



## Indoor air problems and the perceived social climate in schools: A multilevel structural equation analysis



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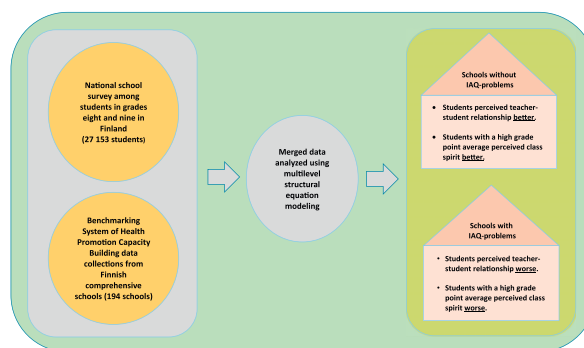
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### HIGHLIGHTS

- We studied whether schools' IAQ problems associated with their social climate.
- Questionnaire data were analyzed with the multilevel structural equation modeling.
- Focus on two spheres: atmosphere and anthroposphere
- Perceived social climate worse in schools with observed IAQ problems.
- Problems in school's physical environment could undermine school's social climate.

### GRAPHICAL ABSTRACT



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### ABSTRACT

Indoor air problems in schools appear to influence learning outcomes and absence rates. However, previous research has not investigated whether indoor air problems influence the social climate of schools. Therefore, we studied whether indoor air problems observed in schools associate with students' perceptions of the teacher-student relationship and class spirit. The nationwide sample of Finnish schools ( $N = 194$  schools/27153 students) was analyzed using multilevel structural equation modeling. Data on the schools' social climate collected from students were merged with independently collected data on observed indoor air problems from school principals. We found that the teacher-student relationship was reported to be worse in schools with observed indoor air problems compared to those without observed indoor air problems. Furthermore, the reported class spirit was worse in schools with observed indoor air problems, but

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Psychosocial effect  
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only among students with a high grade point average. Our findings indicate that indoor air problems may affect the student-perceived social climate.

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## 1. Introduction

Problems in schools' indoor air quality (IAQ) are widespread. For example, some 24% of schools in Finland, 20% in the Netherlands, and 40% Spain were estimated to have moisture problems, such as dampness or mold (Haverinen-Shaughnessy et al., 2012). Furthermore, many studies have found that a large proportion of schools are inadequately ventilated (Haverinen-Shaughnessy et al., 2015; Toyinbo et al., 2016; WHO, 2015). Such problems can increase the risk to students' health (Annesi-Maesano et al., 2012; Borràs-Santos et al., 2013), absence rates (Mendell et al., 2013; Simons et al., 2010), and decreased academic performance (e.g., standardized test scores) (Toyinbo et al., 2016; Mendell et al., 2013; Haverinen-Shaughnessy and Shaughnessy, 2015).

Despite these findings, little is known about whether and how poor IAQ associates with the students' perception of social climate in schools. The social climate reflects, for instance, the goals, norms, interpersonal relationships and teaching practices, organizational patterns, and school facilities present in a specific school (Cohen et al., 2009; Zullig et al., 2010). Poor student-perceived social climate associates with students' decreased well-being and academic performance (Cohen et al., 2009; Zullig et al., 2010; Anderson, 1982; Thapa et al., 2013), lower self-esteem (Way et al., 2007) and problems in their school adjustment (Kuperminc et al., 1997; Loukas and Murphy, 2007), for example. Given that the perceived social climate plays an important role in students' psychosocial well-being and learning, it is essential to study how schools' IAQ problems relate to it. The need to study the effects of IAQ on the social climate in schools is acknowledged in the "indoor air research" literature as well (Magzamen et al., 2015).

### 1.1. Student-perceived social climate and indoor air problems in schools

Although there is no previous research assessing whether and how schools' IAQ problems relate to the student-perceived social climate, some indirect evidence suggests that there may be an association between them. Previous research has associated schools' IAQ problems with increased rates of teachers' sick leave and decreased well-being (Ervasti et al., 2012; Sahakian et al., 2008), and it may induce interpersonal conflicts as well as anxiety and fear (Lahtinen et al., 2002). Furthermore, it has been shown that teachers, who perceive their school's physical environment unsatisfactory, report more negative attitudes and lower moral toward their work and notice more problems in the school's social climate than teachers who perceive the environment as satisfactory (Earthman and Lemasters, 2009; Uline and Tschannen-Moran, 2008; Uline et al., 2009). Finally, also principals' perceptions of their school's physical environment has been associated with their understanding of the school's ability to deliver instruction (Duyar, 2010).

However, it is unlikely that IAQ problems influence only school personnel. First, given that school's organizational culture and teachers' well-being and attitudes relate to the student-perceived social climate (Cassidy et al., 2016; Elovainio et al., 2011; Hoglund et al., 2015; Virtanen et al., 2009), it is plausible that also students in schools with IAQ problems report lower social climate than students in schools without such problems. Furthermore, previous research indicates that also students' perceptions of their school's physical environment associate with how they perceive the school's social climate (Zullig et al., 2010; Plank et al., 2009). Finally, students' absence rates have been found to be higher in schools with poor IAQ than in schools without such problems (Simons et al., 2010), which may also reflect issues in the social

climate, since the social climate associates with school absenteeism (Kearney, 2008). Based on the evidence, it appears that schools' IAQ problems may relate to factors which constitute the student-perceived social climate, such as perceived social support, discipline, and peer relationships, in many ways.

### 1.2. The present study

In this study, we focus on two highly relevant factors of the student-perceived social climate: perceived quality of teacher-student relationship and perceived class spirit (i.e., the classroom's emotional climate) (Cohen et al., 2009; Schaps, 2005). These factors are very influential for students' academic performance, school engagement, health, and health-related behaviors, for example (Jia et al., 2009; McNeely and Falci, 2004; Wang and Eccles, 2012). Therefore, it is important to know whether and how IAQ problems in schools relate to these factors. Our first research question asks whether the perceived teacher-student relationship and class spirit among lower secondary school students differ between schools with observed IAQ problems and schools without such problems. Based on the literature cited above (Ervasti et al., 2012; Lahtinen et al., 2002; Uline and Tschannen-Moran, 2008; Elovainio et al., 2011), we hypothesize that students in schools with IAQ problems report worse perceived quality of the teacher-student relationship and class spirit than students in schools without such problems (H1).

Our second research question asks whether the associations between *student-level characteristics* (e.g., gender) and the student-perceived social climate are different in schools with and without IAQ problems. The need to study this issue is based on previous research showing that students' perceptions of their school's social climate is associated with many student-level characteristics, such as gender, socioeconomic status, ethnicity, social support, and academic performance (Thapa et al., 2013; McGrath and Van Bergen, 2015; Wyrick and Rudasill, 2009); different students perceive the social climate of their school differently. Given that not only student characteristics but also contextual factors can have effects on the student-perceived social climate (McNeely et al., 2002), we also tested whether the association between *school-level characteristics* (e.g., school size) and the student-perceived social climate are different in these two school contexts. Analyzing these interactions was considered important since it provides information on whether there are certain types of students or schools that are especially susceptible to report poor teacher-student relationship or poor class spirit when facing IAQ problems. Given that there are no previous studies considering this issue, no hypothesis is posed.

## 2. Material and methods

### 2.1. Data and participants

The data were obtained from two sources: a) the School Health Promotion Study (SHP) 2013, focusing on comprehensive school students in grades eight and nine (14–16 years old) and b) the Benchmarking System of Health Promotion Capacity Building (BSHPCB) data collections from comprehensive schools in 2013 (for more details, see Finell et al., 2017). The questionnaire of BSHPCB is usually filled in by the school's principals. Two variables from BSHPCB were used in the analysis. The first variable measured if and when the triennial inspection required by Health Care Act 1326/2010 had been carried out in the school. This regulatory inspection is done in co-operation with the

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