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ORIGINAL ARTICLE

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# *Mental health of intellectually gifted individuals: investigating the nonlinearity of the relationship between intelligence and general mental health*

BACKGROUND
Despite intelligence being generally related to better mental health, individuals with extremely high levels of intelligence (also often referred to as gifted) are frequently viewed to be socially maladjusted, emotionally unstable, and eccentric. Although this view has existed for decades, the scientific data on this subject are highly inconsistent and suffer from several methodological limitations.

PARTICIPANTS AND PROCEDURE
In this study, to test whether the relationship between general intelligence and general mental health is nonlinear in such a way that at extreme values of intelligence the relationship turns from positive to negative the data from eight waves of the 1970 British Cohort Study (BCS70) were used (*N* range from 2,870 to 7,984), with intelligence being assessed at age 10, and mental health being assessed with several different measures at ages 16, 26, 30, 34, 42, 46 and 50. Quadratic regression, as well as spline regression, which divides the dataset into intervals, creates a separate regression for each interval and then smooths out the breakpoints, was used for analyses.

RESULTS
The results showed that the nonlinear models generally fit the data better than the corresponding linear models.

CONCLUSIONS
At high values of intelligence, individuals might begin to experience unique issues affecting their mental health, despite their mental health being at potentially the same or higher level than those with average intelligence. Intellectually gifted individuals have a large potential to have a positive impact on the functioning of the whole society. Recognizing and understanding their problems may prove to be of great importance.

KEY WORDS
cognitive ability; cognitive epidemiology; giftedness; nonlinear relationship; too-much-of-a-good-thing effect

ORGANIZATION – Institute of Psychology, University of Gdansk, Gdansk, Poland

AUTHORS' CONTRIBUTIONS – A: Study design · B: Data collection · C: Statistical analysis · D: Data interpretation · E: Manuscript preparation · F: Literature search · G: Funds collection

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*No great mind ever existed without a touch of madness*
Aristotle

*Pain and suffering are always inevitable for a large intelligence and a deep heart. The really great men must, I think, have great sadness on earth*
Fyodor Dostoevsky

## BACKGROUND



A positive relationship between intelligence and mental health is well established by a number of high-quality studies in the field of cognitive epidemiology (e.g., Aichele et al., 2018; Gale et al., 2010; Keyes et al., 2017; Wraw et al., 2015). Intelligence is a strong predictor of educational and financial achievement (Gottfredson, 1997; Kuncel et al., 2004; Strenze, 2007), which can provide resources beneficial to managing psychological distress (Ali et al., 2013). Intelligent individuals tend to use more adaptive coping strategies and are more likely to have flexible schedules, allowing for more opportunities to engage in pleasant activities (Jokela, 2022; Ujma & Scherrer, 2021). Despite that, a stereotype which characterizes individuals with extremely high levels of intelligence (also referred to as gifted) as socially maladjusted, emotionally unstable, and eccentric is prevalent amongst the general population or teachers (Baudson, 2016; Baudson & Preckel, 2013; Solano, 1987). Several figures conforming to this stereotype can be found in pop culture (Cox, 2000) as well as among eminent real-life individuals considered "geniuses" (Simonton, 2014).

A theoretical framework congruent with the notion that high intelligence can be detrimental to one's mental health is the idea of the too-much-of-a-good-thing effect (Grant & Schwartz, 2011; Pierce & Aguinis, 2013). The authors of the theory draw on the works of Aristotle and the idea of the golden mean, suggesting that an excess of virtue is as dangerous as a dearth of it (Aristotle, trans. 1999). They suggest that any positive phenomenon taken to extreme values eventually reaches an inflection point at which its effect becomes negative. Another theory that could explain the "mad genius" stereotype is the positive disintegration theory (Dąbrowski, 1979). It posits that high intelligence is positively related to psychological overexcitability, a heightened and more intense way of experiencing and responding to one's environment. This type of overstimulation can potentially have a negative impact on mental health (Karpinski et al., 2018). Moreover, functioning distinctively from most of one's peers on a basic cognitive level can be detrimental to an individual's sense of relatedness (Falck, 2020; Flakus et al., 2021). The need for relatedness is, alongside the need for autonomy and the need for competence, one of the basic psychological needs according to the self-determination theory (Ryan & Deci, 2000, 2017). The fulfillment of these needs is essential for one's mental health (Stanley et al., 2021; Tang et al., 2019).

Although this topic has existed in the minds of researchers for decades, the data published so far have been highly inconsistent and contradictory. A meta-analysis by Martin et al. (2010) showed no differences between gifted children and non-gifted children in terms of depression and suicidal ideation, and that gifted children showed lower levels of anxiety. Congruently, another meta-analysis reported no differences in happiness between the two groups (Zeidner, 2021). A systematic review on the subject concluded that intellectually gifted individuals had decreased levels of psychopathy operationalized as internalizing and externalizing problems (Francis et al., 2015). However, all three of those papers concerned a relatively small number of studies that met the criteria set by their authors, and in all three of them, the authors recognized that most studies included were problematic in terms of small and unrepresentative samples.

On the other hand, studies on Mensa members show that compared to the general population, they had an increased risk of affective disorders, anxiety disorders, attention deficit hyperactivity disorder, autism spectrum disorder, and physiological disease (Karpinski et al., 2018), as well as lower levels of meaningfulness, subjective well-being, and self-compassion (Vötter & Schnell, 2019). It is important to note, however, that Mensa members are also not considered representative of the entire population of the intellectually gifted (Haugen, 2018). A cohort study of over 1 million Swedish men showed that the relationship between intelligence and bipolar disorder was curvilinear U-shaped for the *g* factor and specific subtests, except for the logical ability scale (Gale et al., 2012). Another cohort study found a U-shaped relationship between intelligence and psychotic symptoms among 12-year-olds (Horwood et al., 2008). Brown et al. (2021) also reported that for the relationship between general intelligence and depression, as well as subjective well-being, a quadratic model explained additional variance over a linear one and that the correlation between the two decreased above a certain threshold. Autism spectrum disorder is more common at the extreme values of intelligence (Billeiter & Froiland, 2023) and has a complex genetic overlap with intelligence (see Crespi, 2016). Moreover, qualitative data show intellectually gifted individuals expressing feeling isolated due to having higher intelligence than their peers, overstimulated, and struggling with their identity (Jackson, 1998; Jackson & Peterson, 2003; Jacobsen, 1999). Some gifted go as far as to refer to their high intelligence as a disability "because you then can't understand the norm" (Falck, 2020, p. 79).

When referring to research on the intellectually gifted, it is imperative to consider that most studies on this subject suffer from methodological limitations partially caused by the difficulty in accessing the target population. The aforementioned unrepresentative samples (such as students from special programs or Mensa members) and low sample sizes, which in turn cause low statistical power of the statistical methods used, could be resolved by making use of datasets from cohort studies (Ertl et al., 2020; Lubinski & Humphreys, 1997; Martin et al., 2010). Investigating the top 2% in IQ scores (the most common cut-off point for extremely high intelligence, used, for example, by Mensa) of the large samples usually obtained in such studies should supply a representative sample that will also be sizable enough to provide satisfactory statistical power. An overwhelming majority of the research focuses on children (Rinn & Bishop, 2015), even though having high intelligence is not a phenomenon exclusive to childhood.

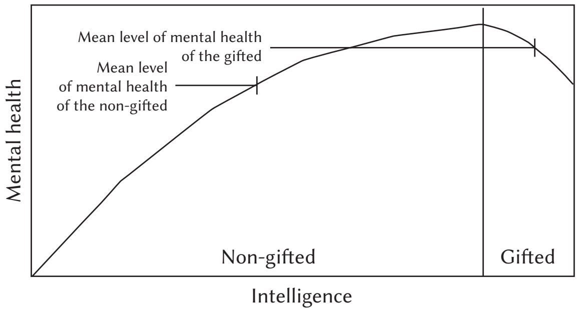
Another crucial drawback of the existing research is the overreliance on comparing gifted samples to nongifted with mean comparisons. If mental health generally increases with intelligence up to a certain inflection point, then even if the relationship turns from positive to negative at that point and mental health will start to drop down, it will still start from a point that is higher than the overall mean (see Figure 1). All the positive consequences of having higher intelligence do not suddenly disappear at a certain threshold. It is just that at high enough intelligence one might start experiencing unique challenges that begin to outweigh the beneficial effects associated with intelligence. As such, comparing means cannot reliably detect a too-much-of-a-good-thing effect if the inflection point is substantially far from the mean.

Nonlinear relationships in psychological research are most often tested with polynomial quadratic regressions. This method, however, has recently found itself under some scrutiny (see Simonsohn, 2018). It imposes a parabolic shape, tends to overfit, and can be problematic when the inflection point is expected to be at extremely high or low values of the predictor variable (Harrell, 2015; Magee, 1998). An alternative approach might be spline regression (Durrleman & Simon, 1989; Marsh & Cormier, 2001; Poirier, 1973), which divides the dataset into intervals, creates a separate regression for each interval, and then smooths out the breakpoints into inflection points (called knots in this technique). This method has an additional advantage in that it can test a specified inflection point. It is more congruent with a confirmatory approach to science when there are theoretical premises about where such an inflection point might be. For this reason, both quadratic regression and spline regression were used in this study.

The aim of the present study was to investigate whether the relationship between intelligence and indicators of mental health is nonlinear in such a way that at extreme values of intelligence, it reaches an

**Figure 1**

*Visualization of how a comparison of means can fail to detect a too-much-of-a-good-thing effect*




*Mental health of intellectually gifted individuals*

inflection point (see Figure 1). For this purpose, data from the 1970 British Cohort Study (BCS70) were used. The cut-off point for intellectual giftedness was set to the 98th percentile of intelligence scores; however, there are also definitions of giftedness that propose a 90th percentile cut-off point (Obergriesser & Stoeger, 2015; Reis et al., 2004). Hence, this will also be tested as an inflection point as auxiliary analyses. Moreover, it has been argued that investigating specific cognitive abilities alongside a general factor of intelligence (*g*) can provide significant additional insights for intelligence research overall (Coyle & Greiff, 2021), as well as specifically for research on giftedness (Wai et al., 2022). For this reason, alongside the findings from Gale et al. (2012), the nonlinear relationship with mental health was also tested for each intelligence subtest. However, these analyses were purely exploratory in nature. Although Brown et al. (2021) have already analyzed the data from BCS70 regarding curvilinear relationships of intelligence, they omitted several waves where mental health was measured and decided to use math ability and reading ability tests as a measure of intelligence. Those can be interpreted more as measures of educational progress than strictly intelligence.

## PARTICIPANTS AND PROCEDURE

### PARTICIPANTS

Data from BCS70 were used. BCS70 is a study conducted by the Centre for Longitudinal Studies (CLS) that follows the lives of 17 196 individuals born in the UK in a single week of 1970 (for a cohort profile, see Elliott & Shepherd, 2006). The data from BCS70 are freely available at https://ukdataservice.ac.uk/. Intelligence was measured at age 10, and mental health was measured in subsequent waves at ages 16, 26, 30, 34, 42, 46, and 50. A total of 11,212 individuals who completed all subscales of an intelligence measure were included in the analyses. The numbers of participants with complete data on both intelligence and each of the mental health measures at each successive wave are presented in Table 1.

## INSTRUMENTS

*The British Ability Scales*. Four subtests from the British Ability Scales (BAS; Elliot et al., 1978) were used to measure intelligence at age 10. The four subscales were: word definitions (37 items), recall of digits (34 items), word similarities (21 items), and matrices (28 items). A 2PL bifactor item response theory model (Gibbons & Hedeker, 1992) was used to obtain latent scores for the *g* factor with the maximum a-posteriori (MAP) method. For the subscales raw z-transformed scores were used. The Cronbach's α reliability coefficients in a previous study were .90 for word definitions, .91 for recall of digits, .86 for word similarities, and .75 for matrices (Sturgis et al., 2010).

*The Malaise Inventory* (Rutter et al., 1970) was used as a measure of general mental health at ages 16, 26, 30, 34, 42, 46, and 50 (e.g., item "Do you often get worried about things?", "Do you often feel miserable or depressed?"). Higher scores indicate worse mental health. A 22-item version was used at age 16, a 24-item version was used at ages 26 and 30, and a 9-item version was used at ages 34, 42, 46 and 50. The scale utilizes a dichotomous (*yes*/*no*) response format, with the exception of the 22-item version, which utilized a 3-point Likert-type response format, ranging from 0 (*rarely or never*) to 2 (*most of the time*). It has shown scalar invariance across gender and successive waves (Ploubidis et al., 2019). The KR20 reliability coefficient reported in a previous study was .84 (Rodgers et al., 1999).

*The General Health Questionnaire-12* (GHQ-12; Goldberg, 1972) was used as a measure of mental health at ages 16 and 30. The instrument consists of 12 items (e.g., "felt constantly under strain") with a 4-point Likert-type response format, ranging from 1 (*not at all*) to 4 (*much more than usual*). The scale is coded in such a way that a higher score indicates worse mental health. The test-retest reliability reported in a previous study was .82 (Piccinelli et al., 1993).

*The Warwick-Edinburgh Mental Wellbeing Scale* (WEMWBS; Tennant et al., 2007) was used as a measure of mental well-being at ages 42 and 46. The instrument consists of 14 items (e.g., "I've been dealing with problems well") with a 5-point Likert-type response format, ranging from 1 (*none of the time*) to 5 (*all of the time*). The test-retest reliability reported in a previous study was .83 (Tennant et al., 2007).

*The Short Form Health Survey*. Four subscales from the Short Form Health Survey (SF-36; Ware & Sherbourne, 1992) were used as a measure of mental health at age 46. Three items measured role limitations due to emotional problems (e.g., "Accomplished less than you would like"), 4 items measured vitality (e.g., "Did you have a lot of energy?"), 5 items measured emotional well-being (e.g., "Have you felt calm and peaceful?"), and 2 items measured social functioning ("During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?"/"During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?"). Items for role limitations due to emotional problems utilize a dichotomous (*yes*/*no*) response format. Items for vitality and emotional well-being utilize a 6-point Likert-type response format, ranging from 1 (*all of the time*) to 6 (*none of the time*). Items for social functioning utilize a 5-point Likert-type response format, ranging from 1 (*not at all/all of the time*) to 5 (*extremely/none of the time*). The test-retest reliabilities reported in a previous study were .76 for role limitations due to emotional problems, .84 for vitality, .81 for emotional well-being, and .80 for social functioning (Ruta et al., 1994).

*Generalized Anxiety Disorder scale-2* (GAD-2; Kroenke et al., 2007) was used as a measure of generalized anxiety disorder at age 50. The instrument consists of 2 items: "Feeling nervous, anxious or on edge" and "Not being able to stop or control worrying" with a 4-point Likert-type response format, ranging from 1 (*not at all*) to 4 (*nearly every day*). The test-retest reliability reported in a previous study was .81 (Staples et al., 2019).

*Patient Health Questionnaire-2* (PHQ-2; Löwe et al., 2005) was used as a measure of depression at age 50. The instrument consists of 2 items: "Feeling down, depressed, or hopeless" and "Little interest or pleasure in doing things" with a 4-point Likert-type response format, ranging from 1 (*not at all*) to 4 (*nearly every day*). The test-retest reliability reported in a previous study was .79 (Staples et al., 2019).

## STATISTICAL ANALYSES

Means, standard deviations, and correlation coefficients were calculated. Eighty-five quadratic regression models and 170 spline regression models were conducted, where either the *g* factor or one of the BAS subscales was the independent variable, and the mental health measures at different BCS70 waves were the dependent variables. The inflection points for the independent variables in spine regressions were set at either +2 *SD* (98th percentile) or +1.28 *SD* (90th percentile). Natural splines were used due to the placement of the inflection points near the boundaries of the data (Perperoglou et al., 2019). The nonlinear models were then compared to the corresponding linear models using lack-of-fit tests. Analyses were conducted in R 4.2.0 (R Core Team, 2022) with the *splines2* and *mirt* packages and visualized with the *ggplot2* package. All tests were two-tailed, and the significance level was set to $\alpha = .05$. The code for the analyses is available through Open Science Framework at the following link: https://osf.io/qxz27/?view_only=b72159cfe93d4b2c895d22e4ca9f6e57.

# RESULTS

The supplementary material is available at https://osf.io/qxz27/?view_only=b72159cfe93d4b2c895d22e4ca9f6e57. Table 1 presents means, standard deviations, and correlation coefficients of intelligence with each

**Table 1**

*Mean scores and standard deviations (SD), numbers of observations with complete data for mental health measures and correlation coefficients with intelligence*



| Variable | Mean (*SD*) | *N* | General intelligence (age 10) | Word definitions (age 10) | Recall of digits (age 10) | Word similarities (age 10) | Matrices (age 10) |
|---|---|---|---|---|---|---|---|
| Malaise Inventory (age 16) | 9.19 (5.53) | 3968 | –.12** | –.11** | –.02 | –.08** | –.06** |
| GHQ-12 (age 16) | 21.73 (5.53) | 3609 | .03 | .02 | .01 | .03 | .03* |
| Malaise Inventory (age 26) | 3.85 (3.38) | 6403 | –.15** | –.12** | –.06** | –.13** | –.13** |
| Malaise Inventory (age 30) | 3.50 (3.47) | 7984 | –.12** | –.09** | –.06** | –.11** | –.12** |
| GHQ-12 (age 30) | 22.61 (4.52) | 7980 | –.01 | .00 | .00 | –.01 | –.01 |
| Malaise Inventory (age 34) | 1.66 (1.89) | 6924 | –.12** | –.09** | –.05** | –.10** | –.11** |
| Malaise Inventory (age 42) | 1.86 (1.98) | 6147 | –.11** | –.08** | –.04** | –.09** | –.09** |
| WEMWBS (age 42) | 49.17 (8.26) | 5794 | .15** | .13** | .07** | –.12** | –.09** |
| Malaise Inventory (age 46) | 1.78 (2.12) | 5623 | –.11** | –.08** | –.04** | –.09** | –.09** |
| WEMWBS (age 46) | 50.09 (8.55) | 5579 | .10** | .09** | .00 | .07** | .08** |
| SF-36 Role limitations due to emotional problems (age 46) | 83.75 (31.89) | 5726 | –.04** | .02 | .00 | –.04** | .05** |
| SF-36 Vitality (age 46) | 56.76 (22.14) | 5736 | .05** | .04* | .00 | .03* | .04** |
| SF-36 Emotional well-being (age 46) | 74.14 (19.32) | 5736 | .09** | .07** | .03* | .07** | .09** |
| SF-36 Social functioning (age 46) | 85.48 (24.04) | 5738 | .13** | .10** | .03* | .10** | .10** |
| Malaise Inventory (age 50) | 1.65 (1.95) | 2864 | –.08** | –.05** | –.02 | –.07** | –.07** |
| GAD-2 (age 50) | 2.91 (1.36) | 2870 | –.05** | –.03 | –.03 | –.03 | –.04* |
| PHQ-2 (age 50) | 2.98 (1.42) | 2874 | –.04* | –.02 | –.03 | –.03 | –.02 |

*Note.* GHQ-12 – General Health Questionnaire-12; WEMWBS – Warwick-Edinburgh Mental Wellbeing Scale; SF – Short Form Health Survey; GAD-2 – Generalized Anxiety Disorder scale-2; PHQ-2 – Patient Health Questionnaire-2; $^*p < .05$, $^{**}p < .01$.

Stanisław K. Czerwiński, Paweł A. Atroszko, Roman Konarski

mental health measurement at each wave of BCS70, as well as numbers of participants with complete data for each analysis.

Table 2, Figure 2, and Figure 3 present the results of quadratic regression and spline regression analyses where the general factor of intelligence was the independent variable. The regression coefficients for quadratic models with calculated inflection points for those models are available in the supplemental material. The nonlinear models fit the data better than the corresponding linear ones for 13 out of 17 model comparisons. The differences in explained variance between the different nonlinear models were mostly marginal. However, the only nonlinear model that had a better data fit for the vitality subscale of SF-36 was the spline model with the inflection point set at +1.28 *SD* and for PHQ-2 it was the only one that did not have a better fit.

Table 3 presents the results of quadratic regression and spline regression analyses where the subscales of BAS were the independent variables. The figures for these analyses and regression coefficients for the quadratic models with calculated inflection points for those models are available in the supplemental material. For word definitions the nonlinear models fit the data better in 12 out of 17 model comparisons for all nonlinear models. For recall of digits the nonlinear models fit the data better in 4 out of 17 model comparisons for quadratic models, 3 out of 17 for spline models with a +2 *SD* inflection point and 2 out of 17 for spline models with a +1.28 *SD* inflection point. For word similarities the nonlinear models fit the data better in 7 out of 17 model comparisons for quadratic models and 5 out of 17 for spline models with a +2 *SD* inflection point and 4 out of 17 for spline models with a +1.28 *SD* inflection point. For matrices the nonlinear models fit the data better in 3 out of 17 model comparisons for all nonlinear models.

**Table 2**

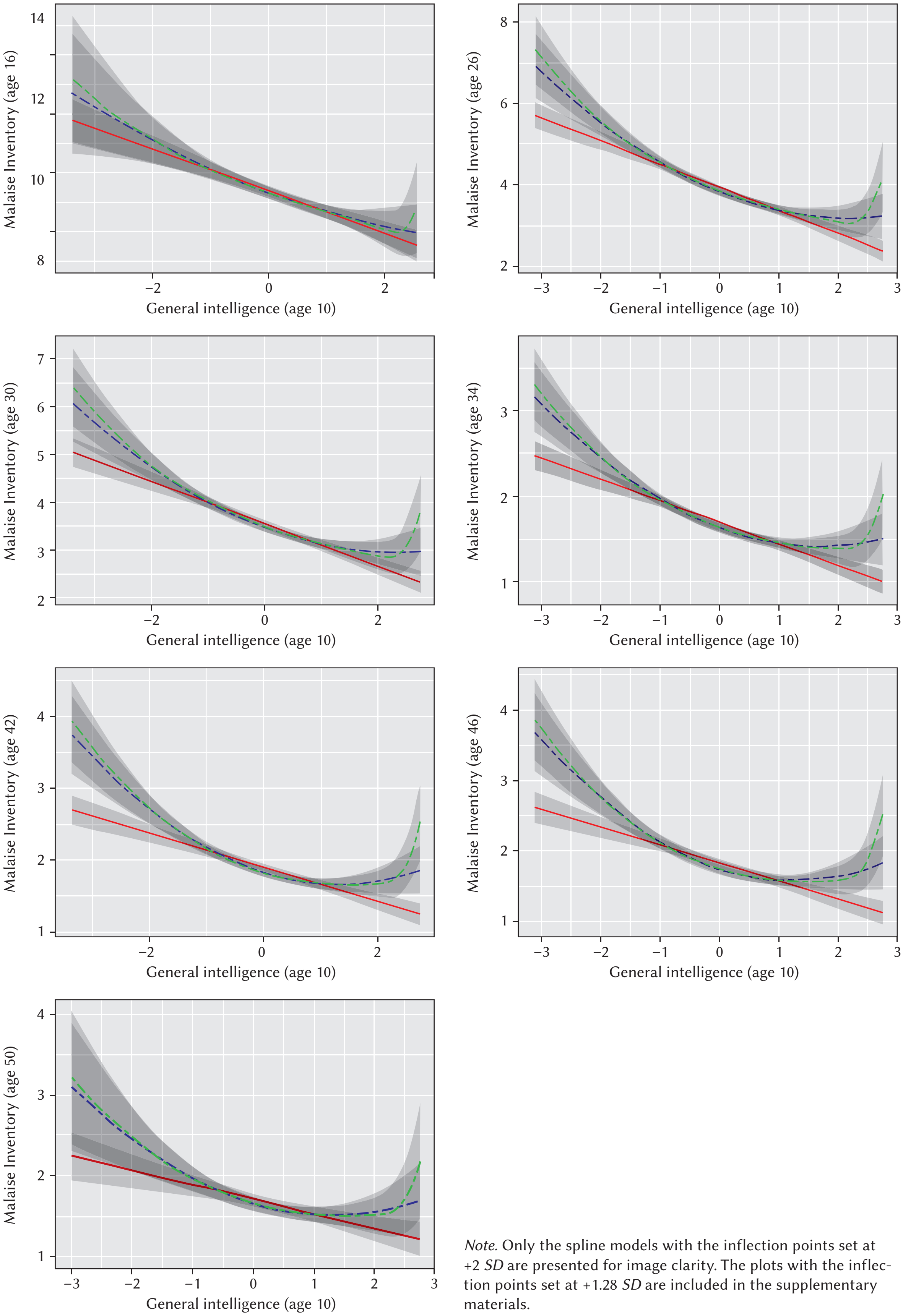
*Variance explained by linear, quadratic and spline models and results of lack-of-fit tests comparing the nonlinear models to analogous linear models, for the analyses using the g factor*

| Variable | General intelligence (age 10) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Linear | Quadratic | | Spline (+2 *SD* inflection point) | | Spline (+1.28 *SD* inflection point) | |
| | $R^2$ | $R^2$ | $F$ | $R^2$ | $F$ | $R^2$ | $F$ |
| Malaise Inventory (age 16) | .01 | .01 | 0.90 | .01 | 0.07 | .01 | 0.00 |
| GHQ-12 (age 16) | .00 | .00 | 0.00 | .00 | 0.05 | .00 | 0.08 |
| Malaise Inventory (age 26) | .02 | .02 | 10.86** | .02 | 9.95** | .02 | 8.28** |
| Malaise Inventory (age 30) | .01 | .01 | 7.50** | .01 | 7.73** | .01 | 6.23* |
| GHQ-12 (age 30) | .00 | .00 | 1.63 | .00 | 1.46 | .00 | 1.60 |
| Malaise Inventory (age 34) | .01 | .02 | 12.61** | .02 | 11.31** | .02 | 8.84** |
| Malaise Inventory (age 42) | .01 | .01 | 16.45** | .01 | 15.06** | .01 | 14.68** |
| WEMWBS (age 42) | .02 | .02 | 9.27** | .02 | 5.98* | .02 | 6.31* |
| Malaise Inventory (age 46) | .01 | .01 | 16.81** | .01 | 16.02** | .01 | 15.74** |
| WEMWBS (age 46) | .01 | .01 | 1.53 | .01 | 0.02 | .01 | 0.75 |
| SF-36 Role limitations due to emotional problems (age 46) | .00 | .00 | 13.55** | .00 | 13.48** | .00 | 13.31** |
| SF-36 Vitality (age 46) | .00 | .00 | 2.30 | .00 | 2.83 | .00 | 4.64* |
| SF-36 Emotional well-being (age 46) | .01 | .01 | 9.71** | .01 | 8.86** | .01 | 8.73** |
| SF-36 Social functioning (age 46) | .02 | .02 | 12.39** | .02 | 12.77** | .02 | 13.68** |
| Malaise Inventory (age 50) | .01 | .01 | 5.19* | .01 | 4.51* | .01 | 4.96* |
| GAD-2 (age 50) | .00 | .01 | 11.02** | .01 | 9.90** | .01 | 11.53** |
| PHQ-2 (age 50) | .00 | .00 | 4.37* | .00 | 4.40* | .00 | 3.82 |

*Note.* GHQ-12 – General Health Questionnaire-12; WEMWBS – Warwick-Edinburgh Mental Wellbeing Scale; SF – Short Form Health Survey; GAD-2 – Generalized Anxiety Disorder scale-2; PHQ-2 – Patient Health Questionnaire-2; *$p$ < .05, **$p$ < .01.

**Figure 2**

*Plots for the analyses conducted using the g factor and the mental health measurements using the Malaise Inventory (red line – linear model, blue line – quadratic model, green line – spline model)*

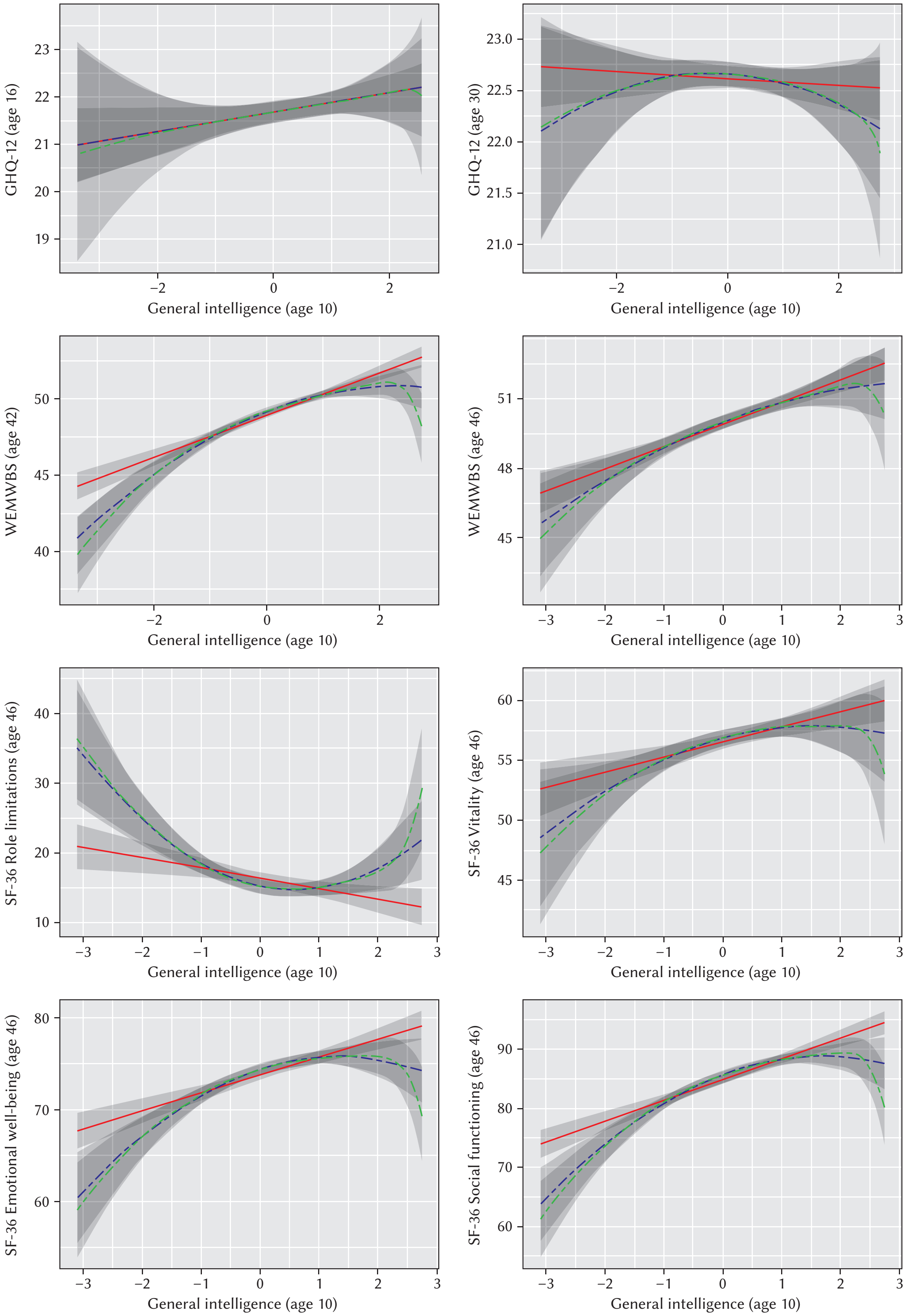





*Note.* Only the spline models with the inflection points set at +2 *SD* are presented for image clarity. The plots with the inflection points set at +1.28 *SD* are included in the supplementary materials.

**Figure 3**

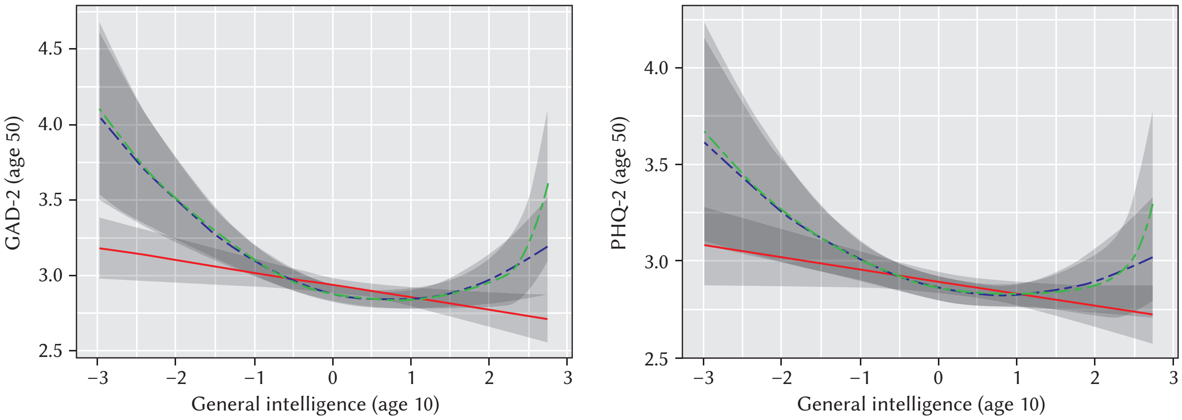
*Plots for the analyses conducted using the g factor and the rest of the mental health measurements (red line – linear model, blue line – quadratic model, green line – spline model) (Figure 3 continues)*




Stanisław K. Czerwiński, Paweł A. Atroszko, Roman Konarski

**Figure 3**

*(Figure 3 continued)*




*Note.* Only the spline models with the inflection points set at +2 *SD* are presented for image clarity. The plots with the inflection points set at +1.28 *SD* are included in the supplementary materials.



**Table 3**

*Variance explained by linear, quadratic and spline models, and results of lack-of-fit tests comparing the nonlinear models to analogous linear models, for the analyses using the subscales of BAS*

| Variable | Linear | Quadratic | | Spline (+2 *SD* inflection point) | | Spline (+1.28 *SD* inflection point) | |
|---|---|---|---|---|---|---|---|
| | $R^2$ | $R^2$ | $F$ | $R^2$ | $F$ | $R^2$ | $F$ |
| Word definitions (age 10) | | | | | | | |
| Malaise Inventory (age 16) | .01 | .01 | 4.27* | .01 | 5.22* | .01 | 5.54* |
| GHQ-12 (age 16) | .00 | .00 | 0.23 | .00 | 0.02 | .00 | 0.02 |
| Malaise Inventory (age 26) | .01 | .02 | 10.04** | .02 | 10.65** | .02 | 10.29** |
| Malaise Inventory (age 30) | .01 | .01 | 9.37** | .01 | 10.56** | .01 | 10.81** |
| GHQ-12 (age 30) | .00 | .00 | 0.95 | .00 | 0.88 | .00 | 0.94 |
| Malaise Inventory (age 34) | .01 | .01 | 9.06** | .01 | 8.80** | .01 | 8.47** |
| Malaise Inventory (age 42) | .01 | .01 | 19.23** | .01 | 20.25** | .01 | 20.84** |
| WEMWBS (age 42) | .02 | .02 | 18.22** | .02 | 17.18** | .02 | 16.05** |
| Malaise Inventory (age 46) | .01 | .01 | 13.49** | .01 | 13.51** | .01 | 13.46** |
| WEMWBS (age 46) | .01 | .01 | 5.77* | .01 | 4.78* | .01 | 3.89* |
| SF-36 Role limitations due to emotional problems (age 46) | .00 | .00 | 4.71* | .00 | 4.49* | .00 | 4.53* |
| SF-36 Vitality (age 46) | .00 | .00 | 2.67 | .00 | 2.21 | .00 | 2.00 |
| SF-36 Emotional well-being (age 46) | .01 | .01 | 10.32** | .01 | 9.49** | .01 | 8.93** |
| SF-36 Social functioning (age 46) | .01 | .01 | 6.79** | .01 | 5.75* | .01 | 5.62* |
| Malaise Inventory (age 50) | .00 | .00 | 2.18 | .00 | 1.16 | .00 | 0.63 |
| GAD-2 (age 50) | .00 | .00 | 7.26** | .00 | 6.28* | .00 | 5.50* |
| PHQ-2 (age 50) | .00 | .01 | 0.95 | .00 | 0.75 | .00 | 0.44 |

*(Table 3 continues)*

**Table 3**

*Table 3 continued*

| Variable | Linear | Quadratic | | Spline (+2 *SD* inflection point) | | Spline (+1.28 *SD* inflection point) | |
|---|---|---|---|---|---|---|---|
| | $R^2$ | $R^2$ | *F* | $R^2$ | *F* | $R^2$ | *F* |
| Recall of digits (age 10) | | | | | | | |
| Malaise Inventory (age 16) | .00 | .00 | 0.02 | .00 | 0.80 | .00 | 0.40 |
| GHQ-12 (age 16) | .00 | .00 | 4.04* | .00 | 1.70 | .00 | 2.16 |
| Malaise Inventory (age 26) | .00 | .00 | 4.35* | .00 | 4.59* | .00 | 2.35 |
| Malaise Inventory (age 30) | .00 | .00 | 7.32** | .00 | 7.78** | .00 | 5.60* |
| GHQ-12 (age 30) | .00 | .00 | 1.01 | .00 | 1.37 | .00 | 1.07 |
| Malaise Inventory (age 34) | .00 | .00 | 3.82 | .00 | 2.27 | .00 | 3.69 |
| Malaise Inventory (age 42) | .00 | .00 | 1.44 | .00 | 3.06 | .00 | 1.61 |
| WEMWBS (age 42) | .00 | .00 | 0.45 | .01 | 2.11 | .00 | 0.00 |
| Malaise Inventory (age 46) | .00 | .00 | 6.12* | .00 | 5.75* | .00 | 6.16* |
| WEMWBS (age 46) | .00 | .00 | 1.63 | .00 | 1.09 | .00 | 0.70 |
| SF-36 Role limitations due to emotional problems (age 46) | .00 | .00 | 1.84 | .00 | 1.34 | .00 | 0.56 |
| SF-36 Vitality (age 46) | .00 | .00 | 0.81 | .00 | 0.58 | .00 | 0.70 |
| SF-36 Emotional well-being (age 46) | .00 | .00 | 1.09 | .00 | 0.16 | .00 | 0.00 |
| SF-36 Social functioning (age 46) | .00 | .00 | 1.87 | .00 | 0.20 | .00 | 0.00 |
| Malaise Inventory (age 50) | .00 | .00 | 0.21 | .00 | 0.00 | .00 | 0.00 |
| GAD-2 (age 50) | .00 | .00 | 0.39 | .00 | 0.23 | .00 | 0.06 |
| PHQ-2 (age 50) | .00 | .00 | 0.49 | .00 | 0.41 | .00 | 0.43 |
| Word similarities (age 10) | | | | | | | |
| Malaise Inventory (age 16) | .01 | .01 | 0.83 | .01 | 0.04 | .00 | 0.00 |
| GHQ-12 (age 16) | .00 | .00 | 0.54 | .00 | 0.34 | .00 | 0.39 |
| Malaise Inventory (age 26) | .02 | .00 | 1.98 | .02 | 0.00 | .02 | 0.00 |
| Malaise Inventory (age 30) | .01 | .01 | 2.53 | .01 | 0.94 | .01 | 0.00 |
| GHQ-12 (age 30) | .00 | .00 | 0.37 | .00 | 0.36 | .00 | 0.30 |
| Malaise Inventory (age 34) | .01 | .01 | 5.97* | .01 | 1.86 | .01 | 0.00 |
| Malaise Inventory (age 42) | .01 | .01 | 2.02 | .01 | 0.27 | .01 | 0.00 |
| WEMWBS (age 42) | .02 | .02 | 3.77 | .02 | 2.37 | .02 | 2.75 |
| Malaise Inventory (age 46) | .01 | .01 | 5.57* | .01 | 2.84 | .01 | 2.43 |
| WEMWBS (age 46) | .00 | .00 | 1.63 | .00 | 1.09 | .01 | 0.04 |
| SF-36 Role limitations due to emotional problems (age 46) | .00 | .00 | 8.49** | .00 | 7.39** | .00 | 6.41* |
| SF-36 Vitality (age 46) | .00 | .00 | 1.85 | .00 | 2.48 | .00 | 2.89 |
| SF-36 Emotional well-being (age 46) | .00 | .01 | 3.81 | .01 | 4.08* | .01 | 3.36 |
| SF-36 Social functioning (age 46) | .01 | .01 | 10.84** | .01 | 8.23** | .01 | 6.98** |

*(Table 3 continues)*

**Table 3**

*Table 3 continued*

| Variable | Linear | Quadratic | | Spline (+2 *SD* inflection point) | | Spline (+1.28 *SD* inflection point) | |
|---|---|---|---|---|---|---|---|
| | $R^2$ | $R^2$ | *F* | $R^2$ | *F* | $R^2$ | *F* |
| Malaise Inventory (age 50) | .00 | .01 | 6.79** | .01 | 3.70 | .01 | 3.15 |
| GAD-2 (age 50) | .00 | .00 | 7.08** | .00 | 4.92* | .00 | 4.22* |
| PHQ-2 (age 50) | .00 | .00 | 8.52** | .00 | 8.24** | .00 | 6.82** |
| Matrices (age 10) | | | | | | | |
| Malaise Inventory (age 16) | .00 | .00 | 2.32 | .00 | 1.44 | .00 | 0.00 |
| GHQ-12 (age 16) | .00 | .00 | 0.18 | .00 | 0.27 | .00 | 0.08 |
| Malaise Inventory (age 26) | .02 | .02 | 0.53 | .02 | 0.00 | .02 | 0.00 |
| Malaise Inventory (age 30) | .01 | .01 | 0.24 | .01 | 0.00 | .01 | 0.00 |
| GHQ-12 (age 30) | .00 | .00 | 1.49 | .00 | 1.10 | .00 | 0.96 |
| Malaise Inventory (age 34) | .01 | .01 | 0.04 | .01 | 0.00 | .01 | 0.00 |
| Malaise Inventory (age 42) | .01 | .01 | 1.60 | .01 | 0.84 | .01 | 2.40 |
| WEMWBS (age 42) | .01 | .01 | 0.40 | .01 | 0.00 | .01 | 0.00 |
| Malaise Inventory (age 46) | .01 | .01 | 3.33 | .01 | 2.83 | .01 | 3.46 |
| WEMWBS (age 46) | .01 | .01 | 0.31 | .01 | 0.43 | .01 | 1.06 |
| SF-36 Role limitations due to emotional problems (age 46) | .00 | .00 | 0.68 | .00 | 0.74 | .00 | 1.12 |
| SF-36 Vitality (age 46) | .00 | .00 | 7.17** | .00 | 7.23** | .00 | 7.17** |
| SF-36 Emotional well-being (age 46) | .01 | .01 | 1.35 | .01 | 0.91 | .01 | 0.25 |
| SF-36 Social functioning (age 46) | .01 | .01 | 7.40** | .01 | 8.31** | .01 | 7.30** |
| Malaise Inventory (age 50) | .01 | .01 | 2.76 | .01 | 2.18 | .01 | 2.22 |
| GAD-2 (age 50) | .00 | .00 | 0.68 | .00 | 0.17 | .00 | 0.21 |
| PHQ-2 (age 50) | .00 | .00 | 5.16* | .00 | 4.73* | .00 | 4.50* |

*Note.* GHQ-12 – General Health Questionnaire-12; WEMWBS – Warwick-Edinburgh Mental Wellbeing Scale; SF – Short Form Health Survey; GAD-2 – Generalized Anxiety Disorder scale-2; PHQ-2 – Patient Health Questionnaire-2; *$p$ < .05, **$p$ < .01.



## DISCUSSION

The aim of this study was to test the nonlinearity of the relationship between intelligence and mental health. Congruently with the expected patterns, for 13 out of 17 model comparisons, the nonlinear model fit the data better than the linear one. For the 4 cases where nonlinearity was not confirmed, several explanations can be proposed. The relationship was linear both times GHQ-12 was used, hinting that this might be an artifact caused by this particular measure of mental health. Moreover, for GHQ-12 the baseline correlations with intelligence were nonsignificant, which is an outlier result in cognitive epidemiology (Aichele et al., 2018; Gale et al., 2010; Jokela, 2022; Keyes et al., 2017; Wraw et al., 2015). For both measures used at age 16, all model comparisons were in favor of the linear model. It is possible that with age, the more intellectually gifted individuals experience more specific challenges due to their exceptionally high cognitive abilities.

The relationship between intelligence and general mental health does indeed seem to be nonlinear. At high intelligence values, the relationship reaches an inflection point, creating a too-much-of-a-good-thing effect. It suggests that intellectually gifted individuals might experience unique issues, which outweigh the beneficial effects associated with high intelligence. It is however important to note that the nonlinearity of this relationship does not mean that intellectually gifted individuals have worse mental health compared to the general population. More research should be conducted on potential mechanisms underlying this effect and the related phenomena such as underachievement (Reis & Mccoach, 2000; White et al., 2018). While there are some general theoretical frameworks potentially explaining these effects, more comprehensive and intelligence-dedicated models should be developed and investigated empirically.

Issues of unidimensional identity (Coakley, 1992) based solely on cognitive prowess coupled with social, emotional, or physical development deficits may likely explain some of the findings. Analogous processes are perhaps best documented in cases of burnout in sports. Young athletes experience identity foreclosure based on mastery in a particular discipline, resulting in a unidimensional identity and perceived loss of autonomy leading to psychological and physical crises (Goodger et al., 2007; Gustafsson et al., 2017). Congruently with this theory, being formally labeled as intellectually gifted has been shown to be related to decreased mental health (Freeman 2006; Lavrijsen & Verschueren, 2023). This could also explain why the results from studies on Mensa members show that they have worse mental health compared to the general population. Being a member of Mensa is likely related to one's intelligence being important to one's identity. A similar phenomenon related to intellectual giftedness may occur among students who are overly focused on academic achievement. In their cases, obsessive and compulsive learning, to the exclusion of other spheres of life, may lead to harm in terms of general health, mental health, and quality of life (Atroszko et al., 2015; Czerwiński et al., 2023).

Auxiliary analyses showed that this effect occurred less frequently when analyzing specific cognitive abilities instead of *g*. This can be seen as a confirmation that specific abilities lack predictive power compared to the general intelligence factor (Thorndike, 1984). However, there was an overall tendency for the effect to occur more often for the subtests measuring crystallized intelligence than those measuring fluid intelligence. This result is somewhat congruent to the one obtained in the study on the relationship between intelligence and bipolar disorder (Gale et al., 2012). It might be of particular importance to other studies using intelligence tests that use items based on matrices. The estimated inflection points for the quadratic models were generally lower than +2 *SD*, especially in the case of particular subscales. This may suggest that the cut-off point where intelligence stops being beneficial for mental health might be lower than expected. Further investigation on the topic is warranted. Despite their shortcomings, the quadratic models provided similar results to more complex spline models. Although the polynomial quadratic models in most cases explained more variance than the spline models, this was expected due to the inflection point being freely estimated in these models.

The results of this study also fit within a wider research framework of showing that personality traits and individual differences that are widely considered to be beneficial can have negative effects on one's life under certain circumstances (Carter et al., 2015; Czerwiński et al., 2023; Smith et al., 2017). Future studies could also use datasets from large cohort studies and statistical techniques such as spline regression to thoroughly investigate the too-much-of-a-good-thing effect in other psychological constructs.

To the authors' knowledge, there have been no simulation studies on the statistical power of analyses for nonlinear relationships with different placements of inflection points. Hence, it may be that the analyses conducted may be underpowered. Although the sample sizes for each analysis are relatively large for psychological studies, the main group of interest consists of only 2% of the entire sample. Under such circumstances, even with a sample as large as 8,000 participants, only 160 of those represent intellectually gifted individuals. Therefore, studies on the intellectually gifted should aim to obtain even larger samples. Another limitation of the present study is that the intelligence test used in the BCS70 measures a fairly narrow scope of cognitive abilities. The Cattell-Horn-Carroll theory of cognitive abilities (CHC; Carroll, 1993; Schneider & McGrew, 2012) is the most widely utilized contemporary psychometric theory of intelligence and provides a much broader taxonomy of abilities. Therefore, the study's results might not fully reflect the modern understanding of intelligence and its measurement. Similarly, for mental health, most of the measures used focus on symptoms of psychopathology. Although this is congruent with more traditional definitions of mental health, in recent years there have been increased efforts to focus on both positive and negative aspects of mental health (Keyes, 2005; Lukat et al., 2016). In line with this, future studies should utilize more comprehensive psychometric tools for both intelligence and mental health that reflect modern definitions of these phenomena.

Understanding the psychosocial problems of the intellectually gifted and the underlying mechanisms behind these problems will allow the development of educational programs, as well as prevention programs for psychological issues and therapies designed specifically to fit the unique experiences of this group. More integrated theoretical models explaining potential causes of issues that affect mental health among the intellectually gifted are needed alongside systematic empirical studies. This is particularly important as highly intelligent individuals have a greater potential to have a positive impact on the functioning of the whole society, and this potential might be wasted due to experiencing certain psychosocial difficulties (Wai & Lovett, 2021).

## Disclosures

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