

**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, and families with children also have lower average household incomes. Past research suggests that absolute income (material position) and income status (psychosocial position) influence psychological distress, but their combined effects on changes in psychological distress have not been examined. Whether absolute income interacts with income status to influence psychological distress are also key questions.

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

**Results** Psychological distress was determined by an interaction between absolute income and income rank: higher absolute income 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 determined by a combination of income-related material and psychosocial factors.

**Conclusions** Both material and psychosocial factors contribute to well-being. Higher absolute incomes were associated with lower psychological distress across the income spectrum, demonstrating the importance of material factors. Conversely, income status was associated with psychological distress only at higher absolute incomes, suggesting that psychosocial factors are more relevant to distress in more advantaged, higher-income parents. Clinical interventions could therefore consider both the material and psychosocial impacts of income on psychological distress.

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

## 1. Introduction

In the context of widening income inequality (Ortiz and Cummins, 2011) and the impact of psychological distress on health and economic outcomes (WHO, 2003; CASE, 2012), 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 (McManus *et al.*, 2009) and lower socioeconomic status (Lorant *et al.*, 2003). Whether this association primarily reflects the importance of income as indicative of material resources, 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 (Theodossiou and Zangelidis, 2009), suggesting that income-related status comparisons that induce anxiety (Layte and Whelan, 2014) and psychosocial stress (Dickerson and Kemeny, 2004) could explain the negative association between income and psychological distress. Associations between income inequality and a range of mental health outcomes further support this possibility (Pickett, James and Wilkinson, 2006; Burns, Tomita and Kapadia, 2014; Marshall *et al.*, 2014; Johnson, Wibbels and Wilkinson, 2015). These patterns might be particularly important in parents, as families with children typically have lower incomes than families without children (DWP, 2013) and parenthood confers a range of stressors (Ventura, 1987; Tausig and Fenwick, 2001). The underlying risks of psychological distress may also be amplified following the transition to parenthood (Cowan and Cowan, 1995). 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 (2010), a higher prevalence than in the general population (11 per cent (2009)). This is significant because parents' distress presents risks to their children's well-being (Luoma *et al.*, 2001; Kiernan and Huerta, 2008; Goodman *et al.*, 2011). 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 (Wagstaff and van Doorslaer, 2000). While the *distance from the mean hypothesis* states that both the number of people with higher incomes and the distance between incomes is relevant (Bjornstrom, 2011), the *income rank hypothesis* (Boyce, Brown and Moore, 2010) alternatively states that the psychological implications of people's ordinal rank position within the income distribution is important (Subramanian and Kawachi, 2004). By solely capturing income position, rank theory is a purely psychosocial measure, while distance from the mean incorporates income position with the distance between incomes,

combining both psychosocial and material elements. Despite these fundamental theoretical differences, existing research has typically not distinguished rank or average-based comparisons, leaving unanswered the questions of how status comparisons are made and why their psychological burden is so strong.

The income rank hypothesis is founded on evolutionary psychology and cognitive science. In primates, rank-based social comparisons cause social defeat among low-ranking group members. Consequently, adaptive appeasement behaviors termed *Involuntary Defeat Syndrome* (IDS) developed in low-ranking animals to signal the absence of threat and discourage physical aggression from higher-ranking animals (Taylor *et al.*, 2011). In humans, income-based status comparisons replicate the rank-based comparisons that determine status in non-human primates. Although the IDS response promoted peaceful relations in our group-living past (Price, Gardner and Erickson, 2004), in contemporary societies the IDS response carries maladaptive consequences. Experiences of defeat are associated with affective disorders in humans (Siddaway *et al.*, 2015) and non-human primates (Shively, Laber-Laird and Anton, 2000), further suggesting that psychological distress among lower-income people results from rank-based status comparisons that instigate feelings of inferiority and defeat. These risks reflect the stress entailed by social comparisons, particularly for people with lower objective (Cohen, Doyle and Baum, 2006; Li *et al.*, 2007) and subjective status (Adler *et al.*, 2000), and in low-status non-human primates (Sapolsky, 1982; Gesquiere *et al.*, 2011), suggesting a pathway from social rank to psychological distress.

The income rank hypothesis is reinforced by research in cognitive science. When people make relative judgments (for example, their income position in relation to others') it is theorised that they first visualise a distribution of stimuli (others' incomes) from memory, then sequentially compare their own position (their own income) with each of these stimuli, remembering the number of stimuli higher than their own, capturing the person's ranked status position. This process evaluates social position directly and is less cognitively demanding than calculating distance from the average person. Evidence for the rank model is reported across diverse judgments including those relating to pain (Watkinson *et al.*, 2013), gratitude (Wood, Brown and Maltby, 2011), personality (Wood, Brown, *et al.*, 2012), mental health symptoms (Melrose, Brown and Wood, 2013) and information-seeking (Taylor *et al.*, 2015), suggesting that sensitivity to social rank represents a general cognitive capacity.

A growing body of evidence reports that low rank is associated with higher psychological distress (Wood, Boyce, *et al.*, 2012) and depressive symptoms (Hounkpatin *et al.*, 2015) and a higher likelihood of suicidal thoughts and suicide attempts (Wetherall *et al.*, 2015),

independent of absolute income. Moreover, associations between income rank and allostatic load strengthen the pathway between rank, stress and psychological distress, strongly suggesting that income rank relates to health (Daly, Boyce and Wood, 2015). These studies do however have methodological limitations: suicidal thoughts and attempts were restricted to cross-sectional analyses (Wetherall *et al.*, 2015) and the longitudinal analyses (Wood, Boyce, *et al.*, 2012; Hounkpatin *et al.*, 2015) did not control for unobserved variance, introducing the possibility that unobserved variance influenced their results. In the current study, examining the comparative strength of income rank and distance from the mean determines whether people are more sensitive to income rank – implicating an evolutionary explanation for the negative association between income and psychological distress – or whether the magnitude of income differences (distance from the mean) is more relevant to psychological distress.

Furthermore, the possibility that absolute income interacts with income status to influence psychological distress has not been explored. Income status may be more closely associated with psychological distress at either lower incomes (because income status might 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). Related evidence is inconclusive: both the tendency to make income comparisons (Präg, Mills and Wittek, 2013) and the importance of income comparisons (Clark and Senik, 2010) are greater in lower-income people, while preferences for higher relative than absolute incomes were stronger in higher-income people (Mujcic and Frijters, 2013).

### **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, and psychological distress would be more closely associated with income rank than distance from the mean; (2) absolute income and income rank would interact to influence psychological distress: at lower absolute incomes, lower-ranking parents would have higher psychological distress than higher-ranking parents, while at higher absolute incomes, psychological distress would be less closely associated with income status. If plotted graphically, the lines plotting psychological distress by absolute

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income for high- and low-ranking parents are expected to diverge at lower absolute incomes and converge at higher absolute incomes.

## 2. Methods

### 2.1 Data and participants

We used four waves of data from the Millennium Cohort Study (MCS) to examine associations between parents' income and psychological distress. The MCS is a multidisciplinary study of 19,000 UK children born in 2000-01, and we used data from 2003 to 2012. 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. 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 dataset is well suited to the study aims as it contains continuous measures of household income, psychological distress, and covariates.

We included parents with complete information on psychological distress, household income and covariates. Missing covariate data were ascribed the characteristics reported in previous waves. On average, income data was unknown or refused in 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 (Hansen *et al.*, 2014), reducing missing income data to less than two per cent at each survey wave. 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 (Plewis, 2007). 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

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 scales<sup>1</sup>. This is standard practice and approximates spending power (Wood, Boyce, *et al.*, 2012; Daly, Boyce and Wood, 2015; Wetherall *et al.*, 2015). Absolute income was log transformed to reduce skew, then normalised between 0 and 1.

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<sup>1</sup> The 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 while capturing the influence of similar others who form the majority of social interactions. Their relevance to psychological distress has previously been confirmed (Wood, Boyce, *et al.*, 2012; Wetherall *et al.*, 2015). 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 (Brown *et al.*, 2008):

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

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.

### 2.2.3 Distance from the mean

Distance from the mean (DFM)  $C_i$  captures the distance between each parent's absolute household income  $A_i$  and the mean income of their regional comparison group  $\bar{u}$ . This measure has been used previously (Clark, Masclet and Villeval, 2008; Bjornstrom, 2011; Kifle, 2013; Latif, 2015; Zou, 2015) and captures income comparisons against the 'average' group member:

$$C_i = A_i - \bar{u}$$

Incomes above the mean translate to positive values and larger income surpluses, while incomes below the mean produce negative values and greater income shortfalls. The same absolute incomes confer different values of DFM according to the regional income distribution. DFM was then normalised between 0 and 1.

### 2.2.4 Kessler scale

Parents' 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 larger scores indicate higher distress. Screening tools are well-suited for population surveys where typical levels of distress are low (Korten and Henderson, 2000). The good performance of the Kessler scale has previously been established (Kessler *et al.*, 2002, 2003; Gill *et al.*, 2007). 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, distance from the mean 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. For example, a genetic predisposition to psychological distress may be 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 different assumptions can be made about this unobserved heterogeneity: the fixed-effects assumption allows unobserved variance to be associated with the predictor variables (if genetic factors are associated with income), whereas the random-effects assumption states that unobserved variance is not associated with the predictor variables (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 between parents may be associated with their incomes. Formal empirical comparison of the two specifications using the Hausman test confirmed this decision (available on request). 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, and working status) were controlled at each wave to account for these changes, 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 in the sample over time. No existing research examining income rank and mental health outcomes used fixed-effects panel models (Wood, Boyce, *et al.*, 2012; Hounkpatin *et al.*, 2015; Wetherall *et al.*, 2015), so the current study uses more rigorous methods.

We used linear models to utilise the full range of Kessler scores. Count models are unsuitable as they ignore detail capturing the severity of symptoms. Logistic models examining cases and non-cases of serious psychological distress are also unsuitable because fixed-effects panel models only examine observations where the explanatory or outcome variables change over time. For logistic models this removes a large proportion of observations, dramatically reducing statistical power and compromising analyses.

Models were specified to predict psychological distress from a constant term, fixed effects of absolute income, distance from the mean, income rank, and covariates. All models adjusted for the sampling design, clustering of parents within families and covariates. We normalised each income variable between 0 and 1, which makes no difference to the distribution of values, the size of coefficients, or standard errors but gives each income variable the same interpretation, making comparisons clearer. Fixed-effects panel models assume that residuals are normally distributed with means of zero. Graphical inspection confirmed that these assumptions were met for all models (available on request). All analyses were undertaken using Stata 13 software (StataCorp., 2013).

### 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 each of the income variables and continuously distributed Kessler scores (Models 1-3, 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 the income variables. Comparing goodness-of-fit tests captures the unique characteristic of each income variable to identify which income variable is most strongly associated with psychological distress. Because the income variables are correlated, we undertook a detailed examination of multicollinearity that demonstrates that multicollinearity does not present a problem to the analyses undertaken in this study (available on request). As a robustness check, we then considered whether non-linear (squared) income variables fit the data better (Models 4-6, Table 2).

We next examined (a) distance from the mean and (b) income rank, controlling for absolute income (Models 7-8, Table 3). This captured the unique associations between psychological distress and distance from the mean and income rank, independent of absolute income. This strategy first identified the income variable that was most strongly associated with psychological distress, then confirmed that this association did not reflect shared variance

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with absolute income. To examine our second research question we explored interactions between absolute income and (a) distance from the mean and (b) income rank (Models 9-10, Table 3). These interaction terms were examined to determine whether income status was more strongly associated with psychological distress at lower or higher absolute incomes.

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 (Spiegelhalter *et al.*, 2002). 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. Kessler scores and distance from the mean 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. As the survey progressed, a greater proportion of parents had university- or college-level qualifications, were married or cohabiting, female, owned their home, had no disability and were in work. At each survey wave, Kessler scores were progressively 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), a one percentage point increase in distance from the mean (approximately £11.61) was associated with 0.079 per cent lower Kessler scores (Model 2), and a one percentage point increase in income rank was associated with 0.077 per cent lower Kessler scores (Model 3). A nonlinear effect of absolute income was evident and model fit improved significantly (Model 4). Nonlinear effects of distance from the mean (Model 5) and income rank (Model 6) were nonsignificant and model fit was unchanged.

Table 3 displays the results of linear fixed-effects panel models examining the joint influence of absolute income and income status on parents' log-transformed Kessler scores. Both distance from the mean (Model 7) and income rank (Model 8) remained significantly associated with Kessler scores and AIC figures indicated improved model fit over models containing main effects and non-linear effects of income. Psychological distress was more strongly associated with income rank (Model 8) than distance from the mean (Model 7). The coefficients for distance from the mean and income rank became positive after controlling for absolute income, suggesting that increasing income status was surprisingly associated with higher psychological distress.

We next examined interactions between absolute income and income status. The influence of distance from the regional mean income on Kessler scores did not vary clearly by absolute income (Model 9). Significant interactions between absolute income and income rank (Model 10) demonstrated that the positive effect of income rank was stronger at higher absolute incomes. AIC values indicated that Model 10 was the best fitting model.

Figure 1 illustrates the interactions 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 4 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 (available on request). First, we estimated all models using logistic fixed-effects panel models where Kessler scores above 12 denoted serious psychological distress (Kessler *et al.*, 2003). All results were replicated for clinically significant psychological distress. Second, the interactions reported in Model 10 could reflect non-linear effects of the income variables, not true interactions between absolute income and income rank. Exploring this possibility, this interaction was robust after including non-linear income variables, confirming the strength of the interaction between absolute income and income rank on psychological distress. Finally, log-transforming the Kessler scores can result in plots that diverge and might produce spurious interactions. The interactions in Figure 1 were replicated using log-transformed and untransformed Kessler scores, confirming their validity. Collectively these analyses support 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 considered whether parents' income status is associated with psychological distress. Our first hypothesis was partially supported: higher income rank was associated with lower psychological distress, but only in high-income parents. This suggests that – consistent with rank theory – higher psychological distress could reflect the impact of psychosocial status comparisons that prompt feelings of inferiority and defeat. Our second research question considered whether 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 lower absolute incomes, was not supported. Instead, psychological distress was not associated with parents' income rank at lower absolute incomes, while at higher absolute incomes, higher-ranking parents had lower psychological distress than lower-ranking parents.

##### 4.1 Theoretical implications

Our results contribute to debates over whether the negative association between income and psychological distress reflects material or psychosocial factors by demonstrating that both material and psychosocial factors are associated with psychological distress. At the lowest incomes, psychological distress was clearly associated with absolute income but was not associated with income rank, suggesting that psychosocial factors are not strongly relevant to psychological distress in low-income parents. In contrast, at the highest incomes, higher income rank was associated with lower psychological distress. Material and psychosocial factors therefore appear to play different roles in determining parents' well-being.

The relevance of income rank to parents' psychological distress broadly corroborates previous research reporting lower psychological distress in higher-ranking adults (Wood, Boyce, *et al.*, 2012; Hounkpatin *et al.*, 2015; Wetherall *et al.*, 2015). Moreover, replication using binary measures of serious psychological distress reinforces the clinical significance of our results. While in its simplest form, rank theory states that higher status is associated with lower psychological distress, we found that higher rank was associated with distress only among high-income parents. As we used fixed-effects panel models, which provide the most rigorous means of examining income rank and well-being using survey data, our results are more robust than those reported in previous research.

Differences in income status – implicating psychosocial pathways – therefore appeared to be more salient to higher-income parents, reinforcing evidence that both status seeking (Paskov,

Gërkhani and van de Werfhorst, 2013) and preferences for higher-ranking over higher absolute incomes are greater in higher-income groups (Mujcic and Frijters, 2013). Our results 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 (Elgar *et al.*, 2013). This discrepancy probably reflects methodological differences that preclude direct comparisons between studies.

The greater importance of income status to higher-income parents is consistent with evidence for high levels of anxiety and depression in advantaged adolescents, which might reflect an over-emphasis on the value of status, wealth and success (Luthar and Becker, 2002; Luthar, 2003). Our results also relate to claims made in the income inequality hypothesis that higher income inequality is harmful to all people, not just lower-income groups (Wilkinson and Pickett, 2009), which has been widely challenged. Empirical investigation is largely absent, so our observation that income rank was only associated with parents' psychological distress at higher absolute incomes provides initial evidence that the income distribution is relevant to distress in higher-income groups.

### **4.2 Policy implications**

Two key policy implications emerge from our results. The first is the importance of addressing low absolute incomes, as psychological distress was progressively lower at higher incomes, independent of rank. Families with children typically have lower incomes than those without children (DWP, 2013), placing them at risk from material disadvantages, with potential consequences for parents' psychological distress. Incomes should therefore be increased where possible. Second, the association between income rank and psychological distress in higher-income parents suggests that the psychosocial consequences of social status in higher-income groups should be considered. Therapeutic interventions should focus on reducing both the tendency to make social comparisons and the value placed on social comparisons to reduce the negative impact of low rank on psychological distress among higher-income people.

### **4.3 Strengths and limitations**

The main strength of this study is its longitudinal design and fixed-effects panel analyses. We examined the effects of income on psychological distress after controlling for both measured and unmeasured characteristics, allowing a clear examination of the impact of income on psychological distress. Past studies of income rank have used less stringent methods (Wood, Boyce, *et al.*, 2012; Hounkpatin *et al.*, 2015; Wetherall *et al.*, 2015), so this work provides the

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most rigorous examination of rank theory. The large MCS population also confers the statistical power required to explore previously unexamined interactions between absolute income and income status.

This study's main limitation is the reliance on self-reported psychological distress, which could be artificially inflated by negative affectivity in distressed parents. Nonetheless, the Kessler scale performs well in general populations (Kessler *et al.*, 2003; Gill *et al.*, 2007) and income rank relates to both self-reported and clinically-measured physical health outcomes (Daly, Boyce and Wood, 2015), suggesting that associations between income rank and psychological distress are not due to negative affectivity in low-ranking parents.

Income rank and distance from the mean were defined using regional comparison groups. Our aims were not to examine different comparison groups, and the appropriate specification of comparison groups is an established limitation of psychosocial accounts of psychological distress. However, people with similar characteristics tend to group geographically, locality defines group membership in non-human species (Sapolsky, Alberts and Altmann, 2000), and regional income comparisons are relevant to psychological distress (Wood, Boyce, *et al.*, 2012; Wetherall *et al.*, 2015). Furthermore, all results were reported in analyses where income rank and distance from the mean were defined within countries and the UK, confirming that our results are not specific to regional income comparisons (available on request).

We controlled for changes in employment and marital status by including covariates at each survey wave 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**

This study provided the first examination 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 important among more advantaged parents. Consequently, policy interventions aimed at supporting parents with young children should consider both the material and psychosocial impacts of income on psychological distress.

**Conflicts of interest**

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

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## 6. Tables

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

|                          |  | Wave 2 (2003)<br><i>n</i> =27,564 |           | Wave 3 (2006)<br><i>n</i> =26,683 |           | Wave 4 (2008)<br><i>n</i> =24,156 |           | Wave 5 (2012)<br><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 distance from the mean (£/week) |                                   | -26.90    |                                   | -27.80    |                                   | -24.09    |                                   | -4.89     |
|                          | 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.

INCOME RANK AND PARENTS' PSYCHOLOGICAL DISTRESS

Table 2 Linear fixed-effects panel regression analyses of parents' log-transformed Kessler scores predicted by exponentiated coefficients of absolute income, distance from the mean 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***<br>(0.019) |                     |                     | 0.944<br>(0.120)   |                  |                  |
| Distance from the mean                                   |                     | 0.921***<br>(0.021) |                     |                    | 0.914<br>(0.059) |                  |
| Income rank  |                     |                     | 0.923***<br>(0.015) |                    |                  | 0.966<br>(0.050) |
| <i>Non-linear terms (exponentiated coefficients, se)</i> |                     |                     |                     |                    |                  |                  |
| Absolute income squared                                  |                     |                     |                     | 0.729**<br>(0.072) |                  |                  |
| Distance from the mean squared                           |                     |                     |                     |                    | 1.009<br>(0.065) |                  |
| Income rank squared                                      |                     |                     |                     |                    |                  | 0.957<br>(0.044) |
| <i>Goodness-of-fit</i>                                   |                     |                     |                     |                    |                  |                  |
| AIC  | 102,282             | 102,667             | 102,649             | 102,265            | 102,669          | 102,649          |

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

AIC = Akaike's Information Criterion

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

INCOME RANK AND PARENTS' PSYCHOLOGICAL DISTRESS

Table 3 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 ( $n=83,394$ )

|   | Model 7             | Model 8             | Model 9             | Model 10            |
|---|---------------------|---------------------|---------------------|---------------------|
| <i>Fixed effects (exponentiated coefficients, se)</i>       |                     |                     |                     |                     |
| Absolute income   | 0.450***<br>(0.020) | 0.366***<br>(0.019) | 0.436***<br>(0.022) | 0.365***<br>(0.019) |
| Distance from the mean                                      | 1.495***<br>(0.049) |                     | 1.528***<br>(0.056) |                     |
| Income rank   |                     | 1.496***<br>(0.044) |                     | 1.845***<br>(0.077) |
| <i>Interaction effects (exponentiated coefficients, se)</i> |                     |                     |                     |                     |
| Absolute income X<br>Middle DFM                             |                     |                     | 1.029<br>(0.018)    |                     |
| Absolute income X<br>High DFM                               |                     |                     | 1.007<br>(0.022)    |                     |
| Absolute income X<br>Middle rank                            |                     |                     |                     | 0.901***<br>(0.018) |
| Absolute income X<br>High rank                              |                     |                     |                     | 0.828***<br>(0.024) |
| <i>Goodness-of-fit</i>                                      |                     |                     |                     |                     |
| AIC   | 102,054             | 101,957             | 102,047             | 101,879             |

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

DFM = Distance from the mean AIC = Akaike's Information Criterion

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

Table 4 Mean predicted Kessler scores by interactions between absolute income and income rank (Model 10)

| Income quintile   | Mean<br>equivilised<br>weekly<br>income | Predicted Kessler score |                |           | Percentage reduction<br>in Kessler scores<br>between low- and<br>high-ranking parents<br>(%) |
|---|---|-------------------------|----------------|-----------|--|
|   |   | Low rank                | Middle<br>rank | High rank |  |
| Lowest incomes  | £12.86                                  | 6.55                    | 6.55           | 6.55      | 0.00   |
| 20 <sup>th</sup> percentile   | £100.84                                 | 5.35                    | 5.24           | 5.15      | 3.70   |
| 40 <sup>th</sup> percentile   | £202.97                                 | 4.37                    | 4.20           | 4.06      | 7.27   |
| 60 <sup>th</sup> percentile   | £285.58                                 | 3.58                    | 3.36           | 3.19      | 10.70  |
| 80 <sup>th</sup> 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

