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Cross-National Trends in Adolescents Psychological and Somatic Complaints Before and After the Onset of COVID-19 Pandemic



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 A B S T R A C T

Purpose: Building on research suggesting that the COVID-19 pandemic may have led to an exacerbation of deteriorating trends in mental health among adolescents, this paper examined trends in adolescents' psychological and somatic complaints across 35 countries from 2010 to 2022, and tested trends in sociodemographic inequalities in these outcomes between 2018 and 2022.

Methods: Using data from 792,606 adolescents from 35 countries (51% girls; mean age = 13.5; standard deviation 1.6) across four Health Behaviour in School-aged Children surveys (2010, 2014, 2018, 2022), hierarchical multilevel models estimated cross-national trends in adolescent psychological and somatic complaints. We tested whether observed values in 2022 were in line with predicted values based on 2010–2018 linear trends. Finally, moderation effects of age, family affluence, and family structures on the outcomes were tested (2018–2022).

Results: Both girls and boys showed substantially higher levels of psychological complaints in 2022 compared with the predicted values. For somatic complaints, higher levels than predicted in 2022 were observed only in girls. Moderation analyses revealed an increase from 2018 to 2022 in age gaps and a narrowing in the socioeconomic gap for both outcomes. Also, there was a

 IMPLICATIONS AND CONTRIBUTION

This study shows that population changes in adolescent psychological and somatic complaints during the COVID-19 pandemic among a large and diverse group of countries across Europe and North America were greater than would be expected based on previous trends.

Conflicts of interest: The authors have no conflicts of interest to disclose.

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widening gap between adolescents living with 2 parents and those living in a single parent household in 2022 compared to 2018.

Discussion: Cross-national increases in adolescent psychological and somatic complaints were higher than expected in 2022, based on previous trends. Magnitudes of change varied across different sociodemographics groups, with implications for pre-existing mental health inequalities.

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Many studies suggest the COVID-19 pandemic had a negative impact on the mental health of adolescents. Indeed, several systematic reviews and meta-analyses have indicated that pre-pandemic levels of mental health problems among adolescents were considerably lower than during the pandemic [1–3]. These results are in line with analyses of registry data showing that cases of mental health diagnosis and hospitalizations for adolescents increased during COVID-19 in countries such as Norway [4] and Canada [5]. The decrease in mental health has been related, among others, to social distancing measures and school closures, decreased opportunities to socialize with friends, disruption to household routines, and apprehensions about the health and well-being of loved ones (e.g., [6]). In addition, the experience of somatic complaints (e.g., headaches, stomach-aches, etc.) is a well-recognized part of the broader spectrum of internalizing disorders [7] and these complaints are rather common in adolescence [8]. Although, while previous research examining changes over time in reported symptoms during the early 2000s showed either limited change or a decline [9,10], recent findings suggest that during and post-COVID-19 pandemic, there has been an increase in pediatric emergency department admissions due to somatic symptom disorders [11] as well as population increases in self-reported symptomatology [8].

Notwithstanding, research on the impact of the COVID-19 pandemic on the mental health of adolescents is limited in several ways. First, studies have relied primarily on small-scale or national-level data. This potentially hampers the generalizability of the findings both within and across countries. Second, many studies included only one cohort of adolescents, which implies that changes in mental health problems over time may be confounded with changes across age or time [1]. Third, there is a scarcity of studies covering both the pandemic period and the preceding years. This is an important limitation as increases in mental health problems were already apparent prior to the COVID-19 pandemic [12–14]. To illustrate, across Europe there has been an increase in the proportion of girls with high psychological complaints over the past decade, with these changes varying substantially across countries [12]. Consequently, it is unclear to what extent the COVID-19 pandemic exacerbated these pre-existing trends or whether changes observed are simply reflective of anticipated secular trends. In order to address these 3 major limitations to the current literature, this study made use of an internationally comparable repeated cross-sectional study, utilizing representative samples.

Previous research also suggests that trends in adolescent mental health problems, before and during the COVID-19 pandemic, are heterogeneous across different populations. Studies focusing on the intersectional impact of COVID-19 for young people suggested that the deleterious impact of the pandemic has not been experienced equally across population

groups but has been compounded by (multiple) marginalized social positions (e.g. race/ethnic group, sexual identity, gender, and socioeconomic status) [15–17].

There is strong evidence that mental health problems among adolescent girls have increased more over the past decade, as well as during the pandemic, compared with boys [1,18], with these effects being more pronounced for older compared with younger girls [12,19]. This could be attributed to the fact that girls' mental health might be more susceptible to social stressors [20,21], especially schoolwork pressure [22], which may have increased especially for older girls during the COVID-19 pandemic [23]. An additional factor contributing to the negative impact of the COVID-19 pandemic on girls' mental health compared with boys may also be their tendency to engage in corumination [24]. Therefore, to capture these gendered trajectories, all analyses undertaken in this study were stratified by gender.

Trends in mental health problems over the period of the COVID-19 pandemic may not only be different for boys and girls of different ages but may also vary across family affluence and family structure subgroups [16]. Adolescents who were already susceptible to experiencing poor mental health and who lacked effective coping and emotional regulation strategies prior to the pandemic [25], may have faced a heavier mental health burden during COVID-19. This may be particularly true for adolescents living in poverty or in single-parent households [26] who may have been exposed to multiple stressors such as financial and/or job insecurities, limited access to resources and elevated parental stress [27,28]. Indeed, several studies revealed that increases in mental health problems were more pronounced for adolescents in low affluence families and in single parent households [27,29]. Yet, other studies conducted in the Netherlands, Finland, and Norway did not report such differences [30–32].

This study

To summarize, previous findings show an increase in adolescent mental health problems over recent years, with older adolescent girls reporting the worst outcomes. The experience of the COVID-19 pandemic might have exacerbated some of these trends, but there is a current lack of internationally comparative studies which have examined whether possible increases in mental health problems during and after COVID-19 are greater than what have been anticipated in the context of existing trends. Additionally, the social disparities in the reported burden of psychological and somatic complaints might have widened, with young people with (multiple) vulnerable and marginalized social positions reporting worse outcomes. The current study aimed to address these gaps by using repeated cross-sectional data to examine time trends in psychological and somatic complaints among representative samples of adolescent girls and

boys in 35 countries across Europe and Canada between 2010 and 2022. The following research questions were addressed: (1) How do adolescent psychological and somatic complaints among boys and girls observed in 2022 compared to the expected values based on data obtained preonset of COVID-19 pandemic (2010 to 2018)? (2) To what extent do psychological and somatic complaints differ across age, family affluence, and family structure, and has this changed between 2018 to 2022? Based on the literature on the impact of the COVID-19 pandemic on adolescent mental health, we hypothesized that change estimates for psychological and somatic complaints from 2022 would be significantly larger than the predicted value based on data from 2010 to 2018, with stronger estimates in girls compared to boys. Additionally, we hypothesized that older adolescents, those from low affluence families, and those living in single parent households, would report significantly higher levels of, and increases in, psychological and somatic complaints in 2022 as compared with 2018.

Methods

Sample

The Health Behaviour in School-aged Children (HBSC) study is a collaborative cross-national survey conducted every 4 years since 1983, in partnership with the World Health Organization, to monitor the health and well-being of adolescents across Europe and North America. In each survey round, the HBSC employs a standardized research protocol with each country collecting data from a nationally representative sample of 11-, 13-, and 15-year-olds [33]. The HBSC protocol is used in all countries and is key to ensuring high comparability of data across countries and survey years. Stratified random cluster sampling is utilized, with classes nested within schools serving as the primary sampling units. Adolescents completed anonymous questionnaires in classroom settings. Questionnaires were translated from English into national languages, following a validated protocol that included back-translation checks. Ethical consent was obtained from relevant institutions in each participating country.

The present study used data from 4 survey rounds: 2010, 2014, 2018, and 2022. Participating countries were eligible for inclusion in the present analyses if they had collected data on both psychological and somatic complaints across all 4 of the survey cycles. This resulted in the analysis of data from a total of 792,606 adolescents across 35 countries or regions, with 50.6% of the participants being girls. The mean age was 13.55, with a standard deviation of 1.63. Detailed information about the study sample can be found in Table 1.

Measures

Psychological and somatic complaints. Adolescents reported the frequency with which they had experienced 8 health complaints over the past 6 months, using the following response options: (1) "about every day," (2) "more than once a week," (3) "about every week," (4) "about every month," and (5) "rarely or never". These health complaints can be grouped into 2 dimensions: psychological complaints (feeling low, irritability or bad temper, feeling nervous, and difficulties in getting to sleep) and somatic complaints (feeling dizzy, headache, stomach-ache, and backache). Somatic and psychological complaints tend to be comorbid (e.g. Haugland et al. [34]; Heinz et al. [35]) with evidence that they

Table 1

Description of the sample (unweighted N = 792,606)

	2010	2014	2018	2022
	N (%)	N (%)	N (%)	N (%)
Survey round	186,458	187,616	188,392	230,140
Gender				
Girls (%)	51	51	50	50
Age group				
11-year-olds (%)	32	32	34	33
13-year-olds (%)	34	35	35	34
15-year-olds (%)	34	33	31	33
Mean psychological health complaints (SD) ^a	1.15 (0.96)	1.22 (1.02)	1.33 (1.03)	1.64 (1.13)
Mean somatic health complaints (SD) ^a	0.80 (0.83)	0.82 (0.86)	0.81 (0.82)	1.04 (0.96)

SD = standard deviation.

^a Scale range: 0–4.

either load on the same psychosomatic complaints factor [36] or on 2 different factors (i.e., psychological and somatic complaints) [10,35,37]. Prior to calculating mean scores for each dimension, all responses were recoded to a 0 to 4 scale (i.e., (0) "rarely or never"; (1) "about every month,"; (2) "about every week"; (3) "more than once a week"; (4) "about every day"), with higher scores indicating a greater symptom burden [13]. Given the low rates of missing data for individual health complaints (ranging from 1.7% to 2.9% per symptom), a mean score was computed for those with no more than one missing item on the scale for each dimension.

Gender and age. Participants were asked to indicate whether they are a boy or a girl, as well as the month and year of their birth based on which their age was calculated.

Family affluence. Socioeconomic status was assessed using the Family Affluence Scale II (FAS) [38], which is a measure of family material wealth encompassing items related to the household's count of cars and computers, whether adolescents possessed their individual bedrooms, and the number of holidays abroad. Sum scores were calculated and then converted into proportional ranks based on the residential country. These ranks were subsequently categorized into 3 groups: 1 (lowest 20%), 2 (middle 60%), and 3 (highest 20%) [39].

Family structure. Adolescents were asked to indicate who lives in "the home where you live all or most of the time" whereby they could tick boxes for: mother, father, stepmother (or father's girlfriend/partner), stepfather (or mother's boyfriend/partner), I live in a foster home or children's home, and an open answer category of someone or somewhere else. A categorical variable was created that corresponded to the following categories: (1) living with 2 parents in their main home; (2) living in a single parent household; and (3) other.

Data analysis

We first plotted psychological and somatic complaints by survey cycle and by country to explore the underlying trends and confirm whether a linear trend from 2010 to 2018 was an appropriate estimation [40]. We then ran a series of multilevel

regression analyses with psychological and somatic complaints as outcomes and survey year treated as a continuous variable (where appropriate given an observed linear trend), controlling for FAS, family structure, and age. The models had two-levels: individual-level (participants) and country-level (to account for unaccounted country effects that may be associated with mental health outcomes). All analyses were stratified by gender. If a linear trend was found (survey year variable statistically significant, $p < .05$), we predicted the 2022 adjusted-mean psychological and somatic complaints based on that model. We then calculated the observed mean 2022 psychological and somatic complaints (adjusted for FAS, family structure, and age), to enable us to compare the observed values with the predicted value.

To explore potential sociodemographic differences in changes in outcomes from 2018 (preonset COVID-19) to 2022, we ran a series of multilevel regressions with interaction terms on age, family affluence, family structure with a dichotomous survey year variable as predictors at the individual level, and country level included as a second level random effect.

Results

Time trends in psychological and somatic health complaints

Overall, there was a statistically significant linear increase for psychological complaints among boys and girls between 2010 and 2018. The increase was more pronounced for girls than for boys ($B = 0.029$, $p < .001$ for girls vs. $B = 0.017$, $p < .001$ for boys) (Table 2). This equates to a predicted yearly increase of 0.029 in psychological complaints scores for girls and a 0.017 increase for boys. The trends analysis for somatic complaints revealed a small but significant linear increase over time for girls ($B = 0.004$), but no significant change for boys over this period. Within-country analyses revealed that for the majority of countries, there was a linear increase in both psychological and somatic complaints from 2010 to 2018 (Table 3).

When comparing the observed estimates in 2022 with predictions based on the changes between 2010 and 2018, for both outcomes, the observed values for the pooled data in 2022 were significantly greater ($p < .05$ determined through 95% confidence intervals [CIs] that do not include the predicted point estimate, [41]) than what was expected based on previous linear trends (Table 2). For girls, the expected average psychological complaints score in 2022 was 1.63 (95% CI 1.58, 1.68); however, the observed estimate was 1.93 (95% CI 1.86, 2.00), whereas the expected average somatic complaints score was 0.99 (95% CI 0.94, 1.03) and the observed estimate was 1.26 (95% CI 1.21, 1.34). The expected average psychological complaints score for boys in

2022 was 1.19 (95% CI 1.14, 1.24), whereas the observed estimate was 1.31 (95% CI 1.25, 1.37). As somatic complaints for boys were stable from 2010 to 2018 and no linear trend was found, a post hoc analysis was conducted treating the survey year as a categorical variable to see if an increase occurred between 2010 and 2022. In line with the analysis where year was treated as linear, there were no significant differences ($p \geq .05$) in somatic complaints for 2014 and 2018 compared to 2010 (adjusting for FAS, age, and family structure). However, a significant difference was found in 2022, with higher values of somatic complaints among boys in 2022 compared to 2010 ($B = 0.122$; $p < .001$).

As we found evidence of a statistically significant increase in both psychological and somatic complaints in the last survey year, we did a post hoc calculation of effect size of the observed values in both 2022 versus 2018 (Cohen's d) using a method that allows for multilevel clustering [42]. The effect sizes for boys were rather small (i.e., psychological complaints $d = 0.16$ and somatic complaints $d = 0.15$) whereas for girls were medium (i.e., psychological complaints $d = 0.36$; somatic complaints $d = 0.32$). When exploring the within-countries trends (Table 3; Figures S1 and S2), observed psychological and somatic complaints among adolescent girls in 2022 were consistently significantly higher than the values predicted based on the linear trends from 2010 to 2018 in almost all countries. A similar pattern across countries was observed for psychological complaints in boys.

Age, family affluence, and family structure differences in psychological and somatic complaints (2018–2022)

Age, family affluence, and family structure were significantly associated with both outcomes in adjusted models from the 2 most recent cycles (Tables 4 and 5). Compared to 11-year-olds, adolescents aged 13 and 15 reported higher values of psychological and somatic complaints. Furthermore, the moderation analysis indicated that this age gap increased from 2018 to 2022 for both girls and boys. Girls aged 13 and 15 showed a larger average increase in psychological and somatic complaints compared to 11-year-old girls (Table 4; Figure S3). For example, for the 11-year-olds the adjusted mean was 1.19 in 2018 and 1.54 in 2022 (a 0.35 increase), while for the 15-year-olds the adjusted mean score was 1.78 in 2018 and 2.19 in 2022 (a 0.41 increase) (Figure S3). Among the boys, psychological complaints increased more strongly in 15-year-olds than 11-year-old boys and somatic complaints increased more strongly among 13- and 15-year-olds compared to 11-year-old boys (Table 5; Figure S4). Although interactions with age were statistically significant, model fit only improved (reduced better model fit form model a) in the models for girls when including interaction terms.

Table 2
Overall psychological and somatic complaints predicted versus observed values in 2022

	Psychological complaints			Somatic complaints		
	Linear trend 2010–2018 (B)	Predicted 2022 (95% CI)	Observed 2022 (95% CI)	Linear trend 2010–2018 (B)	Predicted 2022 (95% CI)	Observed 2022 (95% CI)
Girls	0.029***	1.62 (1.57, 1.67)	1.92 (1.85, 2.00)	0.004***	0.97 (0.93, 1.02)	1.26 (1.20, 1.32)
Boys	0.017***	1.18 (1.14, 1.23)	1.31 (1.25, 1.37)	0.000	-	-

Linear trend in somatic complaints was not predicted for boys as there was no significant increase found from 2010 to 2018. All models were adjusted for country/region using multilevel linear model, including age, FAS, and were stratified by gender *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 3
Within countries psychological and somatic complaints predicted versus observed values in 2022

	Girls			Somatic health complaints			Boys		
	Psychological health complaints						Psychological health complaints		
	Linear trend 2010–2018	Predicted 2022 (95% CI)	Observed 2022 (95% CI)	Linear trend 2010–2018	Predicted 2022 (95% CI)	Observed 2022 (95% CI)	Linear trend 2010–2018	Predicted 2022 (95% CI)	Observed 2022 (95% CI)
Armenia	0.01ns	1.18 (1.10,1.25)	1.48 (1.43,1.53)	−0.01**	0.52 (0.46,0.57)	0.77 (0.73,0.81)	0.01ns	1.04 (1.08,1.11)	1.15 (1.10,1.20)
Austria	0.05***	1.52 (1.46,1.59)	1.73 (1.69,1.77)	0.02***	0.97 (0.92,1.03)	1.2 (1.16,1.24)	0.04***	1.19 (1.14,1.25)	1.19 (1.15,1.22)
Belgium (Flemish)	0.05***	1.57 (1.51,1.63)	1.82 (1.79,1.85)	0.01ns	0.90 (0.85,0.96)	1.27 (1.24,1.3)	0.03***	1.24 (1.20,1.25)	1.25 (1.22,1.28)
Belgium (French)	0.04***	1.77 (1.71,1.84)	1.96 (1.92,2.00)	0.01ns	1.11 (1.06,1.16)	1.36 (1.32,1.39)	0.04***	1.46 (1.40,1.52)	1.44 (1.41,1.48)
Canada	0.02***	1.60 (1.56,1.64)	1.92 (1.89,1.95)	0.01ns	1.07 (1.04,1.10)	1.38 (1.36,1.41)	0.01ns	1.04 (1.01,1.07)	1.18 (1.15,1.2)
Croatia	0.01***	1.41 (1.35,1.47)	1.74 (1.69,1.78)	−0.01***	0.76 (0.71,0.81)	1.04 (1.01,1.08)	−0.01**	0.92 (0.86,0.97)	1.11 (1.07,1.15)
Czech Republic	−0.01ns	1.57 (1.52,1.61)	1.94 (1.91,1.97)	−0.03***	0.63 (0.60,0.67)	1 (0.98,1.02)	0.01ns	1.18 (1.15,1.22)	1.35 (1.32,1.37)
Denmark	0.03***	1.57 (1.50,1.64)	1.81 (1.77,1.85)	0.02***	0.95 (0.89,1.01)	1.18 (1.15,1.22)	0.02***	1.09 (1.04,1.16)	1.09 (1.05,1.12)
England	0.04***	1.76 (1.67,1.84)	2.29 (2.24,2.33)	−0.01ns	0.97 (0.91,1.04)	1.5 (1.46,1.54)	0.05***	1.41 (1.35,1.48)	1.54 (1.49,1.58)
Estonia	0.04***	1.76 (1.69,1.83)	1.98 (1.93,2.03)	0.02***	1.14 (1.08,1.19)	1.34 (1.30,1.39)	0.02***	1.28 (1.22,1.34)	1.33 (1.29,1.38)
Finland	0.05***	1.93 (1.87,1.99)	1.92 (1.87,1.97)	0.02***	1.23 (1.18,1.29)	1.36 (1.32,1.40)	0.02***	1.37 (1.31,1.43)	1.21 (1.16,1.25)
France	0.02***	1.75 (1.70,1.80)	2.00 (1.96,2.04)	−0.01**	1.05 (1.02,1.10)	1.38 (1.35,1.42)	0.02***	1.36 (1.32,1.41)	1.37 (1.33,1.41)
Germany	0.03***	1.39 (1.34,1.45)	1.79 (1.75,1.83)	0.1***	1.10 (1.05,1.16)	1.25 (1.22,1.29)	0.02***	1.07 (1.02,1.12)	1.26 (1.22,1.29)
Greece	0.03***	1.76 (1.68,1.83)	2.28 (2.24,2.32)	0.01***	1.11 (0.99,1.22)	1.42 (1.38,1.46)	0.02***	1.31 (1.25,1.38)	1.63 (1.59,1.67)
Greenland	0.05***	1.70 (1.56,1.84)	1.61 (1.52,1.7)	0.04***	1.10 (0.96,1.06)	0.97 (0.91,0.4)	0.02**	1.01 (0.88,1.14)	1.06 (0.98,1.15)
Hungary	0.04***	1.73 (1.65,1.79)	2.12 (2.07,2.17)	0.01*	1.16 (1.01,1.22)	1.54 (1.49,1.59)	0.01***	1.29 (1.22,1.36)	1.53 (1.48,1.58)
Iceland	0.03***	1.67 (1.62,1.73)	2.03 (2.00,2.06)	0.01***	1.27 (1.23,1.32)	1.53 (1.5,1.56)	0.01*	1.16 (1.12,1.21)	1.44 (1.41,1.46)
Ireland	0.03***	1.59 (1.52,1.66)	1.86 (1.81,1.91)	0.01ns	0.93 (0.87,0.99)	1.26 (1.22,1.31)	0.02***	1.18 (1.12,1.24)	1.32 (1.26,1.37)
Italy	0.04***	2.08 (2.01,2.15)	2.37 (2.33,2.41)	0.01***	1.39 (1.33,1.45)	1.60 (1.56,1.65)	0.02***	1.57 (1.50,1.62)	1.64 (1.60,1.68)
Latvia	0.04***	1.79 (1.73,1.86)	2.03 (1.99,2.08)	0.01***	1.39 (1.33,1.45)	1.34 (1.30,1.38)	0.01***	1.21 (1.14,1.27)	1.24 (1.20,1.28)
Lithuania	0.01ns	1.48 (1.41,1.55)	2.09 (2.04,2.13)	0.03***	1.18 (1.15,1.21)	1.31 (1.27,1.35)	−0.01*	0.95 (0.89,1.01)	1.35 (1.31,1.39)
Luxembourg	0.04***	1.84 (1.77,1.91)	1.99 (1.95,2.04)	−0.01*	1.16 (1.10,1.22)	1.3 (1.26,1.34)	0.04***	1.46 (1.40,1.52)	1.38 (1.34,1.42)
Netherlands	0.03***	1.41 (1.35,1.46)	1.70 (1.65,1.75)	0.01***	0.94 (0.88,0.99)	1.15 (1.11,1.19)	0.02***	1.09 (1.03,1.14)	1.13 (1.09,1.18)
North Macedonia	0.03***	1.46 (1.38,1.55)	1.48 (1.42,1.53)	−0.01***	0.65 (0.60,0.70)	0.97 (0.93,1.01)	0.02***	1.11 (1.04,1.16)	1.17 (1.13,1.21)
Norway	−0.01ns	1.23 (1.17,1.30)	1.80 (1.75,1.85)	−0.02***	0.70 (0.64,0.75)	1.16 (1.12,1.21)	0.01ns	1.00 (0.94,1.06)	1.23 (1.18,1.27)
Poland	0.04***	1.80 (1.74,1.87)	2.16 (2.11,2.2)	−0.01ns	0.96 (0.90,1.01)	1.42 (1.38,1.47)	0.02***	1.37 (1.31,1.43)	1.54 (1.50,1.59)
Portugal	0.05***	1.57 (1.50,1.63)	1.93 (1.89,1.98)	0.02***	0.84 (0.80,0.87)	1.04 (1.00,1.08)	0.04***	1.05 (1.00,1.10)	1.12 (1.08,1.16)
Romania	0.01*	1.55 (1.48,1.63)	1.88 (1.84,1.92)	−0.01**	0.97 (0.91,1.02)	1.27 (1.24,1.30)	0.01*	1.19 (1.12,1.25)	1.41 (1.38,1.45)
Scotland	0.03***	1.56 (1.51,1.63)	2.07 (2.02,2.12)	0.01ns	0.96 (0.91,1.01)	1.37 (1.32,1.41)	0.02***	1.24 (1.19,1.30)	1.45 (1.40,1.49)
Slovakia	0.02***	1.55 (1.49,1.62)	1.87 (1.83,1.91)	−0.01ns	0.95 (0.87,1.00)	1.25 (1.21,1.29)	0.01*	1.26 (1.20,1.31)	1.37 (1.33,1.40)
Slovenia	0.06***	1.71 (1.65,1.77)	1.76 (1.72,1.80)	0.02***	0.82 (0.78,0.87)	0.91 (0.88,0.95)	0.04***	1.20 (1.15,1.25)	1.09 (1.05,1.12)
Spain	−0.01 ns	1.09 (1.03,1.15)	1.61 (1.55,1.66)	−0.01ns	0.82 (0.77,0.87)	1.01 (0.97,1.05)	−0.01ns	0.67 (0.62,0.73)	0.94 (0.90,0.98)
Sweden	0.05***	2.08 (2.02,2.14)	2.15 (2.11,2.19)	0.02***	1.30 (1.24,1.35)	1.43 (1.38,1.47)	0.03***	1.42 (1.37,1.48)	1.53 (1.49,1.57)
Switzerland	0.01**	1.52 (1.47,1.57)	1.87 (1.83,1.90)	0.01ns	1.03 (0.99,1.08)	1.34 (1.31,1.38)	0.01ns	1.12 (1.08,1.17)	1.27 (1.24,1.30)
Wales	0.05***	1.71 (1.67,1.75)	1.93 (1.92,1.95)	0.01ns	1.00 (0.97,1.03)	1.29 (1.27,1.30)	0.04***	1.36 (1.32,1.40)	1.36 (1.35,1.38)

ns = statistically non-significant association.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Compared to adolescents living in low affluence families, those living in medium or high affluence families reported lower levels of psychological complaints (Tables 4 and 5). The moderation analyses testing differences across family affluence in psychological and somatic complaints revealed that, for both girls and boys, there was a greater increase in somatic complaints from 2018 to 2022 among the highest family affluence compared to the lowest family affluence groups (Tables 4 and 5). This resulted in narrowing gaps in somatic complaints between adolescents in low and high affluent families for boys (Figure S6). No significant interaction was observed for the highest family affluence category compared to the lowest on psychological complaints. For girls, the change in psychological complaints from 2018 to 2022 in the middle family affluence category was greater than in the low family affluence category (Figure S6).

Adolescents living in single-parent households or other settings consistently reported higher average values of psychological and somatic complaints compared to those in two-parent households (see Tables 4 and 5). Furthermore, there were

widening inequalities (significant interactions at $p < .05$) between adolescents who lived with 2 parents and those who lived in a single-parent household in 2022 compared to 2018 for both psychological and somatic complaints among boys and girls (Tables 4 and 5, Figures S7 and S8). For example, boys living in a single parent household had an adjusted mean in psychological complaints of 1.26 in 2018 and 1.44 in 2022 (0.18 increase) while boys in a two-parent household had an adjusted mean of 1.10 in 2018 and 1.25 in 2022 (0.15 increase) (Figure S8).

Discussion

The present study examined trends in adolescents' psychological and somatic complaints across 35 countries from 2010 to 2022, with a particular focus on changes pre (2018) and post (2022) onset of the COVID-19 pandemic. In line with previous research, we found a linear increase from 2010 to 2018 in psychological complaints for both boys and girls, and a slight linear increase in somatic complaints for adolescent girls [12,13]. Inclusion of the HBSC

Table 4
Moderation by age, family affluence, and family structure on psychological and somatic complaints among girls (2018–2022)

Dependent variable model	Psychological complaints (n = 192,659)				Somatic complaints (n = 192,910)			
	1a	1b	1c	1d	2a	2 b	2c	2d
Fixed effects								
Survey year (ref 2018)	0.405***	0.354***	0.385***	0.403***	0.303***	0.171***	0.292***	0.290***
Age (ref [11])								
13	0.417***	0.363***	0.417***	0.417***	0.351***	0.244***	0.351***	0.351***
15	0.625***	0.597***	0.625***	0.625***	0.559***	0.451***	0.559***	0.559***
FAS (ref low)								
Medium	−0.0263***	−0.0259***	−0.0416***	−0.0261***	−0.0258***	−0.0256***	−0.0306***	−0.0255***
High	−0.0318***	−0.0314***	−0.0427***	−0.0318***	0.0187**	0.0197**	0.00368	0.0187**
Family structure (ref 2 parents)								
Single	0.222***	0.222***	0.222***	0.200***	0.176***	0.177***	0.176***	0.143***
Other	0.195***	0.195***	0.195***	0.217***				
Moderators					0.160***	0.160***	0.160***	0.151***
Age × survey year								
13		0.0999***				0.195***		
15		0.0515***				0.196***		
FAS × survey year								
Medium			0.0273*				0.00848	
High			0.0194				0.0285*	
Family structure × survey year								
Single				0.0434**				0.0643***
Other				−0.0350*				0.0160
Random effects								
Country variance	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Bayesian information criteria	573,286.0	573,241.1	573,306.0	573,290.5	510,375.6	509,913.7	510,394.8	510,368.3

Bold indicates lower BIC = better model fit form model a.

FAS = Family Affluence Scale.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5
Moderation by age, family affluence, and family structure on psychological and somatic complaints among boys (2018–2022)

Dependent variable model	Psychological health complaints (n = 184,369)				Somatic health complaints (n = 186,649)			
	3a	3 b	3c	3d	4a	4b	4c	4d
Fixed effects								
Survey year (ref 2018)	0.158***	0.142***	0.166***	0.152***	0.119***	0.102***	0.106***	0.113***
Age (ref [11])								
13	0.0684***	0.0611***	0.0683***	0.0684***	0.0671***	0.0543***	0.0672***	0.0671***
15	0.167***	0.148***	0.167***	0.167***	0.131***	0.116***	0.131***	0.131***
FAS (ref low)								
Medium	−0.0372***	−0.0371***	−0.0334***	−0.0369***	−0.0343***	−0.0341***	−0.0406***	−0.0340***
High	−0.0733***	−0.0731***	−0.0625***	−0.0732***	−0.0168**	−0.0166**	−0.0320***	−0.0167**
Family structure (ref 2 parents)								
Single	0.176***	0.176***	0.176***	0.160***	0.132***	0.132***	0.132***	0.111***
Other	0.148***	0.149***	0.149***	0.148***	0.126***	0.126***	0.126***	0.128***
Moderators								
Age × survey year								
13		0.0134				0.0235**		
15		0.0344**				0.0272**		
FAS × survey year								
Medium			−0.00655				0.0110	
High			−0.0200				0.0282*	
Family structure × survey year								
Single				0.0314*				0.0282*
Other				0.00160				−0.00242
Random effects								
Country variance	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Bayesian information criteria	511,994.6	512,009.4	512,016.9	512,012.7	423,537.0	423,550.0	423,555.2	423,543.8

FAS = Family Affluence Scale.

* $p < .05$, ** $p < .01$, *** $p < .001$.

survey data for 2022 revealed significant increases in psychological and somatic complaints since 2018 which were considerably larger than what was expected based on previous trends. Although the effect size for the observed increases was at the threshold deemed small for boys and near moderate for girls it has been argued that small effect sizes in mental health population studies may still have a substantial impact when considered at the population level [43]. Additionally, our results indicated that observed changes were sociodemographically patterned across gender, age and socioeconomic groups, adding to literature emphasizing the importance of adopting an intersectional lens when understanding the impact of the pandemic [16,17].

Firstly, both girls and boys showed substantially higher levels of psychological complaints in 2022 compared with predicted values based on the previously observed linear trend (2010–2018). The same applied to somatic complaints for girls. For boys, the trends in somatic complaints were fairly stable until 2018, but the results indicated that boys were reporting higher levels of these complaints in 2022 when compared to 2010. Studies from different regions of the world conducted at various time points during the COVID-19 pandemic have already provided evidence of an increase in mental health problems among adolescents during the period of the pandemic [1,25,44]. However, this study is unique in demonstrating that the changes over the time of the pandemic were more significant than expected given previous trends, prior to the pandemic. As more population level data becomes available, future research should continue to monitor the progression of these trends.

In addition, our results showed that the increase in psychological and somatic complaints from 2018 to 2022 was larger for girls than for boys. These results reinforce the evidence that the mental health of adolescent girls deteriorated more than of boys during the COVID-19 pandemic period (e.g., [45,46]). This could be due to the greater impact of a loss of social support and isolation during lockdown on girls, for whom social relationships may play a larger role in their coping mechanisms [47]. It could also be driven by the girls' increased social media use or reduced vigorous activity compared to boys between 2018 and 2022 [45]. However, it is important to note that we also found that the increase in boys' levels of psychological complaints between 2018 and 2022 exceeded the predicted trend from 2010 to 2018. This finding warrants further investigations that explore gender specific drivers of change in mental health over time. In addition, across both genders, there has been an increase in the age gap in psychological and somatic complaints in recent years with older adolescents reporting a larger increase in the burden of complaints compared to younger ones. Similar results have been reported previously and these effects could be due to increased academic pressure following the sudden switch to distance learning during lockdowns, more severe lockdown policies for older adolescents, their better grasp and awareness of the implications of the pandemic [48], as well as a greater impact of more limited in-person socialization with peers at a developmental stage where peers increasingly replace parents/family as key socializing figures, as adolescents get older [49,50]. We note that although statistically significant, the difference in change is not large; however, given that marked differences between these groups already exist it is still important to monitor these differences to try to avoid exacerbating existing inequalities. Future research could undertake a more comprehensive exploration of the mechanisms driving these changes at the

individual and country level. Additionally, the within country analyses revealed many commonalities in the patterns of change over time, although divergent patterns also emerged. More research is warranted that explores which country specific factors can explain the cross-national variation in these changes over time.

The results also emphasize the differential intersectional impact of the COVID-19 pandemic on adolescents from different social groups [16,17]. They highlight the vulnerability of young people growing up in single-parent households, especially given that all analyses were controlled for family affluence. This indicates stressors beyond SES that may have contributed to the widening gap during the pandemic period. The processes underlying these findings are diverse and might tap into parental mental health, family functioning, living conditions, parenting practices, as well as marginalized social position, such as racial/ethnic and sexual identity [15]. For example, previous research showed that severe financial hardship during the pandemic was associated with increased levels of stress, relationship and parenting difficulties which in turn were risk factors for elevated mental health problems in young people [28,51]. The stressors associated with caregiving rose for individuals across the board. However, certain families, particularly those who were already grappling with low-income employment, limited access to affordable childcare, and the struggle to meet their family's essential needs on a tight budget, encountered amplified difficulties and sources of stress [52]. Similar effects were reported in countries such as Norway where living in a single-parent household was associated with a significant increase in psychological symptoms during COVID-19 [26]. As more longitudinal data collected across the COVID-19 pandemic and post-pandemic become available, future studies could explore these individual trajectories and identify potential risk and protective factors.

Nevertheless, our results also point to a small reduction in socioeconomic inequalities in psychological and somatic complaints from 2018 to 2022, which was in contrast to our expectations. Although a widening in socioeconomic inequalities in adolescent mental health during the pandemic has been observed, this is not consistent across studies [e.g., 32]. Possible explanations for this unexpected finding may be that some countries introduced economic interventions which specifically targeted lower socioeconomic groups, or that some exposure to adversity often associated with low socioeconomic backgrounds may foster subsequent resilience [53]. However, given that the adolescents from the less family affluent groups still reported a higher burden of symptoms in 2022, addressing their vulnerability remains a priority through further research and the development of social policies.

The COVID-19 pandemic has had a significant impact on adolescents' health and well-being, primarily owing to substantial disruptions in their social lives and education. However, it is important to acknowledge that the direct consequences of SARS-CoV-2 infection cannot be disregarded. The prevalence of severe COVID-19 is less common in children and adolescents than in adults [54]; however, "long-COVID" (i.e., the presence of one or more symptoms more than 4 weeks following a SARS-CoV-2 infection) has been identified among children and adolescents [55]. A recent meta-analysis showed that one out of 4 children or adolescents that had COVID-19 also present long-COVID symptoms, with mood symptoms being the most prevalent clinical manifestation, followed by fatigue and sleep disturbances. Older adolescents and girls have been shown to have an increased risk

towards reporting long-COVID [56]. Future studies would need to examine the long-term impacts of a COVID-19 infection on adolescent health.

This study has several strengths such as comparable data across countries and time, representative samples of adolescents and the use of a validated study protocol. Furthermore, our outcomes were measured through an instrument that has demonstrated robust psychometric properties and cross-national invariance [35]. Nonetheless, there are a few limitations that should be noted and addressed in future research. First, while our study is best placed to highlight the nature and the size of the changes in adolescent psychological and somatic complaint burden covering the pre- and post-COVID-19 pandemic period, it is limited in its scope to investigate causal mechanisms due to its repeated cross-sectional design. However, our repeated cross-sectional data capture population level changes in psychological and somatic complaints over time which answers our research questions and would have not been possible with other types of research designs. Second, we acknowledge that the public health messaging during the pandemic has encouraged people of all age groups to monitor their physical and mental health complaints and this could have had an impact on the present results by increasing the awareness and (over)reporting of symptoms [57]. However, as cases of mental health diagnosis and hospitalizations for adolescents have been found to increase in the same period as well [4,5,58], it is highly unlikely that the substantial increases in psychological and somatic complaints are primarily the result of the increased awareness. Third, a binary measure of gender (boy vs. girl) did not allow us to capture those who fall outside this binary conceptualization, ignoring a potential vulnerable group of adolescents [59]. In addition, although the interactions tested were statistically significant, in some cases the differences observed were not large. Nevertheless, findings reported here still provide evidence of widening inequalities in adolescent population mental health among certain groups that requires longer-term monitoring. Therefore, it is important to take a note of these early signs of widening gaps, and future research is needed in order to monitor and address them. Finally, these analyses did not account for country specific COVID-19 mitigation strategies which could have had an impact on adolescent responses at the time of data collection. However, it is important to note that regardless of this, the within country trends showed a very homogenous pattern.

In conclusion, our study revealed that population level increases in adolescent psychological and somatic complaints observed between 2018 and 2022 were beyond the predicted values based on analysis of data from 2010 to 2018. Moreover, the extent to which mental health changed between 2018 and 2022 varied across different subgroups of adolescents with 15-year-old adolescents representing the most vulnerable group. Overall, these findings stress the need for more preventive interventions on adolescent mental health throughout Europe as substantial increases in mental health problems have been found, especially in the last couple of years. In doing so, special attention should be paid to certain groups as the “one size fits all” approach might not be appropriate. Rather, these findings suggest that in times of (multiple) stressors, more resources should be invested in interventions for vulnerable groups (e.g., girls, those living in single parent households). Additionally, our results confirm the need for wider and broader systemic changes to support adolescent mental health across and within countries.

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Supplementary Data

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