

Table 1 Descriptive statistics

	Male	Female	MZ	DZ	Total sample
Total N (%)	4576 (44.8)	5646 (55.2)	3636 (35.6)	6586 (64.4)	10222 (100)
Age mean (SD)	16.30 (0.69)	16.34 (0.67)	16.35 (0.66)	16.30 (0.69)	16.32 (0.68)
Mean PSQI (SD) †† (N=7572)	4.34 (2.66)	4.96 (2.84)	4.55 (2.71)	4.74 (2.81)	4.67 (2.78)
Mean ISI (SD) †† (N=7853)	3.33 (3.87)	4.29 (4.44)	3.66 (4.11)	3.95 (4.27)	3.85 (4.22)
Mean SMFQ (SD) †† (N=10142)	2.69 (3.54)	4.41 (4.92)	3.48 (4.40)	3.72 (4.46)	3.64 (4.44)
Mean SDQ <sub>anxiety</sub> (SD) † (N=10130)	1.94 (1.86)	3.40 (2.31)	2.73 (2.26)	2.76 (2.24)	2.75 (2.24)
Mean CASI (SD) † (N=10140)	6.13 (4.85)	9.41 (6.18)	7.98 (5.87)	7.93 (5.86)	7.95 (5.86)

Note: 7148 participants had data for all the variables. ISI: Insomnia Severity Index; PSQI: Pittsburgh Sleep Quality Index; SMFQ: Short Mood and Feelings Questionnaire; SDQ: Strengths and Difficulties Questionnaire; CASI: Children's Anxiety Sensitivity Index

†† Significant differences ( $p < .05$ ) between MZ-DZ and Male-Female.

† Significant differences ( $p < .05$ ) between Male-Female.

Table 2: Univariate analyses

	Model	Model for comparison	A (95% CI)	C/D (95% CI)	E (95% CI)	df	-2LL	AIC	DiffLL	Diffdf	P	rMZ	rDZ
Sleep quality												0.43 (0.38,0.47)	0.19 (0.15,0.23)
	ADE		0.34 (0.18,0.45)	0.10 (0,0.27)	0.57 (0.53,0.61)	7566	11510.74	-3621.26					
	<b>AE</b>	ADE	<b>0.42 (0.38,0.46)</b>	*	<b>0.58 (0.54,0.62)</b>	<b>7567</b>	<b>11511.91</b>	<b>-3622.09</b>	<b>1.17</b>	<b>1</b>	<b>0.28</b>		
	E	AE	*	*	1 (1,1)	7568	11847.70	-3288.30	335.79	1	<0.001		
Insomnia												0.42 (0.38,0.46)	0.17 (0.14,0.21)
	ADE		0.26 (0.11,0.42)	0.16 (0,0.33)	0.58 (0.53,0.62)	7847	18909.28	3215.28					
	<b>AE</b>	ADE	<b>0.41 (0.37,0.44)</b>	*	<b>0.59 (0.56,0.63)</b>	<b>7848</b>	<b>18912.79</b>	<b>3216.79</b>	<b>3.51</b>	<b>1</b>	<b>0.06</b>		
	E	AE	*	*	1 (1,1)	7849	19253.94	3555.94	341.15	1	<0.001		
Depression												0.42 (0.38,0.46)	0.27 (0.24,0.30)
	<b>ACE</b>		<b>0.29 (0.20,0.38)</b>	<b>0.13 (0.06,0.20)</b>	<b>0.58 (0.55,0.62)</b>	<b>10136</b>	<b>25157.21</b>	<b>4885.21</b>					
	AE	ACE	0.45 (0.41,0.47)	*	0.55 (0.53,0.59)	10137	25169.06	4895.05	11.84	1	<0.001		
	CE	ACE	*	0.33 (0.30,0.35)	0.67 (0.65,0.70)	10137	25192.53	4918.53	35.32	1	<0.001		
	E	AE	*	*	1 (1,1)	10138	25755.64	5479.64	589.59	1	<0.001		
Anxiety												0.41 (0.37,0.45)	0.16 (0.13,0.19)
	<b>ADE</b>		<b>0.23 (0.09,0.37)</b>	<b>0.17 (0.02,0.32)</b>	<b>0.59 (0.56,0.63)</b>	<b>10124</b>	<b>18994.53</b>	<b>-1253.47</b>					
	AE	ADE	0.39 (0.35,0.42)	*	0.61 (0.58,0.65)	10125	18999.51	-1250.49	4.98	1	0.03		
	E	AE	*	*	1 (1,1)	10126	19403.67	-848.32	404.16	1	<0.001		
Anxiety Sensitivity												0.41 (0.37, 0.45)	0.22 (0.19, 0.25)
	ACE		0.35 (0.25,0.43)	0.05 (0,0.12)	0.60 (0.57,0.64)	10134	21548.43	1280.93					
	<b>AE</b>	ACE	<b>0.41 (0.38,0.44)</b>	*	<b>0.59 (0.56,0.62)</b>	<b>10135</b>	<b>21550.69</b>	<b>1280.69</b>	<b>1.76</b>	<b>1</b>	<b>0.18</b>		
	CE	ACE	*	0.29 (0.26,0.32)	0.71 (0.69,0.74)	10135	21596.40	1326.41	47.48	1	<0.001		
	E	AE	*	*	1 (1,1)	10136	22036.98	1764.98	486.29	1	<0.001		

Note: A, additive genetic influence; C, shared environmental influence; D, dominant genetic influence; E, non-shared environmental influence; -2LL, negative 2 log-likelihood; AIC, Akaike's information criterion; CI, confidence interval; df, degrees of freedom; P-value, significance value of the likelihood-ratio chi-square test; rDZ, dizygotic correlations; rMZ, monozygotic correlations. Bold text indicates best fitting models

Table 3: cross-twin cross-trait correlations

Measure	MZ		DZ	
	Estimate	95% CI	Estimate	95% CI
Cross-trait cross-twin correlation from the multivariate AE model				
Sleep quality-Insomnia	0.34	(0.32,0.36)	0.17	(0.15,0.18)
Sleep quality-Depression	0.31	(0.29,0.32)	0.16	(0.15,0.16)
Sleep quality-Anxiety	0.24	(0.21,0.26)	0.12	(0.11,0.13)
Sleep quality-Anxiety Sensitivity	0.21	(0.19,0.24)	0.11	(0.09,0.12)
Insomnia-Depression	0.31	(0.28,0.32)	0.15	(0.14,0.16)
Insomnia-Anxiety	0.23	(0.20,0.25)	0.11	(0.10,0.13)
Insomnia-Anxiety Sensitivity	0.21	(0.18,0.23)	0.10	(0.09,0.12)
Depression-Anxiety	0.33	(0.31,0.34)	0.17	(0.15,0.18)
Depression-Anxiety Sensitivity	0.29	(0.27,0.31)	0.15	(0.14,0.15)
Anxiety-Anxiety-Sensitivity	0.28	(0.26,0.31)	0.14	(0.13,0.15)

Note: A, additive genetic influence; E, non-shared environmental influence; DZ, dizygotic; MZ, monozygotic

Table 4: Model fit statistics

Model	-2LL	df	Parameters	AIC	diffLL	Diffdf	<i>p</i>
SATURATED	80702.18	45699	138	-10695.82			
ACE	80861.07	45777	60	-10692.93	158.89	78	<0.001
AE	80880.39	45792	45	-10703.61	19.32	15	0.20
CE	81063.43	45792	45	-10520.57	202.36	15	<0.001
E	82206.23	45807	30	-9407.77	1325.84	15	<0.001

-2LL= fits statistic; A= additive genetic influences; AIC= akaike information criterion; C common environmental influences; df= degrees of freedom; E= unique environmental influences; P= significance value of the likelihood ration chi-square test;

Table 5: Multivariate AE model

	Sleep Quality	Insomnia	Depression	Anxiety	Anxiety Sensitivity
Additive genetic and nonshared environmental overlap between phenotypes					
Sleep Quality					
Insomnia	rA=0.85 (0.82,0.87) rE=0.59 (0.56,0.62) rPH=0.69 (0.68,0.71)				
Depression	rA=0.73 (0.72,0.77) rE=0.27 (0.24,0.30) rPH=0.46 (0.44,0.48)	rA=0.73 (0.68,0.74) rE=0.28 (0.24,0.32)			
Anxiety	rA=0.61 (0.55,0.62) rE=0.26 (0.22,0.30) rPH=0.39 (0.38,0.41)	rA=0.59 (0.53,0.65) rE=0.26 (0.24,0.30) rPH=0.39 (0.37,0.41)	rA=0.82 (0.79,0.85) rE=0.48 (0.45,0.51) rPH=0.62 (0.61,0.63)		
Anxiety Sensitivity	rA=0.52 (0.47,0.57) rE=0.23 (0.19,0.27) rPH=0.35 (0.33,0.37)	rA=0.51 (0.45,0.57) rE=0.23 (0.19,0.27) rPH=0.34 (0.32,0.35)	rA=0.68 (0.65,0.72) rE=0.32 (0.29,0.35) rPH=0.47 (0.46,0.49)	rA=0.72 (0.68,0.77) rE=0.36 (0.33,0.39) rPH=0.50 (0.49,0.52)	
Additive genetic and nonshared environmental on the phenotypes and their association					
Sleep Quality	<b>A=0.40 (0.37,0.44)</b> <b>E=0.60 (0.56,0.60)</b>				
Insomnia	A=0.49 (0.44,0.53) E=0.51 (0.47,0.52)	<b>A=0.40 (0.37,0.43)</b> <b>E=0.60 (0.57,0.63)</b>			
Depression	A=0.66 (0.63,0.71) E=0.34 (0.30,0.37)	A=0.66 (0.64,0.70) E=0.34 (0.30,0.40)	<b>A=0.44 (0.42,0.47)</b> <b>E=0.56 (0.53,0.58)</b>		
Anxiety	A=0.60 (0.54,0.66) E=0.40 (0.34,0.46)	A=0.59 (0.53,0.65) E=0.41 (0.35,0.43)	A=0.54 (0.50,0.58) E=0.46 (0.43,0.50)	<b>A=0.37 (0.35,0.40)</b> <b>E=0.63 (0.59,0.66)</b>	
Anxiety Sensitivity	A=0.61 (0.54,0.67) E=0.39 (0.32,0.41)	A=0.60 (0.53,0.67) E=0.40 (0.34,0.47)	A=0.61 (0.58,0.65) E=0.39 (0.35,0.40)	A=0.56 (0.52,0.60) E=0.44 (0.39,0.44)	<b>A=0.41 (0.38,0.43)</b> <b>E=0.59 (0.57,0.62)</b>

Bold figures in the lower part of the table represent within-trait standardized components of the variance and figures below the diagonal represent the standardized components of the covariance; A, additive genetic influence; E, non-shared environmental influence; rA= additive genetic correlation; rE non-shared environmental correlation; rPH phenotypic correlation from the model

