Parent- and teacher-reported associations from adolescent bifactor models of psychopathology: An outcome-wide association study of 26 outcomes in mid-life

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ABSTRACT

Background: Adolescent mental health problems have lasting impacts on health and social functioning later in life. Evidence to date mostly comes from studies of specific diagnostic categories/dimensions, but hierarchical models can elucidate associations with general as well as specific dimensions of psychopathology. We provide evidence on long-term outcomes of general and specific dimensions of adolescent psychopathology using both parent- and teacher-reports.

Methods: Parents and teachers from the Isle of Wight study completed Rutter behaviour scales when participants were 14-15 years old (n=2,275), assessing conduct, emotional and hyperactivity problems. Metric-invariant bifactor models for parents and teachers were used to test domain-specific and domain-general associations with 26 self-reported psychosocial outcomes at mid-life (age 44-45 years, n=1,423). Analyses examined the individual and joint contributions of parent- and teacher-reports of adolescent psychopathology. All analyses were adjusted for covariates (gender, IQ, and family social class), and weighted to adjust for probability of non-response.

Results: Parent- and teacher-reported general factors of psychopathology (GFP) were associated with 15 and 12 outcomes respectively, across socioeconomic, relationship, health and personality domains, along with an index of social exclusion. Nine outcomes were associated with both parent- and teacher-reported GFP, with no differences in the strength of the associations across reporters. Teacher-reported specific factors (conduct, emotional and hyperactivity) were associated with 21 outcomes, and parent-reported specific factors were associated with seven. Five outcomes were associated with the same specific factors from both reporters; only one showed reporter differences in the strength of the associations.

Conclusions: These findings confirm the relevance of the GFP and the utility of teacher as well as parent reports of adolescent mental health in predicting psychosocial outcomes later in the life course.

Keywords: Mental health; conduct; emotional; ADHD; p-factor; parent; teacher; multi-informant; Rutter scale; life chances.

Abbreviations: GFP, general factor of psychopathology; ECV, Explained common variance; FD, factor determinacy; PUC, Percent of uncontaminated correlations.

INTRODUCTION

Adolescent mental health problems are common (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015) and associated with many negative consequences in adulthood: increased risk of poor mental health later in the life course (Caspi et al., 2020), adverse socioeconomic outcomes (e.g., education, employment and social class), problems in intimate and social relationships, and poor physical health and psychological functioning (Laceulle et al, 2020; Thompson et al, 2021). To inform screening, risk prediction and the development of preventive interventions we need to know more about those aspects of adolescent mental health that are central to conveying these risks, and the most informative reporters in identifying long-term vulnerabilities.

For many years, outcomes of adolescent psychopathology were examined in relation to specific adolescent disorders (Kessler, Foster, Saunders, & Stang, 1995; Lewinsohn, Rohde, & Seeley, 1995; Moffitt et al., 2015). More recently, recognition of the high rates of overlap between disorders has led to development of hierarchical models in which individual symptoms are characterized in terms of a shared source of variance (often referred to as a general psychopathology factor) and residual sources of variance (specific factors, such as conduct or emotional problems). Extensive evidence now shows that bifactor models of this kind provide a good reflection of the covariance structure of child and adolescent mental health (see e.g. Blanco et al., 2015; Patalay et al., 2015), and phenotypic, genetic and neuroimaging evidence also supports models of this kind (Allegrini et al., 2020; Durham et al., 2021; Neumann et al., 2021).

Investigators have now begun to explore these models as predictors of longer-term outcomes. Integrating information across reporters, Laceulle et al., (2020) and Sallis et al., (2019) found that general and specific factors of psychopathology in late adolescence were associated with a broad array of outcomes (social, economic, health and psychological) in early adult life. More recently, a study using parent-report data from the 1958 and 1970 British birth cohorts (Thompson et al., 2021) extended the picture to middle adulthood, finding that a parent-reported general factor of psychopathology (GFP) in adolescence was associated with poor mental and general health, low life satisfaction, non-participation in voting and poor educational attainment, but not employment status or cohabitation.

Reporter issues may also be salient here: information provided by parents, teachers and self-reports of young people's mental health are among the most widely used sources of information but show only modest levels of agreement (Collishaw, Goodman, Ford, Rabe-Hesketh, & Pickles, 2009; De Los Reyes et al., 2015; Ferdinand et al., 2003; Patalay & Fitzsimons, 2018). Regarding external informants, such as parents and teachers, discrepancies may reflect personal biases (i.e., personal characteristics) but also can emerge from the opportunities that different reporters have to observe young

people's emotions or behaviours in different situations (e.g., leisure vs. learning) or relational contexts (e.g., family environment vs. school environment). Parents and teachers may also be differentially influenced by youth characteristics, such as age, gender and socioeconomic group (De Los Reyes, 2011; Martel, Markon, & Smith, 2017). For example, family functioning, parental distress, maternal depression and child physical health have been found to explain variation in parent ratings, while child attainment, socio-economic factors and gender are associated with teacher ratings of youth mental health problems (Boyle & Pickles, 1997; Collishaw et al., 2009). In addition, some evidence points to greater parent-teacher discrepancies among females and youth with internalizing problems, and also when parents exhibit low-caring, laxness and overreactive behaviour (Cheng et al., 2018). Because of these differences, multiple informants may provide unique and complementary information for mental health assessment (De Los Reyes et al., 2015). Past studies using disorder-based or dimensional indicators of adolescent mental health point to both additive/complementary and interchangeable contributions of parent and teacher reports in associations with later outcomes (Dirks, Boyle, & Georgiades, 2011; van der Ende, Verhulst, & Tiemeier, 2020; F. C. Verhulst, Dekker, & van der Ende, 1997; Frank C. Verhulst, Koot, & Van der Ende, 1994), suggesting that reporter effects may also be important to examine in the context of bifactor models.

To contribute to this literature, we used data from a mid-life follow-up of the Isle of Wight epidemiological samples of the 1960s (Rutter, Tizard, & Whitmore, 1970), and explored associations between bifactor models of adolescent mental health problems derived from both parent and teacher reports with self-reports of a broad spectrum of educational, economic, social, health and psychological outcomes collected approximately 30 years later, at mid-life. We estimated separate bifactor models from the two reporters and examined: (i) associations of mid-life outcomes from the general vs. specific dimensions of adolescent psychopathology for each reporter; (ii) where both reports showed significant associations with outcomes, whether those effects were independent; and (iii) whether either report showed significantly stronger associations with mid-life functioning than the other.

Methods

Sample

The Isle of Wight study is an epidemiological/longitudinal study of children born on the Isle of Wight between 1 September 1953 and 31 August 1955 (Rutter et al., 1970). The study included all age-eligible children with home addresses on the Island, excluding the small group who attended private schools (approximately 6% of the child population at the first sweep at ages 9-10 years). We focus here on data collected in 1968–1969, when study members were aged 14–15 years

(n=2,303, 50.6% male) (Rutter, Tizard, Yule, Graham, & Whitmore, 1976). Participants from this assessment (excluding 16 with severe learning disabilities) were selected for either an in-person interview or postal questionnaire assessment for a mid-life follow-up at ages 44–45 years (see Pickles et al., 2010 for details). Ethical approval for the mid-life follow-up was given by the Research Ethics Committee of the Institute of Psychiatry and South London and Maudsley NHS Trust.

Adolescent mental health problems

Adolescent mental health problems were rated by parents and teachers using the Rutter A2 and B2 scales respectively (Rutter, 1967; Rutter et al., 1970). We used 17 parallel parent and teacher-rated items tapping conduct (eight items), emotional (seven items), and hyperactivity problems (two items). The full list of items is shown in Table 1.

Mid-life outcomes

We examined 26 self-reported outcomes at age 44-45 years, reflecting four broad domains of functioning (details in Appendix S1).

Education and socioeconomic. (1) highest educational qualification; (2) socioeconomic status at mid-life; (3) time in current job (years); (4) number of times unemployed since age 30; (5) currently unemployed; (6) not changed jobs since age 30 for better pay or promotion; (7) current housing tenure; (8) whether in a pension scheme.

Relationships and social participation. Mid-life relationship histories were reported as (1) never married or cohabited for at least one month; (2) number of marital/partnership breakdowns and (3) living alone at follow-up. Participants were also asked whether they had friends/family members they could rely on to (4) listen to their problems and/or (5) provide help if needed. (6) We also created an index of social participation (scored 0 to 10) from reports of any current participation in a range of activities (e.g., sports/social clubs; political parties; charity/voluntary organizations). Participants were also asked (7) if they had voted in the last General (national) Election.

Health. Study members reported on (1) their current general health at mid-life (fair/poor vs good/excellent); (2) any long-standing illness or disability; (3) ever registered disabled; (4) past week hazardous alcohol consumption (≥21 units for males; ≥14 for females, Department of Health, 1995); (5) alcohol problems (≥2 on the 4-item CAGE alcohol problems screen, Mayfield, McLeod, & Hall, 1974); (6) current smoker; (7) psychological distress using the 15-tem 'psychological' item Malaise Inventory score (Rodgers, Pickles, Power, Collishaw, & Maughan, 1999; Rutter et al., 1970).

Personality. (1) Neuroticism, (2) extroversion) and (3) psychoticism personality traits were assessed using the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1991). These traits were assessed by asking yes/no questions, such as "Would you call yourself a nervous person?" (neuroticism) and "Can you easily get some life into a rather dull party?"

(extroversion) and reverse-coded items such as "Does it worry you if you know there are mistakes in your work?" (psychoticism). Questions were scored 0 or 1 and there were 12 items for each trait. Internal consistency measured with Cronbach's α was acceptable for neuroticism (α=.92), extroversion (α=.94) and psychoticism (α=.75).

Social exclusion. We created an index of social exclusion from counts of: unemployed at follow-up; not owner-occupier; no occupational/private pension; living alone at follow-up; no support from family or friends; no participation in social groups; did not vote in last General Election; and registered disabled. We contrasted study members reporting ≥3 of these difficulties with those reporting 0-2.

Covariates

Covariates included study member gender, family social class in adolescence based on father's occupation (classes I/II; III; IV/V), and general ability (IQ) at age 9-10 years derived from National Foundation for Educational Research tests (Rutter et al., 1970), with scores mean-centred and z-transformed.

Statistical analysis

Rutter scale factor models. Confirmatory factor analysis (CFA) was applied to test the bifactor structure of the Rutter A and B scale items (Elander & Rutter, 1996) and to generate factor scores for the main analysis. Because different characteristics may drive parents and teachers to report mental health problems in a different manner (Boyle & Pickles, 1997; Cheng et al., 2018; Collishaw et al., 2009; De Los Reyes, 2011; Martel et al., 2017), we fixed the factor loadings to be equal between informants in the final metric-invariant factor model. Therefore, the psychopathology ranking among participants would not differ by how strongly the items are informant-specific. CFA was performed in R (version 4.1.3) using *lavaan* (Rosseel et al., 2018), applying delta parameterization and weighted least squares with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics (WLSMV) estimators. Robust model fit parameters were Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI) and Tucker Lewis Index (TLI). Values of RMSEA below .080 represent acceptable model fit, and values lower than .060 represent good-to-excellent model fit (Hu & Bentler, 1999). CFI and TLI values above .900 represent acceptable model fit and above .950 represent good-to-excellent model fit.

We used six model-based indices to evaluate the bifactor model as described in Appendix S2 (ω, ω hierarchical, factor determinacy (FD), Hancock's H index, Explained common variance (ECV) and percent uncontaminated correlations

(PUC)). We also tested if the bifactor models reached metric and scalar invariance, as described in Appendix S3. After this evaluation, we extracted factor scores from the parent and teacher metric-invariant bifactor models using the Empirical Bayes Modal method and used them as predictors of mid-life outcomes in regression models (Rosseel et al., 2018).

Associations with mid-life outcomes: We modelled separate regressions for each outcome, using the outcome-wide association study (OWAS) approach, (VanderWeele, 2017) accounting for multiple outcome comparisons using false-discovery rate (FDR) (Benjamini & Hochberg, 1995). The OWAS design have two main characteristics. First, it is a systematic test for hypothesis-free discovery while examining the association of one exposure with many outcomes (similar to genome-wide, phenome-wide and exposure-wide association studies). Second, the regression models are adjusted for confounders assessed or originated prior to the exposure variable of interest, so reverse causality is minimized (VanderWeele, 2017). The p-values for all the associations of a given psychopathology factor (n=26 tests per factor) were recalculated by using the *p.adjust* function in R. The equation for each outcome for each reporter was:

$$Y = a + b * GFP + c * Conduct + d * Emotional + e * Hyperactivity + f * Gender + g * \text{Social class} + h * IQ$$

where "Y" is the outcome variable, "a" is the intercept, "b" to "h" are the regression coefficients, GFP is the general factor of psychopathology and IQ is the general ability quotient.

Analyses were conducted in a stepwise manner to: 1) screen for effects of parent and teacher factors using the OWAS approach; 2) test the utility of a second informant when factors from both reporters showed associations with specific outcomes; and 3) test for any superiority between informants when both were associated with the same outcomes. Step 1 was conducted with separate regression models using parent- or teacher-derived factors. Step 2 included the same parent- and teacher-reported factors in a multiple regression model where there were significant associations for both reporters. Step 3 investigated whether associations differed by informant, using a Wald 1*df* test of the constraint that they associated equally versus being free. All models were weighted using inverse probability weights (described below) and adjusted for gender, adolescent social class and IQ. All models were estimated using STATA 17.0. We estimated risk ratios for all outcomes using regression models with robust error variance. We used a Poisson regression model for binary and ordinal outcomes (Pang, Kaufman, & Platt, 2016; Zou, 2004) and a negative binomial regression model for the remaining outcomes. The poorest/lowest level of the outcome contrasted with the better/highest level in each case.

Missing data and attrition

IQ data were available for 98% of the sample at ages 9-10. Teacher- and parent-rated Rutter questionnaires were available for 98.8% and 82.5% of the sample respectively at ages 14-15 years; our analyses focus on cases with complete teacher-rated data for estimation of the bifactor models (n=2,275). A small group (n=56, 2.5%) of these study members was known to have died by the time of the mid-life follow-up. Of the remainder, 91% were traced, and follow-up data were available for 1,423 study members, 70% of those traced. Gender, adolescent family social class, assessment type (interview or postal questionnaire), IQ and reading ability (Rutter et al., 1970) were associated with response at follow-up, and were used to create inverse probability weights (Seaman & White, 2013). In addition, adolescents with missing parent-report data had higher total behaviour scores on teacher reports (M = 2.61, SD = 3.97) than those with both parent and teacher reports (M = 1.60, SD = 2.64); $t_{(2276)} = 6.23$; $p = 1.23 \times 10^{-9}$), so teacher scores were used to estimate the probability of having a parent response. These two weights were multiplied, and weights for the few cases (n=28) with values above the 99th percentile were trimmed (final weight ≥3.66). The resulting weights were used throughout the analyses to mitigate any bias associated with missing data and attrition.

Results

Descriptive data on adolescent predictors and covariates are presented in Appendix S4 and Table S1 and mid-life outcomes in Table S2.

Bifactor models of the adolescent parent and teacher Rutter scale scores

The bifactor models had excellent model fit for both parent reports (RMSEA = .029; 90%CI = .025 – .033; CFI = .976; TLI = .968), teacher reports (RMSEA = .033; 90%CI = .030 – .037; CFI = .983; TLI = .977) and for the metric-invariant model used to obtain the factor scores (RMSEA = .030; 90%CI = .028 – .033; CFI = .980; TLI = .977). The GFP, from both parent and teacher perspectives, could not be interpreted as a unidimensional construct (ωH < .80, ECV and PUC < .70), suggesting that there was room left for specificity. FD and H indices for specific factors were acceptable, except for H indices for hyperactivity (both reporters) and conduct (teacher-report), indicating that these constructs may be poorly replicable. The bifactor model was informant-invariant, meaning that constructs captured by the bifactor models were the same across raters, and that mean differences/correlations can be compared (see Appendix S3 and Table S3).

The informant-specific models differed somewhat on exclusive GFP indicators. In the parent-report model, irritability loaded exclusively on GFP, given its low factor loading on the conduct factor (Table 1). In the teacher-report

model, items assessing irritability, destructiveness, fighting, disobedience and bullying also emerged as exclusive indicators of GFP. As a result, the conduct factor was indicated by items relating to truancy, stealing and lying in the teacher model (Table 1). The metric-invariant model presented destructiveness, fights and irritability as strong indicators of the GFP, leaving truancy, stealing, disobedience, lying and bulling as indicators of the conduct factor. The factor scores from this model were used in future analysis and are presented in the results below.

{Table 1 around here}

In the metric-invariant model, the correlation between the teacher and parent report GFP factor scores was low (r = .24; p < .001), and similar to the association between total parent and teacher raw scores (r = .25; p < .001) (see Appendix S5 and Table S4). Child IQ was negatively correlated with almost all psychopathology factor scores except the emotional factor from parent-report (see Appendix S5 and Table S5). Female gender was correlated with lower general, conduct and hyperactivity factor scores and higher emotional factor scores in both raters (see Appendix S5 and Table S5).

Associations with mid-life outcomes: separate parent and teacher reports of mental health in adolescence

When regressed separately by informant, parent-report factors (general and specific) were exclusively associated with eight and teacher-report factors were exclusively associated with 19 individual mid-life outcome indicators (Figure 1). Table S6 shows full regression model results and Table S7 lists p-values before and after FDR corrections.

For parent reports, the majority of these associations were from the GFP: they were associated with six outcomes spanning education-socioeconomic, relationships and social participation, health and personality domains. Associations were also found for the emotional-specific factor with voting in the last general election and higher psychological distress (Figure 1, Table S6).

For teacher reports, a majority of the associations were from the specific factors: they were associated with 16 outcomes. The teacher-report conduct factor was associated with low social class, number of times unemployed since age 30, current unemployment, housing tenure and not being in a pension scheme, plus not voting in last election, long-standing illness and psychoticism at mid-life. The teacher-reported hyperactivity factor was associated with hazardous drinking and current smoking, while the emotional factor was associated with unemployment, never being married/cohabiting, long-standing illness and low psychoticism (Figure 1, Table S6).

The composite social exclusion index was associated with the GFP from both parent (RR=1.60; 95% CI = 1.29, 1.98; *pFRD* = 5.61x10^{-4}) and teacher (RR=1.42; 95% CI = 1.19, 1.69; *p* = 6.76x10^{-4}) reports, as well as the conduct factor from teacher reports (RR=1.96; 95% CI = 1.39, 2.77; *pFRD* = .001).

{Figure 1 around here}

Associations with mid-life outcomes: joint associations of parent- and teacher-reports

The GFP from both reporters was associated with nine outcomes (low educational qualification, times unemployed since age 30, current unemployment, not in a pension scheme, low social participation, not voting in the last general election, extroversion and psychoticism, and social exclusion, as mentioned above). Moreover, five outcomes were associated with the same specific factors from both informants (low education qualification and current smoker with the conduct factor and not leaving job for better opportunity, higher neuroticism and low extroversion with the emotional factor). We ran additional regression models for these outcomes to test whether parent and teacher reports showed independent effects, and whether either reporter was superior to the other in terms of predictive utility.

As Table S8 shows, the GFP from parent- and teacher-reports showed independent associations with five outcomes (low education, times unemployed, low social participation, extroversion and psychoticism). Current unemployment and social exclusion were associated with parent reports only, and lack of pension provision and not voting in the last general election were associated with teacher reports alone. However, Wald tests gave no suggestion that one reporter was preferable to the other in those instances (Table S8). As for the specific factors, low educational qualification, but not current smoking, was still associated with conduct as reported by both informants, with no superiority between them for both outcomes. Extroversion was negatively associated with the emotional factors from both informants (no superiority). However, a superiority emerged ($\chi 2$ (1, n=1,143)=7.86; p=.005) for the parent-reported emotional factor (RR=1.20; 95% CI = 1.13, 1.27; p=2.39x10^{-9}), compared with the teacher-reported emotional factor (RR=1.04; 95% CI = .97, 1.12; p=.238), in the association with self-reported neuroticism (Table S8).

Discussion

Adolescent mental health problems have long-lasting associations with adverse educational, economic, social, health and psychological outcomes later in the life-course (Erskine et al., 2016; Gotlib, Lewinsohn, & Seeley, 1998; Kessler et al., 1995; Knapp, King, Healey, & Thomas, 2011). Our findings provide evidence that these associations are mostly driven by a general psychopathology factor, with independent contributions from specific conduct, emotional and

hyperactivity dimensions. We found that both parent- and teacher-ratings were associated with mid-life outcomes, but specific factors from teacher-reports were associated with a greater number and range of aspects of adult functioning. Where factors from both reporters showed links with specific outcomes, we found that, with only one exception, neither report was superior to the other.

Dimensional psychopathology and mid-life outcomes

Past studies provide extensive evidence that indicators of adolescent emotional and behavioural disorders are associated with adverse outcomes in adulthood. Studies using hierarchical, dimensional frameworks are beginning to cast these findings in a new light, suggesting that a GFP is broadly associated with socioeconomic, health and psychological outcomes in adulthood, with associations for specific factors being more dependent on the informant (Laceulle et al., 2020; Sallis et al., 2019; Thompson et al., 2021). Our findings also suggest that specific factors might be related with a specific pattern of outcomes. With a few exceptions, the present findings demonstrate that conduct factors were more strongly related to educational and socioeconomic outcomes, inattention/hyperactivity with health-related outcomes, and emotional factors with personality dimensions and psychological distress. Given this pattern of associations, it is possible that the GPF might be related with aspects of symptomatology above and beyond the symptoms themselves, such as impairment (Smith, Atkinson, Davis, Riley, & Oltmanns, 2020). Despite discussions about the meaning of the GFP, its predictive utility has become increasingly clear.

At their most general level, our findings support this growing body of evidence, suggesting that many of the adverse sequelae previously examined in relation to specific aspects of adolescent mental health may primarily be attributable to a GFP (18 out of 26 outcomes in our analyses). This pattern emerged from associations of a wide range of individual aspects of mid-life functioning, and in relation to two broader measures, not examined in prior research: an index of social exclusion, and personality traits. Past studies have shown that multiple health and social problems tend to cluster in a small segment of the adult population (Richmond-Rakerd, D'Souza, Milne, Caspi, & Moffitt, 2021), and that early-life mental health problems are among the predictors of this pattern. Our findings are consistent with that view: taking account of both childhood IQ and family social background, we found that high levels of mid-life social exclusion (reflecting insecure material circumstances, limited social support and participation, and disability) were associated with the GFP from both parent- and teacher-reports. Personality traits were also associated with general, conduct- and emotional-specific psychopathology factors, again as reported by parents and teachers. Early mental health problems are among the few factors known to modify personality traits during development (Jackson & Beck, 2021). Given that mid-life personality traits are

associated with a range of outcomes at older ages, including employment, relationships and mortality (Beck & Jackson, 2020), our study provides evidence that adolescent mental health problems could represent early stages of a chain of events reaching to older age, and traceable from parent- and teacher-reports.

Source of information and mid-life outcomes

Past evidence from two large-scale British birth cohorts (also using the Rutter scales) found that parent reports of GFP in adolescents showed associations with later adult outcomes including educational qualifications, employment, cohabitation, voting, general health, and psychological distress at age 42 (Thompson et al., 2021). Our parent-reported results for the GFP demonstrated similar associations, reinforcing the conclusion that parent reports of adolescent difficulties are informative predictors of mid-life outcomes. Moreover, our results also demonstrated that GFP and specific factors from teacher-reports are also associated with these outcomes and add to the conclusion that mental health problems in adolescence are associated with mid-life outcomes for a broad spectrum of functioning.

In this sample, the teacher-reported specific factors were associated with a greater proportion of mid-life outcomes than measures derived from parent reports (63.6% vs. 31.8% of all reporter-specific significant associations). Several methodological and substantive factors may have contributed to these associations. First, previous evidence suggests that specific factors can be more reliable depending on the context of the assessment (Fernández de la Cruz et al., 2018; Watts, Poore, & Waldman, 2019). The context in this case is the school setting. School is an inherently 'social' context, where teachers observe young people's social interactions as well as their learning-related behaviours and are able to evaluate an individual's strengths and difficulties by contrast with their peers. It may be that the types of problems that adolescents display in the school setting – in their relationships with peers, for example, or in task persistence and attentiveness – may be especially salient markers of characteristics that can impair functioning later in life. For all these reasons, the school setting may be an especially informative for observing specific vulnerabilities.

Second, methodological factors may also have contributed to the pattern of our findings. Among these, we note that we used a metric-invariant model to obtain the factor scores. The resulting factors are, therefore, derived from a model in which the strength of the association of each indicator is equal among reporters, but their mean levels can be different (as reflected in the low correlation between informants). Studies that do not apply this methodology may find different results by allowing scores to be generated with varying latent ranking among participants for each informant. Moreover, although the conduct and hyperactivity factors showed low factor determinacy and poor replicability indices, they were

nonetheless associated with later socioeconomic and health outcomes above and beyond the GFP and have been replicated in a range of different factor models (Hoffmann et al., 2022).

Multiple informants on mid-life outcomes

Our second aim was to investigate whether parent- and teacher-reports showed independent associations with later outcomes and, if so, whether there was evidence for the 'superiority' of one informant over the other. In practice we found nine outcomes that were associated with the GFP from both parent- and teacher-reports, along with associations between low educational qualifications and current smoking for the conduct factor and between not leaving a job for a better opportunity, neuroticism and extroversion and the emotional factors from the two reporters. In half of these instances, both reports showed independent associations with the outcomes. In the other half, one informant was no longer a significant predictor, but they did not show superior association to the other, except for neuroticism, in which the parent-reported emotional factor was superior when compared to the teacher-reported factor. However, it is relevant to mention that previous evidence suggest that adolescent self-reports might be even more relevant to predict later outcomes, especially mental health, when compared to parent reports (Patalay & Fitzsimons, 2018). Thus, despite the findings of the present study suggest that teachers and parents broadly provide complementary insights, future studies examining long-term associations of psychopathology and mid-to-late life outcomes should include self-reports for a comprehensive perspective of the predictive value of multiple informants.

Limitations

This study must be understood in light of its limitations. First, causal claims are unwarranted in this as in any observational study, which face problems of unmeasured confounding and loss to follow-up. We attempted to minimize the latter issue by weighting our analyses to address measured bias due to selective attrition and informant missingness, although our range of predictors of missing data was relatively limited. Nonetheless, we recognize that some bias may remain. Second, caution is needed when interpreting the findings because they could also reflect social causation, whereby parents' and/or teachers' *views* of adolescents in part contribute to determining later outcomes. Third, our findings are potentially sensitive to cohort effects. They relate to one particular cohort of young people (i.e., the generation known as "baby boomers"), studied in one particular era and setting, and may not generalize to other generations or societies. As an example, recent studies demonstrate that associations of the GFP with some mid-life outcomes are weaker for "baby boomers" when compared with individuals from generation X (Sellers et al., 2019; Thompson et al., 2021), and that generation-specific events might be related to these increasing associations (Collishaw, 2015). Moreover, the understanding

and recognition of children's mental health difficulties by teachers and parents may have changed due to reductions in stigma and increases in awareness, and families and schools as social contexts will also have changed (Ribeiro et al., 2022). Further studies are needed to assess the implications of historical change, as well as associations in other cultural settings. Fourth, we focused on a community sample of adolescents, and it is unclear whether our findings would apply to clinical samples, or to psychopathology evident at earlier ages. Fifth, we focused on parent and teacher reports only and associations using self-reports of psychopathology in adolescence could be even stronger (Patalay & Fitzsimons, 2018). Given that associations in the present study were all given using different sources of information while considering predictors (parent and teachers) and outcomes (self-reported), the findings encourage investigations using multiple sources of information to estimate the impact of early mental health problems in later life.

Implications and conclusion

This study demonstrates that ratings of young people's mental health by parents and teachers are similarly and reliably multidimensional, and are associated with multiple self-reported outcome domains across three decades of life. Adding to prior longitudinal studies of this kind, we found that part of this association stems from a GFP, raising important questions about the substantive meaning of this statistical construct, and its clinical implications. In our sample, specific factors from teacher-reports were associated with a broader array of mid-life socioeconomic, relationship, health and psychological outcomes when compared with parent-reports, suggesting that they, and the school environment, have a key role in detection of specific youth mental health problems. Our results encourage further investigations of the predictive utility of teacher-reports, along with incorporation of multiple raters (including clinicians and young people themselves) in evaluations of the external validity of hierarchical/dimensional models, so that young people at risk of poor life chances can be better identified and supported, and appropriate prevention and treatment strategies can be implemented.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1-S8.

Appendix S1. Mid-life outcomes.

Appendix S2. Descriptive table of baseline variables and outcomes.

Appendix S3. Model-based reliability indices.

Appendix S4. Measurement invariance.

Appendix S5. Correlation among baseline covariates and main predictors.

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Key points

- A general factor of psychopathology in adolescence associates with later-life outcomes, but little is known about reporter effects.
- We found that assessments of 17 symptoms of psychopathology in adolescence by parents or teachers are associated with a wide array of mid-life self-reported outcomes, 30 years later.

- Parents and teachers provide unique and independent associations with mid-life outcomes.
- Specific factors from teacher ratings are associated with a wider range of later life outcomes when compared with parent reports.

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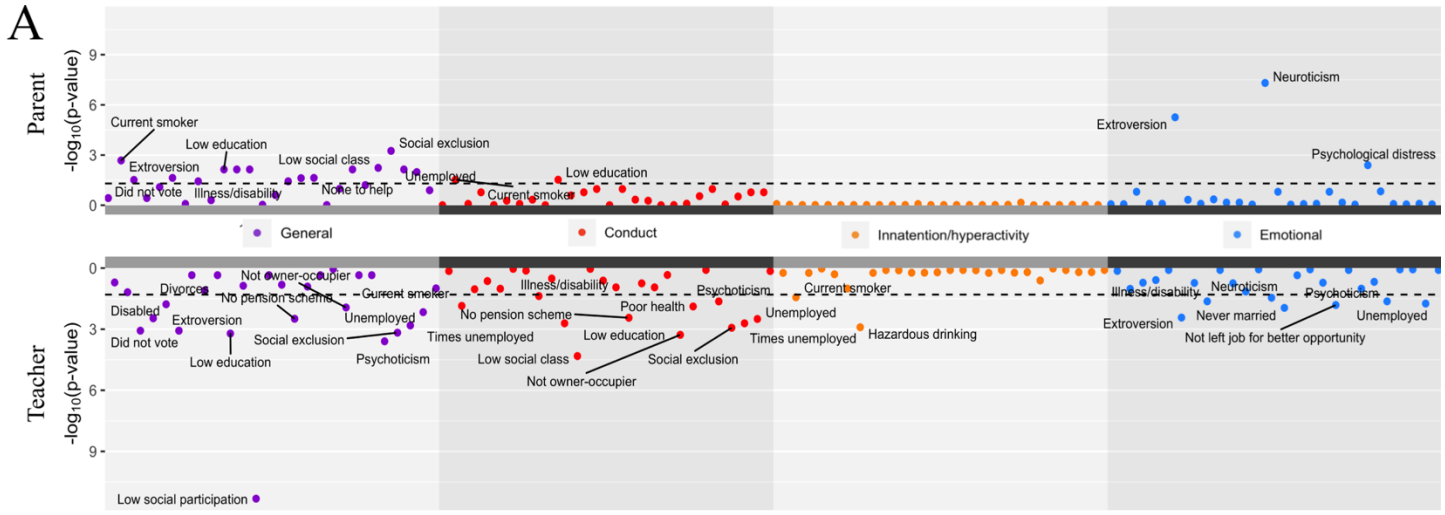
Table 1 -Factor loadings and reliability indices of bifactor models of parent and teacher reported adolescent mental health

Rutter scale items	Parent bifactor model				Teacher bifactor model				Parent-Teacher metric-invariant model			
	General factor	Conduct	Emotional	Hyperactivity	General factor	Conduct	Emotional	Hyperactivity	General factor	Conduct	Emotional	Hyperactivity
Truants	.321	.528			.659	.359			.542	.680		
Steals	.560	.697			.630	.567			.574	.343		
Destructive	.722	.496			.893	.094			.778	.095		
Fights	.720	.343			.930	-.089			.821	-.163		
Irritable	.830	.006			.878	-.231			.825	.219		
Disobedient	.741	.317			.896	.156			.792	.530		
Lies	.641	.589			.869	.458			.736	.262		
Bullies	.674	.482			.900	.076			.781	.415		
Tears	.449		.547		.470		.677		.442		.573	
Worries	.407		.736		.301		.816		.328		.725	
Miserable	.700		.357		.524		.727		.571		.543	
Fearful	.332		.680		.215		.761		.257		.671	
Fussy	.299		.457		.457		.390		.355		.391	
Disliked	.736		.320		.733		.491		.677		.400	
Solitary	.414		.436		.372		.717		.369		.574	
Restless	.620			.770	.700			.700	.600			.610
Fidgety	.597			.463	.697			.584	.615			.590
Indices												
ω	.858	.815	.641	.564	.907	.885	.768	.836	.951	.942	.878	.843
ωH	.638	.106	.278	.146	.697	.013	.411	.185	.780	.134	.549	.416
FD	.937	.865	.879	.943	.985	.910	.953	.967	.956	.862	.897	.824
H	.923	.732	.763	.634	.969	.498	.873	.597	.935	.637	.787	.529
ECV	.572				.632				.611			
PUC	.632				.632				.632			

Note: Metric-invariant bifactor model have factor loadings constrained to be equal between informants. ω, omega reliability index; ωH, hierarchical omega; FD, factor determinacy; H = index of construct replicability; ECV = explained common variance; PUC = percent of uncontaminated correlations.


A
Parent
-log10(p-value)
Current smoker
Low education
Extroversion
Low social class
Social exclusion
Unemployed
Low education
Did not vote
Illness/disability
None to help
Current smoker
Neuroticism
Extroversion
Psychological distress
General
Conduct
Innatention/hyperactivity
Emotional
Teacher
-log10(p-value)
Not owner-occupier
Divorces
No pension scheme
Current smoker
Illness/disability
Psychoticism
Current smoker
Disabled
Extroversion
Unemployed
No pension scheme
Poor health
Unemployed
Illness/disability
Neuroticism
Psychoticism
Did not vote
Social exclusion
Times unemployed
Low education
Times unemployed
Hazardous drinking
Extroversion
Never married
Unemployed
Low education
Psychoticism
Low social class
Social exclusion
Not left job for better opportunity
Not owner-occupier
Low social participation

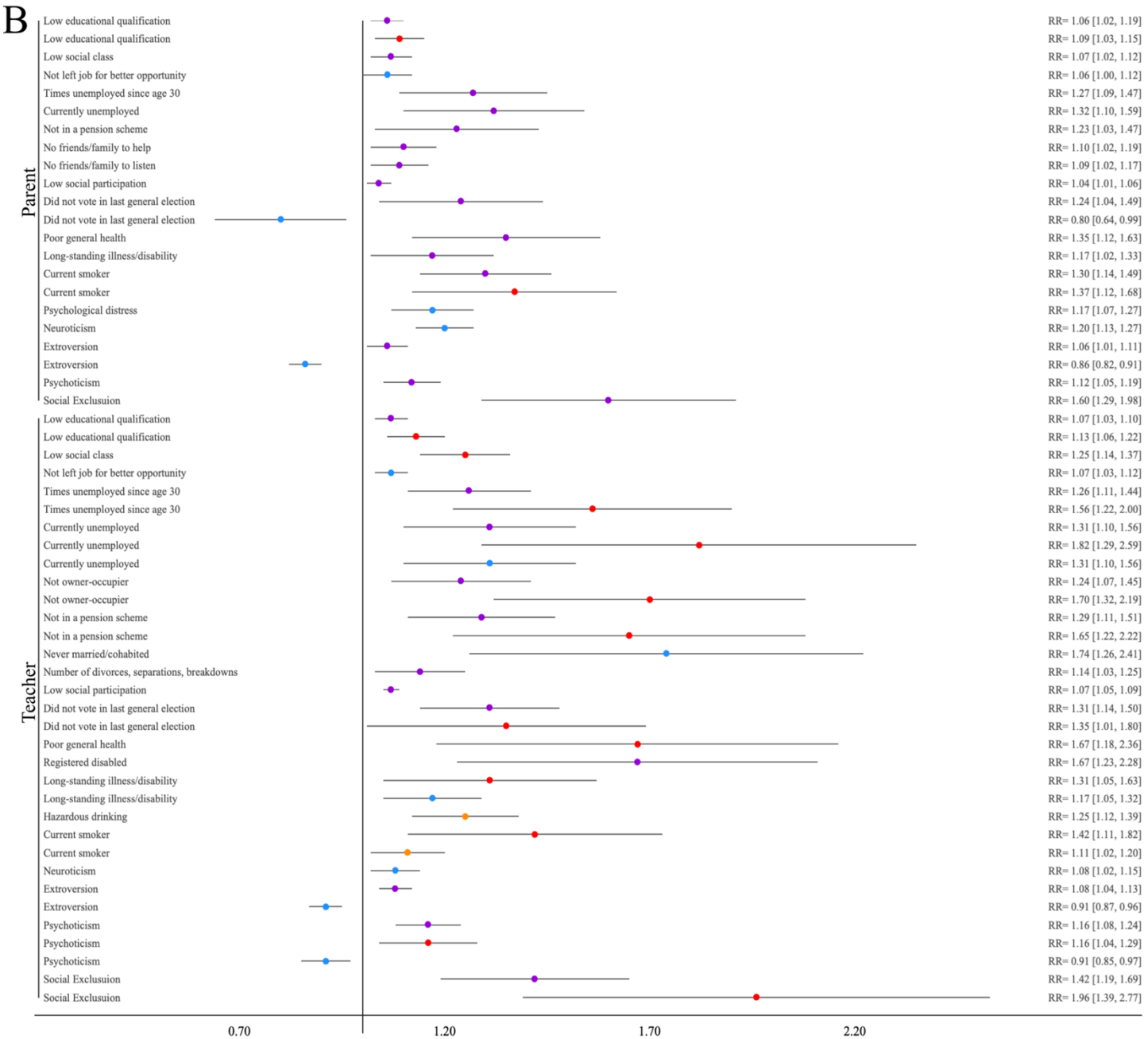

B
Parent
Low educational qualification RR= 1.06 [1.02, 1.19]
Low educational qualification RR= 1.09 [1.03, 1.15]
Low social class RR= 1.07 [1.02, 1.12]
Not left job for better opportunity RR= 1.06 [1.00, 1.12]
Times unemployed since age 30 RR= 1.27 [1.09, 1.47]
Currently unemployed RR= 1.32 [1.10, 1.59]
Not in a pension scheme RR= 1.23 [1.03, 1.47]
No friends/family to help RR= 1.10 [1.02, 1.19]
No friends/family to listen RR= 1.09 [1.02, 1.17]
Low social participation RR= 1.04 [1.01, 1.06]
Did not vote in last general election RR= 1.24 [1.04, 1.49]
Did not vote in last general election RR= 0.80 [0.64, 0.99]
Poor general health RR= 1.35 [1.12, 1.63]
Long-standing illness/disability RR= 1.17 [1.02, 1.33]
Current smoker RR= 1.30 [1.14, 1.49]
Current smoker RR= 1.37 [1.12, 1.68]
Psychological distress RR= 1.17 [1.07, 1.27]
Neuroticism RR= 1.20 [1.13, 1.27]
Extroversion RR= 1.06 [1.01, 1.11]
Extroversion RR= 0.86 [0.82, 0.91]
Psychoticism RR= 1.12 [1.05, 1.19]
Social Exclusuion RR= 1.60 [1.29, 1.98]
Teacher
Low educational qualification RR= 1.07 [1.03, 1.10]
Low educational qualification RR= 1.13 [1.06, 1.22]
Low social class RR= 1.25 [1.14, 1.37]
Not left job for better opportunity RR= 1.07 [1.03, 1.12]
Times unemployed since age 30 RR= 1.26 [1.11, 1.44]
Times unemployed since age 30 RR= 1.56 [1.22, 2.00]
Currently unemployed RR= 1.31 [1.10, 1.56]
Currently unemployed RR= 1.82 [1.29, 2.59]
Currently unemployed RR= 1.31 [1.10, 1.56]
Not owner-occupier RR= 1.24 [1.07, 1.45]
Not owner-occupier RR= 1.70 [1.32, 2.19]
Not in a pension scheme RR= 1.29 [1.11, 1.51]
Not in a pension scheme RR= 1.65 [1.22, 2.22]
Never married/cohabited RR= 1.74 [1.26, 2.41]
Number of divorces, separations, breakdowns RR= 1.14 [1.03, 1.25]
Low social participation RR= 1.07 [1.05, 1.09]
Did not vote in last general election RR= 1.31 [1.14, 1.50]
Did not vote in last general election RR= 1.35 [1.01, 1.80]
Poor general health RR= 1.67 [1.18, 2.36]
Registered disabled RR= 1.67 [1.23, 2.28]
Long-standing illness/disability RR= 1.31 [1.05, 1.63]
Long-standing illness/disability RR= 1.17 [1.05, 1.32]
Hazardous drinking RR= 1.25 [1.12, 1.39]
Current smoker RR= 1.42 [1.11, 1.82]
Current smoker RR= 1.11 [1.02, 1.20]
Neuroticism RR= 1.08 [1.02, 1.15]
Extroversion RR= 1.08 [1.04, 1.13]
Extroversion RR= 0.91 [0.87, 0.96]
Psychoticism RR= 1.16 [1.08, 1.24]
Psychoticism RR= 1.16 [1.04, 1.29]
Psychoticism RR= 0.91 [0.85, 0.97]
Social Exclusuion RR= 1.42 [1.19, 1.69]
Social Exclusuion RR= 1.96 [1.39, 2.77]
0.70
1.20
1.70
2.20

Figure 1: Results from separate regression models of parent and teacher reports of adolescent psychopathology predicting mid-life outcomes. Panel A (Manhattan plot) depicts the statistical significance of psychopathology factors (x-axis) in relation to mid-life outcomes, whereas the y-axis is the -log10 of the FDR-adjusted p-value for each regression model; the dashed horizontal lines indicate the p-value threshold (p = .05). Panel B (Forrest plot) presents the covariate- and weight-adjusted estimates for significant associations (x-axis) between psychopathology factors (coloured dots) and mid-life outcomes (y-axis).