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PERCEIVED INDOOR AIR QUALITY AND PSYCHOSOCIAL WORK ENVIRONMENT IN OFFICE, SCHOOL AND HEALTH CARE ENVIRONMENTS IN FINLAND

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Abstract
Objectives: The study examined the extent and prevalence of perceived indoor environment-related (IE-related) symptoms environmental complaints and psychosocial work environmental factors in Finnish office, school and health care environments. Material and Methods: The data were collected from non-industrial workplaces (N = 455) in 2011–2012 and 2015–2017 using the Finnish Institute of Occupational Health’s Indoor Air Questionnaire (IA Questionnaire). Suspicion of IE-related problems was reported in 59% of workplaces. The data consisted of 28 826 employees’ responses. Results: The employees reported symptoms and environmental discomfort in office environments less often than in school or health care environments. The most often reported IE-related complaints were stuffy air (39% of respondents), dry air (34%) and insufficient ventilation (33%). The most often reported symptoms were irritation of the nose (27% of respondents), irritation of the eyes (26%), and hoarse or dry throat (24%). The results showed differences between the perceived IE in office, school and health care environments. Conclusions: Compared to earlier findings, the most often perceived IE-related symptoms and complaints have increased in Finnish health care environments. The office employees’ perceptions of psychosocial work environment remained fairly unchanged whereas health care personnel more often assessed their psychosocial environment as positive compared to previous reports. Instead of exact reference values, comparing the results of IA Questionnaires with the distributions and mean values of the results of this study may be more informative for those striving to solve IE-related problems. The presented distribution and mean values of perceived symptoms, environmental complaints and psychosocial work environment might help to relate the results to other workplaces. This, in turn, might increase the understanding that IA Questionnaire results are influenced by many factors. The results presented can be used as new reference material when interpreting the results of IA Questionnaires in office, school and health care environments. Int J Occup Med Environ Health. 2020;33(4):479–95

Key words: Indoor Air Questionnaire, school, health care, perceived indoor environment, reference material, office

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INTRODUCTION

Perceived indoor environment – a complex mix of different factors

In Finland there has been extensive, long-term concern about indoor air quality (IAQ) and its impact on health, specifically in non-industrial workplaces. However, although IAQ problems are common in Finland, their prevalence or detected IAQ is not exceptional in comparison to other countries [1–5]. It is also known that indoor environment (IE) comfort influences satisfaction factors in different ways, depending on the country [6], location [4] and socio-cultural context [4].

According to Statistics Finland’s Quality of Work Life Survey 2013 [7], more than 1 in 4 Finnish wage and salary earners are very satisfied with their workspaces. However, female wage and salary earners reported more noise and disruptions in their work environment than males [7]. The most often reported environmental factors were noise, too low or too high temperatures, insufficient ventilation, and dust [7]. According to the same study, the prevalence of different types of experiences is not, in all cases, directly related to the reported environmental factors. Thus, perceived and measured IAQ may be different [8–10].

Several studies have found that perceived IAQ varies according to building types [1,4]. Different building-related factors [4,11–13], individual factors [12,14], the psychosocial environment [10,15–17], the questionnaire information itself [18], and worries [19] have been found to affect perceived IAQ. A previous study found that indoor environmental satisfaction is a flexible, subjective experience, as are cultural factors [6]. Based on earlier studies [8–10,15,16], problem-solving should take account of related contextual factors, such as the condition of the building, perceived IAQ, psychosocial work environment, individual factors, and problem-solving measures. One problem-solving method is to use the Indoor Air Questionnaire (IA Questionnaire) to ask employees about their experiences of IE and the psychosocial work environment. Indoor Air Questionnaires are a relevant part of the IE problem-solving process and are a well-established and commonly used tool for monitoring perceived IE and psychosocial work environment in Finnish workplaces. Indoor Air Questionnaires are primarily intended for health care professionals, but multi-professional teams can also widely use their results as part of problem-solving.

Office environments

In the 1980s, WHO reported that up to 30% of employees complained of building-related symptoms [20]. In the 1990s, Andersson [18] reported reference values based on the results of Örebro MM-40 Indoor Climate Questionnaire (Örebro MM-40) surveys in 9 non-industrial buildings. The most prevalent IE-related complaints were dry air (20% of respondents), stuffy air (10%) and dust or dirt (10%), and the most prevalent symptoms were fatigue (10% of respondents), irritated/runny nose (9%) and irritation of the eyes and itching scalp or ears (6%) [18]. In 2004, Reijula et al. [21] reported the Örebro MM-40 results of 11 154 respondents in 122 non-industrial workplaces. The most prevalent IE-related complaints were dry air (35% of respondents), stuffy air (34%), draft (22%), too high room temperature (17%) and unpleasant odors (17%) [21]. The most prevalent IE-related weekly symptoms were irritated/runny nose (20% of respondents), irritation of the eyes (17%), fatigue (16%), irritation of the skin on the hands (15%) and hoarse throat (14%) [21].

A study published in 2015 [12] on indoor climate comfort in Italian offices revealed that >31% of employees reported symptoms and 65% had made IE-related complaints. In the 2000s, office workplace studies reported (using Örebro MM-40) general IE-related complaints of varying temperatures (21% of respondents) [12], dry air (9%) [12] and stuffy air (8%) [12], while IE-related weekly symptoms were upper respiratory symptoms (30% of respondents) [22], lower respiratory symptoms (25%) [22] and eye irritation (48%) [22].
School environments
In schools, teachers reported more IE-related symptoms than pupils [18,23]. There is some evidence of teachers’ increasing respiratory symptoms in classrooms with too high or too low IA relative humidity [24], poor building condition, and damp and mould exposures [25]. In previous studies in the USA, 72–84% of teachers reported nasal symptoms [25,26], 43% asthma-like symptoms [25], 18–40% throat irritation [25,26], 4–33% wheezing [25,26] and 30% lower respiratory symptoms [25]. In a Finnish follow-up study [27], the symptom prevalence (using Örebro MM-40) among the teachers was high before remediation of the buildings. Teachers’ most often reported IE-related symptoms were hoarseness (93% of respondents), rhinitis (74%), dyspnea (37%) coughing (30%) and fatigue (27%) before remediation of the buildings.

Health care environments
Employees in hospitals more often reported IE-related symptoms and complaints (using the Örebro MM-40-based questionnaire) than employees in offices in Finland [1]. Furthermore, employees more often reported IE-related symptoms and complaints in hospital buildings in need of repairs than in hospital buildings not requiring repairs [1]. According to the same study, the most common IE-related weekly complaints in hospitals were dry air (46% of respondents), stuffy air (40%), noise (30%) and draft (27%). The most common IE-related weekly symptoms were irritation of the nose (25% of respondents), irritation of the hands (24%), irritation of the eyes (23%) and fatigue (21%) [1].

A recent study of Finnish hospital environments [2] found that the most prevalent IE-related symptoms (using Örebro MM-40) were irritated/runny nose (52% of respondents), irritation of the eyes (46%), irritation of the skin on the face (44%) and fatigue and irritation of the skin on the hands (43%). However, in this study [2], building investigation results did not explain the perceived IAQ-related symptoms. In the authors’ earlier study [9], the results (using the Örebro MM-40-based questionnaire) were very similar, such as the prevalence of symptoms of irritation of the nose (>40% of respondents), irritation of the eyes (>30%) and irritation of the skin on the hands (>30%) in Finnish hospital environments. The authors also deduced that extensive impurity sources in the premises are not always associated with the prevalence of perceived symptoms [9].

Psychosocial work environment
In former studies, psychosocial work environment has shown to be significantly associated with IAQ problems, IE-related symptoms and complaints [8,15,17], and thus it was also briefly surveyed in Örebro MM-40. In this respect, this questionnaire could be useful as a rough practical screening method for analyzing the role of psychosocial environment. Lahtinen et al. [15] stated in their study that 75% of respondents perceived their work as being often interesting, 72% received help from their colleagues, 20% had too much work, and 35% were able to influence their working conditions in Finnish office environments. The earlier study of Finnish hospital environments [1] by the Finnish Institute of Occupational Health (FIOH) found that 82% of respondents perceived their work as being often interesting and stimulating, 78% often received help from their colleagues, 21% were often too much work, and 22% often had too much work to do.

The aim of the study
The aim of this study was to assess the prevalence of symptoms and environmental complaints related to IE and perceived psychosocial work environment in office, school and health care environments in Finland in the 2010s. Since IA Questionnaires (Örebro MM-40-based) are an established and commonly used tool in the IE problem-solving process in Finnish workplaces, the authors’ aim
was also to collect up-to-date reference material that can be used to interpret the results of the IA Questionnaires (Örebro MM-40-based) in office, school and health care environments.

MATERIAL AND METHODS

Materials

Since 1995, FIOH has used a standardized IA Questionnaire as a parallel tool with other methods to investigate IE-related problems in workplaces. Usually, someone from the workplace’s occupational health care service contacts FIOH to investigate the extent, severity and probability of the IE-related problem at the workplace. Monitoring the state of perceived IE via a questionnaire is also a normal follow-up measure, for example, after IA-related repairs. In this study, the data were collected primarily from different workplaces a part of FIOH’s customer services, and secondly through FIOH’s research and development projects. The respondents were from different non-industrial workplaces and different locations in Finland. The questionnaire was answered via the internet. The FIOH’s’s IA Questionnaire link was emailed to the participants. The email also contained a cover letter to explain the questionnaire’s purpose and method, and information about the use of the results and personal data protection. Participation was voluntary. To ensure reliable results, the response rate had to be high. Therefore, both FIOH and the employer reminded the participants to answer to the questionnaire.

The data included 28 826 IA Questionnaire responses from 2011–2012 and 2015–2017. This study used all the queries made by FIOH during these years. The background information revealed that workplaces either had suspected IE-related problems (N = 16902 [58.6%]) or that the questionnaire was used for monitoring the state of perceived IE (N = 4244 [14.7%]). The data did not include information on the purpose of the questionnaire in the workplaces (N = 7680 [26.6%]). In this study, the authors focused on the overall data covering 28 862 employees’ responses. They also analyzed separately the responses from the workplaces monitoring the state of perceived IE (N = 4224). The mean response rate was 77%, with a range of 43–100%. As regards gender and age, 70% of respondents were women and mean age was 47.

The data included questionnaire responses from several work environments, 206 offices (57% of responses), 122 schools (18%) and 127 health care environments (25%). The office workplaces were from the government sector (39%), the public sector (21%), the private sector (34%) and other sectors (6%). The schools were from the government sector (4%), the public sector (93%) and other sectors (3%). The school workplaces included universities, elementary and high schools, and schools of applied sciences. The health care workplaces were from the government sector (2%), the public sector (75%), the private sector (19%) and other sectors (4%).

Questionnaire

The IA Questionnaire is based on Örebro MM-40 [18], modified slightly by FIOH in 2006–2008 [1]. It is divided into 4 parts and contains questions on:

1) the work environment,
2) work arrangements,
3) individual allergy history,
4) work environment-related symptoms.

In the first part, the work environment questions deal with draft, stuffy and dry air, insufficient ventilation, mould or other unpleasant odors, room temperatures, tobacco smoke, noise, dim light or reflections, and dust or dirt.

In the second part, individual allergy history concerns past or present asthma, allergic rhinitis and atopic eczema.

In the third part, the IE-related symptoms questions deal with fatigue, headache, feeling heavy-headed, concentration difficulties, fever or chills, irritation of the eyes, irritation of the nose, hoarse or dry throat, coughing, coughing at night, shortness of breath, wheezing, irritation of
the skin on the face, irritation of the skin on the hands, muscular pain and joint pain.

In the first 3 parts, the questions have 3 response options: “yes, often,” “yes, sometimes” and “no, never.” The authors’ study focused on the IE-related symptoms and environmental complaints that occurred weekly and the answer alternative “yes, often.”

In the fourth part, the psychosocial work environment is evaluated using the following questions: “Do you regard your work as interesting and stimulating?” “Do you have too much work?” “Are you able to influence your working conditions?” “Do your fellow workers help you with work-related problems?” The response options are: “yes, often,” “yes, sometimes,” “no, seldom or rarely,” “no, never.”

To study perceived stress, a validated single-item measure of stress symptoms is used [28]. “Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?” The response options were: “not at all,” “just a little,” “some,” “quite a lot,” “very much.” In the analyses, the authors combined the levels “not at all” and “some” and “just a little” into 1 level, and the levels “quite a lot,” and “very much,” into a single level.

Statistical analyses
For the statistical analyses, the authors used the SPSS 25.0 program. In the analyses, they calculated the confidence intervals for percentages based on normal distribution. The calculations also covered the distribution of responses separately for office, school and health care environments. Distribution values were calculated at the workplace level.

As this was a questionnaire-based study in which participation was voluntary and involved no intervention on individuals, according to the Finnish legislation it did not require handling by an ethics committee.

RESULTS

Indoor environment-related complaints
The IE-related complaints differed in office, school and health care environments (Table 1). The health care employees more often reported complaints related to stuffy air (55.7% of respondents), dry air (49.9%), insufficient ventilation (47.7%), mould odor (26.6%) and unpleasant odor (30.5%) than the school or office employees (Table 1). The school employees more often reported complaints about noise (32.8% of respondents) and dust or dirt (20.2%) than the other groups. The office employees less often reported complaints about stuffy air (30.0% of respondents), dry air (27.7%), insufficient ventilation (25.0%), draft (16.7%) and dust or dirt (16.6%) than the other groups (Table 1).

Table 2 presents data on the distribution of perceived IE-related weekly environmental complaints. The mean values in Table 1 are mostly within the range of 50th–75th percentile (Table 2).

Table 3 illustrates the percent mean values of employees’ IE-related complaints in workplaces that were monitoring the state of perceived IE, for example, after IA-related repairs. In addition, IE-related complaints were common in these workplaces.

Indoor environment-related symptoms
The perceived IE-related symptoms differed in the office, school and health care environments (Table 1). The health care employees more often perceived, for example, symptoms of irritation of the nose (39.2% of respondents), irritation of the eyes (37.8%), hoarse or dry throat (33.8%), fatigue (25.9%), or feeling heavy-headed (26.0%) than the other groups (Table 1). The school employees less often perceived symptoms of shortness of breath (30.0% of respondents), dry air (27.7%), insufficient ventilation (25.0%), draft (16.7%) and dust or dirt (16.6%) than the other groups (Table 1).
Table 1. Perceived indoor environment-related (IE-related) weekly complaints and symptoms in office, school and health care environments according to 28 826 IA Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017

| Variable                                | Respondents (N = 28 826) |
|-----------------------------------------|----------------------------|
|                                         | office employees (N = 16 545) | school employees (N = 5241) | health care employees (N = 7040) | total |
|                                         | n  M%  95% CI | n  M%  95% CI | n  M%  95% CI | M% |
| Complaint                               |                           |                           |                           |     |
| stuffy air                              | 4831 30.0 29.3–30.7 | 2175 42.1 40.8–43.4 | 3862 55.7 54.5–56.9 | 38.5 |
| dry air                                 | 4445  27.7  27.0–28.4 | 1500  29.6  28.3–30.9 | 3424  49.9  48.7–51.1 | 33.5 |
| insufficient ventilation                 | 3995  25.0  24.3–25.7 | 1933  37.9  36.6–39.2 | 3280  47.7  46.5–48.9 | 33.0 |
| noise                                   | 2407  15.1  14.5–15.7 | 1658  32.8  31.5–34.1 | 1472  21.7  20.7–22.7 | 20.0 |
| draft                                   | 2616  16.7  16.1–17.3 | 890   17.8  16.7–18.9 | 1881  28.3  27.2–29.4 | 19.7 |
| unpleasant odor                         | 1945  12.2  11.7–12.7 | 1010  19.9  18.8–21.0 | 2072  30.5  29.4–31.6 | 18.1 |
| dust or dirt                            | 2670  16.6  16.0–17.2 | 1029  20.2  19.1–21.3 | 1185  17.4  16.5–18.3 | 17.5 |
| too low room temperature                 | 2435  15.4  14.8–16.0 | 848   16.9  15.9–17.9 | 1288  19.3  18.4–20.2 | 16.6 |
| varying room temperature                | 2067  13.1  12.6–13.6 | 627   12.6  11.7–13.5 | 1479  22.0  21.0–23.0 | 15.2 |
| mould odor                              | 1346   8.5  8.1–8.9 | 789   15.6  14.6–16.6 | 1815  26.6  25.6–27.6 | 14.2 |
| dim light or reflections                 | 1297   8.2  7.8–8.6 | 467   9.2  8.4–10.0 | 931   13.7  12.9–14.5 |  9.7 |
| too high room temperature                | 1146   7.3  6.9–7.7 | 337   6.8  6.1–7.5 | 939   14.1  13.3–14.9 |  8.9 |
| tobacco smoke                           | 315    2.0  1.8–2.2 | 62    1.2  0.9–1.5 | 355   5.2  4.7–5.7 |  2.6 |
| Symptom                                 |                           |                           |                           |     |
| irritation of the nose                  | 3524  21.5  20.9–22.1 | 1413  27.2  26.0–28.4 | 2736  39.2  38.1–40.3 | 26.9 |
| irritation of the eyes                  | 3484  21.4  20.8–22.0 | 1221  23.6  22.4–24.8 | 2633  37.8  36.7–38.9 | 25.8 |
| hoarse, dry throat                      | 3138  19.2  18.6–19.8 | 1470  28.4  27.2–29.6 | 2358  33.8  32.7–34.9 | 24.4 |
| fatigue                                 | 2397  14.6  14.1–15.1 | 1113  21.4  20.3–22.5 | 1810  25.9  24.9–26.9 | 18.6 |
| feeling heavy-headed                    | 1930  11.9  11.4–12.4 | 985   19.1  18.0–20.2 | 1799  26.0  25.0–27.0 | 16.6 |
| irritation of the skin on the hands     | 1737  10.7  10.2–11.2 | 804   15.6  14.6–16.6 | 1682  24.2  23.2–25.2 | 14.9 |
| irritation of the skin on the face      | 1684  10.4  9.9–10.9 | 737   14.3  13.3–15.3 | 1401  20.2  19.3–21.1 | 13.5 |
| headache                                | 1488   9.2  8.8–9.6 | 785   15.2  14.2–16.2 | 1293  18.7  17.8–19.6 | 12.6 |
| coughing                                | 1240   7.6  7.2–8.0 | 568   11.0  10.1–11.9 | 979   14.1  13.3–14.9 |  9.8 |
Table 2. Perceived indoor environment-related (IE-related) weekly complaints and symptoms and the 25th–95th percentile distribution of responses in office, school and health care workplaces according to 28 826 IA Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017

| Variable                          | Respondents (N = 28 826) |
|-----------------------------------|--------------------------|
|                                  | Office employees (N = 16 545) | School employees (N = 5241) | Health care employees (N = 7040) |
|                                  | n | P25 | P50 | P75 | P95 | min. [%] | max. [%] | n | P25 | P50 | P75 | P95 | min. [%] | max. [%] | n | P25 | P50 | P75 | P95 | min. [%] | max. [%] |
| concentration difficulties        | 1379 | 8.5 | 8.1–8.9 | 381 | 7.4 | 6.7–8.1 | 623 | 9.0 | 8.3–9.7 | 8.5 |
| joint pain                        | 638 | 3.9 | 3.6–4.2 | 243 | 4.7 | 4.1–5.3 | 460 | 6.6 | 6.0–7.2 | 4.7 |
| muscular pain                     | 687 | 4.3 | 4.0–4.6 | 180 | 3.5 | 3.0–4.0 | 438 | 6.4 | 5.8–7.0 | 4.6 |
| shortness of breath               | 488 | 3.0 | 2.7–3.3 | 266 | 5.2 | 4.6–5.8 | 346 | 5.0 | 4.5–5.5 | 3.9 |
| fever or chills                   | 382 | 2.4 | 2.2–2.6 | 193 | 3.7 | 3.2–4.2 | 244 | 3.5 | 3.1–3.9 | 2.9 |
| coughing at night                 | 306 | 1.9 | 1.7–2.1 | 158 | 3.1 | 2.6–3.6 | 236 | 3.4 | 3.0–3.8 | 2.5 |
| wheezing                          | 248 | 1.5 | 1.3–1.7 | 120 | 2.3 | 1.9–2.7 | 172 | 2.5 | 2.1–2.9 | 1.9 |
Table 2. Perceived indoor environment-related (IE-related) weekly complaints and symptoms and the 25th–95th percentile distribution of responses in office, school and health care workplaces according to 28,826 IE Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017 – cont.

| Variable                          | Respondents (N = 28,826)                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
|-----------------------------------|-----------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                                   | office employees (N = 16,545)                  | school employees (N = 5,241) | health care employees (N = 7,040) |
|                                   | n   | P_{25} | P_{50} | P_{75} | P_{95} | min. [%] | max. [%] | n   | P_{25} | P_{50} | P_{75} | P_{95} | min. [%] | max. [%] | n   | P_{25} | P_{50} | P_{75} | P_{95} | min. [%] | max. [%] |
| Symptom                           | n   | P_{25} | P_{50} | P_{75} | P_{95} | min. [%] | max. [%] | n   | P_{25} | P_{50} | P_{75} | P_{95} | min. [%] | max. [%] | n   | P_{25} | P_{50} | P_{75} | P_{95} | min. [%] | max. [%] |
| fatigue                           | 2397| 7     | 12    | 19    | 37    | 2      | 73      | 1113| 11    | 18    | 29    | 52    | 0      | 63      | 1810| 14    | 21    | 31    | 45    | 0      | 68      |
| feeling heavy-headed              | 1930| 4     | 8     | 18    | 33    | 0      | 67      | 985 | 8     | 16    | 24    | 46    | 3      | 76      | 1799| 12    | 21    | 31    | 44    | 0      | 80      |
| headache                          | 1488| 3     | 7     | 12    | 31    | 0      | 53      | 785 | 6     | 13    | 20    | 35    | 0      | 47      | 1293| 9     | 16    | 22    | 40    | 0      | 59      |
| concentration difficulties        | 1379| 4     | 7     | 11    | 23    | 0      | 47      | 381 | 4     | 6     | 11    | 19    | 0      | 35      | 623 | 4     | 7     | 11    | 26    | 0      | 55      |
| irritation of the eyes            | 3484| 12    | 19    | 29    | 49    | 3      | 72      | 1221| 10    | 22    | 31    | 48    | 0      | 72      | 2633| 26    | 34    | 44    | 59    | 0      | 79      |
| irritation of the nose            | 3524| 11    | 19    | 30    | 50    | 0      | 73      | 1413| 17    | 26    | 34    | 47    | 3      | 67      | 2736| 24    | 35    | 44    | 63    | 8      | 80      |
| hoarse, dry throat                | 3138| 9     | 15    | 29    | 49    | 0      | 73      | 1470| 16    | 26    | 36    | 53    | 3      | 69      | 2358| 20    | 28    | 39    | 57    | 4      | 69      |
| coughing                          | 1240| 3     | 6     | 11    | 24    | 0      | 38      | 568 | 5     | 9     | 15    | 25    | 0      | 39      | 979 | 6     | 11    | 17    | 33    | 0      | 38      |
| coughing at night                 | 306 | 0     | 1     | 3     | 9     | 0      | 29      | 158 | 0     | 1     | 5     | 10    | 0      | 18      | 236 | 0     | 2     | 5     | 13    | 0      | 22      |
| irritation of the skin on the face| 1684| 4     | 9     | 15    | 30    | 0      | 56      | 737 | 6     | 11    | 18    | 33    | 0      | 61      | 1401| 12    | 18    | 24    | 41    | 0      | 67      |
| irritation of the skin on the hands| 1737| 4     | 9     | 15    | 25    | 0      | 57      | 804 | 7     | 13    | 21    | 33    | 0      | 83      | 1682| 12    | 23    | 30    | 46    | 0      | 65      |
| shortness of breath               | 488 | 0     | 2     | 5     | 13    | 0      | 53      | 266 | 0     | 4     | 7     | 17    | 0      | 25      | 346 | 1     | 3     | 7     | 13    | 0      | 30      |
| wheezing                          | 248 | 0     | 0     | 2     | 8     | 0      | 29      | 120 | 0     | 1     | 4     | 8     | 0      | 13      | 172 | 0     | 1     | 4     | 8     | 0      | 17      |
| fever or chills                   | 382 | 0     | 1     | 4     | 13    | 0      | 40      | 193 | 0     | 2     | 6     | 12    | 0      | 26      | 244 | 0     | 2     | 4     | 12    | 0      | 22      |
| joint pain                        | 638 | 1     | 3     | 6     | 14    | 0      | 36      | 243 | 0     | 4     | 7     | 14    | 0      | 28      | 460 | 3     | 5     | 9     | 17    | 0      | 31      |
| muscular pain                     | 687 | 1     | 4     | 6     | 15    | 0      | 33      | 180 | 0     | 2     | 5     | 12    | 0      | 15      | 438 | 2     | 6     | 8     | 17    | 0      | 35      |

P – percentile.
Table 3. Perceived indoor environment-related (IE-related) weekly complaints and symptoms in office, school and health care workplaces which were monitoring the state of perceived IE, for example, after IA-related repairs according to 28 826 IA Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017.

| Variable                      | Respondents (N = 4244) | Respondents (N = 2891) | Respondents (N = 587) | Respondents (N = 766) | total |
|-------------------------------|------------------------|------------------------|-----------------------|-----------------------|-------|
|                              | n          | M%     | 95% CI    | n          | M%     | 95% CI    | n          | M%     | 95% CI    | n          | M%     | 95% CI    | M%     |
| Complaint                     |            |        |           |            |        |           |            |        |           |            |        |           |        |
| stuffy air                    | 760        | 27.1   | 25.5–28.7 | 232        | 39.7   | 35.7–43.7 | 454        | 59.7   | 56.2–63.2 | 34.8       |
| dry air                       | 855        | 30.5   | 28.8–32.2 | 182        | 31.8   | 28.0–35.6 | 384        | 51.3   | 47.7–54.9 | 34.5       |
| insufficient ventilation      | 589        | 21.2   | 19.7–22.7 | 199        | 34.6   | 30.7–38.5 | 360        | 47.9   | 44.3–51.5 | 28.0       |
| noise                         | 398        | 14.4   | 13.1–15.7 | 203        | 35.4   | 31.5–39.3 | 161        | 21.6   | 18.6–24.6 | 18.6       |
| draft                         | 487        | 17.9   | 16.5–19.3 | 92         | 16.2   | 13.2–19.2 | 229        | 31.2   | 27.8–34.6 | 20.1       |
| unpleasant odor               | 338        | 12.1   | 10.9–13.3 | 100        | 17.5   | 14.4–20.6 | 226        | 30.2   | 26.9–33.5 | 16.1       |
| dust or dirt                  | 383        | 13.7   | 12.4–15.0 | 76         | 13.2   | 10.4–16.0 | 152        | 20.5   | 17.6–23.4 | 14.9       |
| too low room temperature      | 422        | 15.3   | 14.0–16.6 | 97         | 17.1   | 14.0–20.2 | 179        | 24.3   | 21.2–27.4 | 17.2       |
| varying room temperature      | 392        | 14.3   | 13.0–15.6 | 66         | 11.7   | 9.0–14.4  | 175        | 23.9   | 20.8–27.0 | 15.6       |
| mould odor                    | 191        | 6.9    | 6.0–7.8   | 82         | 14.3   | 11.4–17.2 | 208        | 27.9   | 24.7–31.1 | 11.7       |
| dim light or reflections      | 205        | 7.4    | 6.4–8.4   | 47         | 8.2    | 6.0–10.4  | 107        | 14.4   | 11.9–16.9 | 8.8        |
| too high room temperature     | 263        | 9.6    | 8.5–10.7  | 24         | 4.3    | 2.6–6.0   | 96         | 13.3   | 10.8–15.8 | 9.5        |
| tobacco smoke                 | 37         | 1.3    | 0.9–1.7   | 7          | 1.2    | 0.3–2.1   | 39         | 5.2    | 3.6–6.8   | 2.0        |
| Symptom                       |            |        |           |            |        |           |            |        |           |            |        |           |        |
| irritation of the nose        | 660        | 23.1   | 21.6–24.6 | 187        | 32.0   | 28.2–35.8 | 325        | 42.7   | 39.2–46.2 | 27.9       |
| irritation of the eyes        | 645        | 22.7   | 21.2–24.2 | 158        | 27.1   | 23.5–30.7 | 326        | 43.1   | 39.6–46.6 | 27.0       |
| hoarse, dry throat            | 587        | 20.6   | 19.1–22.1 | 206        | 35.2   | 31.3–39.1 | 276        | 36.4   | 33.0–39.8 | 25.5       |
| fatigue                       | 367        | 12.9   | 11.7–14.1 | 144        | 24.7   | 21.2–28.2 | 229        | 30.2   | 26.9–33.5 | 17.6       |
| feeling heavy-headed          | 304        | 10.8   | 9.7–11.9  | 119        | 20.6   | 17.3–23.9 | 247        | 32.6   | 29.3–35.9 | 16.1       |
| irritation of the skin on the hands | 323    | 11.4  | 10.2–12.6 | 91         | 15.7   | 12.7–18.7 | 213        | 28.2   | 25.0–31.4 | 15.0       |
| irritation of the skin on the face | 317   | 11.2  | 10.0–12.4 | 110        | 18.9   | 15.7–22.1 | 187        | 24.7   | 21.6–27.8 | 14.7       |
| headache                      | 211        | 7.5    | 6.5–8.5   | 110        | 18.8   | 15.6–22.0 | 173        | 22.8   | 19.8–25.8 | 11.9       |
| coughing                      | 223        | 7.9    | 6.9–8.9   | 71         | 12.2   | 9.5–14.9  | 132        | 17.5   | 14.8–20.2 | 10.2       |
| concentration difficulties    | 247        | 8.8    | 7.8–9.8   | 50         | 8.7    | 6.4–11.0  | 86         | 11.5   | 9.2–13.8  | 9.3        |
hoarse or dry throat (19.2%), fatigue (14.6%), or feeling heavy-headed (11.9%) than the health care and school employees (Table 1).

Table 2 shows the data on the distribution of perceived IE-related weekly symptoms. The mean values in Table 1 are within the range of 50th–75th percentile (Table 2).

Table 3 illustrates the percent mean values of employees’ IE-related symptoms in workplaces that were monitoring the state of perceived IE, for example, after IA-related repairs. In addition, IE-related symptoms were common in these workplaces.

**Perceived psychosocial work environment and stress**

The school employees and health care employees perceived their work as more interesting and stimulating than the office employees (Table 4). The office employees (17.2% of respondents) felt they often had too much work to do and reported this more often than the school (13.9%) or the health care employees (16.6%) (Table 4). The school employees (34.6% of respondents) were able to influence their working conditions more often than the health care employees (27.5%) (Table 4). The health care employees (77.7% of respondents) felt that they received help from their fellow employees in their work more often than the office (72.7%) and school (73.3%) employees (Table 4). The office employees (3.6% of respondents) most often experienced “very much” stress in their work. The health care workers (17.7% of respondents) most often reported “not at all” being stressed in their work (Table 4).

Table 5 shows the data on the distribution of perceived psychosocial work environment and stress. The mean values in Table 4 mostly fall within the range of 50th–75th percentile (Table 5).

**DISCUSSION**

The data used in the study were extensive and described the perceived IA situation in office, school and health care workplaces.
The most often perceived symptoms were irritated/runny nose, irritation of the eyes, hoarse throat, fatigue and feeling heavy-headed. These perceived symptoms also found to be common in FIOH’s earlier study [1] and other studies [2]. The prevalence of the symptoms and environmental complaints had both increased.

School employees’ environmental complaints most often addressed stuffy air, insufficient ventilation, noise, dry air, and dust or dirt. Notably, noise was complained about much more often in schools than in office or health care environments. The most often perceived symptoms were hoarse throat, irritated/runny nose, fatigue, feeling heavy-headed, and irritation of the skin on the hands. Other studies [23,26,30] have also found these perceived environmental complaints [23] and symptoms [26,30] to be common.

The employees in health care environments more often regarded their work as interesting and stimulating; they had fewer situations with too much work, and more possibilities to influence their working conditions than in FIOH’s 2008 study [1]. In some respects, similar trends can be found in Statistics Finland’s Quality of Work Life Survey 2013 [7]. This nationwide survey showed that wage and salary earners’ general satisfaction with their current jobs, and especially with the content of their tasks, social relations and the ability to influence the workplace, had increased since 2008, whereas experiences of time pressure had eased during the studied period.

One interesting aspect in the authors’ results was that although the office employees found their work less interesting, more often had too much work and experienced slightly more stress than the other study groups, they nevertheless reported less environmental discomfort and fewer symptoms than the school and health care employees. This seems to contradict the results of earlier studies, which have reported significant associations between the psychosocial environment and both IE-related complaints and symptoms [15,17]. Further studies should pay attention to this issue.
Table 4. Perceived psychosocial work environment and stress in office, school and health care work according to 28 826 IA Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017

| Response option | Respondents (N = 28 826) |
|-----------------|--------------------------|
|                 | office employees (N = 16 545) | school employees (N = 5241) | health care employees (N = 7 040) | total |
|                 | n  | M% | 95% CI | n  | M% | 95% CI | n  | M% | 95% CI | M% |
| "Do you regard your work as interesting and stimulating?" | | | | | | | |
| "yes, often" | 12 201 | 74.2 | 73.5–74.9 | 4433 | 85.0 | 84.0–86.0 | 5888 | 84.0 | 83.1–84.9 | 78.5 |
| "yes, sometimes" | 3583 | 21.8 | 21.2–22.4 | 703 | 13.5 | 12.5–14.4 | 964 | 13.7 | 12.9–14.5 | 18.3 |
| "no, seldom or rarely" | 608 | 3.7 | 3.4–4.0 | 76 | 1.5 | 1.2–1.8 | 140 | 2.0 | 1.7–2.3 | 2.9 |
| "never" | 57 | 0.3 | 0.2–0.4 | 5 | 0.1 | 0.01–0.2 | 19 | 0.3 | 0.2–0.4 | 0.3 |
| "Do you have too much work?" | | | | | | | |
| "yes, often" | 2822 | 17.2 | 16.6–17.8 | 725 | 13.9 | 13.0–14.8 | 1162 | 16.6 | 15.7–17.5 | 16.5 |
| "yes, sometimes" | 9114 | 55.6 | 54.8–56.4 | 3010 | 57.8 | 56.5–59.1 | 4124 | 58.9 | 57.7–60.1 | 56.8 |
| "no, seldom or rarely" | 4029 | 24.6 | 23.9–25.3 | 1317 | 25.3 | 24.1–26.5 | 1568 | 22.4 | 21.4–23.4 | 24.2 |
| "never" | 439 | 2.7 | 2.5–2.9 | 153 | 2.9 | 2.4–3.4 | 149 | 2.1 | 1.8–2.4 | 2.6 |
| "Are you able to influence your working conditions?" | | | | | | | |
| "yes, often" | 5470 | 33.5 | 32.8–34.2 | 1797 | 34.6 | 33.3–35.9 | 1919 | 27.5 | 26.5–28.5 | 32.2 |
| "yes, sometimes" | 7277 | 44.5 | 43.7–45.3 | 2576 | 49.6 | 48.2–51.0 | 3265 | 46.8 | 45.6–48.0 | 46.0 |
| "no, seldom or rarely" | 3087 | 18.9 | 18.3–19.5 | 746 | 14.4 | 13.4–15.4 | 1597 | 22.9 | 21.9–23.9 | 19.0 |
| "never" | 512 | 3.1 | 2.8–3.4 | 77 | 1.5 | 1.2–1.8 | 193 | 2.8 | 2.4–3.2 | 2.7 |
| "Do your fellow workers help you with work-related problems?" | | | | | | | |
| "yes, often" | 11 945 | 72.7 | 72.0–73.4 | 3824 | 73.3 | 72.1–74.5 | 5445 | 77.7 | 76.7–78.7 | 74.0 |
| "yes, sometimes" | 3782 | 23.0 | 22.4–23.6 | 1178 | 22.6 | 21.5–23.7 | 1338 | 19.1 | 18.2–20.0 | 22.0 |
| "no, seldom or rarely" | 628 | 3.8 | 3.5–4.1 | 186 | 3.6 | 3.1–4.1 | 197 | 2.8 | 2.4–3.2 | 3.5 |
| "never" | 73 | 0.5 | 0.4–0.6 | 27 | 0.5 | 0.3–0.7 | 27 | 0.4 | 0.3–0.5 | 0.5 |
| "Do you experience stress?" | | | | | | | |
| "not at all" | 2247 | 13.8 | 13.3–14.3 | 704 | 13.7 | 12.8–14.6 | 1221 | 17.7 | 16.8–18.6 | 14.7 |
| "just a little" | 6055 | 37.2 | 36.5–37.9 | 1878 | 36.6 | 35.3–37.9 | 2457 | 35.6 | 34.5–36.7 | 36.7 |
| "some" | 5222 | 32.1 | 31.4–32.8 | 1712 | 33.3 | 32.0–34.6 | 2195 | 31.8 | 30.7–32.9 | 32.2 |
Table 5. Perceived psychosocial work environment, stress and the 25th–95th percentile distribution of responses in office, school and health care workplaces according to 28 826 IA Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017

| Response option                                                                 | Participants (N = 28 826) |
|--------------------------------------------------------------------------------|---------------------------|
|                                                                               | office employees (N = 16 545) | school employees (N = 5241) | health care employees (N = 7040) |
|                                                                               | n  P25 P50 P75 P95 min. [%] max. [%] | n  P25 P50 P75 P95 min. [%] max. [%] | n  P25 P50 P75 P95 min. [%] max. [%] |
| “Do you regard your work as interesting and stimulating?”                     |                           |                           |                               |
| “yes, often”                                                                  | 12 201 66 74 81 90 35 97 | 4433 79 85 90 96 61 100  | 5888 77 84 89 95 37 100  |
| “no, seldom or rarely”                                                        | 665 2 4 6 13 0 33 6 0 12 | 81 0 0 3 6 0 12 159 0 1 4 8 0 27 |
| “Do you have too much work?”                                                   |                           |                           |                               |
| “yes, often”                                                                  | 2775 10 16 22 33 0 44 7 12 20 30 0 36 | 1162 9 15 23 35 0 68  |
| “no, seldom or rarely”                                                        | 4468 18 24 33 55 0 93 1470 21 27 34 48 3 85 1717 16 23 33 55 0 82 |
| “Are you able to influence your working conditions?”                          |                           |                           |                               |
| “yes, often”                                                                  | 5470 24 33 40 53 0 64 1797 27 32 42 51 14 67 | 1919 19 27 39 58 4 81  |
| “no, seldom or rarely”                                                        | 3599 15 21 29 47 0 72 823 12 16 22 32 0 52 1790 15 25 34 44 0 52  |
| “Do your fellow workers help you with work-related problems?”                 |                           |                           |                               |
| “yes, often”                                                                  | 11 845 66 73 80 91 39 100 | 3824 64 74 81 88 27 96 | 5445 71 77 84 95 50 100 |
| “no, seldom or rarely”                                                        | 705 1 4 6 13 0 24 213 0 3 6 10 0 47 224 0 3 5 9 0 20  |
| “Do you experience stress?”                                                   |                           |                           |                               |
| “quite a lot or very much”                                                    | 2751 12 16 23 33 0 43 843 10 15 21 34 0 47 1038 10 14 18 29 0 48  |
| “some or just a little”                                                       | 11 277 64 69 74 83 41 93 | 3590 64 71 76 83 41 85 | 4652 61 68 75 83 48 100 |
| “not at all”                                                                  | 2247 9 13 18 27 0 53 704 8 12 17 31 0 35 1221 12 16 23 33 0 50  |

P – percentile.
In this study, the authors present both the distribution and mean values of the questionnaire results. The examination of the distribution values was justified because 59% of the responses were from workplaces with suspected IE-related problems. The authors formulated a hypothesis that complaints and symptoms would be more common in the overall data, in which 59% of the workplaces had suspected IE-related problems, than in the data from the subgroup of workplaces that were monitoring perceived IE. However, contrary to the authors’ hypothesis, IE-related complaints and symptoms were also common in the subgroup.

Buildings and spaces, the factors affecting IA, people’s subjective and individual differences, and their experience of the psychosocial work environment vary [8], making it difficult to define unambiguous reference values for interpreting IA Questionnaire. Instead of exact reference values, comparing the results of Örebro MM-40-based questionnaire with the distributions and mean values of the results of this study may be more informative for those solving IE-related problems. The reported IE-related complaints and symptoms with values of <25th–75th percentile may represent workplaces that are unlikely to require further surveys (e.g., building investigations, occupational health service surveys). The reported IE-related complaints and symptoms with values of 75th percentile → 95th percentile, in turn, may represent workplaces that need further inspections.

The presented distribution and mean values also enable the analysis of the psychosocial work environment at the workplace and the evaluation of possible effects on symptoms and complaints. Furthermore, the presented distribution and mean values might relate the results to other workplaces when interpreting Örebro MM-40-based questionnaire results and solving IE-related problems. This might increase the understanding that questionnaire results are influenced by many factors and that each workplace, situation and human experience is different.

The measures required at each workplace should always be evaluated from many perspectives and the results of IA Questionnaires are only a part of IE problem-solving.

The present study shows that perceived IE varies according to work environments and that IE experiences have changed since earlier study results. Therefore, it is also recommendable to use the present results as new reference data to interpret Örebro MM-40-based questionnaire results in offices, schools and health care workplaces in Finland.

The authors’ study has some limitations. The data contained only self-reported IA Questionnaires results and the authors had no information on, for example, the workplace buildings and their condition or the current situation of the work organizations. The information on possible IE-related problems was based on the workplace’s own assessment. Moreover, there was no information on the reasons why the workplaces that were monitoring the state of perceived IE were doing so.

In addition, the questions concerning the psychosocial work environment in the Örebro MM-40-based questionnaire were quite limited. The questionnaire did not include, for instance, factors such as organizational changes and questions concerning leadership. It was not possible to assess different causal relationships in this study. It was also impossible, due to limitations of the data, to establish why the perceived IE-related symptoms and environmental complaints differed between the office, school and health care environments.

The school category included different types of school environments, such as elementary schools and universities. In addition, 59% of the responses were from workplaces with suspected IE-related problems. The perceived environmental complaints and symptoms were probably slightly higher than in a random sample.

Future studies should assess the relationship between symptoms and perceived environmental complaints, as well as between the IAQ and symptoms and environmental complaints. Further studies of the psychosocial environment are needed which address both IE-related complaints and symptoms. Studies should also assess whether
individual factors can explain the symptoms, environmental complaints, and perceived psychosocial work environment. It would also be interesting to determine whether the workplace is private or public, which may partly be associated with some IE-related complaints.

CONCLUSIONS
There are differences between perceived IE in office, school and health care environments. Most of the perceived IE-related symptoms and environmental complaints had increased in health care environments since the earlier study results of the 2000s. The office employees’ perceptions of psychosocial work environment remained fairly unchanged whereas the health care personnel more often assessed their psychosocial environment as positive compared to earlier findings.

Instead of exact reference values, comparing the results of IA Questionnaires with the distributions and mean values of the results of this study may be more informative for those striving to solve IE-related problems. The presented distribution and mean values of perceived symptoms, environmental complaints and psychosocial work environment might help to relate the results to other workplaces when interpreting IA Questionnaire results and solving IE-related problems. The reported IE-related complaints and symptoms with values within the range of <25th–75th percentile may represent workplaces that are unlikely to require further surveys (e.g., building investigations, occupational health service surveys), and the reported IE-related complaints and symptoms with values of 75th percentile → 95th percentile may represent workplaces that need further investigations.

The presented distribution and mean values of perceived symptoms, environmental complaints and psychosocial work environment might help to relate results to other workplaces when interpreting Örebro MM-40-based questionnaire results and solving IE-related problems. This, in turn, might increase the understanding that IA Questionnaire results are influenced by many factors and that each workplace, situation and human experience is different. Notably, IA Questionnaires are only a part of IE problem-solving.

The results presented can be used as new reference material when interpreting Örebro MM-40-based questionnaire results in office, school and health care environments.

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