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Family income, maternal psychological distress and child socio-emotional behaviour: Longitudinal findings from the UK Millennium Cohort Study^{☆, ☆, ☆}



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ARTICLE INFO

Keywords:

UK
Child health and development
Income gradient
Maternal psychological distress
Health inequalities

ABSTRACT

The association between low family income and socio-emotional behaviour problems in early childhood has been well-documented, and maternal psychological distress is highlighted as central in mediating this relationship. However, whether this relationship holds for older children, and the precise mechanisms by which income may influence child behaviour is unclear.

This study investigated the relationship between family income and child socio-emotional behaviour at 11 years of age, and examined the mediating role of maternal psychological distress over time using the UK Millennium Cohort Study.

The primary outcome was parent-reported behavioural problems, as captured by the Total Difficulties Score (TDS), derived from the Strengths and Difficulties Questionnaire (SDQ). Secondary outcomes were the emotional, peer-related, conduct, and hyperactivity/inattention problems subscales of the SDQ; and teacher-reported TDS. Permanent family income was the primary exposure variable; frequency of poverty up to age 11 years was the secondary exposure variable. Maternal psychological distress was operationalised to reflect the trajectory from child birth to age 11. Multivariable logistic regression models were used to estimate the effect of permanent family income on child behaviour at age 11, controlling for maternal psychological distress and other relevant covariates.

Results showed a statistically significant protective effect of increased permanent family income on the likelihood of behavioural problems at age 11. This finding was consistent for all SDQ subscales apart from emotional problems, and was strongest for teacher-reported behavioural problems. Maternal distress was an important mediator in the income-child behaviour relationship for parent-reported, but not teacher-reported, behavioural problems.

The results of this study strengthen empirical evidence that the child behaviour-income gradient is maintained in older childhood. Mother's psychological distress, particularly longstanding or recurrent, appears to contribute to this relationship. These findings may validate calls for psychosocial and financial supports for families affected by parental mental health issues.

Introduction

Child health and development, and their relationship with socio-economic status, are complex and important issues spanning an array of disciplines including public health, economics, developmental psychology, and social policy. Health experienced in childhood and adolescence affects human capital accumulation, as well as health and labour market status in adulthood (Currie et al., 2008; Lundborg, Nilsson & Rooth, 2014). In the UK, stark inequalities in child physical and mental health have been linked to poverty and social disadvantage

(Social Mobility and Child Poverty Commission, 2017). However, measures to financially assist families with children have been reduced, and the government's dedicated unit to eliminate child poverty was abolished in 2016 (Social Mobility and Child Poverty Commission, 2017; Social Mobility and Child Poverty Commission, 2015; Merrick, 2017). Although studies have consistently documented poorer behavioural outcomes in children with economic deprivation, the precise mechanisms by which income affects health, and how this association may change with age, is less well-understood. Identifying the factors through which income affects both physical and mental health may

[☆] All authors report no conflicts of interest relevant to this article.

^{☆☆} This research was not funded by external funding bodies.

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provide alternative ways to improve health which complement financial contributions.

Increasing attention in recent years has been paid to child development, including behavioural outcomes, and their relationship with economic hardship. Child behavioural difficulties not only reflect impaired mental health, but they are also linked to adult outcomes, including academic attainment and employment (Najman, Aird, Bor, O'Callaghan, Williams, and Shuttlewood, 2004). Problems in child socio-emotional behaviour have been associated with poorer health and behavioural outcomes, such as: obesity; substance abuse; juvenile delinquency; and criminality (Fergusson et al., 2005). Socio-emotional development encompasses externalising behaviours, such as conduct and hyperactivity problems, and internalising behaviours, including emotional and peer problems (Goodman, Lamping, and Ploubidis, 2010). This study seeks to add to the current body of evidence by, firstly, establishing whether the observed association between family income and behaviour in early childhood is maintained in later childhood; secondly, by exploring the role of maternal mental health as a potential mediating mechanism, examining different trajectories of maternal psychological distress over time; and thirdly, building on knowledge of early childhood development, exploring the extent to which later childhood factors may shape child behaviour at age 11. In theory, the relationship may strengthen as a child becomes older, as observed by Currie and Stabile (2003). They suggested that the harmful effects of economic hardship accumulate over time, and that low income children are subject to a greater number of adverse health events than children from higher-income families. A steepening effect of family resources on socio-emotional behaviour over time has been replicated in several more recent studies, possibly reflecting a cumulative effect of economic deprivation (Condliffe & Link, 2008; Khanam, et al., 2009; Fletcher and Wolfe, 2014; Murasko, 2008; Fletcher and Wolfe, 2016). Heckman and colleagues' dynamic framework for capability formation (Conti & Heckman, 2012) suggests that capabilities (including socio-emotional skills) are self-productive, such that better capabilities in earlier years enhance development of capabilities at future ages. They also propose sensitive and critical periods, referring to ages at which parental inputs, enabled by higher family income, are more productive in improving capabilities (Conti & Heckman, 2012). It is therefore possible that socio-emotional skills at age 11 are more important than early years for long-term outcomes, for example due to the age at which children are involved in education.

The findings of this study may be relevant to policy makers regarding financial assistance for families at different stages of child development, as well as to clinicians in supporting the mental health of mothers.

Previous research

The child health-family income gradient refers to the positive association between health and wealth and its origins in childhood (Case et al., 2002), and has been the subject of a growing body of literature within the field of health economics (Propper et al., 2007; Currie, Shields & Price, 2007). It was explored in the influential studies by Case et al. (2002) and Currie and Stabile (2003) using US and Canadian data of children up to age 17, respectively.

Across the literature, it has been consistently demonstrated that children from higher income families also exhibit better behavioural outcomes, from as early as 3 years of age (Najman et al., 2004; Brooks-Gunn & Duncan, 1997; Taylor, Dearing & McCartney, 2004; Bradshaw & Holmes, 2008; Kiernan & Huerta, 2008; Korenman, Miller & Sjaastad, 1995; Kiernan & Mensah, 2009). However, the magnitude of this effect and the pathways through which it operates are less clear. Permanent income has been more strongly linked with behavioural problems than current income, (Taylor et al., 2004; Blau, 1999; Curtis, Dooley, Lipman & Feeny, 2001) and persistent financial adversity is consistently associated with childhood behavioural problems (Fletcher & Wolfe, 2016;

Brooks-Gunn & Duncan, 1997; Korenman et al., 1995; Ackerman, Brown & Izard, 2004; Holmes & Kiernan, 2013). In two recent studies using Millennium Cohort Study (MCS) data when children were aged 11 years, both persistent poverty and first transitions into poverty were strongly linked to childhood mental health problems (Fitzsimons, Goodman, Kelly & Smith, 2017; Wickham, Whitehead, Taylor-Robinson & Barr, 2017).

The mechanisms by which family income exerts an impact on child development has been investigated through both psychological and economic frameworks, namely the parental stress and parental investment theories. The parental investment theory takes a human capital approach, reflecting the ability of parents to invest resources to support their child's development, particularly with learning and cognition (Yeung, Linver & Brooks-Gunn, 2002; Duncan, Magnuson & Votruba-Drzal, 2014). The family stress theory suggests that adverse circumstances such as poverty may create a stressful home environment, which contributes to psychological distress in parents and children (Kiernan & Huerta, 2008; Holmes & Kiernan, 2013). This distress may filter into parenting practices, which tend to be punitive, inconsistent and less nurturing (Duncan et al., 2014). Studies using MCS data for children at 3 and 5 years of age have found that a significant proportion of the effect of economic deprivation on externalising behaviour was accounted for by parenting behaviours (Kiernan & Huerta, 2008; Holmes & Kiernan, 2013). Yeung et al., (2002) found that family income was associated with children's externalising behaviour primarily via maternal emotional distress and parenting practices, in US children aged 3 to 5 years. Both the parental stress and parental investment pathways were explored by Violato et al. (2011) in British children aged 3 and 5 years, finding that the direct effect of income on socio-emotional behaviour reduced substantially when parental stress and investment factors were adjusted for. An Australian study by Khanam and Nghiem (2016) found that family income was no longer significantly associated with non-cognitive development of children up to age 7 after controlling for parental stress and investment variables. A 2015 study by Akee, Simeonova, Costello, and Copeland (2015) in US adolescents found that parenting and family relationships were important potential channels through which household income influences emotional-behavioural outcomes.

The role of maternal mental health has been highlighted as central in mediating the effect of family income (Kiernan & Mensah, 2009; Violato et al., 2011; Khanam & Nghiem, 2016; Schoon, Hope, Ross & Duckworth, 2010; Washbrook et al., 2014). Persistent maternal mental health problems have been most strongly associated with child behavioural problems (Fitzsimons et al., 2017; Schoon et al., 2010; Mensah & Kiernan, 2010). While the role of maternal psychological distress is well established in the relationship between family income and early child development, there is paucity of evidence as to whether this relationship holds for older children. Furthermore, no studies explore child socio-emotional outcomes and different patterns of maternal psychological distress over time.

Methods

Data

The MCS is a longitudinal cohort study of 18,818 children born in the UK between September 2000 and January 2002 (Hansen, 2014). It is a multidisciplinary survey developed to capture the effects of social, economic and health advantages and disadvantages on childhood development and other outcomes (Hansen, 2014). There have been six surveys to date, the first collected when the children were around 9 months of age, followed by surveys at ages 3, 5, 7, 11 and 14. At the time this study was conducted (2016) only the first five surveys were available. There were 13,287 children remaining in the study at the end of the fifth survey (Hansen, 2014). The MCS oversampled from areas with higher levels of poverty, as well as higher proportions of ethnic

minority groups (Hansen, 2014). At each survey, caregivers were surveyed via interview and self-completed questionnaire. Later surveys included teacher interviews and physical, cognitive and behavioural assessments of child development (Hansen, 2014).

Child-health production function

As outlined by Grossman (2000) and Jacobsen (2000) this study estimates child behaviour as the product of parental and other inputs, assuming the child's initial health endowment. The resulting child-health production function can be written as follows:

$$CO_t = \alpha_0 + h_0 + \alpha_1 X_t + \alpha_2 \text{LN}(Y)_t + \sum_{z=1}^Z \alpha_{PS}^z PS_t^z + \sum_{j=1}^J \alpha_{PI}^j PI_t^j + \sum_{j=1}^S \alpha_{OP}^s OP_t^s + \epsilon_t \quad (1)$$

where CO represents the behavioural outcomes being analysed; t denotes child age; h_0 is the child's initial health endowment, such as gestational age and birthweight; X is a set of variables including family sociodemographic controls and some child characteristics; Y is family income given in its logarithmic form; the three summation terms refer to 'parental stress', 'parental investment' and 'other pathways' (for example, peer relationships) variables, respectively; and ϵ_t is the error term.

Family income and poverty persistence

The primary exposure was permanent family income, measured by averaging equivalised household income over the first five available surveys, expressed in its logarithmic form (Currie & Stabile, 2003; Condliffe & Link, 2008; Khanam et al., 2009; Murasko, 2008; Currie et al., 2007; Taylor et al., 2004; Dooley & Stewart, 2007). Income values from surveys 1 to 4 were adjusted for inflation using the Average Weekly Earnings (AWE) (Office for National Statistics, 2016) index, expressing income at 2011 (survey five) prices (Thompson, 2009). Frequency of poverty (defined in the MCS as having a net equivalent family income below 60 per cent of the national median, accounting for the number and age of people in the home (Hansen, 2014)) since child birth was employed as the secondary exposure of interest (Bradshaw & Holmes, 2008; Kiernan & Huerta, 2008; Kiernan & Mensah, 2009; Holmes & Kiernan, 2013; Flouri et al., 2014). As per Holmes and Kiernan (2013) a categorical variable indicating frequency of poverty across the first five surveys was constructed. The five categories were: "never experienced poverty", "poverty at one survey only", "poverty at two or three surveys", and "poverty at four or five surveys". These were generated to capture persistence of poverty, rather than timing, as existing evidence indicates that the former is more strongly associated with problematic child behaviour (Korenman et al., 1995; Holmes & Kiernan, 2013).

Child socio-emotional behaviour

Socio-emotional behaviour at 11 years of age was measured using the Strengths and Difficulties Questionnaire (SDQ) (Hansen, 2014; Goodman, 1997). The SDQ is a concise and well-validated tool used to measure prosocial behaviour and psychopathology of 3 to 16 year olds (Goodman, 2001). Responses generate scores on five subscales: conduct problems, pro-social behaviour, hyperactivity or inattention, emotional problems, and problems with peers (Goodman, 2001; Scoring the SDQ, 2017). For all subscales except prosocial behaviour, a higher score indicates more problems (Goodman, 2001). Emotional and peer-related difficulties are considered "internalising" problems, while conduct and hyperactivity/inattention behaviours are "externalising" problems.

The primary outcome measure was parent-reported socio-emotional

behavioural problems at age 11, captured by the total difficulty score (TDS) (Goodman, 2001). The TDS was calculated by summing the four problem domains, excluding the pro-social domain, with a cut-off of 17 or more (out of 40) applied to generate a binary variable. Secondary outcomes were the four SDQ subscales (emotional, peer-related, conduct, and hyperactivity/inattention problems) (Scoring the SDQ, 2017). Using validated cut-offs for the scores out of 10 (5 for emotional problems, 4 for conduct problems, 7 for hyperactivity and 4 for peer problems) (Goodman, 2001), binary variables were generated for each subscale.

Parent-reported behaviour may be subject to biases, especially in the presence of mother's psychological distress (Fergusson et al., 1993; Breslau, Davis & Prubucki, 1988). To address this point, a secondary analysis was conducted using teacher-reported TDS at age 11, where this information was available. A binary variable for problem behaviour was generated using the validated cut-off of 16 or more out of 40. (Scoring the SDQ, 2017). Binary variables were also generated for the subscales with cut-offs of 6, 4, 7 and 5 out of 10 for emotional problems, conduct problems, hyperactivity and peer problems, respectively (Goodman, 2001).

Covariates

The choice of covariates was informed by previous literature and established parental investment and parental stress theoretical frameworks. The set of standard sociodemographic controls included child age at survey five, child sex and ethnicity, number of siblings, housing tenure (i.e. tenancy status), maternal education and age at the child's birth. The other background variables controlled for were the child's initial endowment of health, captured by birthweight and gestational age, breastfeeding, mother's drinking and smoking during pregnancy. Child longstanding illness was included as a pathway variable, given its relationship with income and potential to affect socio-emotional problems. These variables were included in model specification 2.

Maternal psychological distress (model specification 3)

The MCS utilised the Kessler-6 (K-6) questionnaire (Kessler, Andrews, Colpe, Hiripi, Mroczek & Normand, 2002) at surveys two to five to capture maternal psychological distress (Hansen, 2014). For the first survey (child aged 9 months), an 8-item scale based on the Rutter Malaise Inventory (RMI) was used to capture maternal distress (Schoon, Sacker, Hope, Collishaw, and Maughan, 2005). Both are validated measures, used widely as screening tools for psychological affect. For each survey, a binary variable was constructed from the K-6 or RMI scores indicating whether or not the mother suffered from psychological distress (Johnson, 2012) (1 = yes; 0 = no). A score of ≥ 6 (out of 24) and a score of ≥ 4 (out of 9) were taken to indicate maternal psychological distress for the K-6 questionnaire and the RMI, respectively. Maternal psychological distress trajectory was then operationalised by generating a variable reflecting the mother's distress over the first five available surveys. The groupings were: never experienced psychological distress; distress in early years only (child age 9 months and/or 3 years); distress in middle years only (child age 5 and/or 7 years); current psychological distress (child age 11) only, recurrent distress (at least once in the early years and once in middle/late years of child's life), persistent psychological distress (all five surveys) and other patterns (e.g. the last two or three surveys, sporadic distress).

Parental investment, parental stress and external factors variables (model specification 4)

To operationalise the parental investment and family stress theories (Holmes & Kiernan, 2013; Yeung et al., 2002; Duncan et al., 2014), several variables describing parenting practices and home environment were identified. Information was extracted on change in family structure and parenting style, including discipline measures, structure, and time spent with the child in activities such as reading and playing.

Current alcohol intake and smoking, examples of parent's child-health related behaviours (Violato et al., 2011; Dooley & Stewart, 2007; Jones, Gutman & Platt, 2013), were also controlled for. Additionally, the analysis sought to account for external factors that are important in behavioural outcomes in later childhood, such as peer relationships (Jones et al., 2013). Hours of sedentary screen time have been cited as having small but consistent detrimental effects on childhood mental health (Biddle & Asare, 2011), while lower odds of emotional problems have been observed in youth with higher levels of physical activity (Kremer et al. 2014). As such, variables measuring time spent playing sport and screen time (i.e. computer/video usage) were included. The group of covariates incorporating family, parenting, and later childhood factors is hereafter denoted 'family and external factors'. These variables were extracted from the age 7 survey (survey four) to build a longitudinal picture of the relationship with behaviour at age 11 and to limit reverse causality concerns.

Statistical analyses

Children were eligible for inclusion if they were singletons recruited at 9 months of age, were present for all first five surveys and had responses recorded for all relevant questions. Only mother interviews were used, including natural, adoptive, and foster mothers, if present in the first five surveys of the study. The sample size after exclusions was 8499. Survey weights were included in the analyses to account for the stratified cluster sample design of the study, and attrition bias due to non-response across the surveys (Millennium Cohort Study Initial findings from the Age 11 survey, 2014; Ketende & Jones, 2011).

As the behavioural outcomes in this study are dichotomous, the child health production function (1) was estimated for each outcome of interest using multivariable logistic regression with permanent income in its logarithmic form as the primary exposure. Associations between outcome variables, exposures and other covariates were expressed as partial effects (marginal effects for continuous variables; average effects for categorical variables) measured at the mean of each covariate. Secondary analyses used poverty persistence as the exposure. The primary outcome was parent-assessed problem behaviour, measured by the TDS. The secondary outcomes were the four subscales of the SDQ (emotional, peer-related, conduct and hyperactivity/inattention problems) and teacher-reported behavioural problems, measured by the TDS.

Empirical selection was conducted by assessing conceptually similar variables for collinearity and statistical significance. Covariates were then added to the model in a stepwise fashion in groups reflecting theoretical frameworks. The variables included in the four model specifications are described in Table 1. The same model specifications were adopted for secondary exposures and secondary outcomes as the main model. Teacher-reported TDS was available only for a subsample of the children for whom parent-reported TDS was available, hence the sample size for this secondary outcome was smaller than in the primary analyses. The same covariates were included in this analysis to aid

comparability.

The adjusted Wald test was used to assess significance of covariates. All statistical analysis was conducted using Stata version 12.1. StataCorp (2011).

This study was a secondary analysis of the Millennium Cohort Study, using de-identified data available in the public domain. As the project falls within the remit of the original parent ethics approval (Hansen, 2014), no additional ethics clearance was required.

Results

Descriptive characteristics

Baseline characteristics of the final cohort are summarised in Table 2; statistical significance of the association between covariates and parent-reported problem behaviour are also presented, whilst the association between covariates and family income (Baron & Kenny, 1986) are reported in Table A1.2. There was an equal distribution of males and females in the final sample, which was a predominately White population. The mean age at interview for survey five was 10.7 years. The median permanent income, adjusted for inflation over the years of the data and equivalised for household size, was £23,072 (IQR £15,545 to £31,491). 54.8% of the children's families had never experienced poverty, 15.2% of children lived in persistent poverty, and 13.8% had been under the poverty line once (Millennium Cohort Study Initial findings from the Age 11 survey, 2014).

A total of 692 children (8.14%) were reported to have behavioural problems at age 11, measured by parent-reported TDS. Examining SDQ subscales, 10.68% of children had emotional difficulties, 10.54% peer related problems, 9.07% conduct issues, and 9.85% had hyperactivity or inattention. Only 1.48% of children were reported to have impaired pro-social skills. Teachers reported proportionately fewer socio-emotional problems than parents. Of the 4784 children for whom teacher-reported TDS was available, 6.22% were reported to have behavioural difficulties.

Using the Rutter Malaise Inventory, 14.2% of mothers reported high psychological distress at 9 months of child age. The proportion of mothers indicating medium to very high psychological distress, via the Kessler-6 scale, was markedly higher in subsequent surveys. When the cohort was 3, 5 and 7 years old, 33.8%, 32.5% and 32.7% of mothers reported medium or high psychological distress, respectively. At the age 11 survey, this increased to 41.6% of mothers. In this sample, 36.3% of mothers never reported psychological distress in the first five surveys. Looking at stages of child development, 6.1% of mothers reported psychological distress only in the early years, 7.2% only in the middle years, and 7.6% for the first time at child age 11. Only 4.7% of mothers reported significant distress at all five surveys, while 23.8% experienced recurrent psychological distress, and 14.3% demonstrated other patterns.

As shown in Table A1.2, most covariates, and notably maternal psychological distress, were predicted by family income. The same

Table 1

Variables included in the four model specifications of the child-health production function.

Model specifications	Variables
Model specification 1	Raw model of family income and child behavioural outcome
Model specification 2	Models included family income, standard sociodemographic controls (current age, sex, ethnicity, number of siblings, maternal education, maternal age at child birth, housing tenure) and 'child's health endowment' (birth weight, gestational age, breastfeeding, mother's smoking and alcohol during pregnancy, child's longstanding illness)
Model specification 3	Models included the same variables as in model specification 2 with the addition of 'maternal s psychological distress pattern'
Model specification 4	Models included the same variables as in model specification 3 with the addition of 'family and external factors': <ul style="list-style-type: none"> ● Family stress and parental investment frameworks (change in mother's relationship from wave 4 to 5, indicators of routine/structure, discipline measures, indicators of mother's time spent with the child) ● Mother's child-health-related behaviours (mother longstanding illness, smoking and alcohol intake) ● Older child variables (time spent with friends, time playing sport)

Table 2
Descriptive characteristics and univariate associations with problem behaviour at age 11.

Variable	N (Total = 8499)	% total	N Problem behaviour	% Problem behaviour	N No problem behaviour	% No problem behaviour	p-value
Sociodemographic variables							
Age							0.020
10	2800	34.2	246	40.0	2554	33.6	
11	5666	65.5	444	59.7	5222	66.1	
12	33	0.4	2	0.4	31	0.4	
Sex							< 0.001
Male	4260	50.9	422	62.9	3838	49.7	
Female	4239	49.1	270	37.1	3969	50.3	
Ethnicity							0.721
White	7650	90.6	623	91.1	7027	90.6	
Non-white	849	9.4	69	8.9	780	9.5	
Siblings ^b							< 0.001
0	968	11.6	106	16.0	862	11.1	
1	4041	47.3	273	39.0	3768	48.2	
2	2381	28.0	184	27.0	2197	28.1	
≥ 3	1109	13.1	129	18.0	980	12.6	
Mother's academic qualification ^a							
Tertiary degree	2599	26.8	109	13.3	2490	28.1	
A-levels	926	10.0	56	7.4	870	10.3	
GCSE	3994	50.1	391	58.0	3603	49.3	
None of these	980	13.1	136	21.3	844	12.3	
Mother's age at child's birth							< 0.001
< 20 years	507	7.7	71	12.3	436	7.2	
20–24 years	1260	15.9	166	26.3	1094	14.9	
25–29 years	2410	29.2	212	31.9	2198	28.9	
30–34 years	2797	30.7	161	20.1	2636	31.7	
≥ 35 years	1516	16.6	82	9.4	1434	17.3	
Housing tenure ^b							< 0.001
Own/mortgage	6177	67.2	357	44.9	5820	69.4	
Council	938	13.3	161	25.1	777	12.1	
Rent/other	1384	19.5	174	30.0	1210	18.45	
Child health endowment variables							
Birthweight							0.015
> 2.5 kg	8009	94.2	635	91.2	7374	94.1	
≤ 2.5 kg	490	5.8	57	8.8	433	5.9	
Gestational age							0.012
≥ 37 weeks	7886	92.3	628	88.7	7258	92.6	
< 37 weeks	613	7.7	64	11.3	549	7.4	
Child longstanding illness ^b							< 0.001
No	6928	81.2	462	66.8	6466	82.7	
Yes	1571	18.8	230	33.2	1341	17.3	
Mother's alcohol intake during pregnancy							< 0.001
Never	5715	66.4	504	71.0	5211	65.9	
Light	2164	26.2	124	18.6	2040	26.9	
Moderate	449	5.3	45	7.3	404	5.1	
Heavy/binge	171	2.1	19	3.1	152	2.0	
Mother's smoking in pregnancy							< 0.001
Never smoked	5690	64.5	349	47.9	5341	66.2	
Stopped smoking during pregnancy	1076	13.3	93	12.2	983	13.4	
Smoked throughout pregnancy	1733	22.2	250	40.0	1483	20.4	
Breastfeeding duration							< 0.001
No breastfeeding	2482	32.2	248	38.6	2234	31.6	
< 7 days	979	9.8	107	12.9	872	9.6	
1 week to 3 months (inclusive)	2127	24.8	191	29.1	1936	24.4	
3 to 6 months (inclusive)	1225	14.0	54	7.9	1171	14.6	
> 6 months	1686	19.1	92	11.8	1594	19.8	
Maternal psychological distress pattern							< 0.001
Never	3185	36.3	81	10.9	3104	38.9	
Early years only	520	6.1	19	3.0	501	6.4	
Middle years only	604	7.2	44	6.5	560	7.24	
Age 11 only	637	7.6	48	6.1	589	7.8	
Other pattern	1237	14.3	169	23.3	1068	13.4	
Recurrent	1930	23.8	243	37.6	1687	22.4	
Persistent	386	4.7	88	12.7	298	3.9	
Family/External factors variables							
Change in mother's relationship, wave 4–5							0.001
Became single	531	6.4	61	8.1	470	6.22	
Became partnered	358	4.8	56	7.9	302	4.4	
No change	7610	88.9	575	84.0	7035	89.3	
Regular bedtime on weekdays ^b							0.036
Never/almost never	288	3.4	36	4.8	252	3.2	
Sometimes	435	5.0	51	6.9	384	4.9	

(continued on next page)

Table 2 (continued)

Variable	N (Total = 8499)	% total	N Problem behaviour	% Problem behaviour	N No problem behaviour	% No problem behaviour	p-value
Usually	2699	31.7	226	31.8	2473	31.7	
Always	5077	59.9	379	56.5	4698	60.2	
Hours spent playing computer/video games during week ^b							< 0.001
None	866	10.4	91	13.6	775	10.1	
< 1 hour	4644	53.7	322	44.5	4322	5.5	
1–3 hours	2668	32.0	229	34.4	2439	31.8	
> 3 hours	321	3.9	50	7.5	271	3.52	
Mother's satisfaction with time spent with child ^b							0.001
Enough or more than enough	2029	24.1	195	27.8	1834	23.7	
Just enough	3682	43.6	243	35.3	3439	4.4	
Not enough	2788	32.3	254	36.9	2534	31.9	
Tells off when naughty ^b							< 0.001
Never	48	0.5	1	0.2	47	0.5	
Rarely	1019	12.1	51	7.9	968	12.5	
Sometimes	3003	35.1	146	20.4	2857	36.6	
Often	4429	52.3	494	71.6	3935	50.4	
Sends to room when naughty ^b							< 0.001
Never	1037	11.4	39	5.3	998	12.0	
Rarely	2498	29.5	126	15.7	2372	15.7	
Sometimes	3406	39.5	227	33.3	3179	33.3	
Often	1558	19.6	300	45.7	1258	45.7	
Takes things away when naughty ^b							< 0.001
Never	687	7.4	39	4.8	648	7.7	
Rarely	2414	28.6	109	15.0	2305	29.9	
Sometimes	3931	46.1	271	39.2	3660	46.8	
Often	1467	17.9	273	41.0	1194	15.5	
Amount of time reading to child ^b							< 0.001
Not at all	176	2.0	19	2.2	157	1.9	
Approximately monthly	615	7.2	69	12.7	546	6.7	
Weekly or more	7708	90.8	604	85.1	7104	91.4	
Time spent playing games with child ^b							< 0.001
Not at all	385	4.4	61	7.2	324	4.14	
Approximately monthly	2226	26.5	154	22.2	2072	26.9	
Weekly or more	5888	69.1	477	70.6	5411	68.9	
Mother longstanding health condition ^b							< 0.001
No	6382	75.1	427	61.4	5955	76.4	
Yes	2117	24.9	265	38.6	1852	23.6	
Mother smoking							< 0.001
Non-smoker	6383	73.0	417	57.4	5966	74.6	
Smoker	2116	27.0	275	42.6	1841	25.4	
Mother's alcohol intake ^b							< 0.001
5+ weekly	576	7.3	30	4.4	546	7.6	
3–4 times weekly	1069	12.7	49	6.2	1020	13.3	
1–2 times weekly	2445	28.1	172	23.8	2273	28.6	
Monthly	3067	36.8	283	42.0	2784	36.3	
Never/almost never	1342	15.2	158	23.7	1184	14.3	
Time spent with friends outside school ^b							< 0.001
Not at all	440	5.1	94	13.2	346	4.23	
Approximately monthly	1532	19.0	120	18.2	1412	19.0	
Regularly, 1–3 times per week	4667	55.7	284	41.7	4383	5.71	
Most days	1860	20.3	194	26.9	1666	19.64	
Time playing sport ^b							< 0.001
Never/rarely	2334	29.1	313	47.2	2021	27.2	
Once per week	2309	26.9	175	25.8	2134	26.9	
2–3 times per week	3154	36.2	174	21.9	2980	3.8	
≥ 4 times per week	702	7.8	30	5.1	672	8.1	

Note: Unweighted counts and survey-weighted proportions reported; numbers may not add up to 8499 due to individuals with missing information; p-values calculated using chi-square tests

^a Information from wave 1 (age 9 months)

^b Information from wave 4 (age 7 years)

socio-economic pattern was found also when family income was replaced by poverty (results not shown).

Effect of permanent income

The marginal effects (ME) of permanent income on the six indicators of child behaviour at age 11 are summarised in Table 3, which shows the effect of a 1% increase in permanent family income on the likelihood of behaviour problems, in model specification 4. A 1%

increase in family income was associated with 4.4% (SE 0.014) and 5.2% (SE 0.016) lower probabilities of behavioural problems being reported by parents and teachers, respectively. The effect of income was smaller in magnitude for the SDQ subscales and was not significant for emotional problems.

As shown in Table A1.1, the marginal effect of permanent income was attenuated in magnitude across model specifications, but it remained statistically significant at the 1% level. In model specification 1, a 1% increase in permanent income was associated with a reduction in

Table 3

The impact of permanent family income and maternal psychological distress on childhood behavioural outcomes at age 11 years: logit models - partial effects (SE).

	Parent TDS ^{a,b}	Teacher TDS ^{a,b}	Internalising ^c		Externalising ^c	
			Emotional problems ^{a,b}	Peer problems ^{a,b}	Conduct problems ^{a,b}	Hyperactivity/Inattention problems ^{a,b}
log of permanent income	-0.044*** (0.014)	-0.052*** (0.016)	-0.022 (0.016)	-0.037** (0.016)	-0.039*** (0.014)	-0.026 [†] (0.014)
Maternal psychological distress pattern^d						
Never #	–	–	–	–	–	–
Early years only	0.002 (0.013)	0.002 (0.016)	0.031** (0.015)	0.019 (0.016)	-0.001 (0.013)	0.003 (0.014)
Middle years only	0.039** (0.014)	0.035 [†] (0.017)	0.025 [†] (0.013)	0.063*** (0.015)	0.023 (0.015)	0.027** (0.012)
Current (age 11) only	0.035** (0.013)	0.033 (0.021)	0.075*** (0.017)	0.048*** (0.017)	0.050*** (0.016)	0.056*** (0.014)
Other pattern	0.079** (0.012)	0.024 [†] (0.011)	0.116*** (0.014)	0.088*** (0.014)	0.060*** (0.010)	0.085*** (0.013)
Recurrent	0.071** (0.009)	0.015 (0.010)	0.089*** (0.011)	0.076*** (0.011)	0.058*** (0.009)	0.077*** (0.010)
Persistent	0.116** (0.018)	0.026 (0.018)	0.150*** (0.023)	0.107*** (0.021)	0.121*** (0.021)	0.115*** (0.020)
Sample size	8499	4784	8499	8499	8499	8499

Notes: # Reference case;

^a Partial effects with standard errors in parentheses^b Each regression included standard socioeconomic controls, child health endowment variables, family and external factor variables (see Methods section on data and variable definitions for details)^c Individual subscales of SDQ from parent-completed survey^d Maternal psychological distress measured using Kessler-6 scale at wave 2–5 and Rutter Malaise Inventory at wave 1

* Significant at the 10-percent level;

** Significant at the 5-percent level;

*** Significant at the 1-percent level.

the probability of parent-reported problem behaviour of 0.104 (SE 0.009, $p < 0.01$). Accounting for sociodemographic and health endowment factors (model specification 2), the marginal effect of family income was $-0.077 \pm SE 0.013$ ($p < 0.01$). This effect was reduced by a further 24.7% (ME $-0.058 \pm SE 0.016$, $p < 0.01$) by adjusting for maternal psychological distress pattern (model specification 3). Model specification 4 showed a reduction in the likelihood of socio-emotional behaviour problems of 0.044 (SE 0.014, $p < 0.01$) with each percentage increase in income.

There were distinct effects of family income on the different subscales of the SDQ (Table A2). The strength of association was substantially diminished across subsequent model specifications, with small in magnitude but statistically significant relationships seen for all but the emotional subscale in model specification 4.

As detailed in Table A3, the unadjusted marginal effect of income on teacher-assessed behavioural problems (model specification 1) was slightly weaker in magnitude than for parent-completed behavioural problems (ME $-0.086 \pm SE 0.012$, $p < 0.01$ vs. ME $-0.104 \pm SE 0.009$, $p < 0.01$). However, the association was not attenuated to the same extent as parent-reported TDS (Table A1.1) over the subsequent model specifications. When fully adjusted (model specification 4), a 1% increase in income was associated with a reduction in the probability of teacher-assessed problem behaviour of 0.052 (SE 0.016, $p < 0.01$), compared to a 0.044 reduction for parent-reported TDS.

Effect of poverty

The partial effects of poverty across the five waves of the MCS on child socio-emotional behaviour at age 11 are shown in Table 4. The relationships between family poverty patterns and child socio-emotional behaviour are analogous to that of permanent income. Persistent poverty was associated with the greatest increase in the probability of behavioural problems at age 11, compared with never experiencing poverty. This was consistent for parent and teacher TDS, as well as internalising subscales, but the relationship was less significant for externalising problems. The association between poverty and child behavioural problems was greater in magnitude for teacher-reported than parent-reported TDS. For children who experienced poverty at 4 or 5 surveys, there was a partial effect of 0.061 (SE 0.020, $p < 0.01$) for teacher-assessed behaviour, compared to 0.038 (SE 0.015, $p < 0.05$) for

parent-reported behaviour. The likelihood of behavioural problems, as reported by teachers, increased with poverty frequency. This pattern was not consistent with the analysis using parent-reported TDS.

Role of maternal psychological distress

Maternal distress pattern was an important mediating factor in the relationship between income and parent-reported child behaviour. The marginal effect of income in model specification 2 was attenuated by 24.7% after controlling for maternal psychological distress in model specification 3 (Table A1.1). The size and statistical significance of the association of poverty with parent-reported behaviour also decreased between model specifications 2 and 3. The partial effect of poverty was reduced by 18.2%, 22.9% and 21.3% in children who experienced poverty once, twice or three times, and four or five times over the period covered by the survey, respectively (Table A4). A similar pattern was observed in the income and poverty models with SDQ subscales (Table A2 and A5). The marginal effects of income on emotional and peer problems were reduced by 41.3% and 27.9%, respectively, between model specification 2 and 3. The association between income and conduct and hyperactivity/inattention problems was attenuated by 23.4% and 35.2%, respectively, between model specification 2 and 3.

Conversely, maternal psychological distress had little impact on the association between income and teacher-assessed child behaviour. The marginal effect of income was attenuated by only 8.0% between model specification 2 and 3 (Table A3).

Regarding the direct association of maternal psychological distress with parent-reported TDS (Table 3), children whose mothers were persistently distressed had 11.6% greater probability of being reported as having socio-emotional problems than children whose mothers had never reported psychological distress. Maternal psychological distress only in the early years (age 9 months and/or 3 years) of the child's life was not significantly associated with problem behaviour at age 11. Persistent and recurrent distress patterns were also significantly associated with all four SDQ subscale models, with the largest effect on emotional symptoms.

Other covariates

A substantial mediating effect of family and external factors

Table 4

The impact of family poverty and maternal psychological distress on childhood behavioural outcomes at age 11 years: logit models - partial effects (SE).

	Parent TDS ^{a,b}	Teacher TDS ^{a,b}	Internalising ^c		Externalising ^c	
			Emotional problems ^{a,b}	Peer problems ^{a,b}	Conduct problems ^{a,b}	Hyperactivity/Inattention problems ^{a,b}
Poverty pattern						
Never#	–	–	–	–	–	–
Once only	0.023 ^{**} (0.011)	0.010 (0.011)	0.041 ^{***} (0.014)	0.001 (0.011)	-0.001 (0.013)	0.004 (0.011)
2–3 waves	0.018 (0.011)	0.033 ^{**} (0.014)	0.023 [*] (0.014)	0.033 ^{**} (0.015)	-0.004 (0.012)	0.008 (0.012)
4–5 waves	0.038 ^{**} (0.015)	0.061 ^{***} (0.020)	0.061 ^{***} (0.019)	0.046 ^{**} (0.019)	0.022 (0.016)	0.034 [*] (0.017)
Maternal psychological distress pattern^d						
Never #	–	–	–	–	–	–
Early years only	0.002 (0.013)	0.003 (0.016)	0.031 ^{**} (0.015)	0.020 (0.016)	0.000 (0.013)	0.004 (0.014)
Middle years only	0.039 ^{**} (0.014)	0.037 [*] (0.017)	0.026 ^{**} (0.014)	0.064 ^{***} (0.016)	0.024 (0.015)	0.027 ^{**} (0.012)
Current (age 11) only	0.035 ^{**} (0.013)	0.035 (0.022)	0.076 ^{**} (0.017)	0.048 ^{***} (0.017)	0.052 ^{***} (0.016)	0.058 ^{***} (0.014)
Other pattern	0.080 ^{***} (0.012)	0.026 [*] (0.011)	0.114 ^{***} (0.014)	0.089 ^{***} (0.014)	0.062 ^{***} (0.011)	0.086 ^{***} (0.013)
Recurrent	0.073 ^{***} (0.009)	0.018 [*] (0.010)	0.089 ^{**} (0.010)	0.078 ^{***} (0.011)	0.060 ^{***} (0.009)	0.078 ^{***} (0.010)
Persistent	0.119 ^{***} (0.018)	0.029 (0.018)	0.149 ^{***} (0.023)	0.109 ^{***} (0.021)	0.125 ^{***} (0.021)	0.117 ^{***} (0.020)
Sample size	8499	4784	8499	8499	8499	8499

Notes: # Reference case;

“Wave” denotes data collection points, i.e. waves 1, 2, 3, 4, and 5 collected at ages 9 months, 3, 5, 7, and 11 years respectively

Maternal psychological distress measured using Kessler-6 scale at wave 2–5 and Rutter Malaise Inventory at wave 1

^a Partial effects with standard errors in parentheses^b Each regression included standard socioeconomic controls, child health endowment variables, family and external factor variables (see Methods section on data and variable definitions for details)^c Individual subscales of SDQ from mother-completed survey

* Significant at the 10-percent level;

** Significant at the 5-percent level;

*** Significant at the 1-percent level.

(representing parental stress and parental investment constructs) on the child behaviour-family income gradient was observed in model specification 4. The marginal effect of income on parent-assessed behaviour was reduced by 24.1% between model specifications 3 and 4 (Table A1.1). Similarly, the association of poverty with parent-reported behavioural problems became smaller in magnitude after adjusting for these factors.

There were statistically significant protective effects of both time spent with friends and siblings on behavioural issues for parent-reported TDS, internalising and externalising problems (Table A1.1 and A2). High frequency of punitive parenting practices, such as sending the child to their room, or confiscating belongings when naughty, was associated with higher levels of problem behaviour, particularly externalising problems (Table A2). In contrast, there was little effect of early life influences such as gestational age, birthweight, and mother's education on behaviour at age 11 (Table A1.1).

Discussion

This study demonstrated that the relationship between permanent family income and socio-emotional behaviour holds at age 11. The results reinforce the importance of financial stability and a family's material wealth in the behavioural outcomes of their child. The effect of a 1% (10%) increase in permanent income was associated with 7.7 (77) percentage points reduction in child behavioural problems when accounting for standard socio-demographic controls (model specification 2, Table A1.1). The direct effect of income was stronger for children of poorer families: at the 25th percentile of income distribution, a 1% increase in permanent income was associated with 9.3 percentage points reduction in child behavioural problems, and 5.6 percentage points at the 75th percentile. These results may be significant for policy makers, in that children may experience worse outcomes because they are poorer, not only through the effect of income on parenting and household characteristics. The income-child behaviour relationship remained significant even when accounting for factors known to influence child behaviour, which differs from findings of several studies involving children at younger ages (Yeung et al., 2002; Violato et al.,

2011; Khanam & Nghiem, 2016; Dooley & Stewart, 2007; Kelly, Sacker, Del Bono, Francesconi & Marmot, 2011).

Unsurprisingly, the associations between poverty and child behavioural problems reinforced the results for income, more so as reported by teachers than parents. This finding is consistent with literature examining this relationship at younger child ages (Bradshaw & Holmes, 2008; Kiernan & Huerta, 2008; Kiernan & Mensah, 2009).

The emotional problems subscale was most weakly affected by family income, but most strongly associated with poverty. This may be driven by non-linearity in the family income effects, in that effects on emotional problems are strongest at the lower end of the income distribution. A 2013 systematic review (Cooper & Stewart, 2013) found strong evidence of a greater impact of money on behavioural and emotional outcomes of children whose families were poorest (Taylor et al., 2004; Dearing et al., 2001; Dearing, McCartney & Taylor, 2006; Akee, Copeland, Keeler, Angold & Costello, 2010; Isaacs & Magnuson, 2011). This finding is also consistent with Plewis and Kallis (2008) study using the MCS at child age 3 and Taylor et al. (2004) study of US children aged 1 to 3 years.

Consistent with findings in the UK and USA (Holmes & Kiernan, 2013; Wickham et al., 2017; Yeung et al., 2002; Schoon et al., 2010), there was a striking effect of maternal mental health on the relationship between family income and child behaviour. There were also marked differences in the size of the effect of maternal psychological distress with child behavioural problems depending on trajectories of distress over time. The overall pattern was reflective of both duration and temporality of mother's psychological distress, exerting the strongest effect for the longest durations.

An interesting finding was the discrepancy in the association of maternal psychological distress with child behaviour between parent- and teacher-reported behaviour. It is possible that the constricted sample size for teacher-reported behaviour may not have provided adequate power to detect this effect, or that the children with available teacher-reported TDS were systematically different from those without. School quality could impact on teacher rating, which is tied to income and area of deprivation (Washbrook et al., 2014). Additionally, there is potential for bias in parent reports of behaviour (Fergusson et al.,

1993). The analysis using teacher-reported TDS aimed to assess the extent of such bias. The parent-reported analysis was repeated for the restricted sample of children with teacher-completed TDS. For those children, a 1% increase in income was associated with a statistically significant reduction in probability of behavioural issues (ME $-0.059 \pm SE 0.016$, $p < 0.01$). This is similar to the teacher-reported effect of income ($-0.052 \pm SE 0.016$, $p < 0.01$). Mothers experiencing high psychological distress may perceive their children to be more difficult. Indeed, a positive association has been observed between maternal levels of distress, usually measured through self-report, and discrepancies between mothers' assessment of their child and the ratings of other informants, such as teachers (Breslau et al., 1988; Collishaw, Goodman, Ford, Rabe-Hesketh & Pickles, 2009). Najman et al. (2001) found that, in mothers rating their child's behaviour, as the mother's current emotional impairment increased, so did her reports of the child's behavioural problems, compared with child self-reports. Nonetheless, the assessment of problem behaviour by teachers should be interpreted with a degree of caution. It is possible that a child's behaviour at school may be systematically different from that at home (Washbrook et al., 2014). Furthermore, there is invariable discrepancy between informants when evaluating youth behaviour (De Los Reyes and Kazdin, 2005). Agreement between informants tends to be better in younger children than older children, and in reporting externalising than internalising problems (De Los Reyes and Kazdin, 2005). There can be marked gender differences in behaviour assessment by teachers, as well as influences of socioeconomic status, academic attainment and neighbourhood disadvantage (Collishaw et al., 2009), the so called "negative halo effect" (Abikoff, Courtney, Pelham, and Koplewicz, 1993).

Family and external factors, representing the parental stress and investment frameworks, substantially mitigated the effect of income and poverty on children's behaviour. This corroborates Australian findings (Khanam and Nghiem, 2016) and results from earlier surveys of the MCS (Kiernan & Huerta 2008; Violato et al., 2011). It suggests that it is factors affecting parents' capacity to promote positive development, in combination with financial hardship, which contributes to variation in behaviour. Treating a mother's mental health may be a beneficial way to also improve child behaviour, as shown in a study by Creswell et al. (2015). Identification of key mediating mechanisms through further research may guide more service-oriented policy, beyond what income distribution itself can achieve. Our findings also support the importance of peer relationships in child behavioural development, as time with friends consistently emerged as beneficial for socio-emotional behaviour. There is potential for a degree of reverse causality, in that disruptive or antisocial children may seek fewer friendships, or be excluded by their peers (Laird, Jordan, Dodge, Pettit & Bates, 2001).

The study findings need to be interpreted considering some limitations. Firstly, loss to follow up and the list-wise deletion approach of the study meant that the sample size was reduced by almost half of the original cohort. It may be possible that children who were not present at all five surveys are systematically different to those for whom we had complete data. Loss to follow up, however, is commonplace in longitudinal cohort designs and some previous studies using MCS data in similar areas of investigation indicated that the latter circumstance does not bias results (Wickham et al., 2017; Violato et al., 2011; Violato et al., 2009). Secondly, the role of fathers has not been explored in this study. Violato et al., (2011) assessed the impact of fathers in the relationship between income and child development, finding that paternal attitudes towards parenting and their involvement in child-rearing were significantly associated with child behaviour. Thirdly, we included maternal psychological distress at age 11 and family income at age 11 to operationalise the maternal psychological distress trajectory and the permanent income measure, respectively. However, there may be potential for reverse causality and the results need to be interpreted with caution in light of this potential limitation. Also, the number of

sibling variable was measured when the child was aged 7, but income may affect family planning and number of children, which is a potential further limitation.

Given the wealth of data collected in the MCS, a range of important covariates were included in the model, reducing residual unobserved heterogeneity. However, unobserved family background characteristics may lead to inflated effects as they potentially increase family income and reduce the likelihood of socio-emotional problems. Area-level socioeconomic data would be a valuable inclusion in future analysis using the MCS in order to further control for social deprivation. Previous papers examining parental income-child outcome relationships have used instrumental variable (IV), fixed-effect methods, and natural experiments to correct for this endogeneity, but those were beyond the scope of this study. Future studies using the MCS would warrant use of these methods. Finally, although associations between income and child behaviour have been observed, these effects may not be causal.

Conclusions and policy implications

This work contributes to an established, albeit limited, body of literature in the health economics discipline. The findings highlight the importance of maternal mental health in the child behaviour-family income relationship and have potential implications for priorities in the treatment of childhood socio-emotional problems.

Consistent with developmental psychology literature (Yeung et al., 2002), there were strong associations between mothers' psychological distress and parent-reported behavioural problems, with greater likelihood of difficulties with more persistent psychological distress. These results may validate calls for further financial and psychosocial supports for families affected by parental mental health issues.

The issue of child poverty is particularly topical, with UK levels increasing for the first time in almost two decades (Social Mobility and Child Poverty Commission, 2017). As of 2013-14, 3.7 million children were living in poverty (Department for Work and Pensions, 2015), but former child poverty targets were abandoned in 2015 and the dedicated Child Poverty Unit was abolished in 2016 (Merrick, 2017). Proposed reductions to tax credits and benefits are also likely to reduce the income of some households considerably (Taylor-Robinson et al., 2015). In early 2016, the Social Mobility and Child Poverty Commission compared the prospects of UK children from poorer backgrounds in terms of academic attainment, future employment and standard of living, demonstrating considerable differences in terms of life chances (Social Mobility and Child Poverty Commission, 2017). This study supports these findings from the perspective of child behavioural problems, and calls for improved government intervention to ameliorate health and developmental outcomes of children from deprived backgrounds.

Ethical statement

This study was a secondary analysis of the Millennium Cohort Study, using de-identified data available in the public domain. As the project falls within the remit of the original parent ethics approval (Hansen K (editor). Millennium Cohort Study: A Guide to the Datasets (Eighth Edition) First, Second, Third, Fourth and Fifth Surveys. London: Centre for Longitudinal Studies, 2014) no additional ethics clearance was required.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.ssmph.2018.03.002>.

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