO-5 in the whole population. Fifth, regarding subgroup analyses, those were largely underpowered, with only 2-3 studies in several subgroup analyses, very wide confidence intervals, and, low power. COH-FIT was adequately powered to detect changes in outcomes and cross largely represented risk groups. Sixth, follow-up was limited to 2020 in 96.3% of the 134 cohorts, with only five studies measuring outcomes in 2021, limiting generalizability of findings beyond the very early stages of the pandemic. COH-FIT collected data for >2 years.

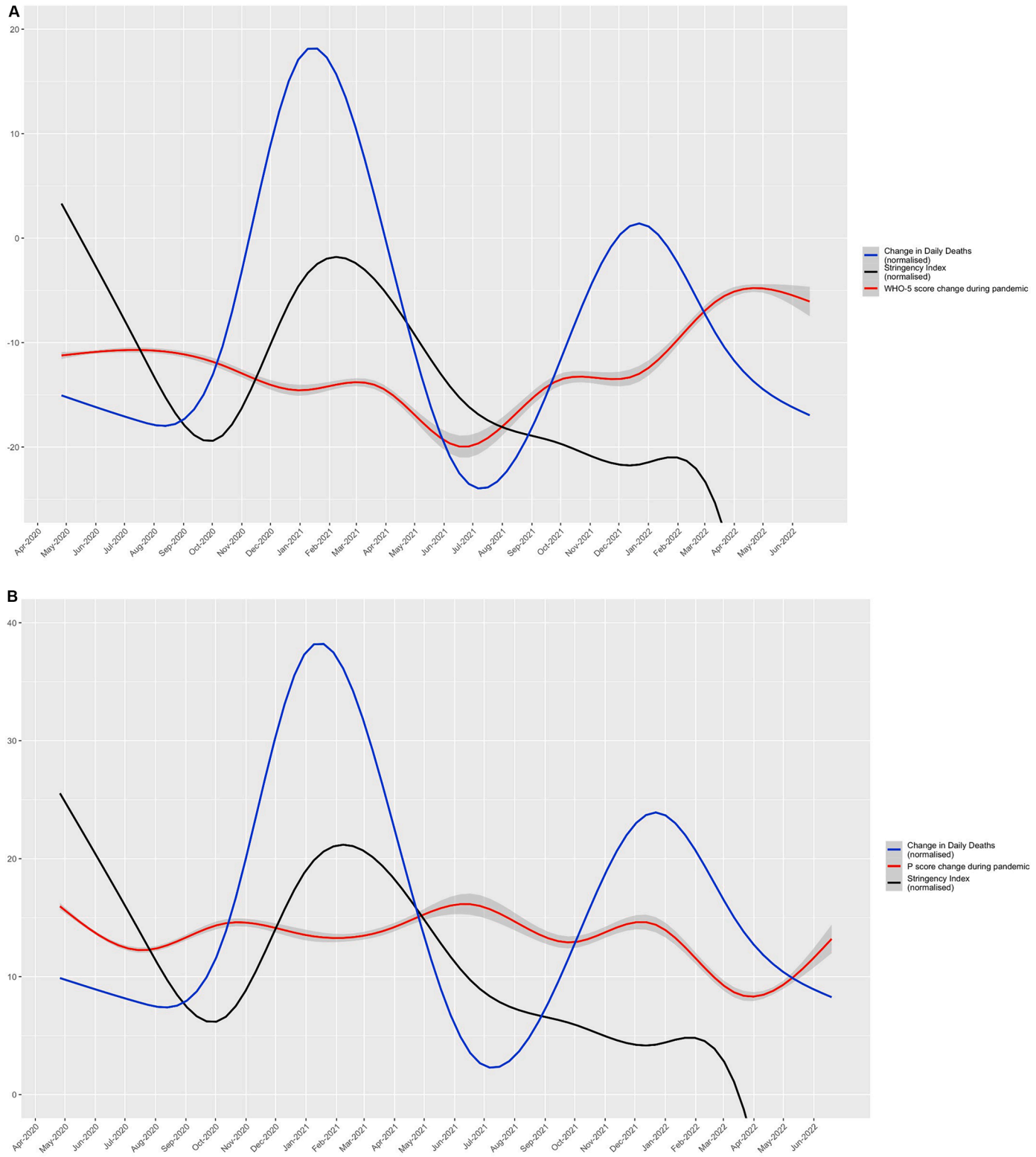


**Fig. 4.** Trajectory of change in WHO-5 well-being score (A) and composite psychopathology P-score (B), stringency and daily death rate.

Despite the differences above, COH-FIT converges with the systematic review in concluding that on average, after >2 years of the pandemic, adverse effects on well-being and mental health seem to have largely disappeared in the general population.

However, worsening of both well-being and mental health were consistently larger in people with mental disorders, females, COVID-19-related loss, living in low-income countries, and those with physical disorders. That mental illness emerged as a top vulnerability factor indicates an urgent need for primary and secondary mental illness prevention. Access to mental healthcare for those with preexisting mental disorders has been disrupted, despite legislative efforts facilitating telemedicine (Kinoshita et al., 2022), with subsequent risk of poor clinical outcomes (Sánchez-Guarnido et al., 2021). Several factors can explain the poor well-being and mental health in females, including

pre-pandemic higher prevalence of mental disorder (GBD 2019 Mental Disorders Collaborators, 2022), poor access to care, and disproportionately excessive burden of family functioning disruption affecting women more than men, including home schooling (Racine et al., 2021). COVID-19-related loss is a traumatic event, whose reliving has been continuously triggered since COVID-19 outbreak. Regarding low-income countries, poorer pre- and intra-pandemic individual and healthcare system resources, lower government financial support for the population, excessive implementation of restrictions potentially affecting human rights might have worsened well-being, and mental health (Aksunger et al., 2023). For those with physical conditions, access to care deteriorated for non-COVID-19 diseases (Topriceanu et al., 2021), generating poor objective health status and anxiety regarding uncertain care.

Age 18-29, being a healthcare worker and living in large cities worsened both co-primary outcomes, yet with different magnitude. In young adults, whose academic, professional, and social routine was seriously disrupted (Patel et al., 2022), a larger effect on mental health rather than well-being emerged, suggesting that the P-score may be more change-sensitive to monitor mental health in this age group. Conversely, healthcare workers and large cities were risk factors associated with larger worsening in well-being. Healthcare workers have been exposed to unprecedented traumatic events, including death of patients and coworkers, risk for their life, fear of infecting others, long working hours, lack of personal protective equipment, and increased media attention, challenging well-being (Dragioti et al., 2022). Ongoing negative effects on mental health (Dragioti et al., 2022), might have been mitigated by the protective factor of lived altruism. Regarding larger cities, reasons for WHO-5 worsening include higher population density facilitating virus spread and more enforced lockdowns/restrictions, urbanicity's association with poorer mental health (Luo et al., 2021), worse housing conditions with less access to green areas, and higher cost of living, increasing job/financial insecurities. Better access to mental healthcare in urban centers might have mitigated the ongoing negative impact on mental health.

Other risk factors, namely COVID-19 infection, unemployment, first-generation immigrant status, and obesity, may have non-specific or specific effects. Having had COVID-19 infection can worsen acute (Rogers et al., 2020) and long-term mental health, cognition, and physical health (Di Gennaro et al., 2023), yet not necessarily universally. Larger negative effects have been associated with severe COVID-19 infection, likely worsening well-being and mental health (Huang et al., 2022). Job strain that can lead to unemployment is a known risk factor for depression (Köhler et al., 2018). First-generation immigrants have faced most severe isolation (Gama et al., 2022). Regarding obesity, BMI-threshold for obesity varies based on ethnicity and is lower in low-income than middle-/high-income countries. While within each country, obesity is likely associated with larger worsening of well-being and mental health, at the global level the effect of obesity is probably counterbalanced by higher income in countries with larger BMI, likely driving the association to non-significance (P-score), or even in the opposite direction (WHO-5).

Importantly, having multiple risk factors increased the pandemic's impact on well-being and mental health, suggesting that public health prevention, promotion and interventions should prioritize individuals with specific and, especially, multiple risk factors and reduce risk factors globally.

Finally, COVID-19-related deaths, restriction stringency, and their ratio were only minimally associated with well-being and P-score, suggesting that the pandemic and a more complex network of factors needs to be considered to understand how modifiable and non-modifiable factors might interact.

Regarding coping strategies, exercise or walking, internet use and direct social contact were most important. Exercise or walking are a positive intervention for physical and mental health (Firth et al., 2020). With appropriate limitations to restrict virus spread, exercise or walking should be allowed. Exercise in open spaces might be a compromise not to spread virus in close spaces, and to also expose persons to sun light and green areas which might boost the effect of exercise alone. Governments should facilitate internet access, including for those unlikely to afford it. Moreover, allowing direct social contact whenever possible/-safe seems relevant to cope with the pandemic.

Strengths of COH-FIT include the longitudinal data collection at the population level for >2 years, describing the trends of outcomes over time accounting for COVID-19 deaths and restrictions. Most studies published to date covered a limited time since COVID-19 outbreak. A recent large meta-analysis showed that the majority of studies measuring mental health during COVID-19 were limited to time points up to around 100 days since first recorded COVID-19 case (Salanti et al., 2022). Also, COH-FIT covered the population level with representative samples and population demographic weighting from all continents, used validated psychometric instruments, and assessed a comprehensive set of risk factors. Also, according to a recent living meta-analysis of cohort studies measuring mental health changes during versus before the COVID-19 pandemic (Sun et al., 2023), only one used WHO-5 as an outcome.

Limitations include the cross-sectional design at the individual level paired with retrospective recall to allow for calculation of pre- to intra-pandemic status, which however we assessed using regression and evidence synthesis approaches. Furthermore, we did not detect a drift in the retrospective recall of the pre-pandemic WHO-5 or P-factor during the study period and the pre-pandemic WHO-5 values were similar in COH-FIT compared to published pooled matched country scores of the general population. Moreover, we mixed non-representative with representative samples. However, we weighted the non-representative sample, and having representative data from numerous countries is one of the unique strengths of COH-FIT. Moreover, importantly, results in WHO-5 and the P-score did not significantly differ between representative and non-representative COH-FIT samples. Accounting for severity of COVID-19 infections was not possible due to the anonymous nature of data and absence of link to clinical records. In addition, multivariable and network analyses were not conducted, as they go beyond the aims of this global descriptive report, and will require a specifically dedicated approach. Importantly, while this work provides a unique global overview of COVID-19 pandemic impact on the population mental health and well-being, only few to no responses came from several regions including middle East is not well-represented, nor is much of South American and the Caribbean. Also, we did not account for vaccinations in our analyses, and future works will focus on this. Moreover, digital barriers precluded a larger participation from larger strata of the population, and more data are needed from subjects older than 65 years old. Finally, some risk factors might vary within each country, such as the impact of obesity, or socio-economic status. Indeed, detailed within-country analyses leveraging COH-FIT data will better investigate the impact of those two risk factors. More broadly, only local reports from individual countries can inform local policies, and such COH-FIT reports are being prepared to complement global findings described in this work.

In conclusion, the COVID-19 pandemic adversely affected well-being and mental health of the general population globally, with differences across countries with different income, across different strata of the population with a-priori defined risk factors, increasingly in presence of more concomitant risk factors, yet with very small associations with COVID-19-related deaths and restrictions, and with overall a return to near-pre-pandemic values after >2 years into the pandemic. Nevertheless, during infection times groups at risk should be protected and risk factors should be targeted, and access to exercise or walking (ideally in open spaces), internet use, direct social contact and other effective coping strategies should be facilitated to promote and protect wellbeing and mental health during infection times. Results inform public health prevention and intervention policies, at the global level, which should target those at particular risk.

## Statement of ethics

The online survey launches on the COH-FIT website (www.coh-fit.com) occurred immediately after the first ethics committee/Institutional Review Board (IRB) approval (Aristotle University of Thessaloniki, Greece, 04/27/2020). Afterwards, prior to active local/national investigator outreach and advertisement activities regarding COH-FIT dissemination, approval or waiver (due to the anonymous, observational nature of the study) was obtained from at least one national IRB.

## Funding statement

All the institutions and funding agencies are listed in eTable 7. COH-FIT PIs and collaborators have applied/are actively applying for several national and international grants to cover expenses related to the coordination of the study, website, nationally representative samples, advertisement of the study, and future dissemination of study findings.

## CRediT authorship contribution statement

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## Declaration of competing interest

Conflict of interest statements of all authors are detailed in eTable 8.

## Data availability

Data are not publicly available, currently. Data are currently being used for additional global publications. Local data are available to local COH-FIT collaborators. We estimate making data available upon request and with a specific project proposal in 2025.

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2024.115972.

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