Additional file 1

Do Divergent Parent and Adolescent Reports of Topic-Discussion Frequency Predict Subsequent Depressive Symptoms? A Two-Wave Observational Study in China

The primary sample and five-term polynomial model were specified before formal outcome modeling. This additional file provides item wording, measurement analyses, sample-flow details, missing-data and selection diagnostics, sensitivity analyses, observed-support grids, cross-software verification, an official student longitudinal-weight sensitivity, and a coefficient-level W1-class cluster-robust sensitivity. Analyses added after the primary specification are identified as post hoc.

Table S1. Wave 1 aligned topic-discussion items, translations, and coding.

Topic	Reporter	Variable	Chinese wording	English translation	Coding
school	parent respondent	ba1401	您是否主动与孩子讨论以下问题-学校发生的事情	Do you actively discuss the following issue with your child: things that happened at school?	1=Never; 2=Occasionally; 3=Often
school	adolescent about respondent parent	b24a1 or b24b1 selected by ba01	你的爸爸/妈妈是否经常与你讨论以下问题-学校发生的事情	Does your respondent parent often discuss the following issue with you: things that happened at school?	1=Never; 2=Occasionally; 3=Often
peers	parent respondent	ba1402	您是否主动与孩子讨论以下问题-孩子与朋友的关系	Do you actively discuss the following issue with your child: the child's relationships with friends?	1=Never; 2=Occasionally; 3=Often
peers	adolescent about respondent parent	b24a2 or b24b2 selected by ba01	你的爸爸/妈妈是否经常与你讨论以下问题-你与朋友的关系	Does your respondent parent often discuss the following issue with you: your relationships with friends?	1=Never; 2=Occasionally; 3=Often
teachers	parent respondent	ba1403	您是否主动与孩子讨论以下问题-孩子与老师的关系	Do you actively discuss the following issue with your child: the child's relationships with teachers?	1=Never; 2=Occasionally; 3=Often
teachers	adolescent about respondent parent	b24a3 or b24b3 selected by ba01	你的爸爸/妈妈是否经常与你讨论以下问题-你与老师的关系	Does your respondent parent often discuss the following issue with you: your relationships with teachers?	1=Never; 2=Occasionally; 3=Often
worries	parent respondent	ba1405	您是否主动与孩子讨论以下问题-孩子的心事或烦恼	Do you actively discuss the following issue with your child: the child's private concerns or worries?	1=Never; 2=Occasionally; 3=Often
worries	adolescent about respondent parent	b24a5 or b24b5 selected by ba01	你的爸爸/妈妈是否经常与你讨论以下问题-你的心事或烦恼	Does your respondent parent often discuss the following issue with you: your private concerns or worries?	1=Never; 2=Occasionally; 3=Often

Note. Parent items ask about active discussion; adolescent items ask how often the parent discusses the topic. The agency/target difference limits interchangeability.

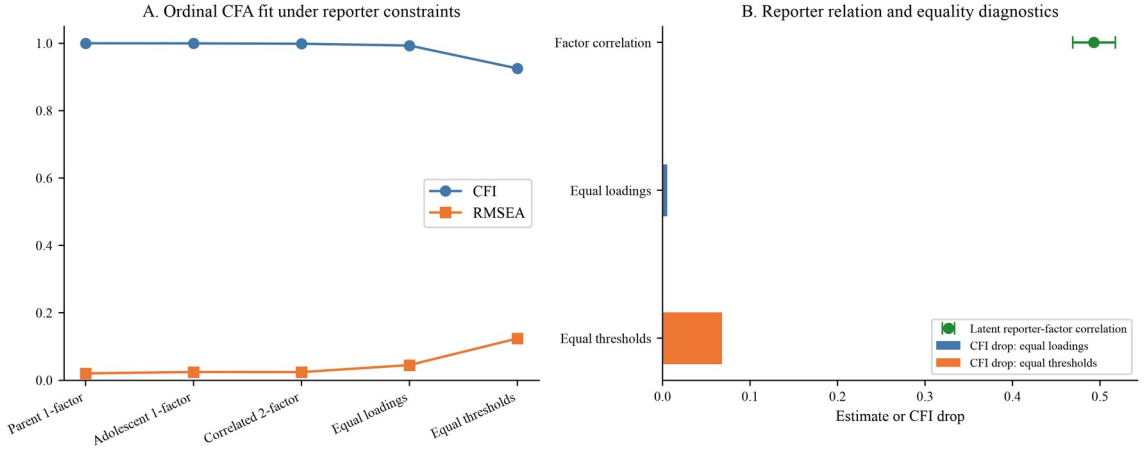
Table S2. Topic-discussion reliability and cross-reporter measurement diagnostics.

Reporter	Ordinal α	ω	Standardized loading range
parent	0.881	0.882	0.735–0.863
adolescent	0.843	0.846	0.636–0.836

Model	CFI	TLI	RMSEA	SRMR
P1: Parent one-factor model	0.9998	0.9993	0.0203	0.0053
A1: Adolescent one-factor model	0.9995	0.9985	0.0244	0.0074
T2: Correlated two-factor model with matched-topic residuals	0.9984	0.9971	0.0241	0.0145
T3: Equal corresponding loadings	0.9930	0.9897	0.0450	0.0275
T4: Equal corresponding thresholds	0.9251	0.9223	0.1239	0.0275

Note. N = 7,455; WLSMV with ordered indicators and theta parameterization. The latent reporter-factor correlation was .493, 95% CI [.469, .517]. Exact scaled tests rejected corresponding-loading equality, $\Delta\chi^2(4) = 254.229$, $p < .001$, and threshold equality, $\Delta\chi^2(8) = 2{,}759.617$, $p < .001$. Equality constraints did not support interchangeability.

Figure S1. Cross-reporter measurement diagnostics.



Separate factors fit well and correlated at .493, but equality constraints—especially thresholds—were not supported. Reporter-specific indices are related but not interchangeable.

Table S3. Longitudinal ordinal invariance of depressive-symptom items.

Model	χ^2	df	CFI	TLI	RMSEA [90% CI]	SRMR	ΔCFI	ΔRMSEA	Accept
M1 configural	141.503	15	.9984	.9970	.0331 [.0282, .0382]	.0125	—	—	Yes
M2 loadings	191.189	18	.9978	.9966	.0354 [.0309, .0400]	.0152	−.0006	.0023	Yes

Model	χ^2	df	CFI	TLI	RMSEA [90% CI]	SRMR	ΔCFI	ΔRMSEA	Accept
M3 full thresholds	294.265	26	.9966	.9964	.0366 [.0329, .0404]	.0140	−.0012	.0013	Yes

Note. N = 7,700. Ordered indicators, WLSMV, theta parameterization, and same-item cross-wave residual correlations. Approximate change criteria supported loading and full-threshold invariance, but exact scaled tests rejected loading equality, $\Delta\chi^2(3) = 112.333$, $p < .001$, and threshold equality, $\Delta\chi^2(8) = 158.342$, $p < .001$. No threshold was released.

Table S4. Complete sample flow for Sample A, B1, and B2.

Sample	Step	Criterion	Remaining	Removed	% W1 Grade 7
Primary sample (A)	1	W1 Grade 7 cohort	10,279	0	100.0%
Primary sample (A)	2	W2 successful follow-up	9,449	830	91.9%
Primary sample (A)	3	W1 biological parent respondent	8,475	974	82.4%
Primary sample (A)	4	W1 parent discussion valid	8,326	149	81.0%
Primary sample (A)	5	W1 adolescent discussion valid	8,027	299	78.1%
Primary sample (A)	6	W1 depressive symptoms valid	7,854	173	76.4%
Primary sample (A)	7	W2 depressive symptoms valid	7,831	23	76.2%
Primary sample (A)	8	locked W1 controls complete	7,595	236	73.9%
Same-parent repeated-measures sample (B1)	1	Sample A eligible	7,831	2,448	76.2%
Same-parent repeated-measures sample (B1)	2	same biological parent respondent W1-W2	5,659	2,172	55.1%
Same-parent repeated-measures sample (B1)	3	W2 adolescent discussion valid	5,584	75	54.3%
Same-parent repeated-measures sample (B1)	4	W2 parent discussion valid	5,533	51	53.8%
Same-parent repeated-measures sample (B1)	5	locked W1 controls complete	5,373	160	52.3%
Sample_B2_same_parent_respondent	1	W1 Grade 7 cohort	10,279	0	100.0%
Sample_B2_same_parent_respondent	2	W2 successful follow-up	9,449	830	91.9%
Sample_B2_same_parent_respondent	3	same biological parent respondent W1-W2	6,112	3,337	59.5%
Sample_B2_same_parent_respondent	4	W1 parent discussion valid	5,998	114	58.4%
Sample_B2_same_parent_respondent	5	W1 adolescent discussion valid	5,791	207	56.3%
Sample_B2_same_parent_respondent	6	W1 depressive symptoms valid	5,673	118	55.2%
Sample_B2_same_parent_respondent	7	W2 depressive symptoms valid	5,659	14	55.1%
Sample_B2_same_parent_respondent	8	locked W1 controls complete	5,486	173	53.4%

Table S5. Locked covariate and SES coding.

Construct	Raw variable	Exact Chinese label	Original coding	Recoding	Primary/ auxiliary status	Notes
Sex	stsex	学生性别	0=女; 1=男	male=0 if stsex=0; male=1 if stsex=1	Primary covariate	Binary sex coding; not a gender-identity measure
Age	a02a	你的出生日期-年	Reported birth year (numeric)	Used with a02b: age_w1=2013.75-[a02a+(a02b-0.5)/12]	Primary component	Approximate W1 age; not exact interview age
Age	a02b	您的出生日期-月	Reported birth month (numeric, 1-12)	Used with a02a: age_w1=2013.75-[a02a+(a02b-0.5)/12]	Primary component	Approximate W1 age; not exact interview age
Only child	stonly	是否独生子女	1=是; 2=不是	1->1; 2->0	Primary covariate	Family-composition control
Co-residence	stlb_2c	父母是否在家同住(二分类)	0=父母都在家; 1=只有一方在家或都不在家	1->1; 0->0 (construction code also maps legacy value 2 to 0)	Primary covariate	Not legal marital status; combines one-parent and neither-parent co-residence
SES Scheme A	stmedu	学生母亲的教育程度	1=没受过任何教育; 2=小学; 3=初中; 4=中专/技校; 5=职高中 ; 6=高中; 7=大学专科; 8=大学本科; 9=研究生及以上	Population-SD z-score; row mean of eight SES components when at least 5/8 are valid	Primary SES component	Higher categories indicate more education
SES Scheme A	stfedu	学生父亲的教育程度	1=没受过任何教育; 2=小学; 3=初中; 4=中专/技校; 5=职高中 ; 6=高中; 7=大学专科; 8=大学本科; 9=研究生及以上	Population-SD z-score; row mean of eight SES components when at least 5/8 are valid	Primary SES component	Higher categories indicate more education
SES Scheme A	b08a	你妈妈是做什么工作的	1=国家机关事业单位领导与工作人员; 2=企业/公司中高级管理人员; 3=教师,工程师,医生,律师; 4=技术工人(包括司机); 5=生产与制造业一般职工; 6=商业与服务业一般职工; 7=个体户; 8=农民; 9=无业,失业,下岗	Project status map: 1/2/3->5; 4/7->3; 5/6->2; 8->1; 9->0; then population-SD z-score for SES Scheme A	Primary SES component	Project-defined mapping; not official ISEI
SES Scheme A	b08b	你爸爸是做什么工作的	1=国家机关事业单位领导与工作人员; 2=企业/公司中高级管理人员; 3=教师,工程师,医生,律师; 4=技术工人(包括司机); 5=生产与制造业一般职工; 6=商业与服务业一般职工; 7=个体户; 8=农民; 9=无业,失业,下岗	Project status map: 1/2/3->5; 4/7->3; 5/6->2; 8->1; 9->0; then population-SD z-score for SES Scheme A	Primary SES component	Project-defined mapping; not official ISEI
SES Scheme A	steco_5c	学生家庭经济状况(五分类)	1=非常困难; 2=比较困难; 3=中等; 4=比较富裕; 5=很富裕	Population-SD z-score; row mean of eight SES components when at least 5/8 are valid	Primary SES component	Higher categories indicate greater perceived family affluence

Construct	Raw variable	Exact Chinese label	Original coding	Recoding	Primary/ auxiliary status	Notes
SES Scheme A	b12	你家里的书多吗(不包括课本,杂志)	1=很少; 2=比较少; 3=一般; 4=比较多; 5=很多	Population-SD z-score; row mean of eight SES components when at least 5/8 are valid	Primary SES component indicator	Household books
SES Scheme A	b11	在你家里,你有自己独立的书桌吗	1=有; 2=没有	1->1; 2->0; then population-SD z-score for SES Scheme A	Primary SES component indicator	Dedicated-desk
SES Scheme A	b13	你家里有电脑和网络吗	0=都没有; 1=有电脑,无网络; 2=有电脑和网络	Population-SD z-score; row mean of eight SES components when at least 5/8 are valid	Primary SES component indicator	Ordered digital-access
Rural hukou	sthktype	学生目前的户口类型	0=非农业户口; 1=农业户口	rural_hukou=0 if 0; rural_hukou=1 if 1	Primary covariate	Distinct from rural school and current rural residence
Migrant status	stmigrant	学生迁移流动状态	1=本地非流动; 2=省内流动; 3=跨省流动	1->0; 2 or 3->1	Primary covariate	Distinct from rural hukou
Achievement	stdchn	学生 2013 年期中考试标准化成绩(均值 70,标准差 10)-语文	Official continuous standardized score (mean 70, SD 10)	Mean of available stdchn/stdmat/stdeng if >=2/3; then (mean-70)/10	Auxiliary	Used in selection/imputation models; not a primary outcome-model covariate
Achievement	stdmat	学生 2013 年期中考试标准化成绩(均值 70,标准差 10)-数学	Official continuous standardized score (mean 70, SD 10)	Mean of available stdchn/stdmat/stdeng if >=2/3; then (mean-70)/10	Auxiliary	Used in selection/imputation models; not a primary outcome-model covariate
Achievement	stdeng	学生 2013 年期中考试标准化成绩(均值 70,标准差 10)-英语	Official continuous standardized score (mean 70, SD 10)	Mean of available stdchn/stdmat/stdeng if >=2/3; then (mean-70)/10	Auxiliary	Used in selection/imputation models; not a primary outcome-model covariate

Table S6. Inverse-probability selection diagnostics and sensitivity analysis.

Panel A. Denominator selection models

Model	Estimator	Term	Estimate	SE	Ridge α
Unpenalized denominator	Unpenalized logistic regression	const	1.4940	0.0290	—
Unpenalized denominator	Unpenalized logistic regression	male	-0.0535	0.0272	—
Unpenalized denominator	Unpenalized logistic regression	age w1	-0.1856	0.0260	—
Unpenalized denominator	Unpenalized logistic regression	only child	0.2139	0.0305	—
Unpenalized denominator	Unpenalized logistic regression	parents not both co residing	-0.5626	0.0237	—
Unpenalized denominator	Unpenalized logistic regression	rural hukou	-0.0872	0.0297	—
Unpenalized denominator	Unpenalized logistic regression	migrant	-0.2075	0.0252	—
Unpenalized denominator	Unpenalized logistic regression	ses a	0.1238	0.0327	—
Unpenalized denominator	Unpenalized logistic regression	w1 achievement z	0.1962	0.0266	—
Unpenalized denominator	Unpenalized logistic regression	w1 dep	-0.0777	0.0256	—
Unpenalized denominator	Unpenalized logistic regression	age w1 missing	-0.2504	0.1505	—
Unpenalized denominator	Unpenalized logistic regression	migrant missing	-0.9869	0.2581	—
Unpenalized denominator	Unpenalized logistic regression	ses a missing	-0.8894	0.6219	—
Unpenalized denominator	Unpenalized logistic regression	w1 achievement z missing	-0.4193	0.1633	—
Unpenalized denominator	Unpenalized logistic regression	w1 dep missing	-26.8866	11705.9562	—
Weak-ridge denominator	Weak-ridge logistic regression	const	1.4931	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	male	-0.0534	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	age w1	-0.1855	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	only child	0.2136	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	parents not both co residing	-0.5622	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	rural hukou	-0.0870	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	migrant	-0.2073	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	ses a	0.1238	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	w1 achievement z	0.1963	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	w1 dep	-0.0777	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	age w1 missing	-0.2497	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	migrant missing	-0.9793	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	ses a missing	-0.8589	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	w1 achievement z missing	-0.4183	—	1e-05
Weak-ridge denominator	Weak-ridge logistic regression	w1 dep missing	-7.4178	—	1e-05

Panel B. Numerator and stabilization

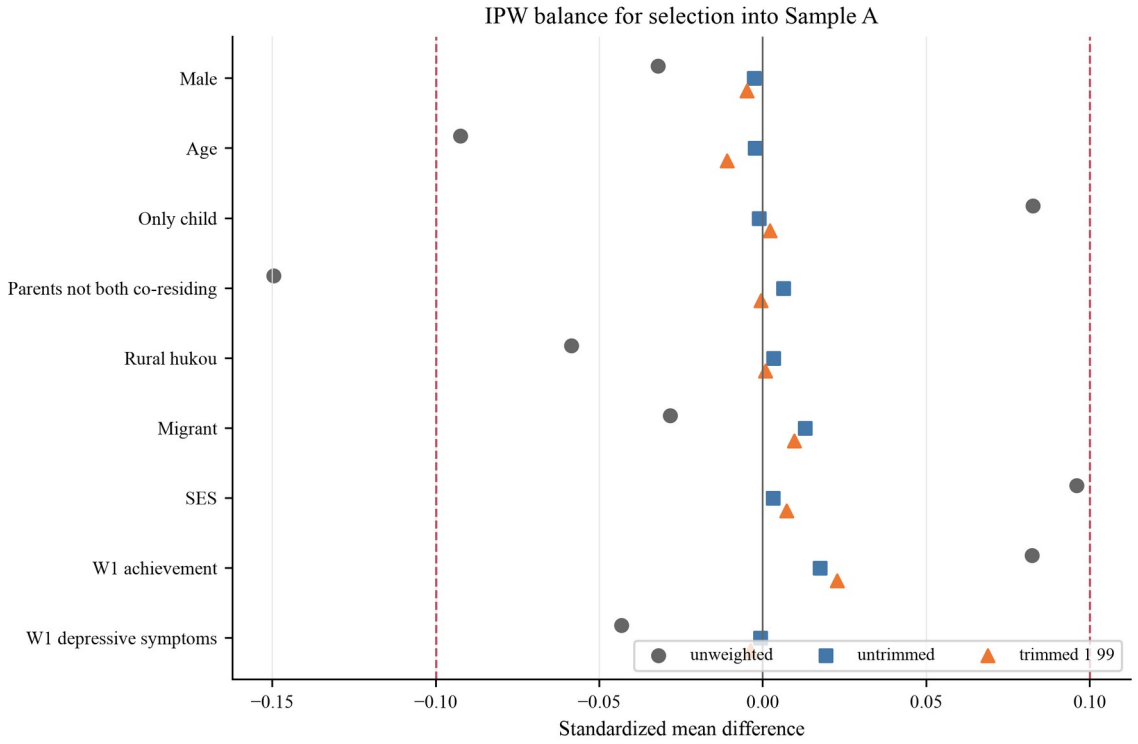
Version	Numerator logit	Numerator	Denominator	Probability bounds	Mean w	Max w	ESS
Untrimmed	1.1628	Pr(S=1)	Pr(S=1|X)	[.01,.99]	0.976	4.308	7386.6
Trimmed at 1st/99th percentiles	1.1628	Pr(S=1)	Pr(S=1|X)	[.01,.99]	0.972	1.962	7462.1

Panel C. Covariate balance and weight diagnostics

Version	Maximum |SMD|	Weight universe N	Outcome-model N	Retained in outcome sensitivity?	Selected using RSA outcome?
Trimmed at 1st/99th percentiles	0.023	7,831	7,595	Yes	No
Untrimmed	0.017	7,831	7,595	No	No
Unweighted	0.150	7,831	7,595	No	No

Note. Baseline-symptom missingness produced definition-induced complete separation because measurement eligibility requires observed baseline symptoms. Weak ridge (α = 10−5) stabilized the denominator model. The final post hoc sensitivity used 1st/99th-percentile-trimmed weights; model stability and balance, not RSA significance, determined this choice. These weights address measured selection into the 7,831-person measurement-eligible sample only; the final 236 complete-covariate exclusions remain unweighted.

Figure S2. Covariate balance before and after inverse-probability weighting.



Dashed lines mark |SMD| = .10. Trimmed maximum |SMD| = .023; balance is limited to measured selection-model covariates.

Table S7. Target-specific multiple-imputation models and reliability gates.

Target	Group	Method	Missing n	Predictors	Converged	Covariance reliable
ba1401	W1 parent discussion	ordered logit	18	144	Yes	Yes
ba1402	W1 parent discussion	ordered logit	43	144	Yes	Yes
ba1403	W1 parent discussion	ordered logit	47	144	Yes	Yes
ba1405	W1 parent discussion	ordered logit	41	144	Yes	Yes
w1_adolescent_school_events	W1 adolescent discussion	ordered logit	41	144	Yes	Yes
w1_adolescent_peer_relations	W1 adolescent discussion	ordered logit	64	144	Yes	Yes
w1_adolescent_teacher_relations	W1 adolescent discussion	ordered logit	101	144	Yes	Yes
w1_adolescent_worries	W1 adolescent discussion	ordered logit	57	144	Yes	Yes
a1801	W1 depressive symptoms	ordered logit	179	143	Yes	Yes
a1803	W1 depressive symptoms	ordered logit	189	143	Yes	Yes
a1804	W1 depressive symptoms	ordered logit	208	143	Yes	Yes

Target	Group	Method	Missing n	Predictors	Converged	Covariance reliable
a1805	W1 depressive symptoms	ordered logit	198	143	Yes	Yes
w2c2501	W2 depressive symptoms	ordered logit	25	143	Yes	Yes
w2c2503	W2 depressive symptoms	ordered logit	39	142	Yes	Yes
w2c2504	W2 depressive symptoms	ordered logit	48	142	Yes	Yes
w2c2506	W2 depressive symptoms	ordered logit	31	142	Yes	Yes
ses_component_mother_education	SES components	ordered logit	4	141	Yes	Yes
ses_component_father_education	SES components	ordered logit	4	141	Yes	Yes
ses_component_mother_occupation_status	SES components	ordered logit	685	141	Yes	Yes
ses_component_father_occupation_status	SES components	ordered logit	626	141	Yes	Yes
ses_component_family_economic	SES components	ordered logit	7	141	Yes	Yes
ses_component_books	SES components	ordered logit	27	141	Yes	Yes
ses_component_desk	SES components	binomial logit	198	141	Yes	Yes
ses_component_digital_access	SES components	ordered logit	113	141	Yes	Yes
age_w1	analysis covariates	bayesian linear	206	141	Yes	Yes
migrant	analysis covariates	binomial logit	46	141	Yes	Yes

Note. *N* = 8,123; m = 30; seed = 20260713. Every target-specific matrix excluded the target and any composite containing it. Exact aliases or zero-variance columns were removed on the observed target subset before fitting. All 26 target models passed convergence and covariance gates; no target or deterministic target-containing composite entered its own predictor matrix. The invalid archived MI estimates are not reproduced or interpreted.

Figure S3. Target-specific multiple-imputation distribution and Monte Carlo diagnostics.

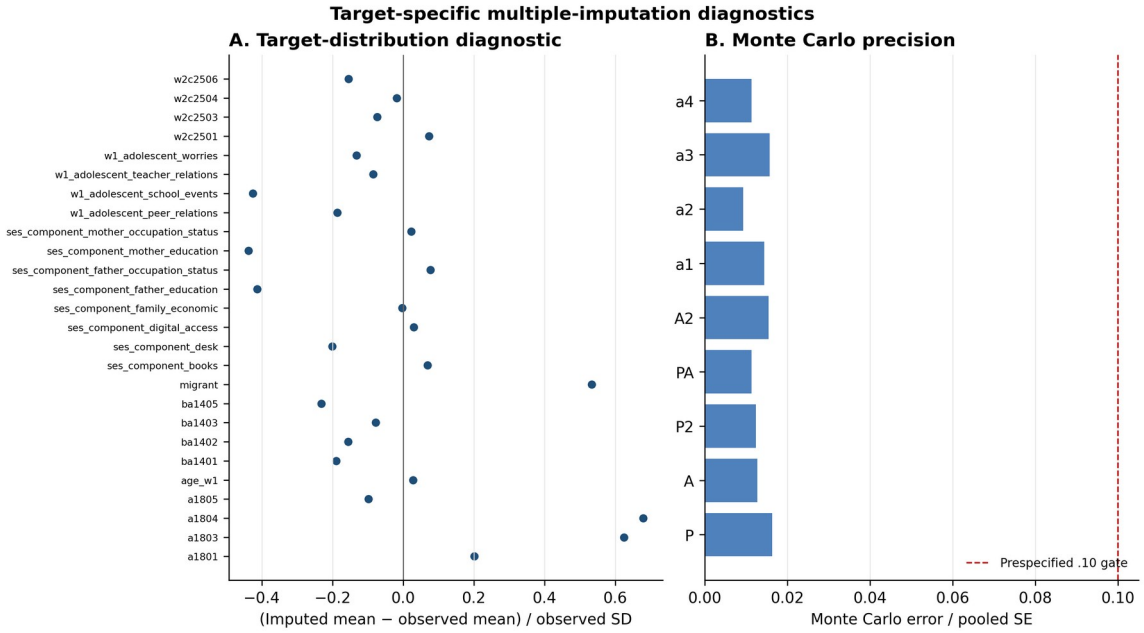


Table S8. Repaired target-specific multiple-imputation coefficients and response-surface parameters.

Quantity	Type	Estimate	95% CI	Raw p	Holm p	MCSE/SE
P	Coefficient	0.007	[−0.052, 0.067]	.807	—	0.016
A	Coefficient	-0.006	[−0.049, 0.037]	.788	—	0.013
P2	Coefficient	-0.015	[−0.081, 0.052]	.668	—	0.012
PA	Coefficient	-0.029	[−0.108, 0.051]	.481	—	0.011

Quantity	Type	Estimate	95% CI	Raw p	Holm p	MCSE/SE
A2	Coefficient	-0.007	[−0.066, 0.051]	.811	—	0.015
a1	Surface parameter	0.002	[−0.062, 0.065]	.962	1.000	0.014
a2	Surface parameter	-0.050	[−0.129, 0.028]	.209	.837	0.009
a3	Surface parameter	0.013	[−0.068, 0.095]	.750	1.000	0.016
a4	Surface parameter	0.007	[−0.147, 0.161]	.931	1.000	0.011

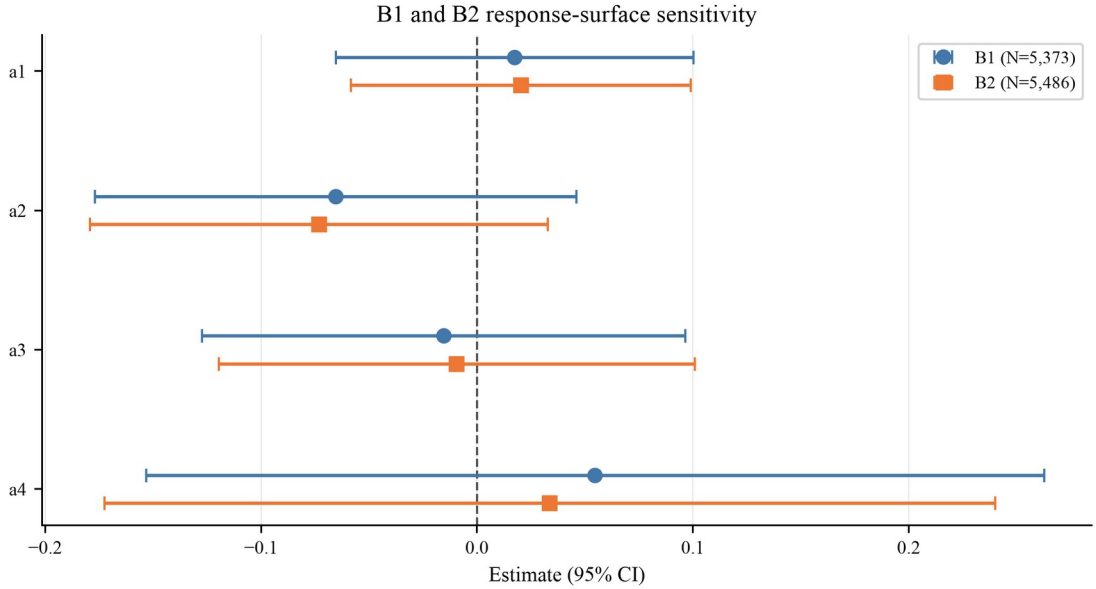
Note. The complete within- and between-imputation covariance matrices for *b1–b5* were combined using Rubin's rules. The same pooled covariance was used to derive *a1–a4*. Holm correction applies only to *a1–a4*. All 30 outcome models completed at N = 8,123, no passive composite or polynomial term remained missing, no range violation occurred, and the maximum MCSE/*SE* was .016. This sensitivity does not replace the complete-case primary model.

Table S9. B1 and B2 polynomial and response-surface results.

Quantity	B1 est.	B1 95% CI	B1 raw p	B1 Holm p	B2 est.	B2 95% CI	B2 raw p	B2 Holm p
P	0.001	[−0.078, 0.080]	.981	—	0.005	[−0.071, 0.082]	.891	—
A	0.016	[−0.043, 0.076]	.583	—	0.015	[−0.042, 0.072]	.608	—
P2	0.002	[−0.089, 0.094]	.957	—	0.001	[−0.090, 0.091]	.991	—
PA	-0.060	[−0.170, 0.050]	.280	—	-0.053	[−0.160, 0.053]	.324	—
A2	-0.008	[−0.086, 0.070]	.841	—	-0.020	[−0.096, 0.056]	.597	—
a1	0.017	[−0.065, 0.100]	.678	1.000	0.020	[−0.059, 0.099]	.612	1.000
a2	-0.066	[−0.177, 0.046]	.246	.985	-0.073	[−0.179, 0.033]	.174	.695
a3	-0.016	[−0.127, 0.096]	.784	1.000	-0.010	[−0.120, 0.101]	.864	1.000
a4	0.055	[−0.153, 0.263]	.604	1.000	0.034	[−0.173, 0.240]	.748	1.000

Note. Holm *p* values apply only to *a1–a4*; coefficient rows show an em dash. Support status is deliberately omitted because support is a two-dimensional property reported in Table S11.

Figure S4. B1 and B2 response-surface sensitivity.



B2 removes the unnecessary W2 discussion-item requirement. Signs were unchanged and all intervals included zero.

Table S10. Father–mother secondary comparison.

Group/contrast	Par.	Estimate	SE	95% CI	Raw p	Holm p
Mother respondents	a1	-0.021	0.042	[-0.104, 0.062]	.622	—
Father respondents	a1	0.036	0.047	[-0.057, 0.128]	.444	—
Father minus Mother	a1	0.057	0.058	[-0.058, 0.171]	.331	1.000
Mother respondents	a2	-0.068	0.052	[-0.172, 0.035]	.195	—
Father respondents	a2	-0.027	0.066	[-0.158, 0.104]	.684	—
Father minus Mother	a2	0.041	0.084	[-0.125, 0.207]	.623	1.000
Mother respondents	a3	0.017	0.064	[-0.111, 0.144]	.798	—
Father respondents	a3	0.056	0.067	[-0.076, 0.188]	.404	—
Father minus Mother	a3	0.039	0.096	[-0.150, 0.229]	.681	1.000
Mother respondents	a4	-0.027	0.119	[-0.263, 0.209]	.822	—
Father respondents	a4	-0.047	0.125	[-0.294, 0.201]	.710	—
Father minus Mother	a4	-0.020	0.185	[-0.387, 0.347]	.915	1.000

Note. Joint five-term interaction Wald $\chi^2(5) = 2.651$, $p = .754$. Group-specific estimates are descriptive; formal contrasts form a separate Holm family.

Table S11. B1 and B2 observed-support grids.

Sample	Parent bin	Adolescent bin	N	Coverage	Density
B1	0	0	77	1.43%	Dense
B1	0	1	60	1.12%	Dense
B1	0	2	30	0.56%	Dense
B1	0	3	20	0.37%	Sparse
B1	0	4	7	0.13%	Sparse
B1	1	0	115	2.14%	Dense
B1	1	1	169	3.15%	Dense
B1	1	2	95	1.77%	Dense
B1	1	3	90	1.68%	Dense
B1	1	4	26	0.48%	Sparse
B1	2	0	131	2.44%	Dense
B1	2	1	313	5.83%	Dense

Sample	Parent bin	Adolescent bin	N	Coverage	Density
B1	2	2	322	5.99%	Dense
B1	2	3	302	5.62%	Dense
B1	2	4	178	3.31%	Dense
B1	3	0	119	2.21%	Dense
B1	3	1	292	5.43%	Dense
B1	3	2	318	5.92%	Dense
B1	3	3	534	9.94%	Dense
B1	3	4	336	6.25%	Dense
B1	4	0	93	1.73%	Dense
B1	4	1	193	3.59%	Dense
B1	4	2	239	4.45%	Dense
B1	4	3	503	9.36%	Dense
B1	4	4	811	15.09%	Dense
B2	0	0	84	1.53%	Dense
B2	0	1	61	1.11%	Dense
B2	0	2	31	0.57%	Dense
B2	0	3	20	0.36%	Sparse
B2	0	4	7	0.13%	Sparse
B2	1	0	120	2.19%	Dense
B2	1	1	176	3.21%	Dense
B2	1	2	95	1.73%	Dense
B2	1	3	91	1.66%	Dense
B2	1	4	28	0.51%	Sparse
B2	2	0	132	2.41%	Dense
B2	2	1	319	5.81%	Dense
B2	2	2	331	6.03%	Dense
B2	2	3	312	5.69%	Dense
B2	2	4	180	3.28%	Dense
B2	3	0	121	2.21%	Dense
B2	3	1	300	5.47%	Dense
B2	3	2	324	5.91%	Dense
B2	3	3	545	9.93%	Dense
B2	3	4	341	6.22%	Dense
B2	4	0	95	1.73%	Dense
B2	4	1	197	3.59%	Dense
B2	4	2	244	4.45%	Dense
B2	4	3	510	9.30%	Dense
B2	4	4	822	14.98%	Dense

Note. Each sample has 25 cells. B1 contains 22 dense and 3 sparse cells; B2 contains 22 dense and 3 sparse cells. Coverage is the cell proportion within the corresponding sample.

Table S12. Primary complete-case Sample A 5 × 5 observed-support grid.

Parent bin	Adolescent bin	n	%	Support status
0	0	127	1.67%	Dense
0	1	83	1.09%	Dense
0	2	42	0.55%	Dense
0	3	28	0.37%	Sparse
0	4	15	0.20%	Sparse
1	0	176	2.32%	Dense
1	1	247	3.25%	Dense
1	2	134	1.76%	Dense
1	3	130	1.71%	Dense
1	4	39	0.51%	Dense
2	0	207	2.73%	Dense
2	1	451	5.94%	Dense
2	2	447	5.89%	Dense
2	3	429	5.65%	Dense
2	4	244	3.21%	Dense
3	0	180	2.37%	Dense
3	1	441	5.81%	Dense
3	2	460	6.06%	Dense
3	3	749	9.86%	Dense
3	4	454	5.98%	Dense
4	0	136	1.79%	Dense
4	1	279	3.67%	Dense
4	2	345	4.54%	Dense
4	3	694	9.14%	Dense
4	4	1058	13.93%	Dense

Note. N = 7,595, matching the primary outcome model. Twenty-three of 25 cells had $n \geq 30$ and covered 99.4% of cases; two sparse cells (n = 28 and n = 15) were masked in surface figures.

Table S13. Model diagnostics and leave-one-school-out stability.

Diagnostic	Value	Interpretation
Scaled condition number	23.1165	No severe numerical instability
Maximum polynomial VIF	2.3323	Below common concern thresholds
Breusch–Pagan	$p < .001$	Heteroskedasticity; clustered SE retained
Predicted outcome range	1.168–4.131	Within 1–5 observed range
LOSO a1 range	−.004 to .009	Near zero
LOSO a2 range	−.070 to −.050	No supported refit
LOSO a3 range	.026 to .049	No supported refit
LOSO a4 range	−.050 to −.012	No supported refit
Dense support	23/25 cells; 99.4%	Two sparse cells masked

Table S14. Python–R independent numerical reproduction.

Quantity	Term	Python	R	Absolute difference
Coefficient	P	0.019427	0.019427	8.01e-16
Coefficient	A	-0.016873	-0.016873	3.47e-17
Coefficient	P2	-0.033829	-0.033829	1.51e-15
Coefficient	PA	-0.012950	-0.012950	3.73e-16
Coefficient	A2	-0.013806	-0.013806	2.83e-16
Surface	a1	0.002554	0.002554	7.70e-16
Surface	a2	-0.060585	-0.060585	1.42e-15
Surface	a3	0.036299	0.036299	8.40e-16
Surface	a4	-0.034685	-0.034685	2.16e-15

Note. All primary *b1-b5* and *a1-a4* values passed absolute tolerance 1×10^{-8}.

Table S15. Official W1–W2 student longitudinal-weight sensitivity.

Term/ parameter	Estimate	SE	95% CI	Raw p	Holm p
P	0.016	0.034	[−0.051, 0.083]	.637	—
A	0.007	0.026	[−0.045, 0.059]	.790	—
P2	−0.033	0.042	[−0.116, 0.051]	.441	—
PA	−0.003	0.050	[−0.102, 0.097]	.958	—
A2	−0.022	0.039	[−0.101, 0.056]	.570	—
a1	0.023	0.036	[−0.048, 0.095]	.521	1.000
a2	−0.058	0.051	[−0.158, 0.043]	.257	1.000
a3	0.009	0.049	[−0.088, 0.106]	.854	1.000
a4	−0.052	0.102	[−0.254, 0.149]	.606	1.000

Note. Post hoc sensitivity using the official CEPS W1–W2 student longitudinal weight, normalized to mean 1, with the otherwise identical school-fixed-effect model and school-cluster-robust covariance. N = 7,595; schools = 112; five-term Wald $\chi^2(5) = 1.377$, $p = .927$. Holm p values apply to a1–a4 only; em dashes identify coefficient rows. The student weight was not calibrated to the final biological-parent dyadic sample and therefore does not replace the unweighted primary model.

Table S16. W1-class cluster-robust coefficient sensitivity.

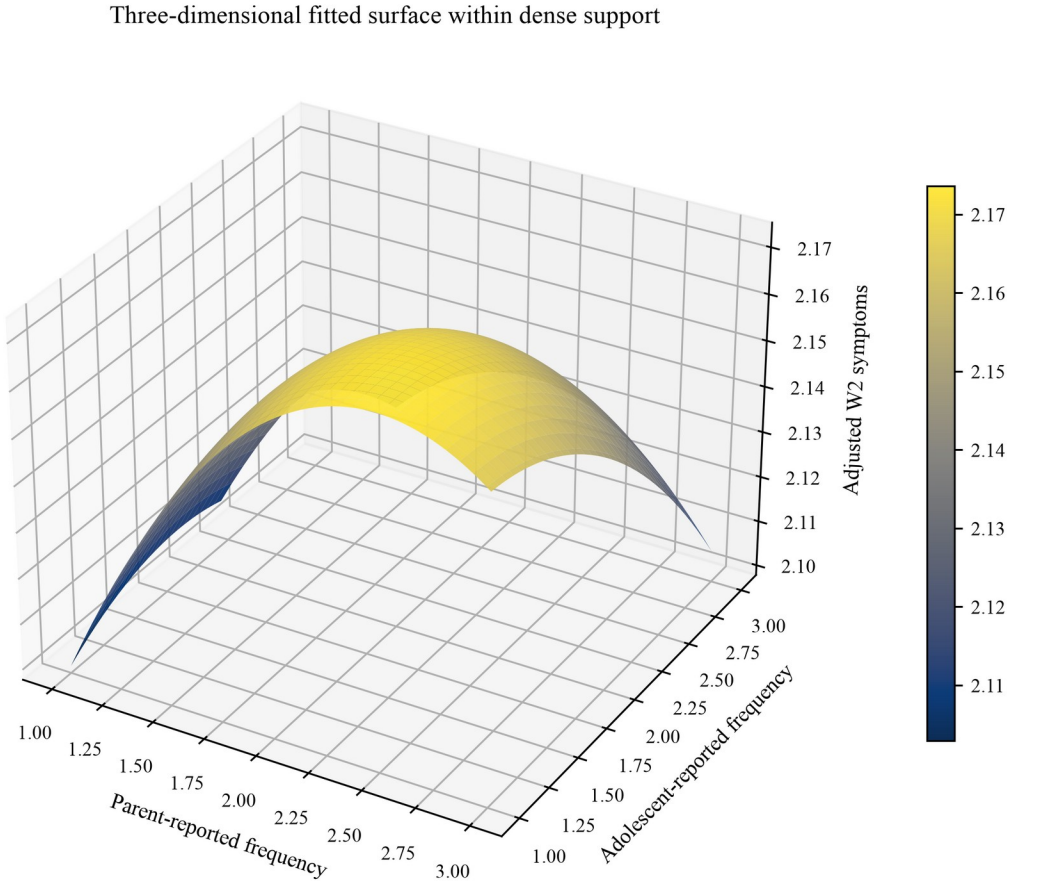
Term	Estimate	SE	95% CI	Raw p	Holm p
P	.019	.030	[−.039, .078]	.513	—
A	−.017	.026	[−.069, .035]	.520	—
P^2	−.034	.036	[−.105, .037]	.347	—
P×A	−.013	.043	[−.098, .072]	.764	—
A^2	−.014	.031	[−.074, .047]	.654	—

Note. N = 7,595; 112 schools; 221 Wave 1 classes. Point estimates are identical to the primary school-cluster specification because only the covariance estimator changes. The reported standard errors, confidence intervals, and p values use W1-class cluster-robust covariance for the five polynomial coefficients. The complete archived W1-class covariance matrix was unavailable for independent reconstruction of a1–a4 uncertainty statistics. This sensitivity is therefore reported at the coefficient level only and is not used for separate response-surface inference.

Table S17. Statistical-analysis deviations and additional diagnostics.

Domain	Original status	Reason/action	Consequence
Clustering specification	Earlier lock named W1-class clustering	School clustering finalized before formal estimates; class clustering retained as sensitivity	Primary school-cluster inference; not result-driven
Sample B2	Not in original lock	Separated same-parent continuity from the W2 discussion-item requirement	Post hoc sensitivity; B1 retained
Cross-reporter equality	Not a confirmatory outcome test	Bounded observed-scale interpretation	No latent interchangeability claim
Weak-ridge IPW	Original denominator separated	Definition-induced baseline-symptom separation required stabilization	Post hoc sensitivity; primary model unchanged
Target-specific MI repair	Archived run used a common contaminated predictor matrix	Discarded old estimates; rebuilt target-specific matrices and passively reconstructed all composites/polynomials	Prespecified missing-data sensitivity retained; primary model unchanged
Joint Wald and incremental R^2	Not originally tabulated	Added block-level information and precision	a1-a4 Holm family unchanged

Figure S5. Three-dimensional fitted surface within dense support.



Note. Supplementary visualization only. The z-axis spans a narrow fitted range; sparse cells are masked and all *a1-a4* Holm tests were unsupported.