

The association of relative deprivation, interpersonal relationships, and problematic social media use in 39 countries/regions: Does school contextual inequality matter?

<https://doi.org/10.1556/2006.2025.00091>

Supplementary materials

Figure S1

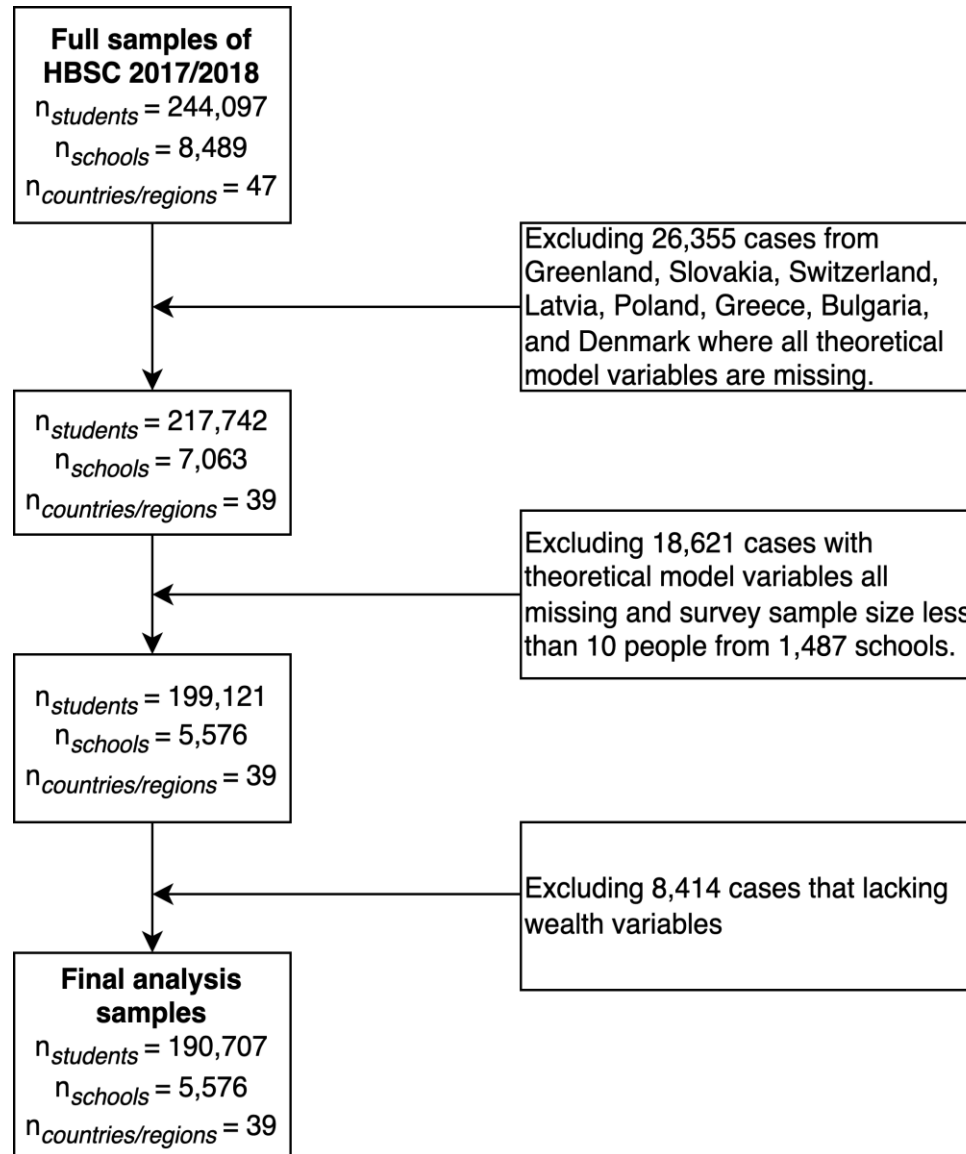


Figure 1: Filter Protocol for HBSC 2017/2018

Figure S2

The Figure 2 displays the Spearman correlation matrix for key variables in the HBSC 2017/2018 dataset, with adjustment for multiple comparisons (Holm method). Significant correlations ($p < 0.05$) are color-coded, with red indicating positive associations and blue indicating negative associations. Non-significant correlations are marked with an “X”. Sample sizes range from 122,869 to 190,717. The matrix reveals significant associations among several variables, supporting the hypothesis that patterns in missing data are predictable.

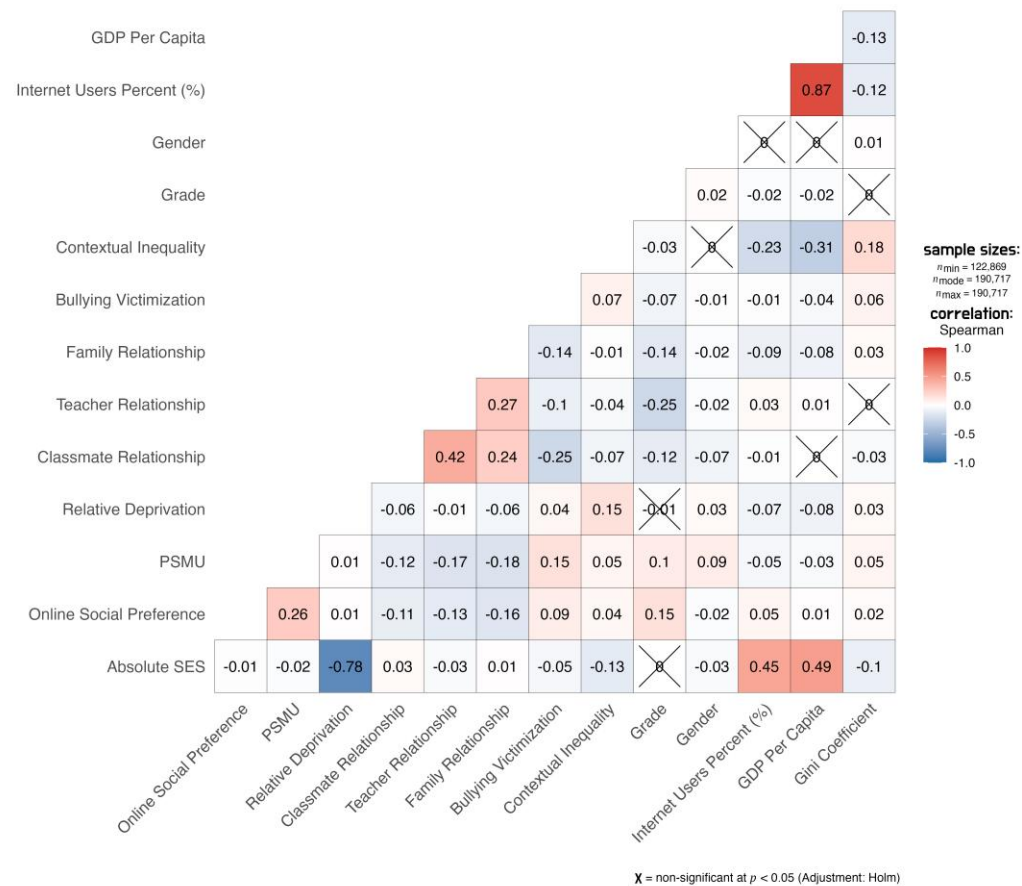


Figure 2: Correlation Matrix of Key Variables in the HBSC 2017/2018

Table S1*Table S1: Country-Level Demographics and Economic Indicators for Adolescent Sample Populations*

Country/Region	Boys	Girls	GDP per Capita (thousands USD)	Gini Coefficient	Internet users (population)
Albania	713	880	4.531	0.331	62.4
Azerbaijan	2,164	2,334	4.147	0.337	79.0
Austria	1,590	1,695	47.429	0.297	87.9
Armenia	2,225	2,231	4.042	0.336	64.7
Belgium (Flemish)	2,037	2,083	44.198	0.274	87.7
Belgium (French)	2,546	2,559	44.198	0.274	87.7
Canada	4,527	4,984	45.130	0.333	92.7
Croatia	2,426	2,393	13.655	0.304	67.1
Czech Republic	5,673	5,605	20.636	0.249	78.7
Estonia	2,308	2,306	20.438	0.304	88.1
Finland	1,462	1,518	46.412	0.274	87.5
France	4,221	4,346	38.781	0.316	80.5
Georgia	2,034	2,065	4.419	0.379	59.7
Germany	1,952	2,220	44.653	0.312	84.4
Hungary	1,332	1,506	14.621	0.306	76.8
Iceland	3,360	3,382	72.010	0.261	98.3
Ireland	1,684	1,658	70.151	0.314	84.1
Israel	2,622	3,126	41.115	0.382	81.6
Italy	1,855	2,042	32.407	0.359	63.1

Kazakhstan	2,381	2,354	9.248	0.275	76.4
Lithuania	1,881	1,862	16.885	0.373	77.6
Luxembourg	1,793	1,809	110.193	0.345	97.4
Malta	1,138	1,281	28.813	0.292	81.0
Republic of Moldova	2,219	2,249	3.453	0.259	49.9
Netherlands	1,963	2,124	48.675	0.285	93.2
Norway	1,314	1,390	76.132	0.270	96.4
Portugal	2,919	3,191	21.490	0.338	73.8
Romania	2,116	2,219	10.728	0.360	63.7
Russia	1,952	2,142	10.659	0.372	76.0
Serbia	1,897	1,954	6.293	0.362	70.3
Slovenia	2,742	2,677	23.514	0.242	78.9
Spain	1,143	1,243	28.185	0.347	84.6
Sweden	1,947	1,993	53.792	0.288	93.0
Turkey	2,730	2,894	10.696	0.414	64.7
Ukraine	2,817	3,171	2.638	0.260	58.9
Macedonia	2,160	2,272	5.955	0.342	74.5
England	1,765	1,541	40.572	0.351	90.4
Scotland	2,266	2,475	40.572	0.351	90.4
Wales	7,494	7,575	40.572	0.351	90.4

Note. GDP per Capita is measured in thousands of US dollars. Gini Coefficient ranges from 0 (perfect equality) to 1 (maximum inequality).

Table S2

Table S2: *Spearman's rank bivariate correlations between study variables*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Relative deprivation	—													
2. PSMU	.01***	—												
3. Classmate relationship	-.06***	-.12***	—											
4. Teacher relationship	-.01***	-.16***	.42***	—										
5. Family relationship	-.06***	-.17***	.24***	.26***	—									
6. Bullying victimization	.04***	.15***	-.25***	-.10***	-.14***	—								
7. SES	-.78***	-.02***	.03***	-.03***	.01***	-.05***	—							
8. Online social interaction preferences	.01***	.25***	-.10***	-.12***	-.15***	.08***	-.01***	—						
9. Family structure	.13***	.07***	-.07***	-.03***	-.10***	.07***	-.18***	.03***	—					
10. Gender	.03***	.08***	-.07***	-.02***	-.02***	-.01***	-.03***	-.01***	.01***	—				
11. Grade	-.00	.10***	-.11***	-.25***	-.14***	-.07***	.00*	.15***	.02***	.02***	—			
12. Contextual inequality	.15***	.05***	-.07***	-.04***	-.01***	.07***	-.13***	.03***	.04***	-.00*	-.01***	—		
13. GDP per	-.08***	-.02***	-.00	.01***	-.08***	-.04***	.49***	.02***	-.05***	-.00	.00	-.31***	—	
14. Gini coefficient	.03***	.05***	-.03***	-.00	.03***	.06***	-.10***	.01***	.08***	.01**	.00	.18***	-.13***	—
15. Internet users (% of population)	-.07***	-.05***	-.01***	.03***	-.09***	-.01***	.45***	.05***	-.00	-.00	.00	-.23***	.87***	-.12***

Note. $p < .05$. ** $p < .01$. *** $p < .001$; The reference group for Gender is *Boy*, for Family Structure is *Both Parents*, and for Grade is the grade level corresponding to being 11 years old in each country or region.

Table S3

Table S3: Multicollinearity analysis of main models

Characteristic	Teacher relationship	Classmate relationship	Family relationship	Bullying victimization	Direct effect	Total effect
	VIF (CI)	VIF (CI)	VIF (CI)	VIF (CI)	VIF (CI)	VIF (CI)
Relative deprivation	2.10 (2.09, 2.11)	2.67 (2.65, 2.69)	1.75 (1.74, 1.76)	2.21 (2.19, 2.22)	1.96 (1.95, 1.98)	1.80 (1.78, 1.81)
Contextual inequality	1.04 (1.04, 1.05)	1.05 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)
SES	2.10 (2.08, 2.11)	2.65 (2.63, 2.67)	1.76 (1.75, 1.77)	2.20 (2.19, 2.22)	1.97 (1.96, 1.98)	1.80 (1.79, 1.82)
Grade	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.10 (1.10, 1.11)	1.03 (1.02, 1.03)
Gender	1.00 (1.00, 1.05)	1.00 (1.00, 1.03)	1.00 (1.00, 1.06)	1.00 (1.00, 1.04)	1.01 (1.00, 1.01)	1.00 (1.00, 1.05)
Online social interaction preferences	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)	1.04 (1.03, 1.04)	1.02 (1.02, 1.03)
Family structure	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.02 (1.02, 1.03)	1.01 (1.01, 1.02)
Gini	1.05 (1.04, 1.05)	1.05 (1.04, 1.05)	1.05 (1.04, 1.05)	1.04 (1.03, 1.04)	1.05 (1.04, 1.05)	1.05 (1.04, 1.05)
Gini coefficient	2.70 (2.68, 2.72)	2.70 (2.68, 2.72)	2.69 (2.67, 2.71)	2.68 (2.66, 2.70)	2.70 (2.68, 2.72)	2.70 (2.68, 2.72)
GDP per	2.72 (2.70, 2.74)	2.72 (2.70, 2.74)	2.71 (2.69, 2.73)	2.70 (2.68, 2.72)	2.72 (2.70, 2.74)	2.72 (2.70, 2.74)
Internet users (% of population)					1.09 (1.08, 1.09)	

Bullying victimization	1.28 (1.27, 1.29)
Teacher relationship	1.27 (1.26, 1.27)
Student relationship	1.06 (1.06, 1.07)

Note. VIF = Variance Inflation Factor; CI = Confidence Interval. The reference group for Gender is *Boy*, for Family Structure is *Both Parents*, and for Grade is the grade level corresponding to being 11 years old in each country or region, adjusted to align with local education systems.

Table S4

Table S4: The three-level null models (Level 1 is individual, Level 2 is school, and Level 3 is country/region) for predicting the outcome and mediating variables

Characteristic	PSMU	Teacher relationship	Classmate relationship	Family relationship	Bullying victimization
<i>Fixed effects</i>	Beta (SE)	Beta (SE)	Beta (SE)	Beta (SE)	Beta (SE)
(Intercept)	1.208*** (0.007)	3.864*** (0.033)	3.906*** (0.034)	5.779*** (0.062)	1.451*** (0.030)
<i>Random effects</i>					
SD (Intercept _{school})	0.043	0.276	0.203	0.290	0.137
SD (Intercept _{country/region})	0.044	0.203	0.214	0.383	0.189
SD (Observations)	0.232	0.870	0.797	1.708	0.927
<i>Goodness-of-fit</i>					
Marginal R ²	0.000	0.000	0.000	0.000	0.000
Conditional R ²	0.065	0.134	0.120	0.073	0.060
AIC	-12357.7	495848.0	460830.2	749099.4	515342.4
BIC	-12317.1	495888.7	460870.9	749140.0	515383.0
ICC _{country/Region}	0.034	0.087	0.057	0.027	0.021
ICC _{School}	0.032	0.047	0.063	0.046	0.039
RMSE	0.23	0.86	0.79	1.70	0.92

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.; SE = Standard Error, SE are in parentheses.

Table S5

Table S5: The two-level null models (Level 1 is individual and Level 2 is country/region) for predicting the outcome and mediating variables

Characteristic	PSMU	Teacher relationship	Classmate relationship	Family relationship	Bullying victimization
<i>Fixed effects</i>	Beta (SE)	Beta (SE)	Beta (SE)	Beta (SE)	Beta (SE)
(Intercept)	1.208*** (0.007)	3.851*** (0.033)	3.903*** (0.034)	5.780*** (0.062)	1.450*** (0.031)
<i>Random effects</i>					
SD (Intercept _{country/region})	0.044	0.204	0.211	0.385	0.190
SD (Observations)	0.235	0.906	0.820	1.731	0.937
<i>Goodness-of-fit</i>					
Marginal R ²	0.000	0.000	0.000	0.000	0.000
Conditional R ²	0.033	0.048	0.062	0.047	0.040
AIC	-10628.3	503679.5	465613.9	750802.3	516495.1
BIC	-10597.8	503710.0	465644.4	750832.8	516525.6
ICC _{country/Region}	0.032	0.047	0.063	0.046	0.039
DEFF	2.248	2.833	3.457	2.794	2.521
RMSE	0.24	0.91	0.82	1.73	0.94

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.; SE = Standard Error, SE are in parentheses.

Table S6*Table S6: Nest models comparison of random Intercept only models and relative deprivation as random slope Models*

	Parameters	AIC	BIC	Log Likelihood	Deviance	χ^2	DF	<i>p</i>
Total effect model (intercept)	14	-25642	-25499	12835	-25670			
Total effect model	16	-25673	-25510	12852	-25705	35.401	2	<0.001
Teacher relationship model (intercept)	14	488630	488773	-244301	488602			
Teacher relationship model	16	488609	488772	-244289	488577	24.921	2	<0.001
Classmate relationship model (intercept)	14	460376	460518	-230174	460348			
Classmate relationship model	16	460372	460534	-230170	460340	8.4436	2	0.015
Family relationship model (intercept)	14	745671	745813	-372822	745643			
Family relationship model	16	745612	745774	-372790	745580	63.554	2	<0.001
Bullying victimization model (intercept)	14	513692	513834	-256832	513664			
Bullying victimization model	16	513650	513813	-256809	513618	45.665	2	<0.001
Direct effect model (intercept)	18	-32869	-32687	16453	-32905			
Direct effect model	20	-32888	-32685	16464	-32928	22.412	2	<0.001

Note. Model fit statistics include AIC (Akaike Information Criterion), BIC (Bayesian Information Criterion), Log Likelihood, Deviance, and chi-square (χ^2) tests for model comparisons, with degrees of freedom (DF) and associated *p* values. Lower AIC and BIC values, as well as significant χ^2 values ($p < 0.05$), indicate improved model fit for models with additional predictors over intercept-only models.

Table S7*Table S7: Country/Region-Specific Indirect Effects of Relative Deprivation on PSMU through Interpersonal Relationships*

Country/Region	Indirect effect			
	Teacher relationship	Classmate relationship	Family relationship	Bullying victimization
Albania	0.0149*** (0.0089, 0.0209)	0.0012** (0.0004, 0.0021)	0.0041 (-0.0021, 0.0104)	0.0035 (-0.0020, 0.0091)
Azerbaijan	0.0171*** (0.0119, 0.0222)	0.0016*** (0.0007, 0.0025)	0.0076* (0.0018, 0.0134)	0.0072* (0.0018, 0.0126)

Austria	0.0209*** (0.0170, 0.0247)	0.0021*** (0.0013, 0.0029)	0.0103*** (0.0065, 0.0141)	0.0115*** (0.0075, 0.0155)
Armenia	0.0167*** (0.0115, 0.0219)	0.0011** (0.0003, 0.0018)	0.0042 (-0.0005, 0.0089)	0.0074** (0.0025, 0.0123)
Belgium (Flemish)	0.0179*** (0.0136, 0.0222)	0.0015*** (0.0007, 0.0022)	0.0109*** (0.0064, 0.0154)	0.0083*** (0.0038, 0.0128)
Belgium (French)	0.0162*** (0.0107, 0.0216)	0.0017*** (0.0009, 0.0026)	0.0081*** (0.0026, 0.0136)	0.0074* (0.0021, 0.0126)
Canada	0.0113*** (0.0075, 0.0152)	0.0011** (0.0004, 0.0017)	0.0015 (-0.0028, 0.0059)	-0.0000 (-0.0043, 0.0042)
Croatia	0.0199*** (0.0150, 0.0249)	0.0016*** (0.0008, 0.0024)	-0.0024 (-0.0071, 0.0024)	0.0072*** (0.0023, 0.0121)
Czech Republic	0.0182*** (0.0138, 0.0227)	0.0014*** (0.0007, 0.0022)	0.0042 (-0.0003, 0.0086)	0.0064** (0.0018, 0.0110)
Estonia	0.0178*** (0.0146, 0.0210)	0.0019*** (0.0012, 0.0026)	0.0055*** (0.0023, 0.0088)	0.0126*** (0.0090, 0.0162)
Finland	0.0134*** (0.0081, 0.0186)	0.0010* (0.0002, 0.0017)	-0.0019 (-0.0075, 0.0037)	0.0017 (-0.0032, 0.0066)
France	0.0153*** (0.0099, 0.0208)	0.0014*** (0.0006, 0.0021)	0.0059* (0.0004, 0.0113)	0.0072** (0.0022, 0.0122)
Georgia	0.0185*** (0.0133, 0.0236)	0.0015*** (0.0006, 0.0023)	0.0046 (-0.0005, 0.0097)	0.0066* (0.0014, 0.0118)
Germany	0.0195*** (0.0149, 0.0241)	0.0015*** (0.0007, 0.0023)	0.0056* (0.0010, 0.0102)	0.0077** (0.0029, 0.0126)
Hungary	0.0167*** (0.0116, 0.0218)	0.0015*** (0.0007, 0.0024)	0.0068** (0.0018, 0.0119)	0.0022 (-0.0029, 0.0073)

Iceland	0.0176*** (0.0124, 0.0229)	0.0014** (0.0006, 0.0022)	0.0008 (-0.0044, 0.0061)	0.0017 (-0.0035, 0.0068)
Ireland	0.0172*** (0.0125, 0.0220)	0.0018*** (0.0010, 0.0027)	0.0079** (0.0029, 0.0129)	0.0109*** (0.0061, 0.0157)
Israel	0.0149*** (0.0101, 0.0196)	0.0015*** (0.0007, 0.0024)	0.0095*** (0.0046, 0.0143)	0.0061* (0.0011, 0.0112)
Italy	0.0189*** (0.0131, 0.0247)	0.0019*** (0.0010, 0.0027)	0.0092*** (0.0034, 0.0151)	0.0079*** (0.0025, 0.0134)
Kazakhstan	0.0151*** (0.0097, 0.0205)	0.0014** (0.0005, 0.0023)	0.0067** (0.0014, 0.0119)	0.0050 (-0.0000, 0.0100)
Lithuania	0.0127*** (0.0070, 0.0183)	0.0009* (0.0000, 0.0019)	0.0065* (0.0004, 0.0126)	0.0032 (-0.0020, 0.0084)
Luxembourg	0.0163*** (0.0122, 0.0204)	0.0014*** (0.0006, 0.0021)	0.0079*** (0.0041, 0.0118)	0.0047* (0.0002, 0.0092)
Malta	0.0149*** (0.0102, 0.0197)	0.0015*** (0.0007, 0.0023)	0.0037 (-0.0012, 0.0086)	0.0038 (-0.0014, 0.0090)
Republic of Moldova	0.0147*** (0.0102, 0.0193)	0.0013*** (0.0005, 0.0021)	0.0045 (-0.0002, 0.0092)	0.0021 (-0.0029, 0.0072)
Netherlands	0.0167*** (0.0116, 0.0218)	0.0013** (0.0004, 0.0021)	0.0067** (0.0019, 0.0115)	0.0051* (0.0003, 0.0098)
Norway	0.0163*** (0.0120, 0.0206)	0.0019*** (0.0010, 0.0027)	-0.0012 (-0.0055, 0.0031)	0.0059* (0.0011, 0.0108)
Portugal	0.0176*** (0.0129, 0.0224)	0.0013** (0.0004, 0.0021)	0.0092*** (0.0036, 0.0148)	0.0080*** (0.0032, 0.0128)
Romania	0.0146*** (0.0093, 0.0199)	0.0012* (0.0004, 0.0020)	-0.0010 (-0.0063, 0.0044)	0.0004 (-0.0046, 0.0053)

Russia	0.0196*** (0.0147, 0.0244)	0.0014** (0.0006, 0.0022)	0.0066** (0.0018, 0.0115)	0.0051* (0.0001, 0.0102)
Serbia	0.0134*** (0.0089, 0.0178)	0.0009* (0.0001, 0.0016)	0.0030 (-0.0016, 0.0076)	0.0026 (-0.0020, 0.0072)
Slovenia	0.0143*** (0.0107, 0.0179)	0.0014*** (0.0007, 0.0021)	-0.0017 (-0.0053, 0.0019)	0.0028 (-0.0009, 0.0065)
Spain	0.0166*** (0.0110, 0.0222)	0.0014*** (0.0005, 0.0023)	0.0056 (0.0001, 0.0111)	0.0014 (-0.0041, 0.0069)
Sweden	0.0191*** (0.0145, 0.0238)	0.0015*** (0.0006, 0.0024)	0.0020 (-0.0031, 0.0070)	0.0087** (0.0041, 0.0133)
Turkey	0.0184*** (0.0136, 0.0232)	0.0016** (0.0008, 0.0024)	0.0045 (-0.0002, 0.0092)	0.0111*** (0.0062, 0.0160)
Ukraine	0.0140*** (0.0102, 0.0179)	0.0013*** (0.0005, 0.0021)	0.0076*** (0.0029, 0.0122)	0.0058* (0.0011, 0.0105)
Macedonia	0.0142*** (0.0095, 0.0188)	0.0013** (0.0005, 0.0021)	-0.0011 (-0.0058, 0.0035)	0.0068** (0.0021, 0.0115)
England	0.0102*** (0.0058, 0.0146)	0.0009* (0.0001, 0.0016)	0.0006 (-0.0044, 0.0056)	0.0050* (0.0002, 0.0097)
Scotland	0.0167*** (0.0122, 0.0212)	0.0013*** (0.0005, 0.0021)	0.0034 (-0.0013, 0.0082)	0.0004 (-0.0041, 0.0050)
Wales	0.0103*** (0.0057, 0.0150)	0.0012** (0.0003, 0.0020)	0.0042 (-0.0006, 0.0089)	0.0071** (0.0022, 0.0120)

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.; Indirect effects represent the estimated mediation paths from *Relative Deprivation* to *Problematic Social Media Use (PSMU)* through *Teacher Relationship*, *Classmate Relationship*, *Family Relationship*, and *Bullying Victimization* for each country/region. Values are presented with 95% Confidence Intervals (CI) calculated using Monte Carlo simulations.