

Supplementary Information for “Social inequalities in child development: the role of differential exposure and susceptibility to stressful family conditions”

Additional information on included measures

Exposure

We categorised mother’s highest attained educational level according to the International Standard Classification of Education (ISCED) as low (primary school or lower vocational education, ISCED 0-2), medium (intermediate vocational education, ISCED 3-4), or high (higher vocational education or university, ISCED 5-7). Maternal education was self-reported in a questionnaire when the children were 5 years old - the latest available measure preceding the mediator and outcome measures.

Emotional and behavioural problems

For the main analysis, we used the total problem score of the child-reported validated Youth Self-Report (YSR), which consists of 112-items and includes both internalizing and externalizing behavioural problems [1]. The scale was reverse coded such that a higher score indicates less emotional and behavioural problems.

In sensitivity analysis, we used the Child Behavior Checklist (CBCL/6-18) as a measure of mother-reported emotional and behavioural problems [2]. This is the parallel version of the YSR, consisting of similar scales.

Cognitive development

Cognitive development was measured using a subset of the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V), which provides a well-standardized assessment of individual cognitive functioning in 6 to 16-year-olds [3]. Four core subtests from the WISC-V (i.e., Matrix Reasoning, Coding, Vocabulary, Digit Span) were administered by trained research assistants to assess specific cognitive domains and to derive an estimated Full Scale Intelligence Quotient. Based on other samples using the WISC-V, the abbreviated IQ assessment correlates .93 with the full-scale IQ (Blok et al., submitted).

Secondary educational level

Secondary educational level was reported by the mother as the secondary school level that their child was currently attending and coded as a 10-point scale. This scale consisted of the different variants in the secondary education system of the Netherlands (wherein students are tracked at around age 12 years) and ranged from ‘still at primary school’ to ‘preparatory scientific education’.

Financial stress

Three measures of financial stress were available to us, and were derived from a self-report questionnaire filled in by the mother. The first question was “Did you have any trouble paying for your food, rent, electricity bill and such in the past year?”. Answer categories were: (1) no, no trouble, (2) yes, a little trouble, or (3) yes, a lot of trouble. The second question asked whether the mother received social security or unemployment benefits (no vs. yes). The third question asked whether or not the household owned certain possessions or conducted the following activities, which roughly corresponds with the material deprivation indicator used in EU-SILC [4]: (1) regularly buying new cloths, (2) sufficient heating in your house during cold weather, (3) pay your rent or mortgage without any problem, (4) on average, one hot meal per day, (5) a car (or lease car), (6) a washing machine, (7) a refrigerator, (8) a telephone. Positive answers were summed and reverse coded such that a higher score indicates less possessions/activities.

Social stress

Two measures of social stress were included corresponding to those included in the Family Stress Model: family functioning and maternal mental health. Both measures impact daily interactions and social context in the family and may put significant strain on a child development and well-being [5]. Family functioning was assessed by the General Functioning subscale of the Family Assessment Device [6], which is a validated 12-item measure of statements describing healthy and unhealthy family functioning. Maternal mental health was assessed using the 21-item short form of the Brief Symptom Inventory which includes depression, hostility, anxiety, and interpersonal sensitivity subscales [7]. Both variables were coded such that higher scores indicate worse family functioning and worse mental health, respectively.

Confirmatory factor analysis and reliability analysis

We used confirmatory factor analysis to investigate whether the mediating variables could be combined into one latent factor that would indicate 'stressful family conditions' (Table S1). The analysis showed that two latent factors could be distinguished: a latent factor 'financial stress' (Eigenvalue=3.30) and a latent factor 'social stress' (Eigenvalue=1.38). Subsequent reliability analyses showed good reliability for 'social stress' (Cronbach's alpha=0.83), but less so for 'financial stress' (Cronbach's alpha=0.55). Because the low reliability of the latter measure is likely due to the limited number of items (3 items, one of which binary), we decided to proceed with using both a composite measure for both financial stress and a composite measure for social stress as our putative mediators rather than to entirely exclude financial stress from the analysis. In addition, we also calculated a mean score of all financial and social stress measures as an overall measure of 'total stress' (Cronbach's alpha=0.77).

Table S1. Factor loadings from confirmatory factor analysis on the mediator variables.

Variables	Factor 1 (Eigenvalue=3.30)	Factor 2 (Eigenvalue=1.38)
Financial difficulties	0.44	0.59
Unemployed/social security	0.26	0.61
Lack of possessions/activities	0.38	0.66
Interpersonal sensitivity	0.79	-0.27
Depression	0.87	-0.15
Anxiety	0.81	-0.22
Hostility	0.76	-0.27
Family functioning	0.54	0.10

*Results: four-way decomposition analysis***Table S2.** Four-way decomposition of the effect of mother's educational attainment on emotional and behavioural problems of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.03	-0.05, -0.02	0.01	-0.01, 0.03	-0.03	-0.09, 0.04	0.00	-0.09, 0.09	-0.05	-0.13, 0.01
Low edu vs. High edu	-0.10	-0.14, -0.06	0.03	-0.03, 0.10	-0.04	-0.13, 0.04	-0.01	-0.15, 0.13	-0.12	-0.27, 0.01
Social stress										
Medium edu vs. high edu	-0.02	-0.03, -0.00	0.00	-0.01, 0.01	0.00	-0.01, 0.01	-0.03	-0.11, 0.03	-0.05	-0.13, 0.02
Low edu vs. High edu	-0.03	-0.05, -0.01	-0.00	-0.03, 0.02	-0.00	-0.02, 0.01	-0.08	-0.21, 0.05	-0.11	-0.25, 0.03
Total stress										
Medium edu vs. high edu	-0.04	-0.05, -0.02	0.01	-0.01, 0.02	-0.02	-0.08, -0.04	0.01	-0.08, 0.09	-0.05	-0.13, 0.01
Low edu vs. High edu	-0.09	-0.12, -0.06	0.01	-0.04, 0.05	-0.02	-0.11, 0.08	-0.02	-0.16, 0.13	-0.12	-0.26, 0.01

Table S3. Four-way decomposition of the effect of mother's educational attainment on internalizing problems of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.03	-0.04, -0.02	0.00	-0.01, 0.02	-0.01	-0.08, 0.05	-0.02	-0.12, 0.07	-0.06	-0.13, 0.01
Low edu vs. High edu	-0.08	-0.12, -0.05	0.02	-0.03, 0.09	-0.03	-0.12, 0.04	0.00	-0.13, 0.14	-0.09	-0.22, 0.04
Social stress										
Medium edu vs. high edu	-0.02	-0.03, 0.00	0.00	-0.01, 0.01	0.00	-0.01, 0.01	-0.04	-0.11, 0.03	-0.05	-0.13, 0.01
Low edu vs. High edu	-0.02	-0.05, -0.01	0.00	-0.02, 0.01	0.00	-0.02, 0.01	-0.05	-0.18, 0.08	-0.08	-0.21, 0.05
Total stress										
Medium edu vs. high edu	-0.03	-0.05, -0.02	0.00	-0.01, 0.01	-0.01	-0.06, 0.05	-0.02	-0.11, 0.06	-0.06	-0.13, 0.01
Low edu vs. High edu	-0.08	-0.11, -0.06	0.01	-0.03, 0.05	-0.02	-0.10, 0.06	0.00	-0.12, 0.14	-0.09	-0.21, 0.04

Table S4. Four-way decomposition of the effect of mother's educational attainment on externalizing problems of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.03	-0.04, -0.01	0.01	-0.01, 0.03	-0.05	-0.11, 0.03	0.04	-0.06, 0.13	-0.03	-0.11, 0.05
Low edu vs. High edu	-0.08	-0.12, -0.05	0.00	-0.07, 0.06	0.01	-0.09, 0.09	-0.01	-0.15, 0.13	-0.09	-0.22, 0.04
Social stress										
Medium edu vs. high edu	-0.01	-0.02, 0.00	0.00	0.00, 0.01	0.00	-0.01, 0.01	-0.01	-0.10, 0.06	-0.02	-0.10, 0.05
Low edu vs. High edu	-0.02	-0.04, -0.01	0.00	-0.03, 0.01	0.00	-0.02, 0.01	-0.06	-0.18, 0.06	-0.09	-0.22, 0.04
Total stress										
Medium edu vs. high edu	-0.03	-0.04, -0.02	0.01	-0.01, 0.02	-0.03	-0.10, 0.03	0.03	-0.07, 0.12	-0.02	-0.11, 0.05
Low edu vs. High edu	-0.07	-0.11, -0.05	-0.01	-0.06, 0.04	0.02	-0.07, 0.12	-0.03	-0.17, 0.13	-0.09	-0.22, 0.04

Table S5. Four-way decomposition of the effect of mother's educational attainment on emotional and behavioural problems (measured by the mother-reported Child Behavior Checklist) of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.05	-0.07, -0.03	0.01	-0.01, 0.03	-0.04	-0.11, 0.02	-0.07	-0.17, 0.02	-0.15	-0.23, -0.08
Low edu vs. High edu	-0.14	-0.18, -0.10	-0.00	-0.07, 0.06	0.00	-0.08, 0.10	-0.02	-0.16, 0.11	-0.15	-0.27, -0.01
Social stress										
Medium edu vs. high edu	-0.03	-0.05, -0.01	0.01	0.00, 0.02	0.01	0.00, 0.03	-0.13	-0.20, -0.07	-0.15	-0.23, -0.08
Low edu vs. High edu	-0.05	-0.08, -0.02	0.00	-0.02, 0.02	0.00	-0.02, 0.02	-0.11	-0.22, 0.01	-0.15	-0.28, -0.02
Total stress										
Medium edu vs. high edu	-0.07	-0.09, -0.04	0.02	0.00, 0.04	-0.08	-0.14, -0.02	-0.02	-0.12, 0.06	-0.15	-0.23, -0.08
Low edu vs. High edu	-0.15	-0.19, -0.11	0.01	-0.04, 0.06	-0.02	-0.13, 0.08	0.01	-0.13, 0.14	-0.16	-0.28, -0.03

Table S6. Four-way decomposition of the effect of mother's educational attainment on intelligence of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.03	-0.04, -0.02	0.01	-0.01, 0.02	-0.02	-0.08, 0.01	-0.25	-0.33, -0.18	-0.29	-0.37, -0.23
Low edu vs. High edu	-0.09	-0.13, -0.06	0.04	-0.00, 0.09	-0.05	-0.12, -0.01	-0.44	-0.55, -0.35	-0.54	-0.64, -0.45
Social stress										
Medium edu vs. high edu	-0.00	-0.01, 0.00	0.00	-0.00, 0.01	0.00	-0.01, 0.02	-0.30	-0.36, -0.24	-0.29	-0.36, -0.23
Low edu vs. High edu	-0.00	-0.01, 0.00	-0.00	-0.02, 0.01	-0.00	-0.02, 0.01	-0.51	-0.61, -0.42	-0.53	-0.62, -0.43
Total stress										
Medium edu vs. high edu	-0.01	-0.02, -0.00	0.01	-0.01, 0.02	-0.02	-0.08, 0.02	-0.27	-0.35, -0.20	-0.29	-0.36, -0.23
Low edu vs. High edu	-0.03	-0.05, -0.01	-0.00	-0.03, 0.03	0.01	-0.04, 0.06	-0.50	-0.60, -0.40	-0.53	-0.62, -0.43

Table S7. Four-way decomposition of the effect of mother's educational attainment on secondary educational level of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.04	-0.06, -0.03	0.01	-0.00, 0.03	-0.05	-0.10, 0.01	-0.40	-0.48, -0.31	-0.47	-0.54, -0.40
Low edu vs. High edu	-0.12	-0.15, -0.08	0.06	0.01, 0.11	-0.08	-0.15, -0.02	-0.08	-0.15, -0.02	-0.84	-0.95, -0.72
Social stress										
Medium edu vs. high edu	-0.01	-0.01, -0.00	0.00	-0.00, 0.01	0.00	-0.00, 0.02	-0.48	-0.54, -0.40	-0.47	-0.54, -0.40
Low edu vs. High edu	-0.01	-0.02, -0.00	-0.00	-0.02, 0.01	-0.00	-0.02, 0.01	-0.80	-0.92, -0.68	-0.82	-0.93, -0.70
Total stress										
Medium edu vs. high edu	-0.02	-0.03, -0.01	0.01	-0.00, 0.02	-0.04	-0.09, 0.01	-0.42	-0.51, -0.35	-0.47	-0.54, -0.40
Low edu vs. High edu	-0.04	-0.07, -0.03	0.01	-0.03, 0.04	-0.01	-0.08, 0.06	-0.77	-0.89, -0.64	-0.82	-0.93, -0.70

Table S8. Four-way decomposition of the effect of mother's educational attainment on school grades of 13-year-old children mediated by stressful family conditions.

	PIE		INTmed		INTref		CDE		TE	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Financial stress										
Medium edu vs. high edu	-0.02	-0.04, -0.01	0.00	-0.02, 0.02	-0.01	-0.08, 0.06	-0.32	-0.43, -0.22	-0.35	-0.42, -0.27
Low edu vs. High edu	-0.08	-0.12, -0.04	-0.03	-0.09, 0.03	0.04	-0.05, 0.12	-0.61	-0.77, -0.45	-0.68	-0.83, -0.53
Social stress										
Medium edu vs. high edu	-0.00	-0.01, 0.00	0.00	-0.00, 0.01	0.01	-0.00, 0.04	-0.36	-0.43, -0.28	-0.34	-0.42, -0.26
Low edu vs. High edu	-0.00	-0.01, 0.00	-0.01	-0.03, 0.00	-0.02	-0.07, 0.00	-0.67	-0.81, -0.52	-0.69	-0.85, -0.54
Total stress										
Medium edu vs. high edu	-0.01	-0.02, -0.00	0.00	-0.01, 0.01	-0.01	-0.06, 0.05	-0.33	-0.43, -0.24	-0.35	-0.42, -0.26
Low edu vs. High edu	-0.02	-0.04, -0.00	-0.03	-0.07, 0.00	0.05	-0.02, 0.13	-0.69	-0.84, -0.53	-0.69	-0.84, -0.54

Results: descriptive statistics**Table S9.** Descriptive statistics (mean (standard deviation) or frequencies) of the Generation-R participants stratified by mother's educational attainment.

	Mother's educational attainment		
	High (n=3,555)	Medium (n=1,993)	Low (n=1,048)
Covariates			
Female	49.23%	50.08%	50.10%
Dutch	72.21%	52.62%	35.06%
Non-Dutch, Western	11.12%	6.59%	4.32%
Non-Dutch, non-Western	16.67%	40.79%	60.61%
Child's age at outcome	13.54 (0.37)	13.56 (0.42)	13.62 (0.48)
Mother's age at intake	32.30 (4.02)	29.21 (5.13)	28.54 (6.02)
Outcomes			
Emotional and behavioural development ^a	0.02 (0.94)	-0.03 (1.04)	-0.03 (1.19)
Cognitive development ^a	0.28 (0.95)	-0.21 (0.95)	-0.59 (0.91)
Secondary educational level ^a	0.32 (0.82)	-0.37 (1.04)	-0.85 (0.99)
Mediators			
Financial stress scale ^b	0.28 (0.55)	0.57 (0.78)	0.97 (0.96)
No financial difficulties ^c	88.51%	74.58%	63.24%
Some financial difficulties ^c	10.36%	21.80%	30.18%
Major financial difficulties ^c	1.12%	3.62%	6.57%
Unemployed/social security ^c	4.24%	10.10%	24.59%
Lack of possessions/activities ^c	0.34 (0.70)	0.60 (0.86)	0.97 (1.05)
Social stress scale ^b	0.68 (0.68)	0.81 (0.89)	0.89 (0.88)
Interpersonal sensitivity ^d	0.23 (0.38)	0.27 (0.48)	0.27 (0.48)
Depression ^d	0.17 (0.35)	0.24 (0.46)	0.27 (0.45)
Anxiety ^d	0.26 (0.35)	0.28 (0.42)	0.33 (0.50)
Hostility ^d	0.21 (0.28)	0.23 (0.35)	0.23 (0.31)
Family functioning ^d	1.49 (0.43)	1.59 (0.47)	1.69 (0.51)
Total stress scale ^b	0.53 (0.52)	0.73 (0.70)	0.97 (0.78)

^a Standardized score; higher score indicates more favourable child development.

^b Mean score of standardized items, rescaled such that a score of 0 indicates absence of stress.

^c Original variables included in financial stress scale.

^d Original variables included in social stress scale.

*Results: sensitivity analysis***Table S10.** Estimated contribution of differential exposure and susceptibility to stressful family conditions on the total effect of maternal education on internalizing problems of 13-year-old children.

	Differential exposure			Differential susceptibility			Total effect	
	RD	95% CI	Prop. of total effect	RD	95% CI	Prop. of total effect	RD	95% CI
Financial stress								
Medium edu vs. high edu	-0.03	-0.04, -0.01	46%	-0.01	-0.06, 0.04	13%	-0.06	-0.13, 0.01
Low edu vs. High edu	-0.06	-0.11, -0.01	68%	-0.01	-0.04, 0.01	10%	-0.09	-0.22, 0.04
Social stress								
Medium edu vs. high edu	-0.02	-0.03, -0.01	29%	0.00	-0.01, 0.01	2%	-0.05	-0.13, 0.01
Low edu vs. High edu	-0.03	-0.06, -0.01	33%	0.00	-0.03, 0.03	4%	-0.08	-0.21, 0.05
Total stress								
Medium edu vs. high edu	-0.03	-0.05, -0.02	59%	-0.01	-0.05, 0.04	11%	-0.06	-0.13, 0.01
Low edu vs. High edu	-0.07	-0.12, -0.04	85%	-0.01	-0.05, 0.03	10%	-0.09	-0.21, 0.04

Table S11. Estimated contribution of differential exposure and susceptibility to stressful family conditions on the total effect of maternal education on externalizing problems of 13-year-old children.

	Differential exposure			Differential susceptibility			Total effect	
	RD	95% CI	Prop. of total effect	RD	95% CI	Prop. of total effect	RD	95% CI
Financial stress								
Medium edu vs. high edu	-0.01	-0.03, 0.00	59%	-0.03	-0.08, 0.02	100%	-0.03	-0.11, 0.05
Low edu vs. High edu	-0.09	-0.15, -0.03	93%	0.00	-0.02, 0.03	0%	-0.09	-0.22, 0.04
Social stress								
Medium edu vs. high edu	-0.01	-0.02, 0.00	52%	0.00	-0.01, 0.02	0%	-0.02	-0.10, 0.05
Low edu vs. High edu	-0.03	-0.06, -0.01	29%	-0.01	-0.05, 0.02	9%	-0.09	-0.22, 0.04
Total stress								
Medium edu vs. high edu	-0.02	-0.04, -0.01	93%	-0.02	-0.08, 0.02	100%	-0.02	-0.11, 0.05
Low edu vs. High edu	-0.08	-0.14, -0.04	88%	0.01	-0.04, 0.07	0%	-0.09	-0.22, 0.04

Table S12. Estimated contribution of differential exposure and susceptibility to stressful family conditions on the total effect of maternal education on emotional and behavioural problems (measured by the mother-reported Child Behavior Checklist) of 13-year-old children.

	Differential exposure			Differential susceptibility			Total effect	
	RD	95% CI	Prop. of total effect	RD	95% CI	Prop. of total effect	RD	95% CI
Financial stress								
Medium edu vs. high edu	-0.04	-0.05, -0.02	25%	-0.03	-0.08, 0.01	21%	-0.15	-0.23, -0.08
Low edu vs. High edu	-0.14	-0.21, -0.08	91%	0.00	-0.02, 0.03	0%	-0.15	-0.27, -0.01
Social stress								
Medium edu vs. high edu	-0.03	-0.04, -0.01	17%	0.02	0.00, 0.04	0%	-0.15	-0.23, -0.08
Low edu vs. High edu	-0.05	-0.09, -0.02	31%	0.00	-0.04, 0.04	0%	-0.15	-0.28, -0.02
Total stress								
Medium edu vs. high edu	-0.05	-0.07, -0.03	34%	-0.06	-0.11, -0.02	41%	-0.15	-0.23, -0.08
Low edu vs. High edu	-0.14	-0.21, -0.09	89%	-0.01	-0.07, 0.04	8%	-0.16	-0.28, -0.03

Table S13. Estimated contribution of differential exposure and susceptibility to stressful family conditions on the total effect of maternal education on school grades of 13-year-old children.

	Differential exposure			Differential susceptibility			Total effect	
	RD	95% CI	Prop. of total effect	RD	95% CI	Prop. of total effect	RD	95% CI
Financial stress								
Medium edu vs. high edu	-0.02	-0.04, -0.01	6%	-0.00	-0.06, 0.05	1%	-0.35	-0.42, -0.27
Low edu vs. High edu	-0.11	-0.16, -0.06	16%	0.01	-0.01, 0.04	0%	-0.68	-0.83, -0.53
Social stress								
Medium edu vs. high edu	0.00	-0.00, 0.01	0%	0.01	-0.01, 0.05	0%	-0.34	-0.42, -0.26
Low edu vs. High edu	-0.01	-0.03, 0.00	1%	-0.02	-0.09, 0.01	3%	-0.69	-0.85, -0.54
Total stress								
Medium edu vs. high edu	-0.00	-0.02, 0.00	1%	-0.01	-0.04, 0.04	3%	-0.35	-0.42, -0.26
Low edu vs. High edu	-0.05	-0.09, -0.02	8%	0.02	-0.01, 0.06	0%	-0.69	-0.84, -0.54

References

- 1 Achenbach TM. *Manual for the youth self-report and 1991 profile*. Burlington: University of Vermont, Department of Psychiatry 1991.
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