

***The Interactive Role of Income (material position) and
Income Rank (psychosocial position) in Psychological
Distress:
A 9-year Longitudinal Study of 30,000 UK Parents***

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Abstract

Purpose Parents face an increased risk of psychological distress compared with adults without children, with material and psychosocial stressors. Past research suggests that absolute income (material position) and income status (psychosocial position) influence psychological distress, but their combined and interactive effects on psychological distress are unknown. This research aims to tease apart the roles of material and psychosocial factors in relation to psychological distress in adults.

Methods We used fixed-effects panel models to examine longitudinal associations between psychological distress (measured on the Kessler scale) and absolute income, regional income rank (a proxy for status) and their interaction, using data from 29,107 parents included in the UK Millennium Cohort Study (2003-2012).

Results Psychological distress was predicted by an interaction between absolute income and income rank: higher absolute incomes were associated with lower psychological distress across the income spectrum, while the benefits of higher income rank were evident only in the highest income parents. Parents' psychological distress was therefore affected by a combination of material and psychosocial factors.

Conclusions Debates considering the importance of income to psychological distress miss the fact that both material and psychosocial factors contribute to distress. Parents with higher absolute incomes reported lower psychological distress across the income spectrum, demonstrating the importance of material factors. Conversely, parents' income status was associated with psychological distress only among higher-income parents, suggesting that psychosocial factors are more relevant to distress in more advantaged parents. Policy and therapeutic interventions could therefore consider the material and psychosocial impacts of income on psychological distress.

Keywords: Health Inequalities; Mental health; Relative Income; Relative Rank; Social Status.

Word count: 4,492 words

1. Introduction

In the context of widening income inequality [1] and the impact of psychological distress on health and economic outcomes [2, 3], addressing the negative association between income and psychological distress is a research priority. Higher levels of distress are consistently reported in adults with lower incomes [4] and lower socioeconomic status [5]. Whether this association primarily reflects the importance of income as a material resource, or the psychosocial relevance of income as a status measure has prompted considerable debate. Psychological well-being is more closely associated with people's perceived economic standing than their absolute incomes [6], suggesting that income-related status comparisons that induce shame, anxiety, and psychosocial stress could explain the negative association between income and psychological distress [7–9]. Associations between income inequality and several mental health outcomes reinforces this possibility [10–13], while research linking poverty with experiences of shame both in the UK and across economically and culturally diverse settings reinforces the fundamental importance of social comparisons [14, 15].

These patterns might be particularly important in parents, as families with children typically have lower incomes than families without children [16], and the transition to parenthood confers a range of stressors which may amplify the underlying risks of psychological distress [17–19]. This could explain why 33 per cent of UK mothers and 16 per cent of UK fathers experienced an episode of depression before their children were 8 years old [20], higher than the general population prevalence (11 per cent) [4]. This is significant because parental distress presents risks to their children's well-being [21–23]. In this study we examined the influence of income-related material and psychosocial factors on psychological distress in parents of young children.

1.1 Characteristics of income and status comparisons

Past research has not clearly identified why income-based status comparisons are detrimental to psychological distress [24]. The *income rank hypothesis* states that the psychological implications of people's ordinal rank position within the income distribution is important [25, 26]. Income rank is a purely psychosocial measure as it solely captures income position, thereby distinguishing rank theory from mean-based conceptualisations of income position, which combine both psychosocial and material elements, making it impossible to isolate the true relevance of psychosocial factors [27–30]. In this study we therefore focus on exploring the roles of absolute income and income rank.

1 The income rank hypothesis is founded on evolutionary psychology and cognitive science. In
2 primates, rank-based social comparisons cause social defeat among low-ranking group
3 members. Adaptive appeasement behaviors termed *Involuntary Defeat Syndrome* (IDS)
4 developed in low-ranking animals to signal the absence of threat and discourage physical
5 aggression from higher-ranking animals [31]. These submission displays are observed in
6 adults, children, and non-human primates, which suggests a fundamental basis [32–34]. In
7 humans, income-based status comparisons replicate the rank-based comparisons that
8 determine status in non-human primates. Although the IDS response promoted peaceful
9 relations in our group-living past, in contemporary societies it carries maladaptive
10 consequences [35]. Experiences of defeat are associated with affective disorders in humans
11 and non-human primates [34, 36], further suggesting that psychological distress among lower-
12 income people results from rank-based status comparisons that instigate feelings of inferiority
13 and defeat.

15 The income rank hypothesis is reinforced by research in cognitive science. When people
16 make relative judgments (for example, their income position in relation to others') it is
17 theorised that they first visualise a distribution of stimuli (others' incomes) from memory,
18 then sequentially compare their own position (their own income) with each of these stimuli,
19 remembering the number of stimuli higher than their own. This captures the person's ranked
20 status position, providing a direct evaluation of social position. If people naturally make
21 judgments based on rank, then associations between income and psychological distress are
22 more likely to reflect rank-based ordinal comparisons than more demanding calculations of
23 distance from the 'average' person. This is particularly relevant in crowded parts of the
24 income distribution where differences between incomes are small, so evaluating distance
25 from the average may be especially challenging. In contrast, the difficulty of making ordinal
26 rank-based comparisons is independent of the characteristics of the income distribution.
27 Accumulating evidence for the rank model across diverse judgments including those relating
28 to pain [37], gratitude [38], personality [39], mental health symptoms [40] and information-
29 seeking [41], galvanizes support for sensitivity to social rank as a general cognitive capacity.

31 An emerging body of evidence reports that low rank is associated with higher psychological
32 distress [42], greater depressive symptoms [43] and a higher likelihood of suicidal thoughts
33 and suicide attempts [44], independent of absolute income. Furthermore, associations between
34 income rank and allostatic load strengthen the pathway between rank, stress and
35 psychological distress, strongly suggesting that income rank relates to health [45, 46]. In the

current study we build on existing evidence using fixed-effects panel models to provide a more robust examination of the potential role of income rank on psychological distress.

A related question that has received little research attention is the possibility that absolute income interacts with income status to influence psychological distress. Income status may be more relevant to psychological distress at either lower incomes (because income status could counteract the negative effects of material disadvantage on distress, implicating material pathways) or higher incomes (because income status might be more desirable to higher-income people, implicating psychosocial pathways [47]). Existing evidence is inconclusive: evidence from children found that higher household income rank was longitudinally related to lower behavioural problems only in children living in the highest-income households [48], while in cross-sectional research, affluence status (based on ownership of material goods) was more strongly associated with psychosomatic symptoms in less affluent adolescents [49]. Substantial methodological differences between studies make it difficult to reconcile these inconsistent results. Determining whether income status is more closely associated with psychological distress at lower or higher absolute incomes is important when considering how best to develop appropriate policy and therapeutic interventions aimed at reducing the negative consequences of status comparisons on psychological distress. A more rigorous examination of potential interactions between absolute income and income status is therefore warranted.

1.4 Purpose of the study

We examined two research questions:

- (1) Is income status associated with psychological distress among parents of young children?
- (2) Do absolute income and income status interact to influence parents' psychological distress?

We hypothesised that (1) lower income rank would be associated with higher psychological distress in parents, independent of absolute income; (2) absolute income and income rank would interact to influence psychological distress: at higher absolute incomes, lower-ranking parents would report greater psychological distress than higher-ranking parents, while at lower absolute incomes, psychological distress would be less closely associated with income status. If plotted graphically, levels of psychological distress by absolute income for high- and low-ranking parents are expected to converge at lower absolute incomes and diverge at higher absolute incomes.

2. Methods

2.1 Data and participants

We used four waves of data from the Millennium Cohort Study (MCS), a multidisciplinary study of 19,000 UK children born in 2000-01 and followed up at 3, 5, 7 and 11 years. Parents are interviewed to provide information about themselves, their child, and the household.

Using stratification and clustering, the sampling strategy over-represented wards in disadvantaged areas, the smaller UK countries, and high ethnic minority populations [50]. The sample included all children born in the 398 selected wards during the sampling period, who were established residents and remained in the UK at 9 months of age. The inclusion of continuous measures of household income, psychological distress, and covariates makes the dataset well suited to our study's aims.

We included parents with complete information on psychological distress, household income and covariates. On average, income data was unavailable for 11.9 per cent of households between 2003 and 2012. This was imputed by the data holder using interval regression based on demographic and household characteristics, reducing missing income data to less than two per cent at each survey wave [50]. Missing covariate data were ascribed the characteristics reported in previous waves. Missing data reduced the sample by 16.6 per cent to 83,395 observations from 29,107 parents, and an examination of nonresponse concluded that respondents and non-respondents were comparable [51]. Parents with 'other' educational qualifications were excluded ($n=1,647$, 1.9 per cent) as these are incomparable with other qualifications. Our results were unaffected by this (available on request).

2.2 Measures

2.2.1 Absolute income

Absolute income A_i captures total household income after tax but before housing costs, then adjusted for family size and composition using the modified OECD equivalence scales², following standard practice [42, 44, 45]. These adjustments serve to approximate spending power, which allows the roles of material resources and psychosocial measures of income to be clearly separated. Absolute income was log transformed to reduce skew, then normalised between 0 and 1.

²The modified Organisation for Economic Co-operation and Development equivalence scales grant the first adult a value of 0.67, subsequent adults 0.33, children aged 14-18 a value of 0.33 and children aged under 14 years 0.20. These values are summed and equivalised income is derived by dividing total household income by the household equivalisation factor.

2.2.2 Income rank

Income rank identifies each parent's ordinal position in the income distribution by capturing the proportion of parents with lower incomes than their own, within the 12 UK regions. Regional income comparisons account for geographical differences in incomes and living costs, and capture the influence of similar others who form the majority of social interactions. Regional reference groups are widely used in research on income comparisons and mental health [42, 44, 49], and an exploration of comparison groups has found that overall health was most clearly associated with income defined within regions than other comparison groups [46]. Income rank R_i captures the income position P_i of parent i divided by the size of comparison group n to identify the proportion of lower-ranking parents [52]:

$$R_i = \frac{P_i - 1}{n - 1}$$

Income rank was normalised between 0 and 1 to control for region size. Differences between absolute income and income rank reflect variation in regional income distributions where the same absolute income confers a higher rank in lower-income regions.

2.2.4 Kessler scale

Parental distress was assessed using the six-item Kessler scale of nonspecific psychological distress, a screening tool developed to identify clinically significant distress in population surveys. Parents reported how often they felt depressed, hopeless, restless or fidgety, worthless, nervous and everything being an effort during the past 30 days, answering on a five-point scale. Overall scores range from 0-24, where higher scores indicate greater distress. Screening tools are well-suited for population surveys where levels of distress are generally low [53], and the good performance of the Kessler scale has previously been established [54–56]. Scores were log transformed to reduce skew.

2.3 Data analysis

We used linear fixed-effects panel models to examine longitudinal associations between income and parents' psychological distress in 83,395 observations from 29,107 parents. Fixed-effects panel models are a type of longitudinal model that capture how change in one variable over time is associated with change in another variable over time. We examined the effects of changes in absolute income and income rank on changes in parents' psychological distress. Statistical analyses can be biased if variables that are correlated with the predictor or outcome variables are not observed so cannot be controlled (eg: if a genetic predisposition to

psychological distress is associated with income). The influence of these variables is known as unobserved heterogeneity, and the main strength of fixed-effects panel models is to reduce the influence of time-constant unobserved heterogeneity. Two opposing assumptions can be made about this unobserved heterogeneity: the fixed-effects assumption allows unobserved variance to be associated with the predictors (if genetic factors are associated with income), whereas the random-effects assumption considers predictors and unobserved variance to be independent (genetic factors are not associated with income). Although the random-effects specification is preferred because coefficient estimates have smaller standard errors, we used the fixed-effects specification because unobserved variance may be associated with parents' incomes. Formal empirical comparison of the specifications using the Hausman test confirmed this decision. Fixed-effects panel models remove the influence of time-constant observed and unobserved characteristics. Time-varying characteristics (age, disability status, housing tenure, marital status, education, working status) were included at each wave to account for parents' changing characteristics, which also controls for life events such as changing employment or marital status that might influence incomes or psychological distress. This allows associations between income and distress to be examined independently of potential confounding variables while adjusting for changes to the sample over time.

We used linear models to utilise the full range of Kessler scores. Logistic fixed-effects panel models exploring serious psychological distress are restricted to examining cases where this binary measure of distress changes over time, which removes a large proportion of observations, dramatically reducing statistical power and compromising analyses. Count models are also unsuitable as they ignore detail on the severity of distress.

Models were specified to predict psychological distress from a constant term, fixed effects of absolute income, income rank, and covariates. All models adjusted for the sampling design, clustering of parents within families, and covariates. We normalised the income variables between 0 and 1, which makes no difference to the distribution of values, the size of coefficients, or standard errors but gives absolute income and income rank the same interpretation, making comparisons clearer. Fixed-effects panel models assume that residuals are normally distributed with means of zero; graphical inspection confirmed these assumptions were met for all models. All analyses were undertaken using Stata 13 software [57].

2.3.1 Modelling strategy

Descriptive statistics of parents' characteristics were examined first (Table 1). To explore our first research question, we examined individual associations between continuous Kessler scores and absolute income and income rank (Models 1-2, Table 2). This is the most conservative method of comparing the strength of association between the income variables and psychological distress because there is no possibility of bias due to residual confounding between income variables. Comparing goodness-of-fit tests captures the unique characteristic of each income variable to identify whether absolute income or income rank is most strongly associated with psychological distress. Because the income variables are correlated, we undertook a detailed examination of multicollinearity, which demonstrated that multicollinearity did not present a problem to our analyses (available on request). As a robustness check, we then considered whether non-linear (squared) income variables fitted the data better (Models 3-4, Table 2).

We next examined income rank, after controlling for absolute income (Model 5, Table 2). This captured the unique association between psychological distress and income rank, independent of absolute income. This strategy first compared the strength of association between psychological distress and the income variables, then confirmed that this association did not reflect shared variance between income variables. Comparing the fit of models that contain a single income variable provides a clear and direct way of identifying the income variable that is more closely associated with psychological distress, with no possible influence of multicollinearity. This step also serves to directly separate the roles of material (absolute income) and psychosocial (income rank) factors.

To examine our second research question we explored interactions between absolute income and income rank to determine whether income status was more strongly associated with psychological distress at lower or higher absolute incomes (Model 6, Table 3). To confirm the robustness of our results, we also conducted a series of sensitivity analyses (available as online resources).

2.3.2 Model fit

Model fit was compared using Akaike's Information Criterion (AIC), which captures model fit adjusted for complexity. Differences above two indicate improved fit in models with smaller values [58]. R-squared values were not considered because the explanatory power of the intercepts is removed in fixed-effects panel models, making these values artificially low.

3. Results

Sample characteristics are shown in Table 1. Parents' Kessler scores were comparable between waves 2-4 and increased thereafter; absolute income increased progressively and more substantially in wave 5; and income rank was comparable throughout. An increasing proportion of parents had higher-level qualifications, were married or cohabiting, female, home owners, had no disability and worked. Throughout, parents' Kessler scores were lower at higher absolute incomes (not shown).

Table 2 displays the results of linear fixed-effects panel models examining associations between income and parents' log-transformed psychological distress, expressed as exponentiated coefficients. Kessler scores have been log transformed, so exponentiated coefficients are reported to show the estimated change in Kessler scores following a one-unit increase in income (from being the lowest- to the highest-income parent). Dividing each exponentiated coefficient by 100 therefore captures the influence of a percentage point increase in income. Exponentiated values lower than one indicate lower Kessler scores among higher-income parents. Higher incomes were associated with significantly lower psychological distress: a one percentage point increase in absolute income (approximately £11.48 per week) was associated with 0.356 per cent lower Kessler scores (Model 1), while a one percentage point increase in income rank was associated with 0.077 per cent lower Kessler scores (Model 2). A nonlinear effect of absolute income was evident and model fit improved significantly (Model 3). Nonlinear effects of income rank (Model 4) were nonsignificant and model fit was unchanged.

When including both absolute income and income rank (Model 5), income rank remained significantly associated with Kessler scores and AIC figures indicated improved model fit over models containing main and non-linear effects of income. The coefficient for income rank became positive after controlling for absolute income, suggesting that increasing income status was surprisingly associated with higher psychological distress.

Finally, significant interactions between absolute income and income rank (Model 6) demonstrated that the positive effect of income rank was stronger at higher absolute incomes. AIC values indicated that Model 6 was the best fitting model. Figure 1 illustrates this interaction between absolute income and income rank. Parents with the lowest absolute incomes had the highest Kessler scores, regardless of their income rank. As absolute incomes increased, Kessler scores became more clearly associated with rank. At the highest absolute incomes, Kessler scores were significantly lower in high- than low-ranking parents. The

vertical columns in Table 3 show the mean predicted Kessler scores by absolute income for low-, middle- and high-ranking parents. Among low-ranking parents, increasing absolute incomes conferred a 63.48 per cent reduction in predicted Kessler scores from the lowest to the highest-income parents (6.55 to 2.39). This effect was stronger for high-ranking parents, whose predicted Kessler scores decreased by 69.76 per cent from the lowest to the highest-income parents (6.55 to 1.98). Equivalently, the horizontal rows show the mean predicted Kessler scores for low-, middle-, and high-ranking parents at different levels of absolute income. At the lowest absolute incomes, predicted Kessler scores were equal across rank groups (6.55). At the highest absolute incomes, predicted Kessler scores decreased by 17.19 per cent from low-ranking to high-ranking parents (2.39 to 1.98). Both absolute income and income rank therefore related to psychological distress, but the substantive effects of absolute income outweighed those of income rank.

We conducted a series of sensitivity analyses to confirm the robustness of our results. First, all analyses were repeated in which income rank was defined within comparison groups of (a) countries (England, Scotland, Wales, Northern Ireland); and (b) the UK. All results were replicated using both comparison groups (Online Resource 1). This replication demonstrates that our results are not sensitive to a specific geographical comparison group, and that absolute income could not be interpreted as a national-level measure of income status. Second, we estimated all models using logistic fixed-effects panel models where Kessler scores above 12 denote clinically significant psychological distress [56], and all results were replicated (Online Resource 2). Third, the interaction reported in Model 6 could reflect non-linear effects of the income variables, not true interactions between absolute income and income rank. The interaction was robust after including non-linear income variables, confirming the strength of the interaction between absolute income and income rank on psychological distress (Online Resource 3). Fourth, log-transforming the Kessler scores can result in graphical plots that diverge and might produce spurious interactions. The interactions in Figure 1 were replicated using untransformed Kessler scores, confirming their validity (Online Resource 4). Collectively these analyses confirm and strengthen our main result that parents' psychological distress was best predicted by an interaction between parents' absolute incomes and their regional income rank.

4. Discussion

In this study we examined longitudinal associations between income and psychological distress in parents of young children. Our first research question explored whether parents' income status is associated with psychological distress. Our first hypothesis was supported: psychological distress was lower in parents with higher income status, even after accounting for the role of absolute income. Our second research question examined the possibility that absolute income interacts with income status to influence parents' psychological distress. Our second hypothesis, that psychological distress would be more closely associated with income status at higher absolute incomes, was supported: at lower absolute incomes, psychological distress was not associated with parents' income status, while at higher absolute incomes, psychological distress was lower in higher-status parents.

4.1 Theoretical implications

Our results contribute to debates over the relevance of material or psychosocial factors to the negative association between income and psychological distress by demonstrating that both material and psychosocial factors are associated with psychological distress. Among the lowest-income parents, psychological distress was clearly associated with absolute income but not income rank, suggesting that psychosocial factors are not strongly relevant to psychological distress at low incomes. In contrast, higher income rank was associated with lower psychological distress for parents with the highest incomes.

The importance of income rank to psychological distress only at the highest incomes replicates evidence from children which found that higher household income rank was associated with lower behavioural problems only in children living in the highest-income households [48]. Differences in income status – implicating psychosocial pathways – therefore appeared to be more salient to higher-income parents, reinforcing evidence that both status seeking and preferences for higher-ranking over higher absolute incomes are greater at higher incomes [47, 59].

We used fixed-effects panel models, which provide the most rigorous means of examining income rank and psychological distress using survey data, so our results provide a stronger test of the role of income status than past research. Nonetheless, our results broadly corroborate previous research reporting lower psychological distress in higher-ranking adults [42–44]. Our findings conversely contrast with cross-sectional evidence that adolescents' affluence status (based on ownership of material goods) was more strongly associated with psychosomatic symptoms in less affluent adolescents [49]. This discrepancy probably reflects methodological and age differences that preclude direct comparisons between studies.

1 The greater importance of income status to higher-income parents is also consistent with
2 reports of high levels of anxiety and depression in advantaged adolescents, which might
3 reflect over-emphasis on the values of status, wealth and success [60, 61]. Conversely, the
4 comparative unimportance of rank effects on psychological distress among lower-income
5 parents is consistent with evidence that poverty focuses people on their immediate material
6 needs and can diminish cognitive function [62–64]. This mechanism is not well understood,
7 so our observation that psychosocial factors were important to psychological distress only
8 among higher-income parents adds insight to this possibility.

10 **4.2 Policy implications**

11 Two key policy implications follow from our results. The first is the importance of addressing
12 low absolute incomes, as psychological distress was progressively lower at higher absolute
13 incomes, independent of income status. Families with children typically have lower incomes
14 than those without children, potentially placing them at risk from material disadvantage and
15 psychological distress. Incomes should therefore be increased where possible. Second, the
16 association between income rank and psychological distress in higher-income parents
17 suggests that the psychosocial consequences of social status in higher-income groups deserve
18 recognition. Therapeutic interventions should attempt to reduce both the tendency to make
19 social comparisons and the value placed on social comparisons [65, 66] to reduce the negative
20 impact of low rank on psychological distress among higher-income people.

22 **4.3 Strengths and limitations**

23 Our study's main strength is its longitudinal design and fixed-effects panel analyses. We
24 examined the effects of income on psychological distress after controlling for both measured
25 and unmeasured characteristics, allowing a direct examination of the impact of income on
26 psychological distress. Past studies of income rank have used less stringent methods, so our
27 work provides the most rigorous examination of rank theory. The large MCS population also
28 confers the statistical power required to explore previously untapped interactions between
29 absolute income and income status.

31 Our study's main limitation is the reliance on self-reported psychological distress, which
32 could be artificially inflated by negative affectivity in distressed parents. Nonetheless, the
33 Kessler scale performs well in general populations [54, 56] and income rank relates to both
34 self-reported and clinically-measured physical health outcomes [45, 46], suggesting that
35 associations between income rank and psychological distress are not due to negative
36 affectivity in low-ranking parents.

Income rank was defined using regional comparison groups. Our aims were not to examine different comparison groups, and the appropriate specification of comparison groups is an important area for future research. However, people with similar characteristics tend to group geographically, locality defines group membership in non-human species [67], and regional income comparisons are relevant to psychological distress [42, 44]. Furthermore, a recent comparison of reference groups found that relative income was more closely associated with adults' self-rated health and allostatic load when calculated within regions than other comparison groups [46]. Nonetheless, a review of comparison groups found that income inequality is more strongly associated with health outcomes when defined at a larger geographic scale [68]. To explore this possibility we replicated all analyses, defining income rank within (a) countries, and (b) the UK. Unlike past research [68], all results were replicated and the size of coefficients in all models were extremely similar across the three comparison groups, demonstrating the suitability of regional reference groups and confirming that our results are not confined to regional income comparisons (Online Resource 1). These contrasting results may reflect differences in the outcomes examined, as the current analyses explored psychological distress while evidence for stronger associations between nationally defined income inequality and health outcomes considered both mental and physical health. The characteristics of social comparisons thought to underpin our results might operate differently for mental and physical health outcomes, a possibility that merits further research attention.

We controlled for changes in employment and marital status over time as these life events may confound or mediate the associations between income and psychological distress. Future research should examine the relevance of absolute income and income status to psychological distress following a broader range of life events, including bereavement and serious illness.

4.4 Conclusions

In this study we undertook the first exploration of rank theory in parents. Using fixed-effects panel models, higher absolute incomes were associated with lower psychological distress, while higher income rank was associated with lower psychological distress only among higher-income parents. Both income-related material and psychosocial factors are therefore relevant to psychological distress, but psychosocial factors are more relevant to advantaged parents. Consequently, policy and therapeutic interventions aimed at supporting parents with young children should consider both the material and psychosocial impacts of income on psychological distress.

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Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Table Captions

Table 1 displays descriptive statistics of the predictor variables, outcome variable and all covariates at each survey wave included in the analyses.

Table 2 displays coefficient estimates, standard errors and measures of model fit for linear fixed-effects panel models predicting parents' log-transformed Kessler scores from exponentiated coefficients of absolute income, income rank, non-linear income terms, and interactions between absolute income and income rank. All models are fully adjusted for covariates.

Table 3 displays mean predicted Kessler scores by interactions between absolute income and income rank.

Figure Captions

Fig 1 Displays marginal effects of the interaction between absolute income and regional income rank tertile on parents' predicted log-transformed Kessler scores. The point estimates represent these marginal effects at each decile of the absolute income distribution for parents whose regional income rank was defined as low, medium or high. 95 % confidence intervals are displayed to show the uncertainty surrounding each point estimate.

6. Tables

Table 1 Descriptive statistics of parents' characteristics at waves 2-5 of the MCS

		Wave 2 (2003)		Wave 3 (2006)		Wave 4 (2008)		Wave 5 (2012)	
		<i>n</i> =27,564		<i>n</i> =26,683		<i>n</i> =24,156		<i>n</i> =21,590	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<i>Income</i>	Median absolute income (£/week)		300.40		325.88		356.19		526.68
	Median rank position		0.53		0.54		0.54		0.53
	<i>Missing</i>	306	1.11	206	0.77	357	1.48	0	0.00
<i>Region</i>	Mean number of parents		2,297		2,224		2,013		1,799
	Range		804-3,954		754-3,783		693-3,429		607-3,015
	<i>Missing</i>	3	0.01	2	0.01	4	0.02	11	0.05
<i>Kessler score</i>	Mean		3.10		3.06		3.04		3.96
	Range		0-24		0-24		0-24		0-24
	<i>Missing</i>	6,122	22.21	3,683	13.80	3,466	14.35	1,718	7.95
<i>Age</i>	Mean (years)		33.36		35.33		37.41		41.23
	Range		14-72		16-77		17-75		18-79
	<i>Missing</i>	52	0.19	3	0.01	3	0.01	0	0.00
<i>Sex</i>	Male	12,505	45.36	11,875	44.50	10,691	44.25	8,826	40.86
	Female	15,062	54.64	14,810	55.50	13,469	55.75	12,775	59.14
	<i>Missing</i>	0	0.00	0	0.00	0	0.00	0	0.00
<i>Disability status</i>	Yes	5,627	20.41	6,069	22.74	5,585	23.12	4,058	18.79
	No	20,595	74.71	19,407	72.73	17,415	72.08	17,419	80.64
	<i>Missing</i>	1,345	4.88	1,209	4.53	1,160	4.80	124	0.057
<i>Education</i>	University	9,347	33.91	9,564	35.84	9,277	38.40	9,199	42.59
	College	4,064	14.74	3,957	14.83	3,668	15.18	3,303	15.29
	School	9,713	35.23	9,094	34.08	7,895	32.68	6,631	30.70
	No qualifications	3,840	13.93	3,603	13.50	2,978	12.33	2,288	10.59
	<i>Missing</i>	603	2.19	467	13.50	342	1.42	180	0.83
<i>Working status</i>	In work	18,965	68.80	19,030	71.30	18,043	74.68	16,397	75.91
	Not in work	8,600	31.20	7,653	23.68	6,116	25.31	5,204	24.09
	<i>Missing</i>	2	0.01	2	0.01	1	0.00	0	0.00
<i>Housing tenure</i>	Owner	18,889	68.92	18,442	69.11	17,060	70.61	14,794	68.49
	Private renter	1,789	6.49	1,929	7.23	1,796	7.43	2,136	9.89
	Social renter	5,888	21.36	5,520	20.69	4,680	19.37	3,938	18.23
	Other	972	3.53	732	2.74	565	2.34	399	1.85
	<i>Missing</i>	29	0.11	62	0.23	59	0.24	334	1.55
<i>Marital status</i>	Married	18,876	68.47	18,136	67.96	16,346	67.66	14,420	66.76
	Cohabiting	5,646	20.48	5,794	21.71	5,187	21.47	4,321	20.00
	Single	1,641	5.95	1,766	6.62	1,487	6.15	1,276	5.91
	Divorced, separated or widowed	644	2.34	986	3.69	1,129	4.67	1,574	7.29
	<i>Missing</i>	760	2.76	3	0.01	11	0.05	10	0.05
<i>Total cases</i>		<i>n</i> =27,564							
<i>Useable cases</i>		20,619	74.81	22,809	85.48	20,348	84.24	19,619	90.87

The large age range reflects the fact that not all parental figures are the child's natural parent.

Table 2 Linear fixed-effects panel regression analyses of parents' log-transformed Kessler scores predicted by exponentiated coefficients of absolute income and income rank and non-linear income terms, adjusted for covariates ($n=83,394$)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Fixed effects (exponentiated coefficients, se)</i>						
Absolute income	0.644*** (0.019)		0.944 (0.120)		0.366*** (0.019)	0.365*** (0.019)
Income rank		0.923*** (0.015)		0.966 (0.050)	1.496*** (0.044)	1.845*** (0.077)
<i>Non-linear terms (exponentiated coefficients, se)</i>						
Absolute income squared			0.729** (0.072)			
Income rank squared				0.957 (0.044)		
<i>Interaction effects (exponentiated coefficients, se)</i>						
Absolute income X Middle rank						0.901*** (0.018)
Absolute income X High rank						0.828*** (0.024)
<i>Goodness-of-fit</i>						
AIC	102,282	102,649	102,265	102,649	101,957	101,879

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

AIC = Akaike's Information Criterion

All regressions contained controls of age, sex, disability status, housing tenure, marital status, education and working status.

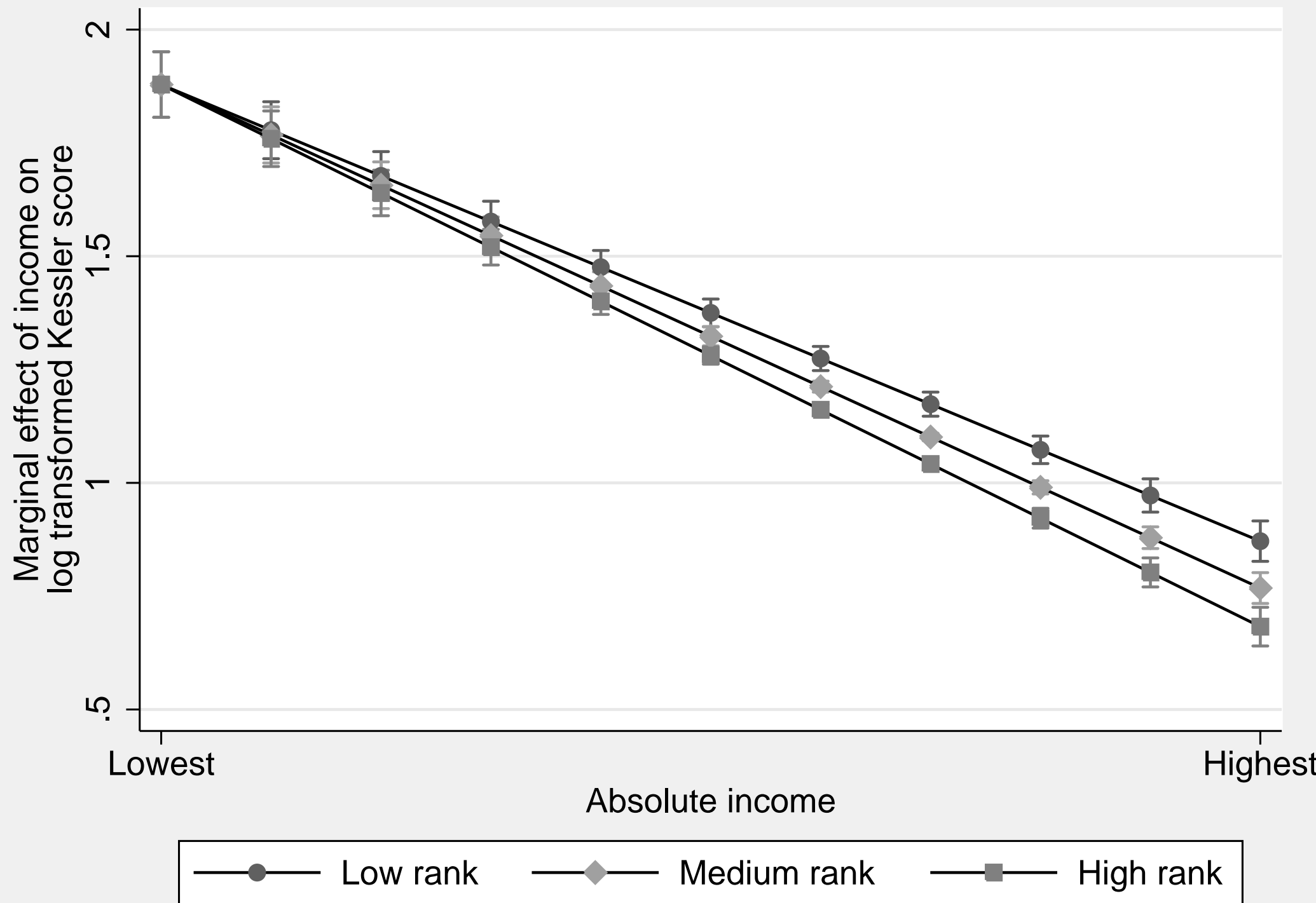
Table 3 Mean predicted Kessler scores by interactions between absolute income and income rank (Model 6)

Income quintile	Mean equivilised weekly income	Predicted Kessler score			Percentage reduction in Kessler scores between low- and high-ranking parents (%)
		Low rank	Middle rank	High rank	
Lowest incomes	£12.86	6.55	6.55	6.55	0.00
20 th percentile	£100.84	5.35	5.24	5.15	3.70
40 th percentile	£202.97	4.37	4.20	4.06	7.27
60 th percentile	£285.58	3.58	3.36	3.19	10.70
80 th percentile	£555.55	2.92	2.69	2.51	14.00
Highest incomes	£1,146.74	2.39	2.16	1.98	17.19
Percentage reduction in Kessler scores between parents with low and high absolute incomes (%)		63.48	67.07	69.76	

Figure 1 Slope of the marginal effects of interactions between absolute income and income rank on parents' log-transformed Kessler scores

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Figure



Supplementary material for manuscript “*The Interactive Role of Income (material position) and Income Rank (psychosocial position) in Psychological Distress: A 9-year Longitudinal Study of 30,000 UK Parents*”. Social Psychiatry and Psychiatric Epidemiology. Elisabeth A. Garratt¹, Tarani Chandola, Kingsley Purdam, Alex M. Wood.

Online Resource 1

This supplementary material replicates all analyses included in the manuscript, defining income rank and distance from the mean using comparison groups defined by (a) countries (England, Scotland, Wales, Northern Ireland); and (b) the UK. This was only possible for parents living in England because Wales, Scotland, Northern Ireland are defined as regions and not subdivided any further, so their comparison groups are the same for region, country, and the UK.

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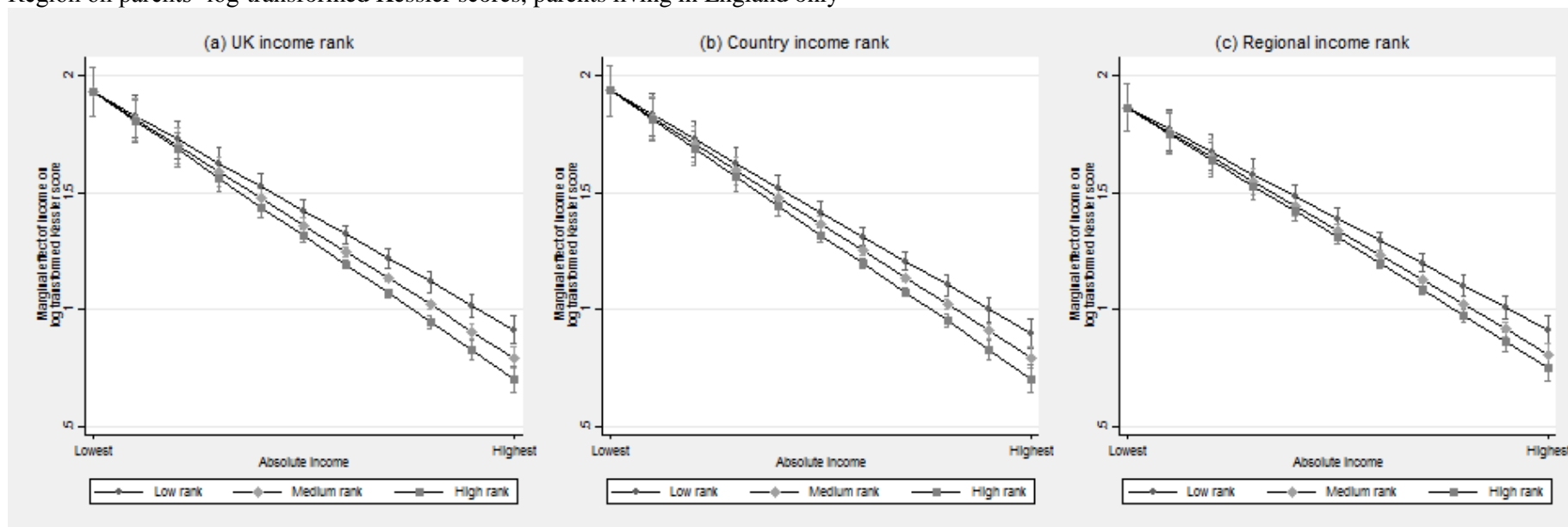
Table 1 Linear fixed-effects panel regression analyses of parents' log-transformed Kessler scores predicted by exponentiated coefficients of absolute income, income rank, non-linear income terms and income interactions, adjusted for covariates, using country comparison groups, England only ($n=47,731$)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Fixed effects (exponentiated coefficients, se)</i>						
Absolute income	0.653*** (0.026)		1.102 (0.186)		0.357*** (0.027)	0.355*** (0.027)
Country income rank		0.905** (0.022)		0.969 (0.072)	1.550*** (0.069)	1.938*** (0.118)
<i>Non-linear terms (exponentiated coefficients, se)</i>						
Absolute income squared			0.654*** (0.084)			
Country income rank squared				0.942 (0.060)		
<i>Interaction effects (exponentiated coefficients, se)</i>						
Absolute income X Country middle rank						0.900*** (0.027)
Absolute income X Country high rank						0.822*** (0.033)
<i>Goodness-of-fit</i>						
AIC	56,432	56,617	56,433	56,639	56,277	56,231

Table 2 Linear fixed-effects panel regression analyses of parents' log-transformed Kessler scores predicted by exponentiated coefficients of absolute income, income rank, non-linear income terms and income interactions, adjusted for covariates, using UK comparison groups, England only ($n=47,731$)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Fixed effects (exponentiated coefficients, se)</i>						
Absolute income	0.653*** (0.026)		1.102 (0.186)		0.365*** (0.027)	0.364*** (0.027)
Country income rank		0.905** (0.021)		0.951 (0.070)	1.515*** (0.066)	1.929*** (0.117)
<i>Non-linear terms (exponentiated coefficients, se)</i>						
Absolute income squared			0.654*** (0.084)			
UK income rank squared				0.959 (0.061)		
<i>Interaction effects (exponentiated coefficients, se)</i>						
Absolute income X UK middle rank						0.883*** (0.026)
Absolute income X UK high rank						0.806*** (0.032)
<i>Goodness-of-fit</i>						
AIC	56,432	56,616	56,433	56,639	56,285	56,233

Figure 1 Slope of the marginal effects of interactions between absolute income and income rank defined within comparison groups of (a) UK (b) Country (c) Region on parents' log-transformed Kessler scores, parents living in England only



Supplementary material for manuscript “*The Interactive Role of Income (material position) and Income Rank (psychosocial position) in Psychological Distress: A 9-year Longitudinal Study of 30,000 UK Parents*”. Social Psychiatry and Psychiatric Epidemiology. Elisabeth A. Garratt¹, Tarani Chandola, Kingsley Purdam, Alex M. Wood.

Online Resource 2

This supplementary material replicates all analyses included in the manuscript using logistic fixed-effects panel models using standard cut-offs, where Kessler scores above 12 denoted serious psychological distress [56]. These models are not entirely equivalent to the models reported in them manuscript because logistic fixed-effects panel models are unable to correct for clustering for parents within families, so standard errors may be slightly overestimated. Additionally, because fixed-effects panel models retain only cases that change over time, a large proportion of cases are excluded when estimating a binary measure of psychological distress. This serves to decrease the sample size and reduce statistical power, which could account for the small differences in the coefficient estimates.

Table 1 Logistic fixed-effects panel regression analyses of parents’ log-transformed Kessler scores predicted by exponentiated coefficients of absolute income, income rank, non-linear income terms and income interactions, adjusted for covariates (n=5,693)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Fixed effects (exponentiated coefficients, se)</i>						
Absolute income	0.429** (0.127)		0.952 (1.128)		0.224** (0.108)	0.190*** (0.093)
Income rank		0.787 (0.160)		0.603 (0.300)	1.757 (0.576)	3.729* (1.831)
<i>Non-linear terms (exponentiated coefficients, se)</i>						
Absolute income squared			0.463 (0.513)			
Income rank squared				1.376 (0.748)		
<i>Interaction effects (exponentiated coefficients, se)</i>						
Absolute income X middle rank						0.684 (0.148)
Absolute income X high rank						0.513* (0.168)
<i>Goodness-of-fit</i>						
AIC	3,871	3,878	3,873	3,880	3,870	3,871

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Online Resource 3

This supplementary material replicates Model 6 with additional controls for non-linear income variables.

Table 1 Linear fixed-effects panel regression analyses of parents’ log transformed Kessler scores predicted by exponentiated coefficients of interactions between absolute income and income status, adjusted for covariates and non-linear income terms ($n=83,394$)

Model 6		
	With absolute income squared	With income rank squared
<i>Fixed effects (exponentiated coefficients, se)</i>		
Absolute income	0.823 (0.111)	0.351*** (0.019)
Income rank	1.868*** (0.078)	2.472*** (0.185)
<i>Interaction effects (exponentiated coefficients, se)</i>		
Absolute income X Middle rank	0.916*** (0.019)	0.878*** (0.019)
Absolute income X High rank	0.873*** (0.025)	0.838*** (0.024)
<i>Non-linear income terms (exponentiated coefficients, se)</i>		
Absolute income squared	0.470*** (0.051)	
Income rank squared		0.753*** (0.042)
<i>Goodness-of-fit</i>		
AIC	101,780	101,840

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

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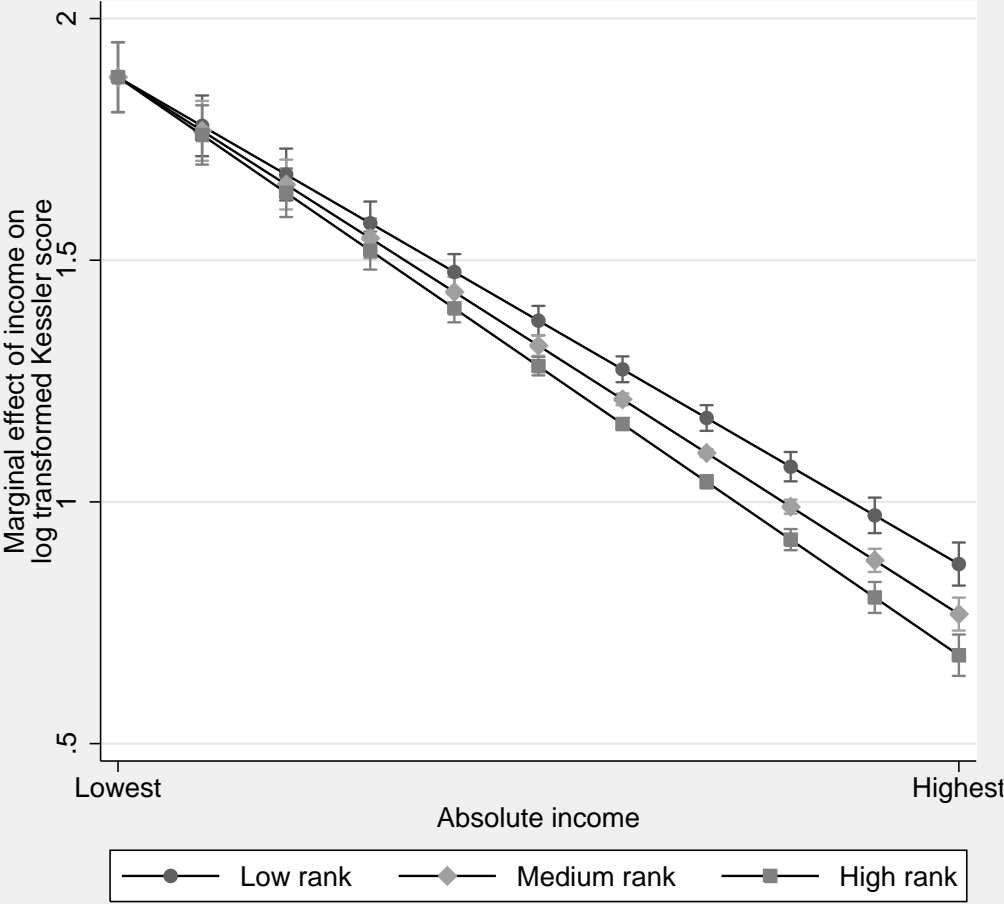
Online Resource 4

This supplementary shows the interaction terms included in Model 6 using log-transformed and untransformed Kessler scores to explore the possibility that log-transforming the Kessler scores can result in plots that diverge and might produce spurious interactions.

Figure 1 Slope of the marginal effects of interactions between absolute income and income rank on parents’ (a) Log-transformed (b) Untransformed Kessler scores

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(a) Log-transformed Kessler scores



(b) Untransformed Kessler scores

