Independent associations between residential neighbourhood and school characteristics and adolescent mental health in the Netherlands

Mathilde E. Brons [a,*], Gideon S. Bolt [b], Marco Helbich [b], Kirsten Visser [b], Gonneke W.J. M. Stevens [a]

[a] *Department of Interdisciplinary Social Science, Utrecht University, Utrecht, the Netherlands*
[b] *Department of Human Geography and Spatial Planning, Utrecht University, Utrecht, the Netherlands*

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ABSTRACT

This study examined associations between characteristics of the residential neighbourhood and the school and adolescent mental health, including the moderating role of family socioeconomic status (SES) and family support. Nationally representative Dutch data from adolescents aged 12–16 (N = 6422) were analysed through cross-classified multilevel models. Findings showed that school characteristics are more strongly linked to adolescent mental health than residential neighbourhood characteristics. More specifically, higher levels of school SES were associated with more hyperactivity-inattention problems, while higher levels of school social disorder were related to more conduct problems and more peer relationship problems. Further, higher levels of school SES were associated with more emotional symptoms only for adolescents with a relatively low family SES. Higher levels of neighbourhood SES were associated with fewer peer relationship problems. Overall, there was little evidence for the moderating role of family SES or family support.

1. Introduction

With a global prevalence of about 13% of adolescents suffering from mental health problems (Polanczyk et al., 2015), it is of vital importance to identify both risk and protective factors for these mental health problems. In addition to person-level characteristics such as gender and socioeconomic status (Afifi, 2007; Rivenbark et al., 2019), there is increasing evidence that contextual factors matter. Ecological theory posits that environmental contexts influence mental health problems among adolescents (Bronfenbrenner, 1977; Cohen et al., 2009; Minh et al., 2017). The residential neighbourhood and school context represent the most important out-of-home environmental contexts, within which adolescents spend a substantial amount of their daily life given compulsory education and mobility restrictions (Allison et al., 1999).

Two often studied contextual characteristics within these contexts include physical factors such as the amount of greenspace and air pollution (Jennings and Bamkole, 2019; Mueller et al., 2019; Vanaken and Danckaerts, 2018; Zhang et al., 2020) and social factors, particularly socioeconomic status (SES), social environment and social disorder (Aldridge and McChesney, 2018; Visser et al., 2020). It is important to consider both physical and social factors, not only because these are

both related to adolescent mental health, but also because they are interrelated (Sugiyama et al., 2008). For instance, nearby greenspace can stimulate social activities within neighbourhoods (Ruijsbroek et al., 2017).

Results from prior studies were mixed regarding whether and to what extent physical and social factors are related to adolescent mental health. Some concluded that less greenspace, more air pollution, higher social disorder, lower SES, and a worse social environment within residential neighbourhoods are associated with worse adolescent mental health (Aminzadeh et al., 2013; Humphrey and Root, 2017; Lawler et al., 2017; Roberts et al., 2019). Yet, others neither found an association between the physical factors (Gubbels et al., 2016; Mueller et al., 2019) nor the social factors (Brazil and Clark, 2017; McKelvey et al., 2011; Roosa et al., 2010) and adolescent mental health.

Results on the school context also were inconsistent. Some studies concluded that less greenspace and more air pollution around the school and less positive social school factors (e.g., lower SES, higher social disorder and worse social environment) are associated with worse adolescent mental health (Aldridge and McChesney, 2018; Boen et al., 2020; Forns et al., 2016; Mohai et al., 2011; Zhang et al., 2020). However, some studies reported no associations for the physical factors

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(Huynh et al., 2013; Srugo et al., 2019) or the social factors (Eisman et al., 2015; László et al., 2019; Nalls et al., 2009).

At least two limitations may explain these inconsistent findings across studies. First, most studies included either the residential neighbourhood or the school. Assessing only one context likely insufficiently captures adolescents' daily life as adolescents operate in multiple settings, each potentially affecting mental health (Helbich, 2018). Excluding either the residential neighbourhood or the school context risks an "omitted context bias", wherein the variance of the missing context is misattributed to the included context due to (partially) overlapping contexts (Evans et al., 2016; Milliren et al., 2018). Only a few studies considered both residential neighbourhood and school contexts simultaneously and it remains unclear which context is most important for adolescent mental health. While some studies found that only school characteristics are important (De Clercq et al., 2014; Dunn et al., 2015; Sykes and Musterd, 2011), others concluded that characteristics of both contexts matter (Aminzadeh et al., 2013; Niu et al., 2019; Williams et al., 2015).

Second, only a few studies addressed how family resources exacerbate or alleviate contextual effects on adolescent mental health (Ma and Klein, 2018; Singh and Ghandour, 2012). It is crucial to investigate this as the vulnerability to environmental effects may vary across adolescents (Brady et al., 2018; Lyubomirsky and Layous, 2013; Oberwittler, 2007; Sharkey and Faber, 2014). More specifically, the adverse effects of the residential neighbourhood or school may be stronger for adolescents with lower levels of family SES and/or family support than for those with higher levels of family SES and family support (Diez Roux, 2001). In general, the former groups are more at risk to parental stress and family conflicts (Conger et al., 1995; Östberg and Hagekull, 2000; Samaan, 2000). Experiencing such stressors makes coping with challenges in the residential neighbourhood or at school more difficult (e.g., environmental stressors like air pollution or social problems like bullying). This accumulation of disadvantages (Lima et al., 2010) may harm adolescent mental health disproportionally (Aneshensel, 2009; Nurius et al., 2015). Alternatively, family resources may protect adolescents from the negative influence of contexts on their mental health (Huang et al., 2020). When adolescents encounter negative events or stressors in their environments (e.g., school or neighbourhood), it takes certain resources to cope with this (Wight et al., 2006). Perceived family social support and economical resources of the family can be particularly important resources for adolescents to buffer against the adverse effects of the neighbourhood or school. Thus, thee above assumes that the adverse effects of the neighbourhood and school are stronger for those with lower levels of family SES and family support, than those with higher levels of family SES and family support. Kim and Ross (2009) examined the moderating role of social support while only considering the residential neighbourhood context. In line with our expectations, they found that the association between neighbourhood disorder and depression was weaker for adolescents with high levels of social support than for those with low levels of social support.

To address these limitations, this study assessed, first, whether and to what extent several characteristics of the residential neighbourhood and the school were related to multiple mental health indicators using a nationally representative sample of Dutch adolescents. Second, we investigated whether these associations varied across family SES and family support. We expected that less greenspace, more air pollution, and negative social factors (i.e., low SES, high social disorder, and a poor social environment) in either the residential neighbourhood or at school are associated with worse mental health. We further expected that adverse effects of the neighbourhood and school were stronger for adolescents with lower levels of family SES and family support, than for those with higher levels of family SES and family support.

2. Data and methods

2.1. Study population

Data from the 2017 Dutch Health Behaviour in School-Aged Children (HBSC) study were used. HBSC is a cross-sectional survey conducted every four years including a nationally representative sample of adolescents aged 11–16 years. For this study, participants attending secondary education were selected. Respondents were sampled based on the following two-stage random cluster procedure. First, a random sample of schools in the Netherlands was drawn stratified by urbanisation level. Second, within each participating school, 3 to 5 classes (depending on school size) were randomly selected. Within the selected class, all students were eligible. Research assistants administered questionnaires. Ethical approval was gained from the Ethics Assessment Committee of the Faculty of Social Sciences at Utrecht University (FETC17-079).

The school-level response rate for secondary schools was 37%, and the student-level response rate was 92%. The participants were aged between 12 and 16 (mean = 13.916; standard deviation (SD) = 1.353), of which 52% were girls. Due to missing data, 2.87% of the participants were excluded resulting in a total sample of 6422 respondents nested in 1398 residential neighbourhoods and 85 schools. Both the residential and school contexts were represented through 4-digit postal code with an average size of 10.212 m^2 (SD = 19.733).

2.2. Measures

2.2.1. Adolescent mental health

Mental health was assessed through the revised version of the Strength and Difficulties Questionnaire (SDQ-R) (Duinhof et al., 2020a). Research on this sample indicated that the SDQ-R showed better psychometric properties than the original SDQ (Duinhof et al., 2020b). In the SDQ-R, reverse worded items were excluded from the original SDQ. The SDQ-R covers 15 items about adolescent behaviours and emotions in the past six months (e.g., "I worry a lot", "I am restless, I cannot stay still for long"). Each item was assessed on a three-point Likert scale ranging from "not true" (0) to "certainly true" (2). The SDQ-R consists of four subscales: emotional symptoms (5 items), hyperactivity-inattention problems (3 items), conduct problems (4 items), and peer relationship problems (3 items). For each subscale, respondents were included if at least half of the items were filled out, with the highest percentage of missing values for the subscale peer relationship problems (0.79%). For each subscale, we averaged the items with higher (mean) values denoting more mental health problems.

2.2.2. Neighbourhood-level variables

Neighbourhood SES was measured by neighbourhood deprivation. Neighbourhood deprivation was assessed with a composite measure based on person-level register data from 2016 aggregated per 4-digit postal code (Roberts et al., 2020). It was constructed by z-scoring and summing three area-level characteristics: unemployment rate, standardized median household income (reverse coded), and share of households with a standardized income below the poverty line. Easing the interpretation, scores were reversely coded with higher scores referring to higher neighbourhood SES.

Neighbourhood social environment was measured with the neighbourhood social fragmentation index which was also retrieved from 2016 register data and was constructed by summing up the z-scores of the following three area-level variables per 4-digit postal code: percentage of adult residents above 18 years who were unmarried, percentage of adult residents living in a single-person household, and percentage of residents above 18 years who had moved to the address within the past 12 months. High residential turnover, high numbers of single-person households, and high numbers of unmarried households within the neighbourhood have been associated with poor community

integration (Roberts et al., 2020). We reversely coded this variable with high scores indicating a more positive neighbourhood social environment.

Neighbourhood social disorder was assessed with a safety composite measure per 4-digit postal code retrieved from the Leefbaarometer 2.0 from 2016 (Ministry of Interior and Kingdom Relations, 2020). The measure was based on vandalism, disruption of public policy, violent felonies, car thefts, and nuisance (e.g., of adolescents). The index was reversely coded with higher positive values referring to higher levels of neighbourhood social disorder, while zero represents the national average.

Neighbourhood greenspace was assessed using the normalized difference vegetation index (NDVI) (Tucker, 1979) derived from the 2017 Landsat-8 satellite imagery obtained through Google Earth Engine. Images with a 30 m spatial resolution were collected between May and September. The NDVI ranges from -1 to $+1$, with higher positive values representing greener vegetative cover. To avoid distortions, negative NDVI scores referring to non-vegetated soil or water were omitted before computing mean NDVI scores per postal code (see also Helbich (2019) for a similar approach). Due to a lack of a gold-standard, others used a different approach, for instance converting the negative values to zero (Reid et al., 2018). As there was a strong correlation ($r = 0.944$) between NDVI including negative values and NDVI excluding negative values, it is highly unlikely that this difference in the assessment of greenspace influenced our findings.

Neighbourhood air pollution was measured using nitrogen dioxide (NO_2) concentrations (in $\mu g/m^3$). Data from the year 2017 were obtained from the Dutch Environmental Health Atlas (RIVM). NO_2 concentrations on a 25 m spatial resolution were aggregated by determining the mean per 4-digit postal code.

2.2.3. School-level variables

School SES was measured using the individual-level Family Affluence Scale (FAS) (Currie et al., 2014). FAS consists of six items indicating family material assets (e.g., "Does your family have a car?" (0 = no, 1 = yes, one, 2 = yes, two or more)). The items were summed and aggregated on the school level with higher scores referring to higher school SES.

School social environment was assessed using individual-level teacher and classmate support scales (Torsheim et al., 2000). Both scales consisted of three items (e.g., "Teachers are nice and friendly"; "Most of the students in my class are kind and helpful") using a five-point Likert scale (0 = totally agree to 4 = totally disagree). Items for both variables were summed and aggregated on the school level. Scores were reversely coded with higher scores indicating higher teacher/classmate support on the school level.

School social disorder was measured by two individual-level items (Hendriks et al., 2019). The first item assessed the frequency of physical fights ("During the past 12 months, how many times were you in a physical fight?"). Answer categories ranged from "I have not been in a physical fight" (0) to "four times or more" (4). The second item asked about the frequency of bullying of others ("How many times have you bullied others at school in the previous months?") (Olweus, 1992). Answer categories ranged from "I haven't" (0) to "several times a week" (4). Based on item content and item correlation ($r = 0.239$), we averaged the two items for respondents who filled out at least one item and aggregated it on the school level. Higher scores denoted more school social disorders.

School greenspace and *school air pollution* were assessed based on the 4-digit postal code of the school using the NDVI and NO_2 (see above).

2.2.4. Individual-level and school-level control variables

We controlled for age (in years), gender (0 = boy, 1 = girl), and family structure (i.e., whether (1) or not (0) the adolescent lives together with both biological parents in the primary household). Educational level was measured by the academic track that the adolescent was

enrolled in. Reflecting the Dutch educational system for secondary schools, four levels were dummy coded using 'high' as the reference category (1 = low; 2 = lower intermediate; 3 = upper intermediate; 4 = high). As a measure for urbanicity of the school, a five-level scale based on zip-codes as developed by HBSC was applied, with 0 being a highly urbanized area and 4 being a rural area.

2.2.5. Individual-level moderators

Family SES was measured on the individual-level using the FAS (see above), with higher scores reflecting higher family SES. Family support was measured using the four-item multidimensional scale of perceived social support (Zimet et al., 1988). For instance: "Family members do their best to help me" and "I can talk about my problems". Answer categories ranged from "completely disagree" (0) to "completely agree" (6). We averaged the four items for respondents who filled out at least half of the items with higher scores indicating more family support.

2.3. Statistical analysis

We fitted three models for the four mental health indicators (i.e., emotional symptoms, hyperactivity-inattention problems, conduct problems, and peer relationship problems). The first two models were traditional multilevel models (MLM) (Hox et al., 2017) assuming that students were nested in either the residential neighbourhoods or schools but not in both contexts. The third model was a cross-classified multilevel model (CCMM) (Barker et al., 2020; Hox et al., 2017) considering that students were nested in both residential neighbourhoods and schools. Putting it differently, the CCMM model takes into account that students attending the same school resided in different neighbourhoods and students living in the same neighbourhood attended different schools. For the MLM and CCMM models, we calculated the intraclass correlation coefficients (ICC) measuring the proportion of variance located at the neighbourhood and school level (Hox et al., 2017). Comparing the ICCs across the MLMs and CCMMs facilitated us to identify a possible omitted context bias.

Five CCMMs were fitted per mental health outcome. Model 1 only included control variables. Model 2 additionally added neighbourhood-level variables, while Model 3 included school-level variables. Model 4 included control, neighbourhood-, and school-level variables simultaneously. In Model 5 only significant cross-level interactions between family SES, family support, and the neighbourhood- and school-level variables were added. In order to assess Model 5, we excluded the nonsignificant cross-level interactions from the model one by one to keep the model parsimonious. If a cross-level interaction term was statistically significant, we plotted the marginal effects and performed stratified adjusted regressions to test whether the associations varied across three subgroups based on family SES and family support (1 SD below average, average, and 1 SD above average). Family SES, family support, and the neighbourhood- and school-level variables were grand-mean centred for the cross-level interactions. We used a Benjamini-Hochberg correction to correct for multiple testing at $\alpha = 0.05$ across all models. All analyses were performed in R, version 4.0.3 (R Core Team, 2020), using the "lme4" package (Bates et al., 2012).

3. Results

Descriptive statistics for the variables are displayed in Table 1. Correlations between the variables are provided in the Appendix (Table A1). With a largest variance inflation factor (VIF) of 8.04, all VIF values were below the critical value of 10 (Hair et al., 1995), indicating no multicollinearity (Table A2).

3.1. Associations on the neighbourhood and/or school level

Table 2 showed the results of the school-only and neighbourhood-only MLMs and the CCMM per mental health indicator. The school-

Table 1
Descriptive statistics of the study variables.

Variables	Min	Max	Mean or %	SD
Outcome: mental health (N = 6422)				
Emotional symptoms	0	2	.509	.460
Hyperactivity-inattention problems	0	2	.822	.599
Conduct problems	0	2	.223	.326
Peer relationship problems	0	2	.368	.408
Individual-level variables (N = 6422)				
Family SES	0	13	9.022	1.881
Family support	0	6	5.041	1.341
Age	12	16	13.916	1.353
Gender (*ref. boys*)	0	1	52%	
Family structure	0	1	76.8%	
Educational level				
Low	0	1	16.7%	
Lower intermediate	0	1	29.8%	
Upper intermediate	0	1	24.9%	
High	0	1	28.6%	
Neighbourhood-level variables (N = 1398)				
SES	−10.967	9.395	-.390	2.449
Social environment	−11.047	3.069	-.321	2.328
Social disorder	-.216	.432	-.025	.121
Greenspace	.141	.735	.506	.120
Air pollution	7.578	35.269	18.430	5.512
School-level variables (N = 85)				
SES	6.775	10.888	8.955	.709
Social environment				
Classmate support	2.590	3.354	3.013	.146
Teacher support	2.244	3.311	2.708	.202
Social disorder	.017	.691	.310	.142
Greenspace	.207	.656	.477	.101
Air pollution	8.540	32.154	19.426	5.379
Urbanicity	0	4	2.176	1.104

Note: all variables are uncentered for descriptive statistics; school urbanicity is a control variable at the school-level.

only and neighbourhood-only MLM showed comparable and significant ICC values at the neighbourhood and school level (e.g., for hyperactivity-inattention problems $ICC_{neighbourhood}$ = 2.7% and ICC_{school} = 3.1%), indicating that the proportion of variance in adolescent mental health was rather similar at both levels. However, when assessing both contexts simultaneously using CCMMs, the neighbourhood-level ICCs for all mental health indicators were considerably smaller than the school-level ICCs, implying that the between-level variance in adolescent mental health was largely driven by schools rather than neighbourhoods. Furthermore, for all mental health outcomes, the $ICC_{neighbourhood}$ values decreased when including the school level, indicating an omitted context bias. Additionally, the CCMM for emotional symptoms and hyperactivity-inattention problems revealed that the neighbourhood variances were nonsignificant. Although these results suggested that we could drop the neighbourhood level from the models and use MLMs with only the school level context for both emotional symptoms and hyperactivity-inattention problems, we performed CCMM for all four mental health outcomes for reasons of consistency.

3.2. Neighbourhood and school characteristics and emotional problems

Model 1 in Table 3 showed that adolescents with lower levels of family SES and family support, who were older, not living together with both biological parents, and girls reported more emotional symptoms. None of the neighbourhood characteristics were associated with emotional symptoms (Model 2). Model 3 indicated that higher school SES was associated with more emotional symptoms. This association remained significant after adjusting for neighbourhood characteristics (Model 4). Model 5 revealed a cross-level interaction between family SES and school SES. In Fig. A3, the marginal effects indicated that estimated coefficients for the association between school SES and emotional problems were positive in the lower ranges of family SES and were absent or slightly negative for adolescents from higher SES

Table 2
Comparison of traditional two-level multilevel models (MLM) and cross-classified multilevel model (CCMM) per mental health outcome ($N_{individuals}$ = 6422; $N_{neighbourhoods}$ = 1398; $N_{schools}$ = 85).

	Neighbourhood-only MLM	School-only MLM	CCMM
Outcome: emotional symptoms			
Fixed effect estimates			
Intercept	.508***(.006)	.508***(.008)	.508*** (.008)
Random effect estimates			
Neighbourhood	.003*(.001)		.002(.001)
School		.003**(.001)	.003**(.001)
Individual	.208***(.004)	.208***(.004)	.207*** (.004)
Intraclass correlations coefficients			
Neighbourhood	1.5%		.7%
School		1.4%	1.3%
AIC	8241	8219	8219
Outcome: hyperactivity-inattention problems			
Fixed effect estimates			
Intercept	.823***(.008)	.825***(.014)	.825*** (.014)
Random effect estimates			
Neighbourhood	.010**(.003)		.002(.002)
School		.011***(.002)	.011*** (.002)
Individual	.349***(.007)	.348***(.006)	.346*** (.006)
Intraclass correlations coefficients			
Neighbourhood	2.7%		.5%
School		3.1%	3.0%
AIC	11,626	11,547	11,548
Outcome: conduct problems			
Fixed effect estimates			
Intercept	.223***(.005)	.228***(.008)	.228*** (.008)
Random effect estimates			
Neighbourhood	.004***(.001)		.002*(.001)
School		.004***(.001)	.004*** (.001)
Individual	.102***(.002)	.103***(.002)	.101*** (.002)
Intraclass correlations coefficients			
Neighbourhood	3.6%		1.7%
School		3.4%	3.3%
AIC	3811	3742	3738
Outcome: peer relationship problems			
Fixed effect estimates			
Intercept	.368***(.006)	.373***(.009)	.373*** (.009)
Random effect estimates			
Neighbourhood	.006***(.001)		.002*(.001)
School		.005***(.001)	.004*** (.001)
Individual	.160***(.003)	.162***(.003)	.160*** (.003)
Intraclass correlations coefficients			
Neighbourhood	3.5%		1.4%
School		2.7%	2.5%
AIC	6678	6637	6635

*p < .05, **p < .01, ***p < .001.
Note: standard errors are provided in between brackets.

families. In line with this, subsequent analyses showed that the positive association between school SES and emotional symptoms was significant only for those with 1 SD below average family SES ($b = 0.064, p < .001$).

3.3. Neighbourhood and school characteristics and hyperactivity-inattention problems

Results for hyperactivity-inattention problems are reported in Table 4. Model 1 indicated that adolescents with higher levels of family SES, lower levels of family support, not living together with both

Table 3
Results of CCMM for emotional symptoms of adolescents ($N_{individuals}$ = 6422; $N_{neighbourhoods}$ = 1398; $N_{schools}$ = 85).

	M1 *Controls*	M2 *Controls + neighbourhood*	M3 *Controls + school*	M4 *Controls + neighbourhood + school*	M3 *Controls + school + cross-level interactions*
Fixed effect estimates	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Intercept	.226***(.061)	.248***(.062)	.226***(.061)	.245***(.063)	.251***(.063)
Control variables					
Family SES	-.016***(.003)	-.017***(.003)	-.019***(.003)	-.019***(.003)	-.019***(.003)
Family support	-.075***(.004)	-.075***(.004)	-.074***(.004)	-.074***(.004)	-.074***(.004)
Age	.013**(.004)	.013**(.004)	.012**(.004)	.012**(.004)	.012**(.004)
Gender (*ref. boys*)	.290***(.011)	.289***(.011)	.290***(.011)	.289***(.011)	.289***(.011)
School urbanicity	-.001 (.005)	-.008 (.007)	.000 (.005)	-.001 (.007)	-.006 (.007)
Family structure	-.052***(.013)	-.052***(.013)	-.050***(.013)	-.005***(.013)	-.050***(.013)
Educational level (*ref. high*)					
Low	-.018 (.019)	-.019 (.019)	.011 (.024)	.009 (.024)	.007 (.024)
Lower intermediate	-.016 (.016)	-.018 (.017)	.005 (.020)	.002 (.020)	-.007 (.020)
Upper intermediate	.014 (.016)	.013 (.016)	.022 (.016)	.020 (.016)	.018 (.016)
Neighbourhood-level variables					
SES		-.002 (.004)		-.006 (.004)	-.005 (.004)
Social environment		.006 (.004)		.008 (.004)	.008 (.004)
Social disorder		-.039 (.112)		-.040 (.112)	-.041 (.111)
Greenspace		.020 (.079)		.012 (.082)	.018 (.082)
Air pollution		.000 (.002)		.000 (.003)	.000 (.003)
School-level variables					
SES			.031**(.012)	.038**(.013)	.034*(.013)
Social environment					
Classmate support			-.062 (.060)	-.069 (.061)	-.066 (.060)
Teacher support			-.032 (.042)	-.031 (.042)	-.037 (.041)
Social disorder			-.033 (.063)	-.015 (.065)	-.007 (.064)
Greenspace			-.083 (.078)	-.100 (.092)	-.116 (.091)
Air pollution			.000 (.002)	.000 (.003)	.000 (.003)
Cross-level interactions					
Family SES * school SES					-.009*(.004)
Random effect estimates	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)
Neighbourhood	.000 (.000)	.000 (.000)	.000 (.000)	.000 (.000)	.000 (.000)
School	.002*(.001)	.002*(.001)	.001*(.001)	.002*(.001)	.001*(.001)
Individual	.175***(.003)	.175***(.003)	.175***(.003)	.175***(.003)	.175***(.003)
Fit statistics					
AIC	7062	7068	7058	7063	7058

*p < .05, **p < .01, ***p < .001.

Note: standard errors are provided in between brackets.

biological parents, and who were enrolled in a lower education level reported more hyperactivity-inattention problems. In Model 2, none of the neighbourhood characteristics were significantly related to hyperactivity-inattention problems. School SES was positively related to hyperactivity-inattention problems (Model 3) and remained significant in Model 4. The cross-level interaction effect in Model 5 indicated that even though there was no main effect of classmate support on hyperactivity-inattention problems, the direction of this association differed with the level of family support. As can be seen in Fig. A4, as family support increased, estimated coefficients for the associations between school-level classmate support and hyperactivity-inattention problems shifted from positive to negative. Yet, subsequent analyses indicated that for none of the family-support groups (i.e., either adolescents with average family support as well as those with 1 SD below or above average family support) the association between school-level classmate support and hyperactivity-inattention problems was significant.

3.4. Neighbourhood and school characteristics and conduct problems

Model 1 in Table 5 showed that adolescents with lower levels of family support, who were younger, boys, who were living in an urban neighbourhood, were not living together with both biological parents, and who were enrolled in a lower education level reported more conduct problems. None of the neighbourhood characteristics were associated with conduct problems (Model 2). In Model 3, higher levels of school-level teacher support were associated with fewer conduct problems, whilst higher levels of school social disorder were related to more conduct problems. Only school social disorder remained significantly

associated with conduct problems after adding neighbourhood and school-level variables to the model simultaneously (Model 4). Even though school greenspace was not significantly related to conduct problems in prior models, Model 5 indicated that this association varied across levels of family support. Fig. A5 showed that as family support increased, estimated coefficients for the associations between school greenspace and conduct problems shifted from positive to negative. Subsequent analyses however revealed that for all groups (i.e., either adolescents with average family support as well as those with 1 SD below or above average family support), the association between school greenspace and conduct problems was nonsignificant.

3.5. Neighbourhood and school characteristics and peer relationship problems

Model 1 in Table 6 showed that adolescents from lower SES families, with less family support, who were older, wo where living in an urban neighbourhood, and were enrolled in lower educational levels reported more peer relationship problems. No significant associations were observed between neighbourhood-level variables and peer relationship problems in Model 2. Higher levels of school social disorder were associated with more peer relationship problems (Model 3). This association remained significant after neighbourhood variables were included in the Model (Model 4). Moreover, in Model 4, higher levels of neighbourhood SES were associated with fewer peer relationship problems.

Two significant cross-level interactions were found (Model 5). First, even though prior models indicated that school-level classmate support was not related to peer relationship problems, Model 5 showed a cross-

Table 4

Results of CCMM for hyperactivity-inattention problems of adolescents ($N_{individuals}$ = 6422; $N_{neighbourhoods}$ = 1398; $N_{schools}$ = 85).

	M1 *Controls*	M2 *Controls + neighbourhood*	M3 *Controls + school*	M4 *Controls + neighbourhood + school*	M3 *Controls + school + cross-level interactions*
Fixed effect estimates	Estimate (S. E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Intercept	.865***(.086)	.902***(.088)	.864***(.086)	.886***(.088)	.893***(.087)
Control variables					
Family SES	.022***(.004)	.021***(.004)	.018**(.004)	.018***(.004)	.018**(.004)
Family support	-.047*** (.006)	-.047***(.006)	-.047***(.006)	-.047***(.006)	-.048***(.006)
Age	-.006 (.006)	-.006 (.006)	-.006 (.006)	-.006 (.006)	-.007 (.006)
Gender (*ref. boys*)	-.007 (.015)	-.007 (.015)	-.007 (.015)	-.006 (.015)	-.007 (.015)
School urbanicity	-.003 (.007)	-.018 (.010)	-.010 (.008)	-.016 (.010)	-.015 (.010)
Family structure	-.094*** (.018)	-.095***(.018)	-.091***(.018)	-.092***(.018)	-.092***(.018)
Educational level (*ref. high*)					
Low	.221***(.028)	.221***(.028)	.268***(.034)	.266***(.033)	.265***(.033)
Lower intermediate	.173***(.025)	.174***(.024)	.211***(.028)	.207***(.028)	.207***(.028)
Upper intermediate	.135***(.023)	.137***(.025)	.149***(.022)	.148***(.022)	.148***(.022)
Neighbourhood-level variables					
SES		.001 (.006)		-.005 (.006)	-.005 (.006)
Social environment		.000 (.006)		.008 (.006)	.001 (.006)
Social disorder		-.180 (.162)		-.164 (.159)	-.147 (.159)
Greenspace		.043 (.113)		.027 (.118)	.030 (.117)
Air pollution		-.001 (.003)		.006 (.043)	.006 (.043)
School-level variables					
SES			.093***(.016)	.093***(.018)	.093***(.017)
Social environment					
Classmate support			-.110 (.085)	-.116 (.084)	-.114 (.083)
Teacher support			-.010 (.058)	-.011 (.058)	-.013 (.058)
Social disorder			.004 (.089)	.032 (.089)	.036 (.089)
Greenspace			.144 (.110)	.041 (.128)	.044 (.127)
Air pollution			-.029 (.002)	-.007 (.004)	-.007 (.004)
Cross-level interactions					
Family support* school classmate support					-.098*(.039)
Random effect estimates	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)
Neighbourhood	.002 (.002)	.002 (.002)	.002 (.002)	.002 (.002)	.002 (.002)
School	.005***(.002)	.004***(.002)	.002*(.001)	.002*(.001)	.002*(.001)
Individual	.341***(.006)	.338***(.006)	.341***(.006)	.338***(.006)	.338***(.006)
Fit statistic					
AIC	11,389	11,357	11,329	11,334	11,329

*p < .05, **p < .01, ***p < .001.

Note: standard errors are provided in between brackets.

level interaction with family support. As can be seen in Fig. A6, estimated coefficients for the associations between school-level classmate support and peer relationship problems were positive for adolescents with lower scores on family support, while they were negative for those with higher scores on family support. Further analyses indicated a significant negative association between school-level classmate support and peer relationship problems only for adolescents with high family support (i.e., 1 SD above the average) ($b = -0.192$, $p = .014$), while these associations were nonsignificant for adolescents with average and low (i.e., 1 SD below the mean) family support. Second, Model 5 revealed a cross-level interaction between school-level teacher support and family support on peer relationship problems. Fig. A7 revealed that as family support increased, estimated coefficients for the associations between school-level teacher support and peer relationship problems shifted from negative to positive. Subsequent analyses indicated a significant association for none of the groups (i.e., either adolescents with average family support as well as those with 1 SD below or above average family support).

4. Discussion

4.1. Main findings

We investigated associations between residential neighbourhood and school characteristics and several mental health outcomes among

adolescents in the Netherlands. Our results showed that school characteristics were more strongly associated with adolescent mental health problems than residential neighbourhood characteristics. For all four mental health outcomes, more variance in adolescent mental health was attributable to the school level than to the neighbourhood level. For emotional symptoms and hyperactivity-inattention problems, mental health differences between residential neighbourhoods were even negligible in size. Assessing both the residential neighbourhood and the school context simultaneously, revealed that higher levels of school SES were associated with more emotional symptoms and hyperactivity-inattention problems. Moreover, higher levels of school social disorder were related to more conduct problems and more peer relationship problems. Concerning residential neighbourhood characteristics, higher levels of neighbourhood SES were associated with fewer peer relationship problems.

We expected the associations of residential neighbourhood and school characteristics with mental health outcomes to vary according to family SES or family support. For five out of possibly ninety-six interactions, the association between either residential neighbourhood or school characteristic and adolescent mental health varied across family SES or family support. However, we only found two cross-level interactions for which a significant association was observed between either residential neighbourhood or school characteristics and a mental health outcome for at least one subgroup. For adolescents with below average family SES, higher levels of school SES were associated with

Table 5
Results of CCMM for conduct problems of adolescents (N$_{individuals}$ = 6422; N$_{neighbourhoods}$ = 1398; N$_{schools}$ = 85).

	M1 Controls	M2 Controls + neighbourhood	M3 Controls + school	M4 Controls + neighbourhood + school	M3 Controls + school + cross-level interactions
Fixed effect estimates	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Intercept	.457***(.043)	.430***(.044)	.465***(.044)	.441***(.045)	.440***(.045)
Control variables					
Family SES	.000 (.002)	.002 (.002)	.002 (.002)	.002 (.002)	.002 (.002)
Family support	-.063*** (.003)	-.063***(.003)	-.063***(.003)	-.063***(.003)	-.063***(.003)
Age	-.015*** (.003)	-.016***(.003)	-.016***(.003)	-.016***(.003)	-.016***(.003)
Gender (*ref. boys*)	-.059*** (.008)	-.058***(.008)	-.057***(.008)	-.056***(.008)	-.056***(.008)
School urbanicity	-.009**(.003)	.001 (.005)	-.007 (.004)	.000 (.005)	.000 (.005)
Family structure	-.034*** (.009)	-.034***(.009)	-.035***(.009)	-.034***(.009)	-.034***(.009)
Educational level (*ref. high*)					
Low	.155***(.013)	.155***(.013)	.133***(.016)	.136***(.016)	.135***(.016)
Lower intermediate	.101***(.011)	.100***(.011)	.081***(.013)	.082***(.013)	.081***(.013)
Upper intermediate	.054***(.011)	.053***(.011)	.046***(.011)	.046***(.011)	.045***(.011)
Neighbourhood-level variables					
SES		-.002 (.003)		-.003 (.003)	-.003 (.003)
Social environment					
Social disorder		.001 (.003)		.001 (.003)	.001 (.003)
Greenspace		.050 (.081)		.017 (.081)	.013 (.081)
Air pollution		-.084 (.058)		-.086 (.061)	-.090 (.061)
		.001 (.001)		.001 (.002)	.001 (.002)
School-level variables					
SES			-.007 (.007)	.000 (.008)	.000 (.008)
Social environment					
Classmate support			-.004 (.038)	-.001 (.038)	.002 (.037)
Teacher support			-.057*(.026)	-.052 (.026)	-.052*(.026)
Social disorder			.094*(.041)	.104*(.041)	.104*(.041)
Greenspace			-.004 (.047)	-.009 (.059)	-.006 (.059)
Air pollution			.001 (.001)	-.001 (.002)	-.001 (.002)
Cross-level interactions					
Family support * school greenspace					-.082**(.028)
Random effect estimates	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)
Neighbourhood	.001 (.001)	.001 (.001)	.001 (.001)	.001 (.001)	.001 (.001)
School	.000 (.000)	.000 (.000)	.000 (.000)	.000 (.000)	.000 (.000)
Individual	.093***(.002)	.093***(.002)	.093***(.002)	.093***(.002)	.093***(.002)
Fit statistics					
AIC	3050	3049	3047	3048	3042

*p < .05, **p < .01, ***p < .001.
Note: standard errors are provided in between brackets.

more emotional symptoms, whilst there was no association between school SES and emotional symptoms for adolescents with average or above average family SES. Further, no association between school-level classmate support and peer relationship problems was observed for adolescents with average or below average family support, while for those with above average family support higher levels of school-level classmate support were associated with fewer peer relationship problems.

4.2. Interpretation of the findings

Studies investigating the associations between residential neighbourhood and school characteristics and mental health simultaneously using cross-classified multilevel models are rare. In line with most of these studies, our results indicated that school characteristics are of greater importance for adolescent mental health than residential neighbourhood characteristics (De Clercq et al., 2014; Dunn et al., 2015; Pauwels et al., 2015; Takakura et al., 2019). Incorporating both contexts is important, as not incorporating the school context results in an overestimation of the neighbourhood effects (Evans et al., 2016; Milliren et al., 2018). The school context may matter more than the residential neighbourhood context because adolescents probably spend less time in their residential neighbourhood than at school. Despite the overall

restricted mobility of adolescents (Allison et al., 1999), Dutch adolescents are highly likely to use their bikes as a means of transportation (CBS, 2016), enabling them to build friendships and have activities outside of their residential neighbourhood. Adding to this, because of the so-called digital revolution, time spent in offline contexts like residential neighbourhoods is nowadays partly substituted by time spent in online contexts (De Looze et al., 2019; Oswald et al., 2020). In contrast, time spent at schools cannot be substituted in any way due to compulsory education till the age of 16. Together, this may explain why school characteristics are more important for adolescent mental health than characteristics of the residential neighbourhood.

Congruent with other studies (Aldridge and McChesney, 2018; Boen et al., 2020; Denny et al., 2011), higher levels of school social disorder were related to more conduct problems and more peer relationship problems. A possible explanation for this finding is the increased likelihood of being involved in problematic behaviour (i.e., bullying or fighting) either as the victim or the bully, if such behaviour is relatively common at school. In line with Walsemann et al. (2009), higher levels of neighbourhood SES were associated with fewer peer relationship problems. This finding could indicate that adolescents residing in advantaged neighbourhoods are more likely to have friends in this particular context (Jansen et al., 2012; Khoury-Kassabri et al., 2004), which subsequently could be associated with fewer peer relationship

Table 6
Results of CCMM for peer relationship problems of adolescents ($N_{individuals}$ = 6422; $N_{neighbourhoods}$ = 1398; $N_{schools}$ = 85).

	M1 Controls	M2 Controls + neighbourhood	M3 Controls + school	M4 Controls + neighbourhood + school	M3 Controls + school + cross-level interactions
Fixed effect estimates	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Intercept	.174*(.056)	.159*(.058)	.185*(.057)	.166*(.058)	.173*(.058)
Control variables					
Family SES	-.020***(.003)	-.018***(.003)	-.019***(.003)	-.018***(.003)	-.018***(.003)
Family support	-.050***(.004)	-.050***(.004)	-.050***(.004)	-.049***(.004)	-.050***(.004)
Age	.015***(.004)	.015***(.004)	.015**(.004)	.015***(.004)	.015***(.004)
Gender (*ref. boys*)	-.016 (.010)	-.017 (.010)	-.014 (.010)	-.014 (.010)	-.016 (.010)
School urbanicity	-.014**(.004)	-.007 (.006)	-.012 (.005)	-.007 (.006)	-.007 (.006)
Family structure	-.021 (.012)	-.021 (.012)	-.022 (.012)	-.021 (.012)	-.022 (.012)
Educational level (*ref. high*)					
Low	.115***(.017)	.113***(.017)	.081**(.022)	.082***(.022)	.081***(.022)
Lower intermediate	.077***(.015)	.073***(.015)	.047*(.018)	.046*(.018)	.045*(.018)
Upper intermediate	.031 (.014)	.028 (.014)	.021 (.015)	.019 (.015)	.018 (.015)
Neighbourhood-level variables					
SES		-.007 (.004)		-.009*(.004)	-.009*(.004)
Social environment		.006 (.004)		.007 (.004)	.008*(.004)
Social disorder		.074 (.106)		.042 (.105)	.058 (.105)
Greenspace		-.051 (.075)		-.081 (.078)	-.076 (.078)
Air pollution		.000 (.002)		-.001 (.003)	-.001 (.003)
School-level variables					
SES			-.004 (.010)	.012 (.011)	.012 (.011)
Social environment					
Classmate support			- .060 (.053)	-.072 (.052)	-.071 (.051)
Teacher support			-.034 (.037)	-.024 (.036)	-.022 (.036)
Social disorder			.133*(.057)	.157*(.056)	.159*(.056)
Greenspace			.007 (.068)	.019 (.080)	.025 (.080)
Air pollution			.001 (.001)	.001 (.003)	.001 (.003)
Cross-level interactions					
Family support * school classmate support					-.099*(.030)
Family support * school teacher support					.056*(.021)
Random effect estimates	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)	Var (S.E.)
Neighbourhood	.002 (.001)	.001 (.001)	.002 (.001)	.001 (.001)	.001 (.001)
School	.001*(.001)	.000 (.000)	.001 (.000)	.000*(.001)	.000*(.001)
Individual	.153***(.003)	.154***(.003)	.153***(.003)	.154***(.003)	.154***(.003)
Fit statistics					
AIC	6293	6280	6286	6273	6263

*p < .05, **p < .01, ***p < .001.

Note: standard errors are provided in between brackets.

problems.

Our findings concerning school SES at first may seem counterintuitive. While previous studies showed that higher levels of school SES were related to lower mental health problems (Dunn et al., 2015; Huang et al., 2020; Niu et al., 2019), we observed the opposite. Higher levels of school SES were related to more emotional symptoms and hyperactivity-inattention problems. It could be that in schools where students on average have a higher SES, the pressure among adolescents is relatively high (De Looze et al., 2020; Luthar et al., 2020). In these schools, there might be a harmful environment for adolescent mental health (particularly regarding emotional problems and hyperactivity–inattention problems), where increased stress is experienced due to high educational expectations from parents and social comparison with ambitious and competitive fellow students (Mishra and Carleton, 2015; LaRue and Herrman, 2008). Our subsequent analyses showed that only for adolescents with a below average family SES, higher levels of school SES were associated with more emotional symptoms, which could indicate that relative deprivation plays a role. Adolescents with a below average family SES attending high SES schools might to some extent feel inferior due to the comparison with fellow ambitious and competitive adolescents, which in turn is associated with more emotional problems in this specific group (Nadler et al., 2020).

Unlike previous studies (Vanaken and Danckaerts, 2018; Zhang et al., 2020), neither greenspace nor air pollution within the residential neighbourhood or the school were associated with one of the mental health outcomes. Though used previously (Zhang et al., 2020), our quantitative measurements of available greenspace per postal code may not have captured the actual exposure to greenspace accurately. We advise further research to consider using proximity to and the quality of greenspace (Mueller and Flouri, 2020). Concerning air pollution, previous studies that revealed associations between air pollution and adolescent mental health measured exposure to air pollution at a younger age (Roberts et al., 2019). The negative impact of air pollution might be stronger for younger children, than for adolescents. Given the limited number of studies assessing the link between air pollution and adolescent mental health, more research is needed to verify our explanation.

Further, contradicting prior studies (Aminzadeh et al., 2013; Ma and Klein, 2018; Singh and Ghandour, 2012), the neighbourhood social environment was not associated with any of the mental health outcomes. It could be that the social function of a neighbourhood has declined nowadays (Van Kempen and Wissink, 2014). Adolescents' social contacts may be bounded to their residential neighbourhood far less than before, as adolescents are well-connected virtually through the internet. Alternatively, the specific measure of our neighbourhood social environment may have explained why we did not find associations with

adolescent mental health. Our measure was based on proxies for social contact instead of the actual frequency of social contacts within a neighbourhood. For instance, the percentage of unmarried people may not have reflected the actual frequency of social contacts within a neighbourhood, and therefore associations may be absent.

Overall, our results on the moderating roles of family SES and family support indicated that the contextual effects hardly vary across these individual-level factors suggesting that individual effects and contextual effects work independently from each other. The first interaction between school and family SES and emotional symptoms has been interpreted above. Contradicting the notion of accumulation of disadvantages, our second cross-level interaction revealed that for adolescents with above average family support, higher levels of school-level classmate were associated with fewer peer relationship problems indicating an accumulation of advantages.

4.3. Strengths and limitations

A key strength of our study is the comprehensive adjustment of variables on multiple levels and across contexts. Moreover, our analyses were based on large and nationally representative data containing a validated mental health measurement (Duinhof et al., 2020b).

However, some limitations must be emphasized too. First, our cross-sectional design hinders causal inference. However, bidirectional associations may not be likely especially for the associations between neighbourhood or school characteristics and adolescent mental health. More specifically, it is hard to imagine how individual feelings or behaviours can impact neighbourhood or school characteristics. Still, families with high levels of mental health problems are more likely to reside in more disadvantaged neighbourhoods (i.e., residential selection) (Jokela, 2014). For the school characteristics, such selection effects seem less plausible as in the Netherlands secondary schools in principle are accessible to all adolescents (e.g., there is no distinction between public and private schools). By controlling for family structure and family affluence, we attempted to reduce results reflecting these selection effects. However, we cannot rule out this possibility entirely as we were not able to control for other potential confounders such as parental education and parental mental health. Second, measures that were used to characterize the two contexts were not identical, which might have obscured the comparison between the two contexts. Third, we aggregated data from a limited number of individuals ($\leq$5 classes per school)

to the school-level, which might have harmed the representativity of these data for the school context. However, since these classes were randomly selected at each school, we overall expect these data to suffice. Fourth, both geographic contexts were assessed at the 4-digit postal code level. Yet, the application of 4-digit postal code may not appropriately represent the spatial context adolescence experience in their daily life. If available, future research should use data on individualized neighbourhoods (Kadarik and Kährik, 2021; Petrović, 2020) as these data may show stronger associations with adolescent mental health (Nieuwenhuis et al., 2015). Lastly, the results do not shed light on the underlying mechanisms through which neighbourhood and school characteristics affect adolescent mental health. Future research should explore this.

5. Conclusion

This study contributed significantly to our understanding of the association between residential neighbourhood and school characteristics and adolescent mental health by assessing both contexts simultaneously. Our findings suggest that the school context is of greater importance to adolescent mental health than the residential neighbourhood context. Especially school characteristics concerning social processes were associated with adolescent mental health. Higher levels of school social disorder were related to more conduct problems and more peer relationship problems. Also, higher levels of school SES were associated with more hyperactivity-inattention problems, while higher levels of school SES were associated with more emotional symptoms only for adolescents with a low family SES. There was little evidence for the moderating role of family SES and family support. Our findings imply that adolescent mental health interventions taking place at schools possibly have the potential to be more effective than those in neighbourhoods, especially when they are aimed at social processes.

Declaration of competing interest

None.

APPENDIX

Table A1
Bivariate correlations between individual-level, neighbourhood-level and school-level variables

	Independent variables								Mental health outcome			
	1	2	3	4	5	6	7	8	ES[d]	HIP[e]	CP[f]	PRP[g]
Individual-level variables												
1. Family SES	1								-.104	.032	-.062	-.136
2. Family support	.089	1							-.236	-.116	-.268	-.189
3. Age	-.019	-.116	1						.072	.000	-.038	.069
4. Gender [a]	-.060	-.013	.005	1					.324	-.010	-.089	-.013
5. Family structure [b]	.159	.116	-.040	-.013	1				-.087	.088	-.099	-.078
6. Low educational level [c]	-.172	.062	-.002	-.012	-.114	1			.009	.073	.137	-.098
7. Lower intermediate educational level [c]	-.092	-.006	-.082	-.002	-.069	-.292	1		-.008	.052	.070	.050
8. Upper intermediate educational level [c]	.058	-.002	.094	-.007	.045	-.258	-.376	1	.018	.023	-.032	-.028
Neighbourhood-level variables												
1. SES	1								-.020	.060	-.005	-.103
2. Social environment	.588	1							.011	.065	-.038	-.063
3. Social disorder	-.711	-.733	1						.010	-.072	.023	.077
4. Greenspace	.466	.622	-.744	1					.005	.053	-.056	.041
5. Air pollution	-.233	-.421	.633	-.655	1				.005	-.035	-.010	-.019
School-level variables												
1. SES	1								-.003	.077	-.554	-.580
2. Classmate support	-.264	1							-.249	-.306	-.415	-.489

Table A1 (*continued*)

	Independent variables								Mental health outcome			
	1	2	3	4	5	6	7	8	ES[d]	HIP[e]	CP[f]	PRP[g]
3. Teacher support	.005	**.503**	1						**-.298**	-.056	-.071	-.155
4. Disorder	**-.478**	**-.289**	.098	1					-.193	**.321**	**.760**	**.614**
5. Greenspace	-.141	-.083	-.016	.174	1				-.024	**.277**	.130	.068
6. Air pollution	.055	-.051	-.056	-.052	**-.546**	1			-.052	**-.295**	-.097	.007
7. Urbanicity	.005	.171	.040	-.038	**.477**	**-.638**	1		-.073	.171	-.016	-.133

Note: significant correlations (p < .05) are set in **bold**; for neighbourhood- and school-level variables the values were aggregated; school urbanicity is a control variable at the school-level.

[a] Reference category: boys.
[b] Reference category: not living together with both biological parents in the primary household.
[c] Reference category: high educational level.
[d] ES = emotional symptoms.
[e] HIP = hyperactivity-inattention problems.
[f] CP = conduct problems.
[g] PRP = peer relationship problems.

Table A2
Variance inflation factors (VIF) of all independent variables under study ($N_{individuals}$ = 6422; $N_{neighbourhoods}$ = 1398; $N_{schools}$ = 85)

|	VIF
Control variables	
Family SES	1.21
Family support	1.04
Age	1.10
Gender (*ref. boys*)	1.02
Urbanicity	2.33
Family structure	1.07
Educational level (*ref. high*)	
Low	2.50
Lower intermediate	2.41
Upper intermediate	1.55
Neighbourhood-level variables	
SES	3.01
Social environment	2.33
Social disorder	5.08
Greenspace	2.93
Air pollution	8.04
School-level variables	
SES	2.01
Social environment	
Classmate support	1.79
Teacher support	1.70
Social disorder	2.05
Greenspace	2.37
Air pollution	6.78
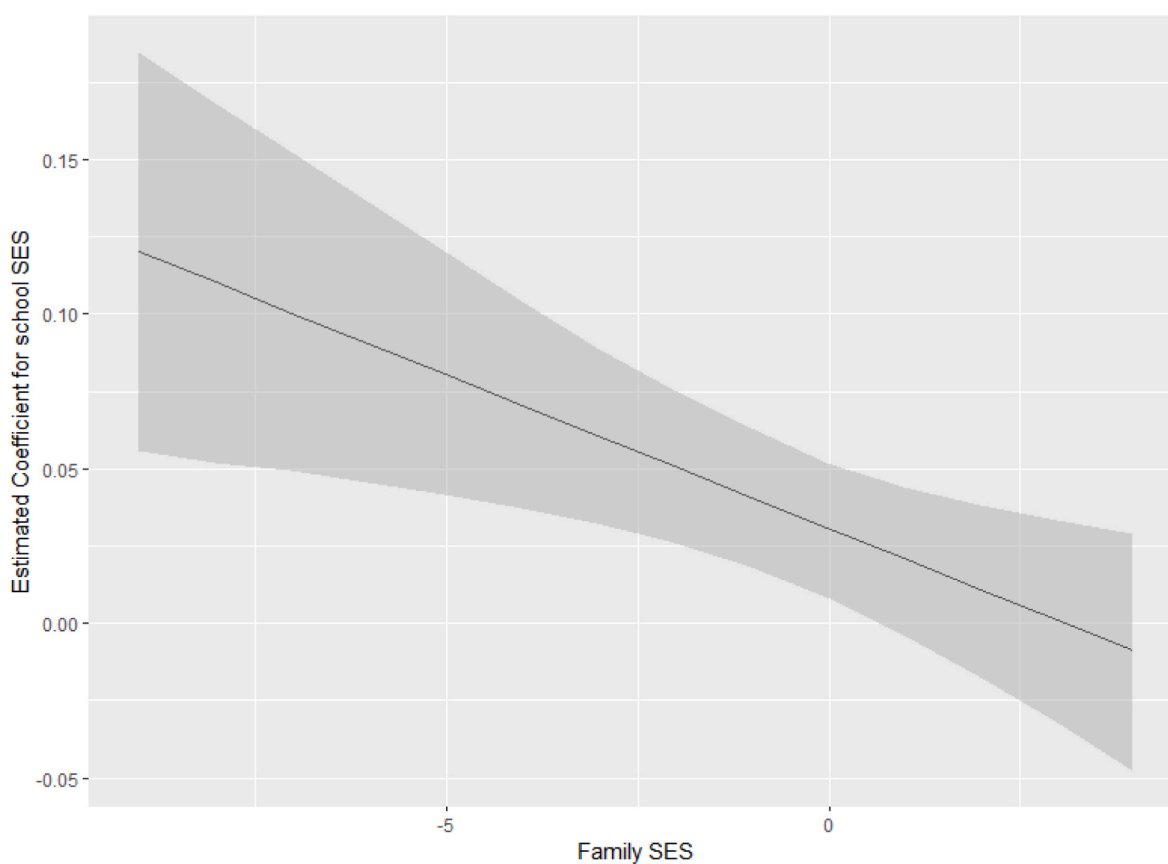
Fig. A3. Marginal effects of the interaction between school SES and family SES on emotional symptoms
Note: family SES was centred, with negative values indicating below average family SES and positive value indicating above average family SES
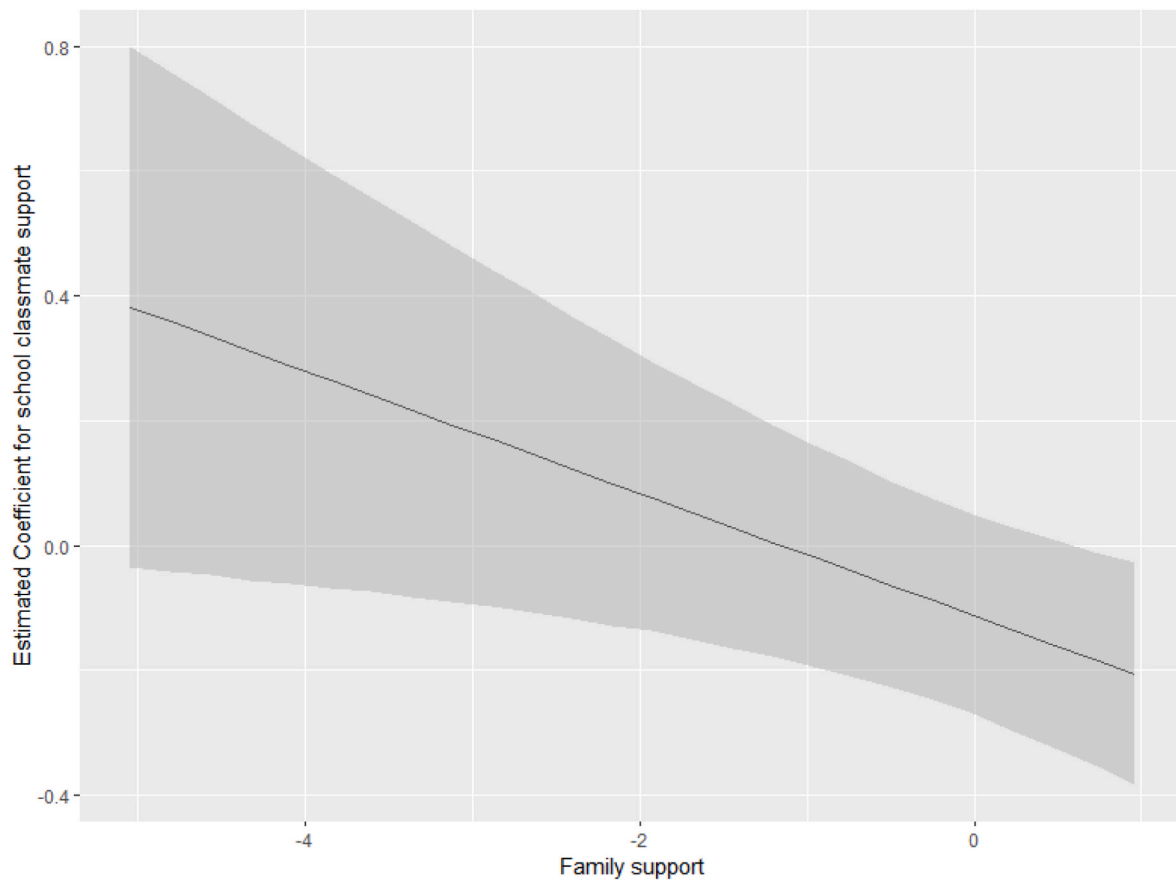
Fig. A4. Marginal effects of the interaction between school-level classmate support and family support on hyperactivity-inattention problems
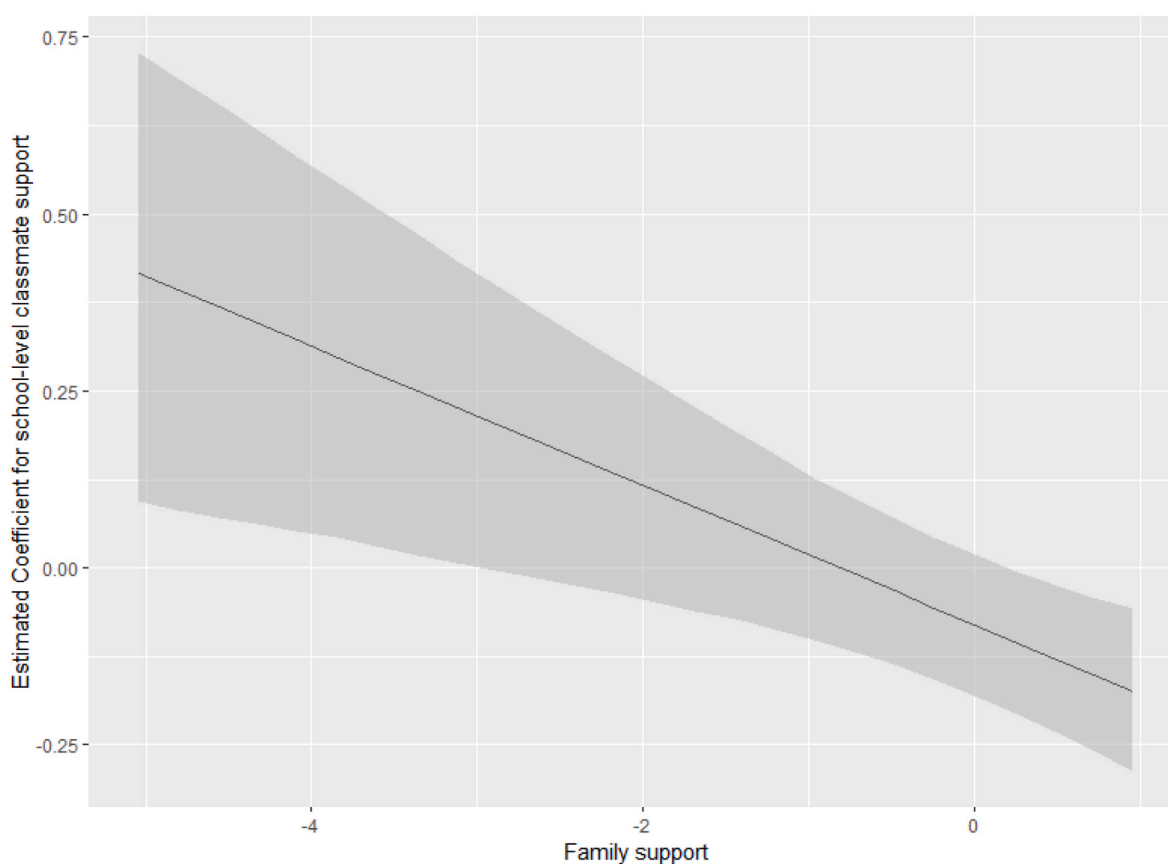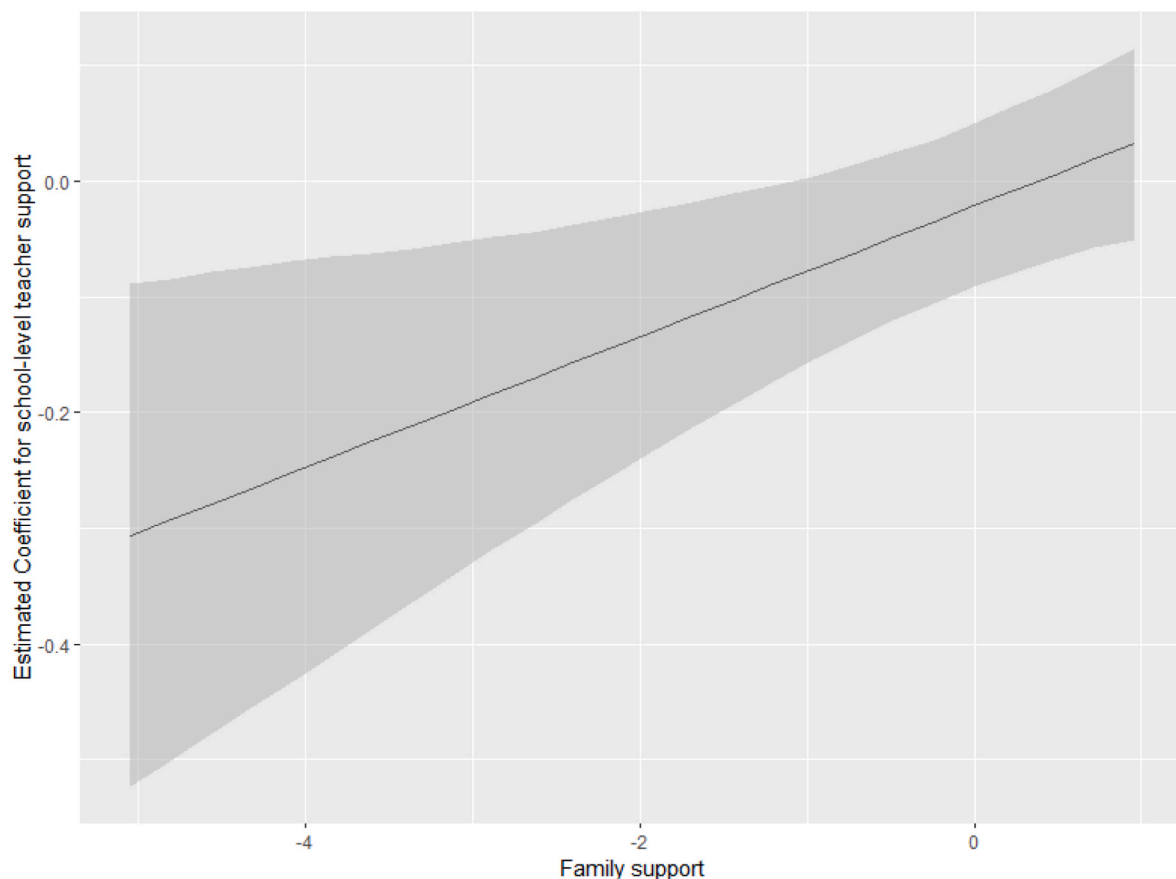
Note: family support was centred, with negative values indicating below average family support and positive value indicating above average family support
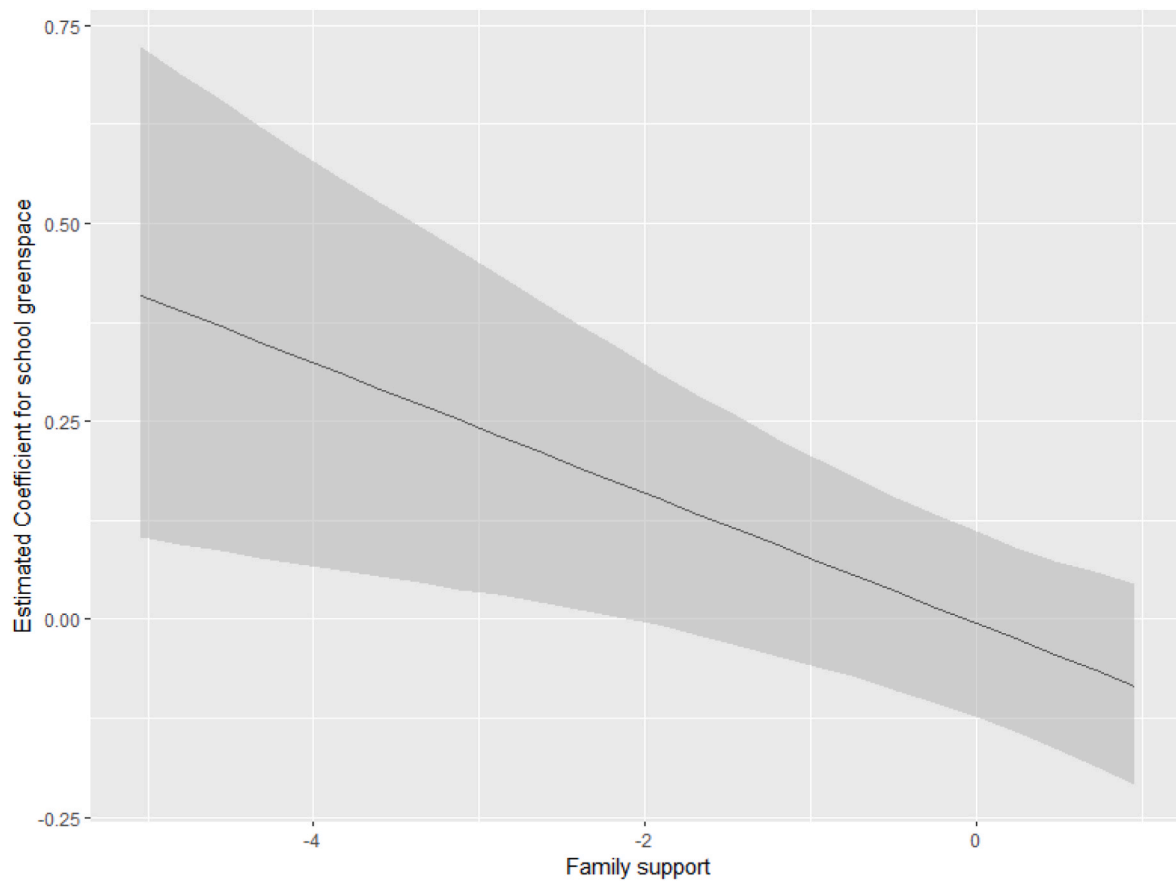
Fig. A5. Marginal effects of the interaction between school greenspace and family support on conduct problems
Note: family support was centred, with negative values indicating below average family support and positive value indicating above average family support

Fig. A6. Marginal effects of the interaction between school-level classmate support and family support on peer relationship problem
Note: family support was centred, with negative values indicating below average family support and positive value indicating above average family support

Fig. A7. Marginal effects of the interaction between school-level teacher support and family support on peer relationship problems
Note: family support was centred, with negative values indicating below average family support and positive value indicating above average family support

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