COVID-19 impact on adolescent mental health: A reassessment accounting for development

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Abstract

Current prospective reports suggest a pandemic-related increase in adolescent mental health problems. We examine whether age-related change over 11-14 years accounts for this increase. Parents and adolescents in a UK-based birth cohort (Wirral Child Health and Development Study; WCHADS; N=737) reported on adolescent depression and behavioural problems pre-pandemic (February 2020), mid-pandemic (August 2020) and late-pandemic (August 2021). Analysis used repeated measures models for over-dispersed Poisson counts with a child-specific intercept with age as a time-varying covariate. Maturational curves for girls, but not for boys, showed a significant increase in self-reported depression symptoms over ages 11-14 years. Behavioural problems decreased for both. After adjusting for age-related change, girls’ depression increased by only 13% at mid-pandemic and returned to near pre-pandemic level at late-pandemic (mid versus late -12%) whereas boys’ depression increased by 31% and remained elevated (mid versus late 1%). Age-adjusted behavioural problems increased for both (girls 40%, boys 41%) and worsened from mid to late-pandemic (girls 33%, boys 18%). Initial reports of a pandemic-related increase in depression in young adolescent girls could be explained by a natural maturational rise. In contrast, maturational decreases in boys’ depression and both boys’ and girls’ behavioural problems may mask an effect of the pandemic.

Introduction

The impact of the COVID-19 pandemic on the mental health of young people has been a topic of widespread concern. A number of reviews and meta-analyses have concluded that the pandemic has had an adverse effect on child and adolescent mental health, most marked in girls and adolescents [1-3]. The strongest evidence for a change in symptoms associated with the pandemic is provided by prospective studies with repeated measurement of mental health prior and during the pandemic. At least eight publications with adolescent samples have prospective data, with pre-pandemic measurement ranging from 3 months to several years. Most studies suggest an increase in depression [4-10] and no change or a decrease in anxiety [4, 6, 9, 10-11]. In a previous publication from this sample using data collected three months pre-pandemic and three months post-onset, we reported an increase in depression and in behavioural problems in 11–12-year-olds [11]. Girls were not disproportionally affected but showed higher absolute rates of depression. Collectively, the evidence from the existing published prospective studies clearly supports an increase in depression in adolescents following the onset of the pandemic. Our findings also supported an increase in behavioural problems.

However, research to now has suffered from limitations which have important consequences for our understanding of the impact of the pandemic. First, most study samples include young people with a wide range of ages, precluding an examination of the relationship between development and pandemic impact. A key developmental period is early adolescence, when depression increases in girls but not in boys [12-15] establishing a life-long sex difference in rates of depression. Second, no previous study has examined whether pandemic related changes in depression or behavioural problems are either accounted for, or masked by, maturational changes in mental health symptoms. Third, none of the studies with both
pre- and post pandemic data have obtained both child and parent reports at the same assessment points. Finally, no study with pre and post pandemic data on the same sample has used an epidemiological sample. In this study we examined the pandemic impact on depression and behavioural problems in young adolescents, addressing these limitations in available evidence.

**Methods**

**Sample**

The study is embedded in the Wirral Child Health and Development Study (WCHADS), a prospective epidemiological sample of first-time mothers and their children (n=1233) (see [16]). Socioeconomic conditions on the Wirral range between the deprived inner city and affluent suburbs, with low numbers from ethnic minorities. The mean age at recruitment in pregnancy was 26.8 years (SD=5.8, range 18–51), 41.8% of the sample were in the most deprived quintile of UK neighbourhoods (Indices of Multiple Deprivation, IMD) [17] and 96.1% were White British. The study has collected 13 waves of data from 20 weeks gestation up to child age 13 years. The study was approved by the Cheshire North and West Research Ethics Committee. Mothers gave written informed consent and children written informed assent.

Families provided data at three time points surrounding the COVID-19 pandemic: pre-pandemic (December 2019–March 16th), mid-pandemic (June 2020–March 2021), and late-pandemic (July 2021–March 2022). Figure 1 shows the participant ow diagram. The pre-pandemic data was provided by families who had completed the planned 12th wave up to the day after the UK social distancing measures were implemented on 16th March (N=226). The wave was being rolled out in age order and only half the sample had been approached (56% response from those approach). The whole ongoing cohort (N=812), including those 226 families who provided pre-COVID data, were approached on June 18th 2020 to complete a COVID-19 lockdown questionnaire wave (87% response rate). The whole sample (N=803) was approached again in July 2021 to complete a post-lockdown questionnaire (82% response rate). The sample analysed here includes families who provided data at the pre- or the mid-pandemic wave or both (N=737). The sample were mean age 11.95 (SD = .35) at pre-pandemic, mean age 11.97 (SD = .50) at mid-pandemic and mean age 13.05 (SD = .49) at late-pandemic. As described in the analysis section estimation by full maximum-likelihood enabled the smaller pre COVID sub-cohort and whole cohort data collections during the pandemic to be analysed together. The characteristics of the cohort are shown in Table 1.

**Measures**

Child sex was recorded at birth and child age at time of assessment was calculated using date of birth and date questionnaire completed. The following measures were administered at all three assessments. Total scores were used for analysis.
Adolescent depression was assessed using parent and child report on the Short Mood and Feelings Questionnaire (SMFQ) [19], which includes 13 items assessing DSM depression symptoms over the prior 2 weeks.

Adolescent behavioural problems were assessed using parent report on the Child Behaviour Checklist (CBCL) [20] Aggressive Behaviour subscale, which includes 18 items assessing disruptive behavioural problems over the prior 6 months.

Parental depression was assessed using the Patient Health Questionnaire-9 (PHQ-9)[21] and was included in parent-reported outcome models to address potential mood-bias on reports [22].

Statistical Analysis

Analyses were undertaken in Stata 17.0[23]. Questionnaire scores were treated as over-dispersed Poisson counts in a repeated measures model that included a child-specific random intercept and estimated in the gsem procedure [24]. The fixed part of the model included initially just birth-sex as a factor with a separate constant and birth-sex coefficients for pre-, mid- and late-pandemic assessments. Subsequent models included the child's age as a time-varying covariate and sex by age interaction. These were included as splines, linear on the log-link scale and thus approximately linear on the symptom mean, but allowing for different rates of change before and after the midpoint of the study at the mean-age of the mid pandemic assessment. For parent reports, an additional time-varying covariate was included for rating bias associated with the informants’ PHQ depression. Estimated by full maximum likelihood, missing data was assumed missing-at-random. For both initial and extended models, the time-specific model estimated means for the whole sample were obtained from the post-estimation margins command. Fractional polynomial plots of the estimated fixed parts of the model were used to display the joint effects of age and assessment time. Reported significance tests and confidence intervals are based on Wald tests. Analyses of missing data, reported in Supplementary Materials 1 found no systematic difference between responders to the part-cohort pre-pandemic assessment compared to the later whole-cohort assessment, except families of older mothers were less likely to participate. As reported there, repeating the model-based analyses with additional covariate adjustment for mothers-age and three further variables associated with attrition since initial recruitment of the families in pregnancy made no material difference to the results.

Results

Table 1 shows sample characteristics of the families providing data for the mid-pandemic assessment. The mean time gap between the pre and mid assessment was 4.46 (SD 1.17) months and between the mid and late assessment was 12.83 (SD 1.63) months.

Table 1: Participant demographic characteristics from the mid-pandemic assessment.
Table 2 shows the descriptive statistics for the outcome measures and Table S1 the bivariate correlations of the outcome measures in boys and girls separately. There were significant differences between parent and adolescent reported depression for both boys at girls at each of the three time points (Wilcoxon paired signs tests all p<.001) with adolescents reporting higher symptoms. Agreement between parent and adolescent was moderate and increased from pre- to mid- to late- pandemic (Spearman's correlations .33, .46, .50 for boys and .40, .46, .50 for girls; all p<.001).

Table 2: Descriptive statistics for the study measures at the pre, mid and late pandemic assessments
<table>
<thead>
<tr>
<th></th>
<th>Study measure</th>
<th>Child-rated depression</th>
<th>Parent-rated child depression</th>
<th>Parent-rated child behavioural problems</th>
<th>Parental depression</th>
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</thead>
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<tr>
<td>Pre-pandemic assessment</td>
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<td>N 87</td>
<td>103</td>
<td>103</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 3.74</td>
<td>2.17</td>
<td>3.83</td>
<td>3.06</td>
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<tr>
<td></td>
<td></td>
<td>SD 4.24</td>
<td>3.58</td>
<td>5.4</td>
<td>3.94</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>N 100</td>
<td>123</td>
<td>123</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 5.72</td>
<td>2.07</td>
<td>3.37</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 5.7</td>
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<td>4.41</td>
<td>4.85</td>
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<tr>
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<td>321</td>
<td>323</td>
<td>318</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>5.61</td>
<td>4.72</td>
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<tr>
<td></td>
<td></td>
<td>SD 4.56</td>
<td>3.96</td>
<td>5.66</td>
<td>4.57</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
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<td>390</td>
<td>391</td>
<td>388</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 5.96</td>
<td>3.22</td>
<td>4.54</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>SD 5.7</td>
<td>3.98</td>
<td>4.86</td>
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<tr>
<td>Late-pandemic assessment</td>
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<td>300</td>
</tr>
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<td></td>
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<td></td>
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<td>364</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean 7.21</td>
<td>3.72</td>
<td>5.06</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>SD 6.36</td>
<td>4.8</td>
<td>4.97</td>
<td>4.17</td>
</tr>
</tbody>
</table>

Figure 2 panel a shows the overlap in ages over the three assessments which range from 11 to 14 years pre-, mid- and late- pandemic. The overlap is important for distinguishing the effects of age maturation from the effects due to the impact of COVID.

**Adolescent-report depression**

Figure 2 panel b shows the marginal means for the self-report depression scores prior to age correction. In girls the rise is clearly sustained at the late-pandemic assessment (mid versus late p<.001), while for boys that rise appears to fall back (mid versus late p<.001; pre versus late p=.361). Using the spline to allow a change in the age-related trend in symptoms proved unnecessary for both boys and girls (2df Wald p=.124), suggesting a uniform trend across the age-range examined here. Allowing for these
uniform age trends gave a model that adjusts for the adolescents’ ages thus separating the changes associated with the mid and late-pandemic periods (reflected in the changing constants) with those associated with age-indexed maturation. Parameter estimates are shown in Table S2. The two effects are shown in Figure 2 panel c with solid lines illustrating the age-related effects in girls, and dotted lines the effects in boys. It is evident that from the slopes of the lines that there are strong sex by age effects. Maturation is associated with rising depression scores for girls (p<.001) but slightly declining scores for boys (p=.149), a highly significant difference (p<.001). Pre-, mid- and late-pandemic scores are contrasted by pale/mid/dark shading, and clearly show no sex difference. Figure 2 panel d shows the COVID effect after accounting for maturational changes, illustrated for the estimated marginal means for a hypothetical child who is exposed to the three pandemic time periods but remains at age 12.5 years (150 months) throughout. We see that for girls not only was the initial rise reduced (13% CI -1% to +27%) and only just significant (p=.063), but the late-pandemic rise was replaced by a return near to the pre-pandemic level (falling mid versus late-pandemic 12%, CI -29% to +6%, p=.188). This is evident in figure 2 panel c where the age-curve for late-pandemic scores merely extends the pre-pandemic age-curve. By contrast, since for boys scores fall with maturation over this age-range, not only is the initial pandemic-related rise now more striking (pre versus mid-pandemic 31% increase CI 10% to 51%, p=.003), but the apparent late-pandemic return to pre-pandemic levels does not occur; instead scores remain elevated (mid- versus late-pandemic increase, 1%, CI -22% to +25%, p=.917).

Parent-reported depression

Based on the simple marginal means shown in Figure 3 panel a parent-reported depression rose following onset of COVID-19 in the same way as self-reported depression (girls pre versus mid and mid versus late both p<.001, boys pre versus mid p=.005 and mid versus late p<.001). With parent ratings we considered it necessary to adjust not only for the child’s maturation but also for the possible variation in the extent of bias in ratings due to time-variation in the levels of depressive symptoms of parents. Unlike for self-report, the changes arising from age-related maturation were not uniform across the age-range, the level increasing among the youngest children but decreasing among both older girls and especially boys. Once these effects were accounted for in the analyses, in contrast to the self-report findings, there was a marked pandemic-related rise for girls (62%, CI 35% to 89%) which slowed (2% further increase, CI -27% to +30%) into the late-pandemic period (pre versus mid-pandemic p<.001; mid versus late-pandemic, p=.911). As for the self-report, in boys once masking by maturational decline had been removed, there was a rise to the mid- (63% CI 33% to 94%, p<.001) that slowed into the late-pandemic period (5% increase from mid to late-pandemic, CI -29% to +39% p=.767). Throughout, parental depression was associated with elevated ratings of adolescent symptoms (p<.001) and the above adjusts for any variation in parental depression.

Parent reported behaviour problems

For behavioural problems the simple marginal means of figure 3 panel d show clear rises mid-pandemic (girls and boys p<.001), and late-pandemic continuing still higher for girls (p<.001) but stable for boys
(p=.103). Figure 3 panel F shows similar non-significant descending estimated maturational curves for behavioural problems for both boys (-16% annually, CI -35% to 2%, p=.088) and girls (-10%, CI -29% to 9%, p=.297). In contrast to the finding for depression in girls, the age trends for behavioural problems shown in the solid lines were modestly downwards, but the pandemic related separation between the lines was marked, showing a pandemic effect in the opposite direction to the age trends. Figure 3 panel E shows the adjusted marginal means where the rates now show marked and consistent increases to mid-pandemic for both girls (46% CI 25% to 66% p<.001) and boys (46% CI 24% to 67% p<.001) and, continuing to increase from mid to late-pandemic, though not significantly so (girls 28% CI -2% to 59% p=.069; boys 14% CI -15% to +43% p=.341).

**Discussion**

In this prospective study over three waves of data collection, before, mid and late in the pandemic, we provide evidence that pandemic impact on mental health in young adolescents can only be ascertained after accounting for age, sex and reporter effects. In girls, according to their self-report, the apparent pandemic related increase in depressive symptoms was accounted for by maturational increases in depression during early adolescence. By contrast, in boys the pandemic related increase in depressive symptoms was greater after accounting for the age effect because it was masked by a maturational decrease. Similar to self-reported depression, there was a sex difference in maturational changes by parent report, but in this case it arose mainly from falling depression scores with increasing age in the boys. According to parental report there was no maturational increase in depressive symptoms in girls, and the pandemic led to an increase in depression. Parental report of boys’ depression told a similar story to self-report, except that the masking effect of the maturational decrease in depression was even greater. Parental report of behaviour problems did not show a sex difference in age-related effects, and the pandemic was associated with an increase in both boys and girls.

**Age and sex-related changes**

Our findings are consistent with previous evidence of increasing depressive symptoms during early adolescence reported by girls from multiple longitudinal cohorts [12, 14–15]. A decrease in boys self-reported depression has been observed [12, 14] and the sex difference widens throughout adolescence [12]. The decrease found in behavioural problems is consistent with prior studies of CBCL aggression and broader externalising behaviour [25–27].

**Similarities and differences in adolescent and parent-reports**

In studies where parent and self-reports of adolescent depression are collected, parents report lower levels of symptoms either for girls [22, 28] or both boys and girls [12], and moderate agreement [12, 28] which we observed in our data. We also observed differences in maturational curves, particularly for girls, which is consistent with a previous study showing that the sex difference in growth of self-reported depression
emerges in late childhood and is not evident until age 14 by parent-report [12]. Lower agreement and under-reporting of symptoms in childhood is generally explained by parents observing children in different situational contexts and by an over-reliance on observable behaviour causing an under-reporting of symptoms [29]. As children develop and are able to communicate their symptoms to parents their agreement may improve, but this is dependent upon parent-child communication. Early adolescence and particularly puberty has been associated with a reduction in parent-adolescent communication [30]. This may explain the diverging maturational curves in self- and parent-report girls’ depression, as girls begin puberty at an earlier age than boys. Or it may be possible that boys’ depressive symptoms are experienced and expressed in observable behaviour more so than they are for girls, leading to greater agreement between parent- and self-ratings.

### Pandemic-related changes

The results of the uncorrected analysis of an increase in depression associated with the lockdown is consistent with most of the existing prospective adolescent studies [4, 6–8, 10]. Three previous studies focused on early adolescence. All collected data around three to six months prior to the onset of the pandemic and again three-six months post-onset, two of three found a significant increase in depression [6, 10] and one did not. No study has explicitly considered age-related change. However, in a study of 13–16 years in Norway [31] with data collected one year prior to the pandemic and during the first lockdown, a significant increase in clinical depression and anxiety by self-report was removed by controlling for baseline age which is indicative of confounding of pandemic and age-related effects. In regards to sex differences, one study found significant moderation with girls more adversely affected [6]. Our findings suggest that this may be explained by an age-typical increase in girls symptoms over time. Further, that the apparent smaller increase in boys’ depression may in fact be masked by age-typical decrease.

This is the first study of adolescents with pre and post-data to examine both parent and adolescent-report of symptoms. The impact of the pandemic was fairly similar for boys’ depression. However, for girls their own report showed no pandemic related increase and parent-report showed an increase which significantly worsened a year on. The reasons for this difference are unclear. In the mid-phase of the pandemic parents and adolescents spent more time together and parents report may reflect that increased observation, although this is a less adequate explanation for a persistence in the increase observed a year on when restrictions had lifted. Given the similarity between parents’ reports of the impact on depression and behavioural problems, it may be that parents are reporting on an emotional response to the pandemic that is externalised in girls.

### Strengths and limitations

A major strength of the study is that we were able to compare mental health measures collected during three time periods surrounding the COVID-19 pandemic with an overlap in ages which allowed separation of age from pandemic related effects. Limitations of this study include indexing development only by chronological age. Whilst chronological age captures many important aspects of development, such as the changing social pressures associated with school year progression, pubertal development in
adolescence is also likely linked to mental health symptom progression. Detailed measurement of pubertal development was not available in this study, but an analysis which attempted to separate out age- from pubertal-related effects would be desirable. While there remains much overlap, the age distributions at mid and late-pandemic assessment, which were a year apart, may limit our ability to separate maturation from late-pandemic effects, likely making results more sensitive to our assumption of smooth log-linear age trends on questionnaire scores. However, results changed little when trends with age rather than log-age was used. Relatively, only part of the whole sample were assessed pre-pandemic and these children were older. We checked whether the maturational effects were uniform across age range and corrected for this in analysis if necessary. Data collection in the mid-pandemic period occurred over 9 months and there will be differences in young peoples’ experiences over this time due to changes in lockdown restrictions. Similarly in the pre-pandemic sample those providing data closer to the initial lockdown will have had greater experience of COVID-19 in the media. Finally, the generalisability of the findings is restricted by lack of ethnic diversity reflecting the demographic characteristics of the Wirral.

**Clinical and research implications**

At a time of widespread concern regarding the impact of the COVID-19 pandemic on young people's mental health, our findings underline the need to understand that impact in the context of development, sex and reporter. For the young people in our study, COVID-19 occurred at a time when vulnerability to depression, especially in girls, is known to increase. We might have predicted that the pandemic would have magnified that vulnerability. According to their own reports, that was not the case for girls. However, levels of girls’ depression were nevertheless rising steeply over the period of the pandemic and were much higher than those of the boys. Parental reports differed in two key respects – they did not show the maturational increase and they did show a pandemic related increase. Future research should examine why this is. For example, are the maturational changes in girls’ depression more internalised, and difficult for a parent to observe, or are the pandemic related changes more externalised and seen by parents as a problem of behaviour rather than emotion. The findings based on self and maternal reports in boys are, by contrast, consistent, and they strongly suggest that boys have been adversely affected by the pandemic. Future research should further explore this sex-differentiated impact to unpick what aspects of the pandemic are protective for girls and conferring risk for boys.

These sex differentiated findings have implications for clinical services which go beyond referrals to child and adolescent mental health services. Boys, who have been markedly impacted by COVID-19, may neither seek help nor be brought for help by parents, because this impact has been masked by their maturational falls in symptoms. It then becomes important to alert parents and others who come in contact with them, such as teachers, to this possibility so that vulnerable boys are identified.

**Statements And Declarations**

**Acknowledgements**
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Author contributions

N.W. planned and conducted the study, planned the data analysis, analysed the data, interpreted the data and drafted the manuscript with A.P. A.P. planned the study, planned the data analysis, analysed the data, visualised the data, interpreted the data and drafted the manuscript with N.W. J.H. planned the study, interpreted the data and revised the manuscript. H.S. planned the study, conducted the study, interpreted the data and revised the manuscript. D.C conducted the study, prepared tables and figures and revised the manuscript. M.R.B conducted the study and revised the manuscript. S.K. conducted the study and revised the manuscript.

Ethics declarations

Conflict of interest

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by the Cheshire North and West Research Ethics Committee on the 27th June 2006 (reference no. 05/Q1506/107), 7th June 2010 (reference no. 10/H1010/4), 22nd December 2014 and again 8th June 2020 (reference no. 14/NW/1484) and 17th June 2021 (reference no. 14/NW/1484_170621).

Informed consent
All participants provided written informed consent or assent, and of those under 18 years of age, written informed consent of all legal guardians was gathered.

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Figures
Figure 1

Participant flow diagram
Figure 2

Self-rated adolescent outcomes: MFQ depression and age overlap in months
Figure 3

Parent-rated child outcomes: MFQ depression and aggression

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.