# All things being equal? Longitudinal patterns of mental disorder symptoms and associations with key social determinants in a large cohort of Australian adolescents

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## Abstract

**Objective:** Using longitudinal data from a large cohort of Australian adolescents, this study examines the following: 1) changes in depression, psychological distress and anxiety symptoms, 2) associations between symptoms and social determinants (gender, cultural/linguistic diversity, family affluence, school socio-educational advantage, and geographic remoteness), and 3) interactions between social determinants and effects on symptoms.

**Methods:** Students from 71 Australian schools completed annual surveys from Year 7 (2019, n=6,639, $M_{age}$:12.7) to 10. Generalised linear mixed effects regression analyses examined associations between social determinants and mental disorder symptoms.

**Results:** Mean mental disorder symptom scores increased over time, with cisgender females and gender diverse participants experiencing heightened baseline symptoms and an increased growth in symptoms compared with cisgender males. Interaction effects suggest that females in the lowest affluence group experienced compounded adversity, with heightened anxiety and depressive symptoms over-and-above the effects of affluence or gender alone.

**Conclusions:** Among this large cohort of Australian adolescents, elevated mental disorder symptoms were common and were associated with key social determinants.

**Implications for public health:** This study highlights the need to address adolescent mental health in public health policy, research, and practice. Responses should proportionately target groups experiencing disproportionate burdens, including female and gender diverse adolescents; particularly those experiencing low affluence.

**Key words:** adolescent, anxiety, depression, social determinants of health, prevalence, schools

## Introduction

The global prevalence of mental disorders has increased in recent decades.[1] The Global Burden of Disease (GBD) Study found that between 1990 and 2019, mental disorders climbed from the thirteenth to the seventh greatest cause of disease burden worldwide.[1] Of all regions included in the GBD Study, Australia and New Zealand had the highest burden of disease attributable to mental disorders.[2] Australian data from 2020-2021 suggested that one in five people aged 16–85 years experienced a mental disorder in the prior 12 months, jumping to nearly two in five (39.6%) people aged 16–24 years, which is a marked increase from 26.4% of people aged 16–24 years in 2007.[3,4] Recent Australian data from younger adolescent cohorts are lacking, but the 2015 'Young Minds Matter' survey of people aged 12–17 years found that 14.4% experienced a mental disorder in the prior 12 months.[5] Additionally, among New South Wales (NSW) children in 2021, 13.1% received mental healthcare from hospital or ambulatory services.[6] Building a contemporary picture of factors associated with mental disorder symptoms in the general population of Australian adolescents to identify potential intervention targets is time-critical.

While substantial evidence exists around psychotherapies and pharmacotherapies to treat mental disorders at an individual level,[7] in recent decades attention has broadened to social determinants, or "upstream" drivers of health outcomes.[8] Social determinants

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encompass factors such as sex, gender, cultural background, socioeconomic status and educational attainment, and their impacts can be observed at an individual, familial or community level. Many social determinants are widely understood to be associated with mental disorder risk, for example sex, with females having a higher likelihood of experiencing a mental disorder than males,[9] and socioeconomic status, with those experiencing greater socioeconomic disadvantage generally at increased risk of mental disorder.[8]

Evidence suggests that the developmental years—including childhood and adolescence—are when social determinants make the greatest long-term impact on social and health outcomes.[10] Relatedly, mental disorders typically emerge in adolescence, with a peak age of onset of 15 years.[11] Recognising that social determinants are impacted by country-specific factors such as differing laws and socio-political climates, it is essential that we collect and report contemporary Australian data that describe the patterns of mental disorder symptoms among the general population of adolescents and associations with key social determinants. However, there are several key limitations to available evidence. Firstly, there are no data from the recent general population of Australian adolescent cohorts that report mental disorder symptoms. Most available adolescent data predates 2015 and is limited by cross-sectional design,[5,12] and/or parental report.[13–16] Secondly, extant literature is inexhaustive in its exploration of the social determinants of mental health among adolescents. The current literature is generally limited to age and binary sex/gender,[13–15,17] with some exploration of socioeconomic status, parental ethnicity, and/or geographic remoteness.[12,16] Whilst some emerging data have examined mental disorder symptoms among specific subgroups such as gender diverse young Australians,[18] there is a gap for general population studies that utilise more inclusive conceptualisations of gender diversity and cultural and linguistic diversity, and that examine the role of school-level factors including socio-educational advantage and geographic remoteness. Finally, to our knowledge, there are no studies that explore intersectionality by examining interaction effects between social determinants and how these relate to mental health outcomes among adolescents. This is important as many people experience intersecting disadvantage in more than one social determinant and the impact on health cannot be wholly captured through examining social determinants singularly.[19,20]

This study seeks to fill these gaps using a large, diverse and contemporary dataset of over 6,500 Australian adolescents surveyed annually throughout their first four years of secondary school (2019–2022, age 11–17).[21,22] Specifically, this study aims to examine 1) changes in depression, psychological distress and anxiety symptoms over time, 2) associations between mental disorder symptoms and social determinants over time [gender (including cisgender and gender diverse identities), cultural and linguistic diversity (CALD), relative family affluence, school socio-educational advantage, and geographic remoteness], and 3) interactions between social determinants and effects on symptoms.

# Methods

## Study design and procedure

This study uses data from the Health4Life cluster randomised controlled trial, which evaluated the efficacy of a multicomponent eHealth intervention to improve lifestyle risk behaviours among Australian secondary school students.[21] Seventy-one schools across NSW, Queensland and Western Australia participated in the trial. Ethics approval was granted by the University of Sydney HREC2018/882, Curtin University HRE2019-0083, University of Queensland 2019000037, NSW Department of Education SERAP 2019006, and relevant Catholic Dioceses. The trial was preregistered with the Australian and New Zealand Clinical Trials registry (ACTRN12619000431123). Schools were recruited through convenience and purposive sampling as is standard practice for school-based cluster randomised controlled trials.[23] Stratification was used to ensure a near-even sex split in the total sample. All Year 7 students were eligible, but participation required active written student consent and either passive or active (written/verbal) parental consent, depending on ethics board requirements. The published protocol details sample size calculations, recruitment procedures and consent procedures.[21] The present study uses data from baseline (2019, Year 7 students), 12-month (2020, Year 8), 24-month (2021, Year 9) and 36-month (2022, Year 10). Data were also collected immediately post-intervention (7 weeks post baseline), but this timepoint was excluded because—at this timepoint only—the intervention was found to be more effective than the active control condition in reducing psychological distress and depressive symptoms.[24] There were no intervention effects on anxiety symptoms.[24] Both the intervention group and control group are included in analyses to maximise sample size, with intervention group adjusted for as a covariate (see Statistical analysis).

## Measures

### *Mental health outcomes*

Further detail on the mental health outcomes is provided in Note S2. Briefly, a modified version of the Patient Health Questionnaire 8 [updated to use language from the adolescent version of the scale (PHQ-A)] was used to measure prior 7-day depressive symptoms.[25,26] A score of 10 or more indicates clinically significant depression.[26] The Kessler 6-item scale (K6) measured prior four-week psychological distress symptoms such as nervousness, hopelessness, restlessness and worthlessness.[27] A score ≥13 indicates high psychological distress.[28,29] The PROMIS Anxiety Paediatric (PROMIS-AP) scale was used to measure prior 7-day anxiety symptoms.[29,30] To calculate severity category, scores were converted to a T-Score, ranging from 32.3 to 88, and "none-to-slight" anxiety is indicated by T-scores less than 55, "mild" by 55–59.5, "moderate" by 60–69.9 and "severe" by 70 and higher.[31]

### *Social determinants*

Measures used for social determinants are summarised in Table 1 and further information is in Note S2.

## Statistical analysis

Descriptive analysis determined the sample characteristics and prevalence of psychological distress, anxiety, and depressive symptoms at each of the four assessment occasions. To examine the relationships between social determinants and symptom scores, regression analysis was used. Linear, quadratic, and categorical treatments of time were tested in unconditional models using linear mixed effects regression for each outcome (depression, anxiety and psychological distress symptoms). Optimal time approach was determined via model fit statistics (AIC & BIC) with quadratic

**Table 1: Measurement of social determinants.**

| | |
|---|---|
| Gender | The best-practice two-step approach to categorising gender was used, whereby gender identity and sex assigned at birth are combined to recognise transgender and gender-diverse participants.[48] |
| Cultural and linguistic diversity (CALD) | Using definitions recommended in a recent Australian review,[49] CALD participants were those who reported being born in a non-English speaking country and/or indicated primarily speaking a language other than English at home. |
| Socioeconomic status | Two measures of socioeconomic status were included. Firstly, relative family affluence was assessed using the family affluence scale III (FASIII).[50] Secondly, school socio-educational advantage was captured using the index of community socio-educational advantage (ICSEA).[51] |
| Geographic remoteness | Participants' school geographical remoteness classification—major city, inner regional, outer regional, remote or very remote (per the nationally recognised Australian statistical geography standard remoteness structure)[52]—was used as opposed to individual remoteness as many students did not know or report their postcode. Inner regional and outer regional were combined to maximise sample size in the regional group. There were no remote or very remote schools. |

treatment of time selected for depressive and psychological distress symptoms but linear time selected for anxiety symptoms (Table S5).

Nested random effects of participant within school were used due to the clustered data collection design. Due to the zero inflated distribution of mental disorder symptom scores, Poisson and negative binomial type I and type II generalised linear mixed effects regressions were tested in addition to linear mixed effects regressions (lme4 package & glmmTMB package). Model fit statistics (AIC & BIC) guided model selection (Table S6). Each social determinant was modelled with each symptom score. Interactions between gender and CALD status, gender and relative family affluence, and relative family affluence and CALD status were tested using the best fitting model type from the single predictor models. Attrition analyses were conducted as described in Note S3, with missing data handled using maximum likelihood estimation in the mixed effects models. Table S1 outlines the proportion of the sample with data for each mental health outcome at each time point, and the number of time points completed for each scale. All analyses were conducted in R Studio version 2022.12.0+353.

## Results

### *Participant characteristics*

Sample characteristics at each timepoint are summarised in Table 2. At baseline (Year 7), there were 6,639 participants [$M_{age}$:12.65 (0.50), 49.5% cisgender male, 48.2% cisgender female, 0.8% gender diverse), and 4,445 (67%) were retained by Year 10 [$M_{age}$:15.71(0.64), 47.9% cisgender male, 46.2% cisgender female, 3.2% gender diverse].

### *Descriptive statistics for depression, high psychological distress and anxiety over time*

In Year 7, 16.8% of participants reported symptoms equating to clinically significant depression, increasing to 28.1% by Year 10. Participants reporting high psychological distress increased from 14.1% in Year 7 to 23.8% in Year 10. Participants reporting moderate-

**Table 2: Characteristics of the sample and prevalence of anxiety, depression and psychological distress.**

| | Participant characteristics | | | |
|---|---|---|---|---|
| | **Year 7, 2019** | **Year 8, 2020** | **Year 9, 2021** | **Year 10, 2022** |
| **Participant n** | 6639 | 5525 | 5014 | 4445 |
| **Age mean (SD)** | 12.65 (0.50) | 13.69 (0.79) | 14.68 (0.82) | 15.71 (0.64) |
| **Gender n(%)** | | | | |
| Cisgender male | 3271 (49.5) | 2590 (47.7) | 2353 (47.5) | 2109 (47.9) |
| Cisgender female | 3185 (48.2) | 2615 (48.1) | 2315 (46.7) | 2035 (46.2) |
| Transgender/non-binary/gender diverse | 51 (0.8) | 88 (1.6) | 168 (3.4) | 142 (3.2) |
| Prefer not to say | 105 (1.6) | 142 (2.6) | 118 (2.4) | 119 (2.7) |
| **School site n(%)** | | | | |
| NSW major city | 2225 (33.5) | 1853 (33.5) | 1611 (32.1) | 1537 (34.6) |
| NSW regional | 1311 (19.7) | 1095 (19.8) | 964 (19.2) | 861 (19.4) |
| QLD | 1788 (26.9) | 1475 (26.7) | 1447 (28.9) | 1212 (27.3) |
| WA | 1315 (19.8) | 1102 (19.9) | 992 (19.8) | 835 (18.8) |
| **Relative family affluence (ridit transformed to a normal distribution) n(%)** | | | | |
| Low | 1595 (26.5) | 1364 (27.0) | 1220 (26.5) | 1092 (26.7) |
| Middle | 2667 (44.3) | 2257 (44.7) | 2057 (44.7) | 1856 (45.4) |
| High | 1752 (29.1) | 1430 (28.3) | 1328 (28.8) | 1141 (27.9) |
| **Cultural and linguistically diverse n(%)** | | | | |
| Non-CALD | 5809 (87.8) | 4855 (88.1) | 4443 (88.8) | 3907 (88.2) |
| CALD | 808 (12.2) | 655 (11.9) | 561 (11.2) | 525 (11.8) |
| **Geographical remoteness n(%)** | | | | |
| Major city | 5953 (89.7) | 4969 (89.9) | 4547 (90.7) | 4046 (91.0) |
| Regional | 686 (10.3) | 556 (10.1) | 467 (9.3) | 399 (9.0) |
| **Index of socio-educational advantage quartile n(%)** | | | | |
| First (lowest advantage) | 210 (3.2) | 156 (2.8) | 110 (2.2) | 109 (2.5) |
| Second | 375 (5.6) | 299 (5.4) | 291 (5.8) | 240 (5.4) |
| Third | 1563 (23.5) | 1198 (21.7) | 1056 (21.1) | 950 (21.4) |
| Fourth (highest advantage) | 4491 (67.6) | 3872 (70.1) | 3557 (70.9) | 3146 (70.8) |

*(continued)*

TABLE 2. Continued

| | Participant characteristics | | | |
|---|---|---|---|---|
| | Year 7, 2019 | Year 8, 2020 | Year 9, 2021 | Year 10, 2022 |
| **Anxiety, depression and psychological distress** | | | | |
| **Depressive symptoms mean(SD)** | 5.08 (5.15) | 5.87 (6.16) | 6.63 (6.49) | 6.79 (6.48) |
| **Depressive symptom severity n(%)** | | | | |
| No or minimal | 3556 (57.4) | 2783 (53.7) | 2234 (48.4) | 1912 (45.9) |
| Mild | 1597 (25.8) | 1243 (24.0) | 1115 (24.1) | 1082 (26.0) |
| Moderate | 624 (10.1) | 593 (11.5) | 641 (13.9) | 609 (14.6) |
| Moderately severe | 277 (4.5) | 287 (5.5) | 346 (7.5) | 303 (7.3) |
| Severe | 138 (2.2) | 272 (5.3) | 282 (6.1) | 260 (6.2) |
| **Probable depression n(%)** | 1039 (16.8) | 1152 (22.2) | 1269 (27.5) | 1172 (28.1) |
| **Psychological distress symptoms mean(SD)** | 6.86 (5.40) | 7.70 (6.27) | 8.06 (6.24) | 8.42 (6.39) |
| **High psychological distress n(%)** | 886 (14.1) | 1079 (20.7) | 1047 (22.5) | 997 (23.8) |
| **Anxiety symptoms mean(SD)** | 23.06 (10.59) | 24.12 (12.32) | 24.92 (12.70) | 25.23 (12.55) |
| **Anxiety symptom severity n(%)** | | | | |
| None to slight | 4524 (73.2) | 3615 (70.2) | 3068 (66.6) | 2702 (64.9) |
| Mild | 659 (10.7) | 485 (9.4) | 483 (10.5) | 455 (10.9) |
| Moderate | 777 (12.6) | 738 (14.3) | 748 (16.2) | 743 (17.8) |
| Severe | 224 (3.6) | 314 (6.1) | 306 (6.6) | 263 (6.3) |

CALD = cultural and linguistic diversity; ICSEA = Index of community socio-educational advantage; NSW = New South Wales; QLD = Queensland; WA = Western Australia.

**Figure 1: Raw mean depressive symptom scores over time, grouped by social determinant.**

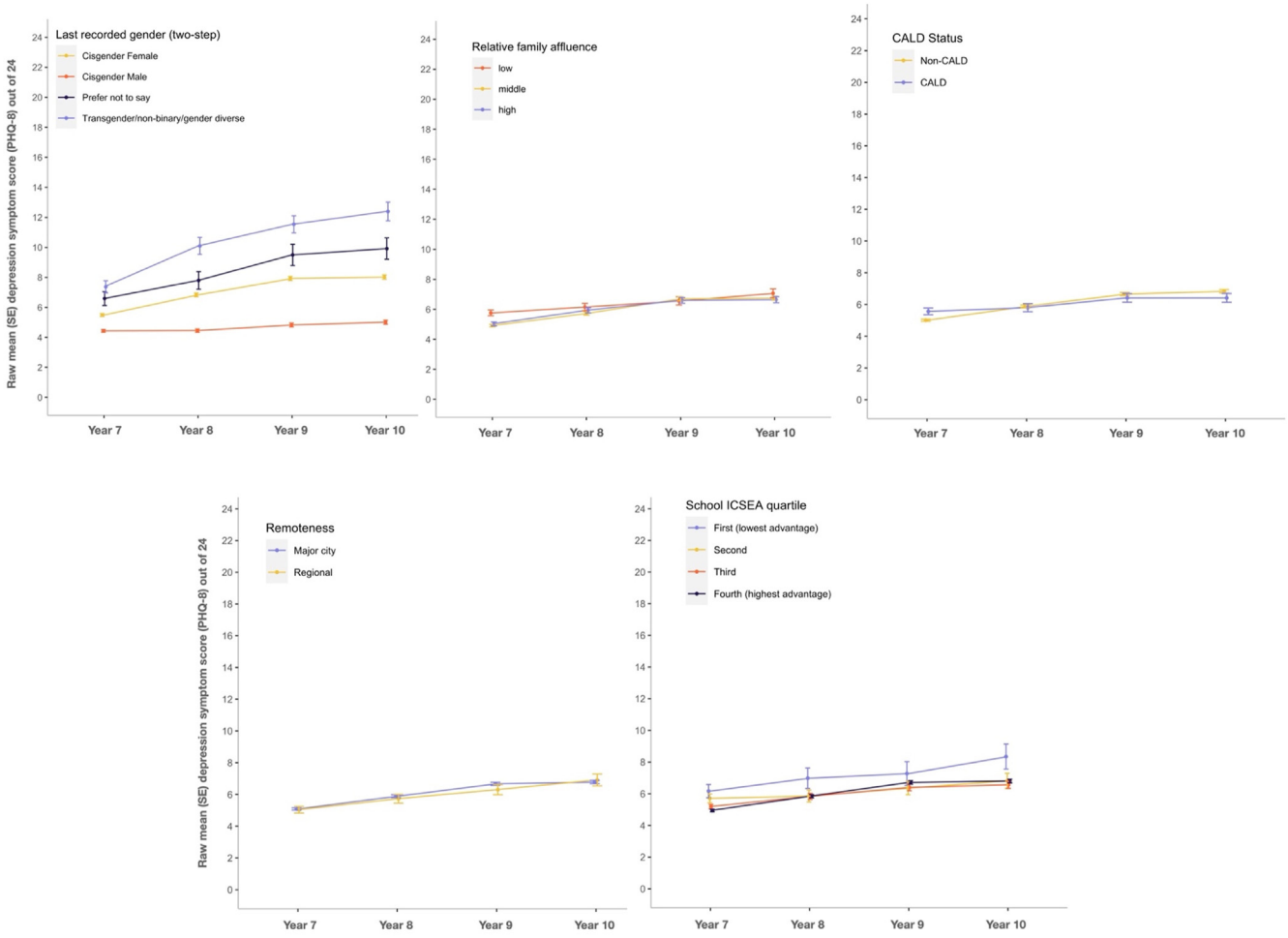
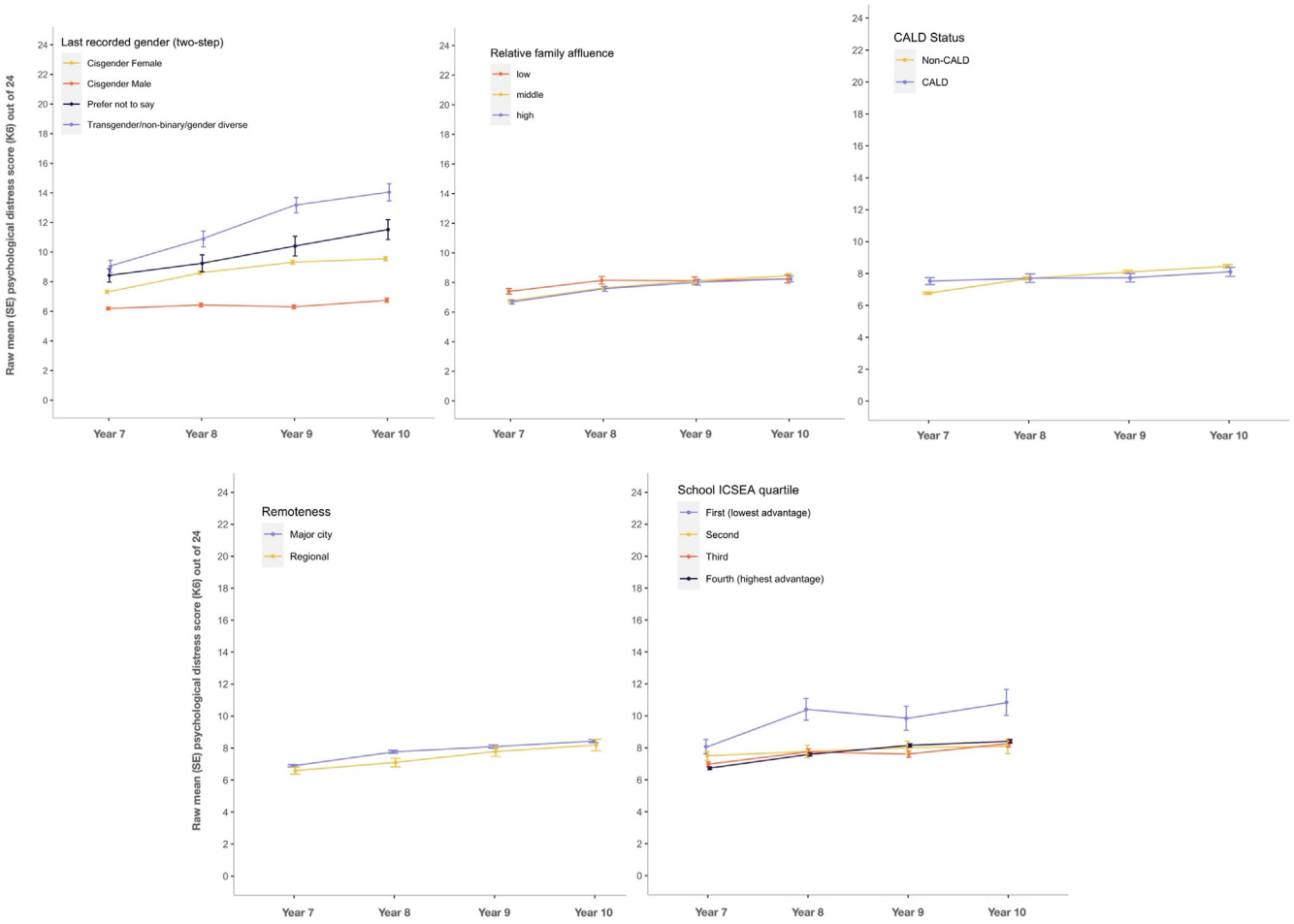


**Figure 2: Raw mean psychological distress symptom scores over time, grouped by social determinant.**




to-severe anxiety grew from 16.2% in Year 7 to 24.1% by Year 10. There was some evidence of differential attrition by baseline symptom scores and some social determinants, detailed in Note S3, Table S2 and Table S3.

### *Descriptive statistics of mental disorder symptoms by social determinant characteristic*

Figures 1–3 summarise the change over time in raw mean symptom scores for depression, psychological distress and anxiety symptoms, grouped by social determinant. Table 3 contains predicted symptom scores and effect estimates from adjusted models.

For all three outcomes, largest between-group differences in raw scores are between gender groups. Gender diverse participants began with the highest symptom scores and reported the sharpest three-year increase in scores, followed by those who preferred not to indicate their gender, then females, and finally males, who had the lowest and most stable scores over time. In adjusted models (Table 3) with cisgender males as the reference group, these between-gender differences reached statistical significance for higher depressive symptoms in females (expβ:0.93 [0.90, 0.95], $p<0.001$); higher psychological distress in females and gender diverse participants (expβ:0.95 [0.94, 0.97], $p<0.001$ and expβ:0.93 [0.88, 0.99], $p=0.015$); and higher anxiety symptoms in females and those who preferred not to say (expβ:1.03 [1.02, 1.04], $p<0.001$ and expβ:1.05 [1.02, 1.08], p=0.004).

For all three outcomes, those in the lowest affluence group had marginally higher symptoms in Year 7 but differences narrowed over time. In adjusted models, the relationship only reached statistical significance for depressive symptoms (middle *vs.* lowest affluence: expβ:0.96 [0.93, 0.99], $p=0.016$; highest *vs.* lowest affluence: expβ:0.96 [0.92, 1.0], $p=0.026$).

For all three outcomes, CALD participants started with higher symptoms than non-CALD participants, but the groups had swapped by Year 10, with non-CALD participants reporting higher symptoms. However, these associations were not statistically significant.

Minimal differences between participants attending schools in regional areas and major city areas were observed in raw symptoms and there was no significant difference in adjusted models.

Those attending schools in the lowest ICSEA quartile (least advantaged schools) had the highest symptom scores over time, despite a dip in Year 9 for psychological distress and anxiety symptoms. However, in adjusted models, the only statistically significant difference was for anxiety, with those in the second

**Figure 3: Raw mean anxiety symptom scores over time, grouped by social determinant**

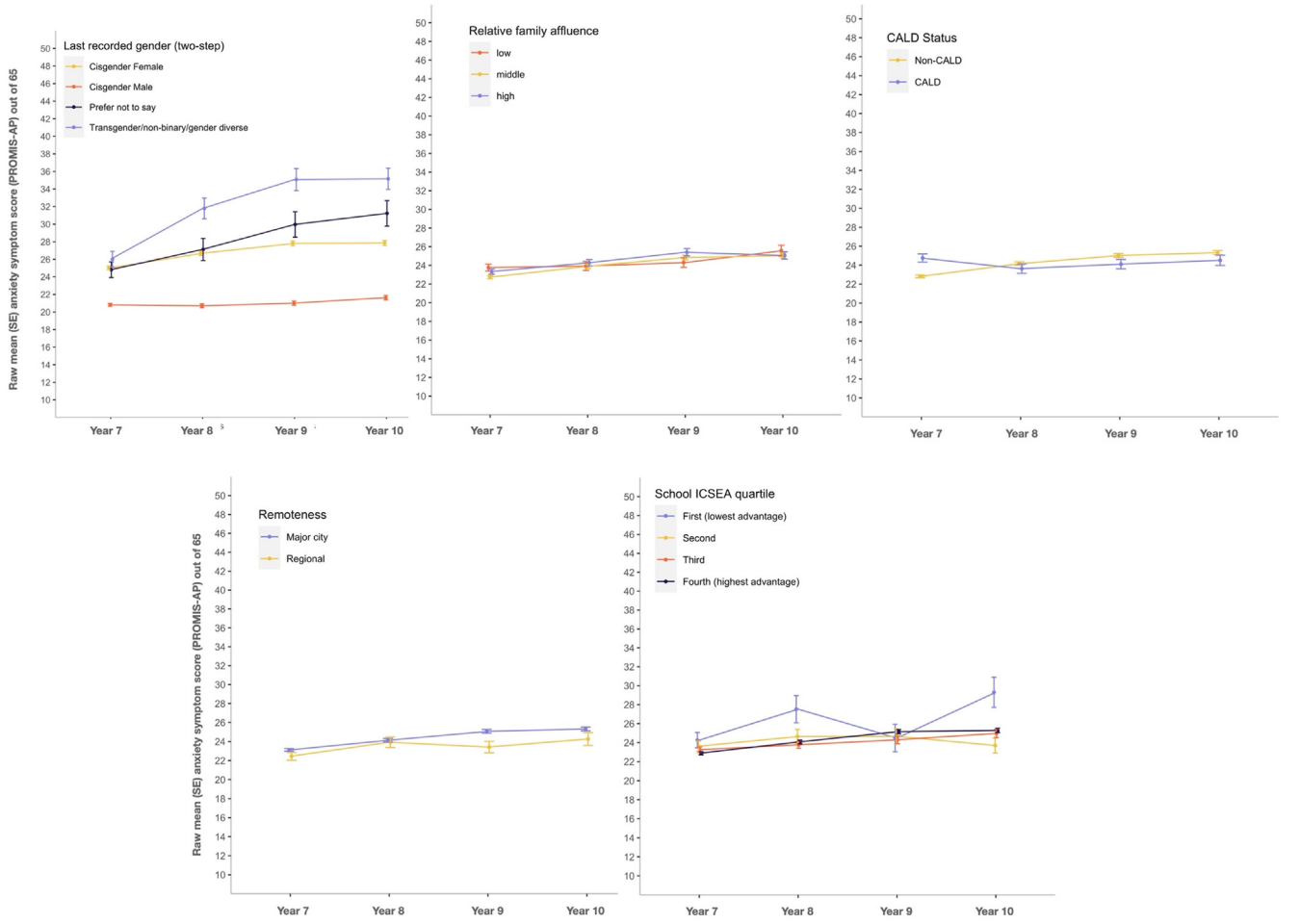



**Table 3: Model-predicted symptom scores and effect estimates by social determinant subgroups.**

| Predictor and outcome | Predictor category | Year 7, 2019 | Year 8, 2020 | Year 9, 2021 | Year 10, 2022 | Incident rate ratio (exponentiated effects) |
|---|---|---|---|---|---|---|
| | | Model-predicted symptom score [95% CI] | | | | |
| Gender, depressive symptoms | Cisgender male | 3.69 [3.52, 3.87] | 3.57 [3.42, 3.74] | 3.63 [3.47, 3.80] | 3.88 [3.67, 4.09] | Reference |
| | Cisgender female | 4.82 [4.62, 5.04] | 6.16 [5.92, 6.41] | 7.08 [6.80, 7.37] | 7.31 [6.99, 7.66] | expβ: 0.93 [0.90, 0.95], *p*: <0.001 |
| | Gender diverse | 6.62 [5.36, 8.18] | 7.81 [6.98, 8.74] | 8.52 [7.70, 9.43] | 8.59 [7.63, 9.67] | expβ: 0.94 [0.87, 1.01], *p*: 0.081 |
| | Prefer not to say | 6.42 [5.41, 7.63] | 6.63 [5.90, 7.45] | 7.21 [6.42, 8.10] | 8.26 [7.17, 9.51] | expβ: 1 [0.93, 1.08], *p*: 0.96 |
| Gender, psych. distress | Cisgender male | 5.59 [5.35, 5.85] | 5.55 [5.32, 5.80] | 5.64 [5.40, 5.89] | 5.85 [5.58, 6.15] | Reference |
| | Cisgender female | 6.78 [6.50, 7.08] | 8.05 [7.72, 8.38] | 8.86 [8.51, 9.24] | 9.07 [8.68, 9.49] | expβ: 0.95 [0.94, 0.97], *p*: <0.001 |
| | Gender diverse | 7.67 [6.41, 9.18] | 9.81 [8.93, 10.77] | 11.08 [10.17, 12.06] | 11.04 [10.01, 12.18] | expβ: 0.93 [0.88, 0.99], *p*: 0.015 |
| | Prefer not to say | 8.92 [7.80, 10.19] | 8.76 [7.97, 9.63] | 9.24 [8.42, 10.15] | 10.48 [9.34, 11.75] | expβ: 1.03 [0.97, 1.08], *p*: 0.39 |
| Gender, anxiety symptoms | Cisgender male | 20.25 [19.75, 20.76] | 20.46 [19.98, 20.95] | 20.67 [20.18, 21.17] | 20.88 [20.34, 21.44] | Reference |
| | Cisgender female | 24.53 [23.94, 25.14] | 25.62 [25.03, 26.22] | 26.75 [26.13, 27.39] | 27.94 [27.23, 28.66] | expβ: 1.03 [1.02, 1.04], *p*: <0.001 |
| | Gender diverse | 28.02 [25.80, 30.43] | 29.38 [27.79, 31.05] | 30.8 [29.49, 32.17] | 32.3 [30.50, 34.20] | expβ: 1.04 [1.00, 1.08], *p*: 0.046 |
| | Prefer not to say | 25.62 [23.93, 27.42] | 27.13 [25.81, 28.51] | 28.73 [27.40, 30.12] | 30.42 [28.57, 32.39] | expβ: 1.05 [1.02, 1.08], *p*: 0.004 |
| CALD, depressive symptoms | CALD | 4.5 [4.10, 4.94] | 4.77 [4.36, 5.21] | 5 [4.57, 5.48] | 5.2 [4.70, 5.77] | Reference |
| | Non-CALD | 4.22 [3.97, 4.47] | 4.94 [4.66, 5.23] | 5.46 [5.16, 5.79] | 5.72 [5.38, 6.07] | expβ: 0.98 [0.94, 1.01], *p*: 0.19 |
| CALD, psych. distress | CALD | 6.72 [6.23, 7.25] | 6.79 [6.31, 7.30] | 6.95 [6.45, 7.48] | 7.21 [6.63, 7.83] | Reference |
| | Non-CALD | 6.17 [5.86, 6.49] | 6.93 [6.60, 7.28] | 7.46 [7.09, 7.84] | 7.67 [7.29, 8.08] | expβ: 0.97 [0.95, 1.00], *p*: 0.04 |
| CALD, anxiety symptoms | CALD | 23.5 [22.54, 24.51] | 23.5 [22.60, 24.44] | 23.51 [22.58, 24.47] | 23.51 [22.48, 24.59] | Reference |
| | Non-CALD | 22.46 [21.81, 23.13] | 23.3 [22.64, 23.98] | 24.17 [23.48, 24.88] | 25.07 [24.33, 25.84] | expβ: 0.98 [0.95, 1.03], *p*: 0.45 |

*(continued)*

TABLE 3. Continued

| Predictor and outcome | Predictor category | Year 7, 2019 | Year 8, 2020 | Year 9, 2021 | Year 10, 2022 | Incident rate ratio (exponentiated effects) |
|---|---|---|---|---|---|---|
| | | Model-predicted symptom score [95% CI] | | | | |
| Relative affluence, depressive symptoms | Low affluence | 4.8 [4.39, 5.24] | 5.05 [4.64, 5.50] | 5.42 [4.97, 5.91] | 5.93 [5.38, 6.54] | Reference |
| | Middle affluence | 4.2 [3.94, 4.48] | 4.97 [4.67, 5.28] | 5.51 [5.18, 5.86] | 5.73 [5.37, 6.12] | expβ: 0.96 [0.93, 0.99], *p*: 0.016 |
| | High affluence | 4.17 [3.86, 4.50] | 4.9 [4.56, 5.27] | 5.39 [5.01, 5.80] | 5.54 [5.12, 6.01] | expβ: 0.96 [0.92, 1.0], *p*: 0.026 |
| Relative affluence, psych. distress | Low affluence | 6.62 [6.15, 7.11] | 7.18 [6.69, 7.69] | 7.46 [6.95, 8.00] | 7.42 [6.85, 8.04] | Reference |
| | Middle affluence | 6.22 [5.89, 6.57] | 6.99 [6.62, 7.37] | 7.51 [7.12, 7.93] | 7.72 [7.30, 8.17] | expβ: 1 [0.97, 1.03], *p*: 0.95 |
| | High affluence | 6.04 [5.67, 6.44] | 6.74 [6.35, 7.17] | 7.25 [6.82, 7.71] | 7.51 [7.02, 8.02] | expβ: 1 [0.97, 1.03], *p*: 0.86 |
| Relative affluence, anxiety symptoms | Low affluence | 23.02 [22.13, 23.95] | 23.64 [22.77, 24.53] | 24.27 [23.36, 25.21] | 24.92 [23.88, 26.00] | Reference |
| | Middle affluence | 22.41 [21.73, 23.11] | 23.2 [22.51, 23.91] | 24.01 [23.29, 24.75] | 24.85 [24.08, 25.65] | expβ: 1.01 [1.00, 1.02], *p*: 0.22 |
| | High affluence | 22.81 [22.02, 23.62] | 23.53 [22.76, 24.33] | 24.28 [23.47, 25.11] | 25.05 [24.15, 25.98] | expβ: 1 [0.99, 1.02], *p*: 0.51 |
| Remoteness, depressive symptoms | Major city | 4.27 [4.02, 4.53] | 4.96 [4.68, 5.27] | 5.46 [5.15, 5.79] | 5.68 [5.34, 6.04] | Reference |
| | Regional | 4.29 [3.78, 4.85] | 4.7 [4.17, 5.30] | 5.17 [4.58, 5.83] | 5.7 [4.99, 6.52] | expβ: 1.03 [0.99, 1.07], *p*: 0.15 |
| Remoteness, psych. distress | Major city | 6.28 [5.97, 6.61] | 6.99 [6.65, 7.36] | 7.48 [7.11, 7.87] | 7.68 [7.29, 8.10] | Reference |
| | Regional | 6.04 [5.44, 6.71] | 6.5 [5.87, 7.19] | 6.93 [6.26, 7.67] | 7.32 [6.54, 8.20] | expβ: 1.02 [0.98, 1.05], *p*: 0.32 |
| Remoteness, anxiety symptoms | Major city | 22.66 [21.99, 23.36] | 23.43 [22.75, 24.14] | 24.23 [23.51, 24.96] | 25.05 [24.29, 25.83] | Reference |
| | Regional | 22.41 [21.11, 23.79] | 22.88 [21.60, 24.22] | 23.35 [22.03, 24.75] | 23.83 [22.38, 25.38] | expβ: 0.99 [0.97, 1.00], *p*: 0.1 |
| ICSEA quartile, depressive symptoms | First quartile | 4.91 [3.98, 6.06] | 5.08 [4.10, 6.30] | 5.46 [4.40, 6.79] | 6.1 [4.80, 7.76] | Reference |
| | Second quartile | 4.82 [4.11, 5.66] | 4.73 [4.04, 5.53] | 4.99 [4.26, 5.84] | 5.66 [4.76, 6.75] | expβ: 1.02 [0.93, 1.11], *p*: 0.69 |
| | Third quartile | 4.4 [3.99, 4.85] | 4.9 [4.45, 5.38] | 5.25 [4.77, 5.78] | 5.44 [4.91, 6.02] | expβ: 0.96 [0.89, 1.04], *p*: 0.33 |
| | Fourth quartile | 4.15 [3.90, 4.42] | 4.95 [4.66, 5.26] | 5.52 [5.19, 5.86] | 5.73 [5.38, 6.10] | expβ: 0.95 [0.88, 1.02], *p*: 0.14 |
| ICSEA quartile, psych. distress | First quartile | 6.87 [5.76, 8.20] | 8.05 [6.75, 9.59] | 8.7 [7.28, 10.39] | 8.68 [7.15, 10.55] | Reference |
| | Second quartile | 6.96 [6.10, 7.96] | 7.12 [6.25, 8.11] | 7.2 [6.32, 8.21] | 7.21 [6.23, 8.33] | expβ: 1.04 [0.97, 1.10], *p*: 0.29 |
| | Third quartile | 6.48 [5.97, 7.03] | 6.93 [6.40, 7.51] | 7.31 [6.75, 7.93] | 7.6 [6.97, 8.28] | expβ: 1.03 [0.98, 1.09], *p*: 0.25 |
| | Fourth quartile | 6.11 [5.79, 6.44] | 6.89 [6.54, 7.26] | 7.43 [7.05, 7.82] | 7.65 [7.25, 8.07] | expβ: 1.02 [0.96, 1.07], *p*: 0.53 |
| ICSEA quartile, anxiety symptoms | First quartile | 23.58 [21.28, 26.13] | 24.74 [22.42, 27.32] | 25.96 [23.44, 28.76] | 27.24 [24.36, 30.47] | Reference |
| | Second quartile | 23.67 [21.91, 25.57] | 23.69 [21.99, 25.51] | 23.7 [21.98, 25.56] | 23.72 [21.87, 25.72] | expβ: 0.95 [0.92, 0.99], *p*: 0.004 |
| | Third quartile | 23.04 [21.96, 24.17] | 23.69 [22.61, 24.82] | 24.36 [23.24, 25.54] | 25.05 [23.84, 26.32] | expβ: 0.98 [0.95, 1.01], *p*: 0.16 |
| | Fourth quartile | 22.39 [21.71, 23.10] | 23.21 [22.51, 23.92] | 24.05 [23.32, 24.79] | 24.92 [24.14, 25.72] | expβ: 0.99 [0.96, 1.01], *p*: 0.36 |

CALD = cultural and linguistic diversity; CI = confidence interval; ICSEA = Index of community socio-educational advantage.
Note: Depressive and psychological symptoms utilise negative binomial type I models and quadratic treatment of time. Anxiety symptoms utilise negative binomial type II linear treatment of time and linear treatment of time.

quartile having significantly lower symptoms than those in the lowest quartile (expβ:0.95 [0.92,0.99], $p$=0.004).

### *Interaction effects*

Model-predicted depressive, psychological distress and anxiety symptom scores for each interaction group are shown in **Figure 4**, while Table 4 shows interaction regression coefficients in adjusted models. Sample sizes were small for some groups including gender-diverse low affluence and gender-diverse CALD (Table S4). However, these groups were retained for inclusivity and exploratory purposes.

The first three plots in Figure 4 display interactions between gender and affluence. For depression, females in the low affluence group experienced a greater increase in symptoms than those in the high affluence group (expβ:0.9 [0.83,0.97], $p$=0.009) and females in the middle affluence group experienced a marginally lower increase in symptoms than females in the higher affluence group (expβ:0.94 [0.88,0.99], $p$=0.031). Gender-diverse middle affluence participants were again best-off for most of the timepoints (expβ:0.78 [0.64,0.96], $p$=0.017); however, gender-diverse low affluence participants experienced a greater reduction of symptoms between 24 and 36 months than both high and middle affluence gender-diverse participants (expβ:0.75 [0.59,0.96], $p$=0.022). For psychological distress, none of the genders by affluence interactions were statistically significant. Finally, for anxiety, the only statistically significant interaction effect was among low affluence females (expβ:0.97 [0.93,1.00], $p$=0.042), with these participants starting and finishing with higher anxiety symptom scores than females in the high affluence group.

The second row of plots in Figure 4 displays interactions between CALD status and relative family affluence. None of these interactions were statistically significant, aside from psychological distress, where low affluence CALD participants had a significantly different progression of symptoms over time (expβ:0.91 [0.84,0.99], $p$=0.025).

The final row of plots in Figure 4 displays interactions between CALD status and gender. CALD females started with higher model-predicted depressive symptoms at baseline but ended with lower symptoms at 36 months than non-CALD females (expβ:1.09

**Figure 4: Model-predicted depressive, psychological distress and anxiety symptom scores by interaction group**

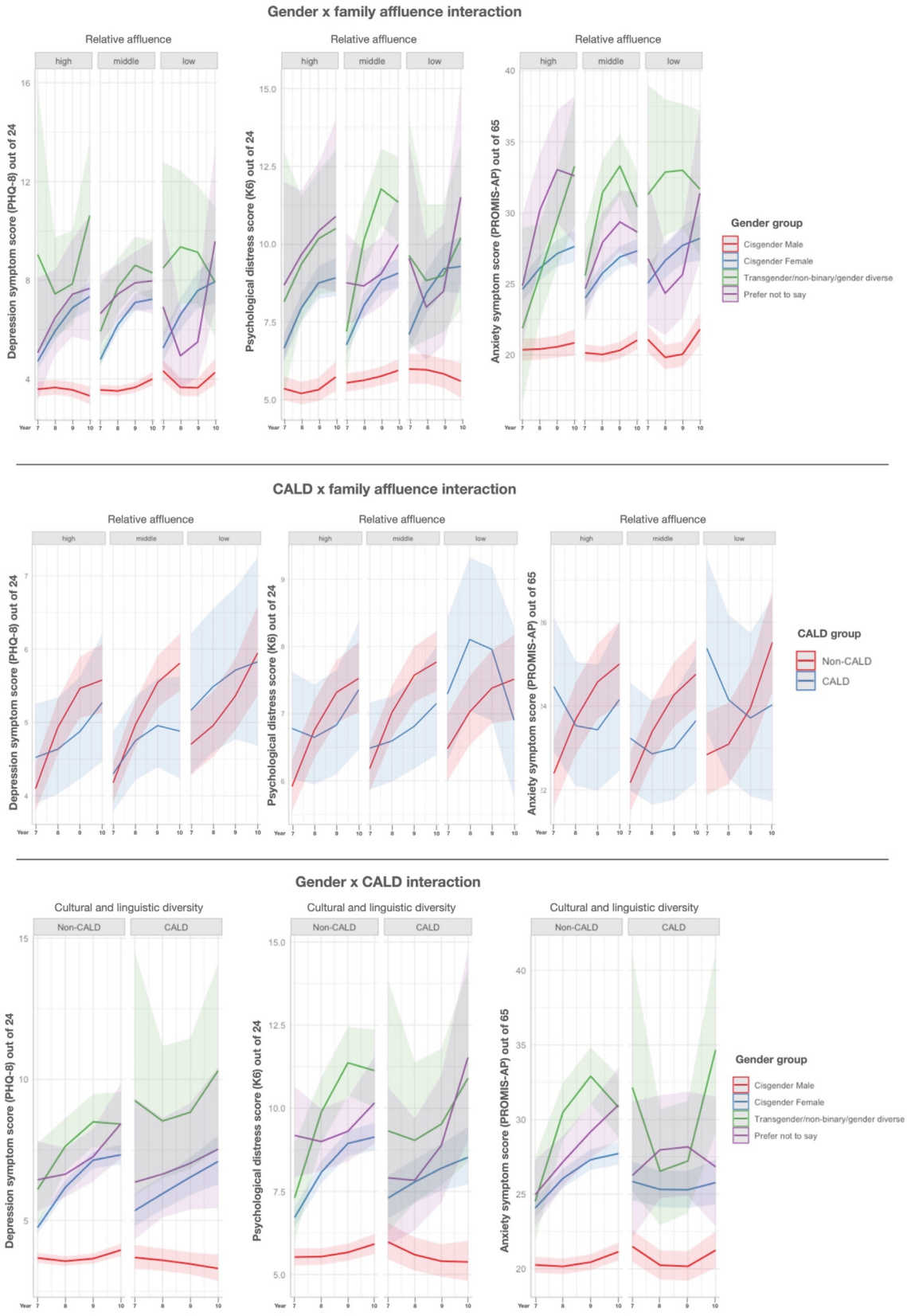


**Table 4: Interaction effect estimates from adjusted models.**

| Outcome | Interaction | Incident rate ratio (exponentiated effects) |
|---|---|---|
| Depressive symptoms | Cisgender female * middle affluence | expβ: 0.94 [0.88, 0.99], *p*: 0.031 |
| | Transgender/non-binary/gender diverse * middle affluence | expβ: 0.78 [0.64, 0.96], *p*: 0.017 |
| | Prefer not to say * middle affluence | expβ: 0.98 [0.79, 1.21], *p*: 0.85 |
| | Cisgender female * low affluence | expβ: 0.9 [0.83, 0.97], *p*: 0.009 |
| | Transgender/non-binary/gender diverse * low affluence | expβ: 0.75 [0.59, 0.96], *p*: 0.022 |
| | Prefer not to say * low affluence | expβ: 1.19 [0.91, 1.56], *p*: 0.21 |
| Psychological distress | Cisgender female * middle affluence | expβ: 1.03 [0.98, 1.07], *p*: 0.28 |
| | Transgender/non-binary/gender diverse * middle affluence | expβ: 0.95 [0.81, 1.13], *p*: 0.58 |
| | Prefer not to say * middle affluence | expβ: 1.07 [0.92, 1.24], *p*: 0.41 |
| | Cisgender female * low affluence | expβ: 1.03 [0.97, 1.10], *p*: 0.28 |
| | Transgender/non-binary/gender diverse * low affluence | expβ: 1.12 [0.91, 1.38], *p*: 0.28 |
| | Prefer not to say * low affluence | expβ: 1.19 [0.97, 1.45], *p*: 0.088 |
| Anxiety symptoms | Cisgender female * middle affluence | expβ: 0.99 [0.97, 1.01], *p*: 0.37 |
| | Transgender/non-binary/gender diverse * middle affluence | expβ: 0.93 [0.84, 1.03], *p*: 0.16 |
| | Prefer not to say * middle affluence | expβ: 1.01 [0.92, 1.10], *p*: 0.88 |
| | Cisgender female * low affluence | expβ: 0.97 [0.93, 1.00], *p*: 0.042 |
| | Transgender/non-binary/gender diverse * low affluence | expβ: 0.95 [0.84, 1.08], *p*: 0.46 |
| | Prefer not to say * low affluence | expβ: 1.1 [0.98, 1.23], *p*: 0.11 |
| Depressive symptoms | Middle affluence* CALD | expβ: 0.95 [0.87, 1.03], *p*: 0.22 |
| | Low affluence* CALD | expβ: 0.93 [0.83, 1.03], *p*: 0.15 |
| Psychological distress | Middle affluence* CALD | expβ: 0.98 [0.92, 1.05], *p*: 0.62 |
| | Low affluence* CALD | expβ: 0.91 [0.84, 0.99], *p*: 0.025 |
| Anxiety symptoms | Middle affluence* CALD | expβ: 0.99 [0.96, 1.03], *p*: 0.67 |
| | Low affluence* CALD | expβ: 0.98 [0.93, 1.02], *p*: 0.3 |
| Depressive symptoms | Female * CALD | expβ: 1.09 [1.01, 1.17], *p*: 0.026 |
| | Gender diverse * CALD | expβ: 1.16 [0.96, 1.40], *p*: 0.12 |
| | Prefer not to say * CALD | expβ: 1.01 [0.84, 1.21], *p*: 0.92 |
| Psychological distress | Female * CALD | expβ: 1.03 [0.97, 1.09], *p*: 0.33 |
| | Gender diverse * CALD | expβ: 1.12 [0.96, 1.32], p: 0.15 |
| | Prefer not to say * CALD | expβ: 1.04 [0.90, 1.20], *p*: 0.63 |
| Anxiety symptoms | Female * CALD | expβ: 1.01 [0.98, 1.04], *p*: 0.63 |
| | Gender diverse * CALD | expβ: 1.17 [1.06, 1.30], *p*: 0.002 |
| | Prefer not to say * CALD | expβ: 0.96 [0.88, 1.05], *p*: 0.35 |

CALD = cultural and linguistic diversity.

[1.01,1.17], $p$=0.026). Gender-diverse CALD participants had a reverse shape to their predicted anxiety symptoms than gender-diverse non-CALD participants, starting and finishing with higher symptoms but with lower symptoms in Year 8 and 9 (expβ:1.17 [1.06,1.30], $p$=0.002).

## Discussion

This study presents contemporary data on depression, psychological distress and anxiety symptoms in a large sample of Australian adolescents, exploring associations with a comprehensive range of social determinants and conducting novel analysis around interaction effects between social determinants. Data span 2019–2022, following up students annually from Year 7–10, which is the first four years of secondary school in Australia. By Year 10 (n=4,445, $M_{age}$:15.7), nearly 3 in 10 reported probable major depression, almost 1 in 4 reported high psychological distress and nearly 1 in 4 reported moderate-to-severe anxiety. The mean symptom scores increased markedly over time. This increase between 12 and 16 years of age is in line with extant literature suggesting prevalence of mental disorders increases throughout adolescence.[11]

'Young Minds Matter'—a 2013/14 population-representative study among a smaller cohort of 2,976 people aged 11–17 years—found that 7.7% met criteria for the past 12 months major depression (DISC-IV) and 19.9% had high/very high psychological distress (K10).[5] Anxiety was only measured by parental report (DISC-IV) and prevalence was 7% in people aged 12–17 years.[5] The participants in our study were born in 2006–2007, whereas the participants aged 12-17 years included in Young Minds Matter would have been born between 1996 and 2002. Although the measures aren't directly comparable and our sample is not population representative, the higher prevalence rates of depression, psychological distress and anxiety in our sample are likely consistent with recent evidence that suggests cohort effects in the increase of psychological distress anxiety and depression, with younger generations experiencing increased prevalence compared with the generation preceding them.[32]

### Gender

Our study demonstrated pronounced gender differences in the prevalence of depression, psychological distress and anxiety symptoms over time. Compared with cisgender males, cisgender females started with higher symptoms in Year 7 and had a steeper increase in symptoms, and gender diverse participants started higher-again and experienced a steeper-again increase. This is consistent with the well-established 'gender gap' in mental health between males and females[9,15,16,33] and adds to the emerging literature suggesting gender diverse adolescents experience increased mental ill-health.[18] While gender differences in prevalence are expected, it is unexpected to see stable mean symptom scores among males throughout adolescence as the literature suggests either no sex differences in age of onset for mental disorders[34] or a marginally *earlier* age of onset among males.[11] The theory of proportionate universalism suggests that responses to an issue must be proportionately targeted to those experiencing disproportionate burdens.[35] The design and implementation of future research and policy to address adolescent mental health must consider methods such as co-design and targeting to ensure efficacy among females and gender diverse adolescents, whilst still ensuring relevance for males.

### Socioeconomic status and geographic remoteness

School socio-educational advantage was significantly associated with anxiety symptoms only, with those in the second ICSEA quartile having lower symptoms than those in the first/lowest ICSEA quartile. Family-level affluence was only significantly associated with depressive symptoms, with those experiencing the lowest relative affluence having the highest symptoms. While these findings are somewhat aligned with the existing literature, we expected differences by affluence (at both school- and individual-levels) to be more pronounced for *all three* outcomes as data generally suggest a strong relationship between socioeconomic status and mental health.[16] Associations may have been stronger had our sample included more schools in the lowest ICSEA quartile and thus a wider range of familial affluence. We found no significant differences between regional and major city areas for any of the three outcomes. A meta-analysis examining the mental health differences between urban and rural adolescents in Australia found high heterogeneity; however, overall the results were consistent with our study, finding no significant differences by geographic remoteness.[12]

### Cultural and linguistic diversity

We found no statistically significant differences between CALD and non-CALD participants. However, there was a crossover in raw mean symptom scores over time, with CALD participants experiencing higher symptoms in Year 7 and lower symptoms in Year 10 than non-CALD participants. Although not statistically significant in our study, this crossover effect was found in another study examining trajectories of symptoms from childhood to adolescence in both UK and Australia, with ethnically diverse participants starting worse-off and ending up better-off.[16] Further research is needed to develop a more nuanced understanding of the relationship between cultural and linguistic diversity and mental health in Australian adolescents.

One possible explanation for higher symptoms among CALD participants in Year 7 is racially motivated bullying victimisation during primary school and the transition to secondary school.[36] The literature shows a natural decline in bullying throughout adolescence,[37] which may explain decreasing mental disorder symptoms among CALD participants by Year 10. If future research confirmed this speculated mechanism, a possible target for mental disorder prevention efforts could be racially motivated bullying in primary schools.[38]

### Interaction effects

This study also presents novel evidence around interaction effects among social determinants. Our findings suggest that female participants in the lowest relative family affluence group experienced compounding adversity, with heightened anxiety and depressive symptoms over-and-above the effects of affluence or gender alone. When examining gender and CALD interactions, a significant interaction effect was found for depression among females; similarly to in CALD-only models, female CALD participants started off with higher depressive symptoms than non-CALD females but by Year 10 the reverse was true. These findings suggest that while tailoring and targeting should apply to females overall, applying proportionate universalism would require additional consideration of low affluence females and—during early adolescence—CALD females.

### Contextual factor: The COVID-19 pandemic

An important contextual factor to consider in the interpretation of findings is that this study encompassed the COVID-19 pandemic period. Data were collected prior to the pandemic (2019); during the pandemic and intermittent lockdowns (2020 and 2021); and in post-restriction 'COVID normal' (2022). The findings echo evidence that adolescents experienced increasing mental ill-health during the pandemic period,[39–41] although it is not possible to isolate the effects of COVID-19 compared with general increases in symptoms that are expected throughout adolescence. This is a general limitation in most literature around the mental health impacts of COVID-19.[40] Of note, there were no observable or statistically significant differences between adolescents in regional areas and major cities, despite fewer restrictions in regional areas. Findings also adjust for school cluster, which would account for differences in school closures and area-level restrictions. Finally, symptoms of mental ill-health remained high in 2022, despite the removal of restrictions. Nevertheless, whether attributable to the pandemic or otherwise, the high prevalence of mental disorder symptoms among this large cohort of Australian adolescents warrants urgent action.

## Strengths and limitations

This study has several notable strengths alongside several limitations. It utilises the largest Australian adolescent sample in which the prevalence of mental disorder symptoms has been measured to date. Due to its size, it includes a substantial number of gender and culturally diverse participants, enabling meaningful reporting on these social determinants. It has a closely population-representative gender split and distribution of participants among the three included states, which span opposite sides of the continent. However, overall

the sample is not population-representative, with more schools in the higher ICSEA quartiles, no schools in rural or remote areas and several states and territories not included in the study. Thus, findings may not be generalisable to all Australian adolescents. In addition, participants who had higher mental disorder symptoms at baseline were less likely to complete follow-up. It is possible that prevalence estimates in Year 8, 9 and 10 would have been higher had these participants remained in the study. There was also differential attrition for some social determinants, with CALD participants and those in the lowest ICSEA quartile less likely to complete follow-up. The analytical methods were rigorous and the study utilised widely validated measures of mental disorder symptoms. However, self-reported symptoms are not directly comparable to clinician diagnosis and responses may be subject to self-report bias. A comprehensive range of social determinants are examined, including novel examination of interactions between determinants. However, interaction effect analyses are limited by small sample sizes for some groups. As a strength, this study provides a detailed picture of mental health in an adolescent cohort attending secondary school in three Australian states before, during and after the COVID-19 pandemic. However as a limitation, we cannot discern the impact of the pandemic and accompanying restrictions, and whether this exacerbated mental ill-health by Year 10. Another potential limitation relates to the varying forms of consent procedures. Depending on ethics board requirements, some participants required active parental consent while others required passive parental consent. Active parental consent procedures typically result in lower consent rates, and potentially, the exclusion of certain demographic and high-risk groups which may introduce a degree of selection bias into studies.[42,43] However, to reduce the likelihood of this in the current study, schools with insufficient active written parental consent followed up parents via a phone call to seek verbal consent. Finally, one study cannot capture all social determinants and there are further social determinants of mental health that were not included in this study, for example identifying as Aboriginal or Torres Strait Islander and/or sexually diverse.

## Conclusions and implications for public health policy, research and practice

Data from this large general population sample suggests that many Australian adolescents are experiencing high symptoms of depression, psychological distress and anxiety, with pressing implications for policy, research and practice. Policy levers to address the social determinants of health have the potential to reduce mental health inequities, with evidence that focussing on childhood and adolescence may yield the greatest results.[10] This includes the provision of universal access to early childhood education, increased investment in disadvantaged schools, and improved welfare benefits for families.[35,44] The findings also highlight the potential value of targeted interventions based on gender. In line with the principles of proportionate universalism, interventions could be tailored to the needs of those exhibiting elevated mental health symptoms—in this case, gender diverse and female adolescents—to ensure they receive equitable and appropriate support.[35] Further, applying a wellbeing lens to policy or 'health in all policies' approach would ensure that impacts on the social determinants of health—which usually sit outside of the remit of the Health Department—are considered in the development and evaluation of policies.[45,46] As of August 2023, the Australian Federal Government has released their first 'Measuring What Matters' Framework and several State Governments are investigating such approaches. The implementation of these initiatives and their impacts on the social determinants of mental health should be followed closely over the coming years. For research and practice, this study highlights the need for the development and implementation of effective prevention interventions to address mental disorders in childhood and adolescence. Such interventions should employ co-design and tailoring towards adolescents experiencing disproportionate burdens, particularly female and gender diverse participants; and among those participants, particularly those experiencing low affluence. As has been argued before,[47] we should not simply dismiss the gender gap in mental health as "to be expected" or as a factor simply to be adjusted for in statistical models. Future research, policy and practice must interrogate this phenomenon and take considered action to address this prevailing barrier to gender equality.

## Ethics

All procedures followed were in accordance with the ethical standards of the responsible committees on human experimentation (University of Sydney HREC2018/882, University of Queensland 2019000037, Curtin University HRE2019-0083, NSW Department of Education SERAP 2019006, and several Catholic Diocese committees).

## Conflicts of interest

NCN is a Director of Climate Schools Pty Ltd and OurFutures Institute Ltd. There are no other potential conflicts of interest to report.

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## Author contributions

SS led the development of this article. LAG and KEC share senior authorship. All authors were involved in conceptualisation. KEC and NCN secured funding for this study. KEC led intervention development. SS, SO, LAG and KEC led data curation. Data were directly accessed and verified by SS, KEC, SO and LAG. SS developed the methodology and conducted formal analysis and data visualisation with support from SO. KEC and LAG were responsible for ethics and governance and overall trial administration with oversight from NCN. NCN, KEC and LAG provided supervision. SS wrote the original draft, and all authors were involved in review and editing. All authors had full access to the data in the study and all had final responsibility for the decision to submit for publication.

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## Appendix A Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anzjph.2025.100243.