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# Profiling outpatient staff based on their self-reported comfort and preferences of indoor environmental quality and social comfort in six hospitals

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ABSTRACT

Comfort and health of outpatient staff is important due to the growing demand of healthcare and its crucial influence on society. Previous studies have mostly focused on the perception of comfort and indicated a large prevalence of building-related symptoms and dissatisfaction with comfort of staff in hospital buildings. Unfortunately, limited information was available of the individual preferences in relation to building aspects, especially in outpatient areas. This study aims to understand the preferences of outpatient staff in relation to their comfort, health, work- and building-related aspects. Data were collected with a survey from 556 outpatient workers in six hospital buildings and building inspection of 107 rooms. TwoStep cluster analysis was performed to identify groups with clear differences in preferences and comfort, that justify the variation of individual comfort and preferences of outpatient workers. Six clusters were produced for preferences and comfort with IEQ; three clusters were produced for preferences and comfort with social aspects. The clusters indicated that preferences and comfort of IEQ are related to health. The social clusters varied in activities of outpatient staff. As the overlap of the profiles of the IEQ clusters with the profiles of the social clusters was limited, the results suggest that it is important to study both simultaneously. Surprisingly, relations with building-related aspects were for both cluster-sets limited. This suggests that outpatient staff members do not relate their preferences to the actual building where they are working.

## 1. Introduction

Previous studies show that the demand on hospital staff is increasing [1–4] and that their comfort and health may be affected negatively by dose- and building-related aspects [5–7]. Perceived comfort and needs related to the layout and the indoor environmental quality (IEQ) may vary between hospital departments. This is because hospitals are complex buildings, with e.g. inpatient areas, outpatient areas, operating rooms and intensive care units. Therefore, it is important to study individual hospital departments. However, outpatient areas seem to be understudied [7].

To better understand comfort and health of staff members in outpatient areas, a survey was performed in which personal aspects, work-related aspects, and social comfort (privacy, crowding and interaction) were assessed. A previous study [8] provided an overview of health and comfort and their differences in relation to different room types. The most prevalent symptoms were dry eyes and headaches. Similar to previous studies, it was found that there is a larger prevalence of building-related symptoms and higher dissatisfaction with comfort aspects in hospitals than in offices [9–12]. Satisfaction with IEQ- and social aspects varied between those working in different room types in outpatient areas. For example, respondents who worked in consultation rooms were more likely to be comfortable with more aspects -except daylight-than respondents working in offices. However, social comfort aspects were more likely to vary than IEQ-aspects, while differences in health were limited.

Since social comfort, IEQ-aspects and health are differently related to personal aspects and room types, there is a need to analyse possible relations with building-related aspects. It is important to specify preferences and to understand their associations with the physical environment, in order to improve the comfort and health of the staff in hospitals [6]. Mourshed and Zhao (2012) studied the preferences of hospital workers in hospital buildings and found differences between the occupants, associated with differences in relation to working hours,

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gender and age [13]. Previous studies in offices indicated that the preferences that were considered more important, were related to comfort [14,15], to personal, and to work-related aspects [16,17]. However, assessing outpatient staff preferences accounting for personal, work-related, and building-related aspects has not been studied yet.

Vischer (2007) [18] suggested that both the physiological perception of IEQ-aspects and the psychological perception of social comfort, can contribute to satisfaction with the physical environment. Perception of social comfort and IEQ may vary between individuals, due to differences in reactions and sensitivity to building- and to dose-related aspects [19]. For example, Boyce and Wilkins (2018) stated that visual comfort depends on the sophistication of the visual system and the expectations of the occupant [20]. Similarly, Hong et al. (2020) found that willingness to discuss control of the indoor environment is related to personal traits [21]. While Hoendervanger at al. (2018) found that satisfaction with the physical environment was related to individual differences in needs for privacy [22].

Profiling occupants may justify the variation of individual needs [23]. Based on different clustering and segmentation methods, previous studies have resulted in profiles of occupants based on their comfort perception of IEQ in offices [24], on preferences and comfort of IEQ of schoolchildren [25], on control of indoor climate [21], on comfort related to activities [17], and on preferences for the control of lighting [26]. These studies identify clear differences between groups in preferences and comfort perception, which justify the variation in physiological and psychological reactions of individuals. However, as the perception of comfort can be associated with the specific context of a building and room type, it is important to identify groups of outpatient staff that vary in preferences and comfort. Additionally, there are no previous studies assessing whether the perception of IEQ and social comfort vary similarly between individuals.

Taking all of the above-mentioned aspects into account, the aim of this study was to explore groups of outpatient staff members working in the six buildings. The present study acts as a follow-up to the aforementioned survey [8]. It identifies clear differences in preferences and the perception of comfort of outpatient staff. For this purpose, clusters were produced to answer the following research questions:

What are the profiles of the outpatient workers, clustered by their preferences and perception of IEQ?

What are the profiles of the outpatient workers, clustered by their preferences and perception of social comfort?

To what extent are IEQ clusters and social comfort clusters similar, in regards to personal aspects, work-related aspects, building-related aspects, and health?

## 2. Method

### 2.1. Study design

This study is part of a larger field study on comfort and health of outpatient staff, conducted in three hospital organizations in six hospital buildings in the Netherlands [8]. The field study comprised of a questionnaire with 148 questions for staff members and of a building checklist to inventory of building -related aspects. The questionnaire was distributed digitally to 1694 outpatient workers and completed by 556 respondents. For the building inspection, the HVAC-systems of all buildings and 127 rooms were inspected. Table 1 shows the main demographic aspects of the respondents and the building characteristics. All buildings, except A2, had partly been renovated or contained newly built parts, that were attached to the main building.

The questionnaire was based on the OFFICAIR questionnaire [9], developed for a study on health and comfort in European offices, and had newly developed questions. The questionnaire was tested in a pilot study with outpatient staff of a general hospital in the Netherlands in December 2018. It comprised of five main components: personal aspects, work-related aspects, health, comfort and preferences. Detailed information about the design of the questionnaire, selection of the population and buildings, and the procedure of the survey are reported in Eijkelenboom et al. [8].

For the building inspection, four checklists were composed to obtain an as complete as possible overview of the building-related aspects of outpatient areas in hospitals: a building checklist, a room checklist, a layout checklist, and a cleaning checklist. The building and room checklists were based on OFFICAIR and adapted with some specific characteristics of outpatient areas. The adaptations were based on visits of hospital buildings, during the preparatory phase. The building checklist was designed to specify characteristics of the HVAC-systems, sources of outdoor light, noise and air pollution and façade characteristics. The room checklist aimed to identify differences and similarities in building-related aspects of the rooms. The layout checklist was created to assess the dimensions, the functions and the structure of circulation areas and rooms. As the importance of cleaning has been indicated in previous studies in hospitals [13,27], a cleaning checklist was developed, based on national regulations for hospital cleaning (e.g. intensity cleaning floor, wall, furniture per room type) [28]. Detailed information on the checklists and building aspects is reported elsewhere.

This paper explores similarities in perception and preferences of outpatient workers in outpatient areas in the six hospital buildings. For comfort, the perception of temperature, temperature variation, air movement, air humidity, air stuffiness, natural light, artificial light, noise from building services, from apparatus and people are included. Furthermore, the satisfaction with the size of workplace, size of storage place, walking distances, proximity of colleagues, contact with others, distraction by noise, visual distraction, safe workplace, crowding at the

**Table 1**
Demographics of the 556 respondents and building characteristics.

| Organization | | A | | B | | C | |
|---|---|---|---|---|---|---|---|
| Demographic aspects | | | | | | | |
| Age | Years (SD) | 46.4 | (12.2) | 47.6 | (11.3) | 45.9 | (11.4) |
| Sex | Female | 94% | | 88% | | 92% | |
| Education | MSc, PhD | 9% | | 23% | | 13% | |
| | Applied | 25% | | 12% | | 24% | |
| | Intermediate | 49% | | 57% | | 54% | |
| | Secondary | 17% | | 9% | | 9% | |
| Building aspects | | | | | | | |
| Location | | A1 | A2 | B1 | B2 | C1 | C2 |
| Region | | Middle | Middle | West | West | East | East |
| Building year main building | | 1983 | 2013 | 1990 | 1989 | 1995 | 1980 |
| Number of building levels | | 4 | 6 | 12 | 4 | 8 | 7 |
| Outpatient area >15.000 $m^2$ | | x | | x | | x | |

workplace, crowding at the building, and privacy of oneself, are included. These aspects were rated on a scale of 1–7. For the preferences the question *"Which 3 building aspects are for you MOST important to perform your work well?"* was included, with the variables "*control of temperature", "control of view", "control of ventilation", "control of sunscreen", "no hinder from noise", "furniture which is adjustable in height", "not too cold or hot", "cleanliness", "appearance of interior (colour and texture)", "view to outside", "view to corridor", "sufficient daylight", "sufficient fresh air", "sufficient room", "sufficient storage room"* and *"skip this question"*. Finally, the question "*Which 3 psycho-social aspects are MOST important to perform your work well?*" was included with the variables *"proximity of colleagues", "contact with colleagues", "contact with patients", "contact with colleagues and patients", "safe workplace", "short walking distances", "no distraction by noise", "no distraction by people passing by", "not too crowded building", "not too crowded workplace", "sufficient privacy of oneself", "sufficient privacy for patient",* and *"skip this question"*.

### 2.2. Procedure

The survey of each hospital was conducted in the spring of 2019. A link to the questionnaire was distributed digitally by the hospital organizations. While the questionnaire was active, the building inspection was performed in outpatient areas of six top-clinical hospital buildings. To systematically inspect the different room types and renovation periods, rooms were selected and marked on layout drawings before the room inspection. The selection criteria were function of the room, orientation of the room, whether the room was indoor or adjacent to the façade, and different wards (e.g. ophthalmology, dermatology). If one of the preselected rooms was occupied with patients during the walk-through, a similar room was selected. The building inspections were planned on days when the outpatient area would be least occupied, in order to have access to most rooms. The procedure and room selection were discussed with the facility managers before the inspection. Information on the HVAC-systems and cleaning protocols was provided by the hospital organizations before inspection. Facility managers provided on site explanation of the HVAC-systems in each building. The observations and oral information of the facility manager were reported on the building and room checklists. Room inspection was generally performed with three researchers. Pictures of the building aspects were taken, while respecting the privacy of both patients and staff.

### 2.3. Data management and analysis

The data was analysed with IBM SPSS Statistics 25. First, a descriptive analysis was performed to provide an overview of the comfort perception and preferences. For comfort, the mean and standard deviation were described of the 7-point scales. For the IEQ-preferences, the combinations of all 15 aspects and distribution were analysed, to assess which aspects were representative for a substantial part of the participants. Similarly, the distribution and most prevalent combinations of the 12 social preferences were analysed.

Subsequently, the strength of correlations of perceived comfort aspects with similar preferences were analysed to decide if both perceived comfort and preferences could be included in the cluster analysis. This analysis was performed because, according to Ketchen and Shook (1996), multicollinearity may affect the weight of constructs in cluster-analysis [29]; therefore, Chi square tests were performed.

Then, as preparation for the cluster analysis, principal component analysis (PCA) was performed to reduce the comfort variables into a smaller set of independent components. As recommended by Tabachnick and Fidell [30], the number of components was determined by an eigenvalue >1; adequacy of the sample was checked with Kayser-Meyer-Olkin >0.6; the selected rotation was orthogonal (varimax) as the components were composed for further analysis. Furthermore, strength was determined by loadings within components >0.4, loadings between components <0.4 [31]. For the PCA of the IEQ-aspects, all respondents were included who answered the question on the IEQ preferences and the comfort-related questions on IEQ. For the PCA of the social aspects only those who answered the question on social preferences and questions on social comfort were included.

After the PCA, TwoStep cluster analysis was performed by including the questions on perceived comfort and preferences. TwoStep cluster analysis was used because it has several advantages according to Tkaczynski (2017) [32]: continuous data (the IEQ-components) and binary data (the preferences) can be clustered simultaneously in contrast to k-means clustering; data can be processed quickly and therefore suitable for large datasets; the number of clusters are determined by the algorithm, an advantage for exploratory studies, which this study is; and the predictor importance of variables may support further interpretation and analysis based on the cluster solution. For the analysis, Akaike's Information Criterion was selected. According to the recommendations of Tkaczynski, the validation of the final model was based on four steps: 1) the silhouette coefficient was checked to be above 0.0 and preferably above 0.2; 2) differences between the clusters were checked ($P < 0.05$); 3) the predictor importance of the variables needed to be 0.02 or larger; and 4) comparison with randomly split samples was performed.

Finally, differences in personal aspects, work-related aspects, health, comfort and preferences were compared. Chi-square tests were used for binary variables and ANOVA for continuous variables, both with Bonferroni correction. This was done to adjust for potential rare events, due to the large number of tests performed.

### 2.4. Ethical aspects

The Ethics committee of Delft University of Technology approved the study on October 5th, 2018. A data manager from Delft University of Technology assessed data security. To respect privacy of the participants, measures were taken for protection of contact information, safe data storage and withholding of personal information. At the start of the digital questionnaire, participants were informed that by completing the questionnaire, they would give their consent to use their responses for research purposes. Only those who confirmed submission at the end of the questionnaire were included in the study.

## 3. Results

### 3.1. Perceived comfort

Fig. 1 presents the mean and standard deviation of perceived comfort with IEQ-aspects at the most frequently used workplace. In general, outpatient staff reported dry air (5.4 ± 1.3), stuffy air (3.4 ± 1.6) and cold temperature (3.5 ± 1.6). The average variation in temperature was reported to be slightly high (3.8 ± 1.6), while the mean air movement was almost neutral (4.1 ± 1.6). The mean satisfaction of the respondents was highest with noise from building services (4.9 ± 1.6), followed by noise from apparatus (4.7 ± 1.7), artificial light (4.2 ± 1.6), natural light (3.7 ± 1.9), and noise from other people (4.0 ± 1.8). Concerning social aspects, the outpatient staff was overall neutral to satisfied (Fig. 2). The mean satisfaction was highest for contact with others (5.8 ± 1.4), and lowest with privacy of oneself (4.3 ± 1.97) and distraction by noise (4.3 ± 1.86). The size of the workplace and storage were rated slightly more than neutral (4.8 ± 1.9, 4.6 ± 2.0). The mean of proximity of colleagues was 5.7 ± 1.45 and for walking distances 4.9 ± 1.79. The mean satisfaction of the outpatient workers with crowding at the building (5.1 ± 1.75) was higher than with visual distraction and crowding at the workplace (4.3 ± 1.86, 4.5 ± 1.92). The mean of safety of the workplace was 5.6 ± 1.50.

### 3.2. Preferences of IEQ-aspects and social aspects

Out of the 15 building- or dose-related aspects, the combinations of

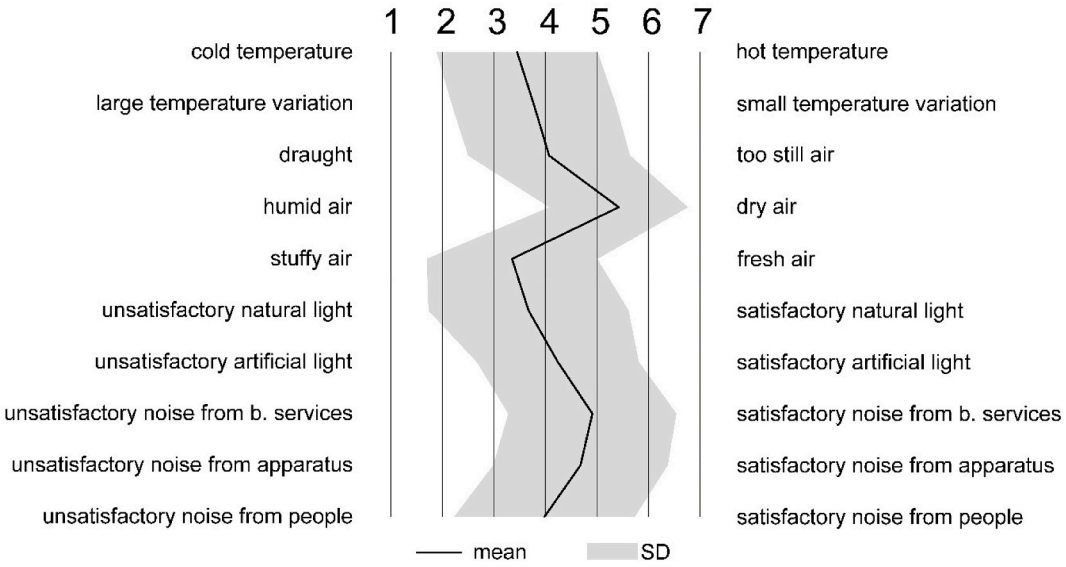


**Fig. 1.** Self-reported comfort with IEQ related aspects.

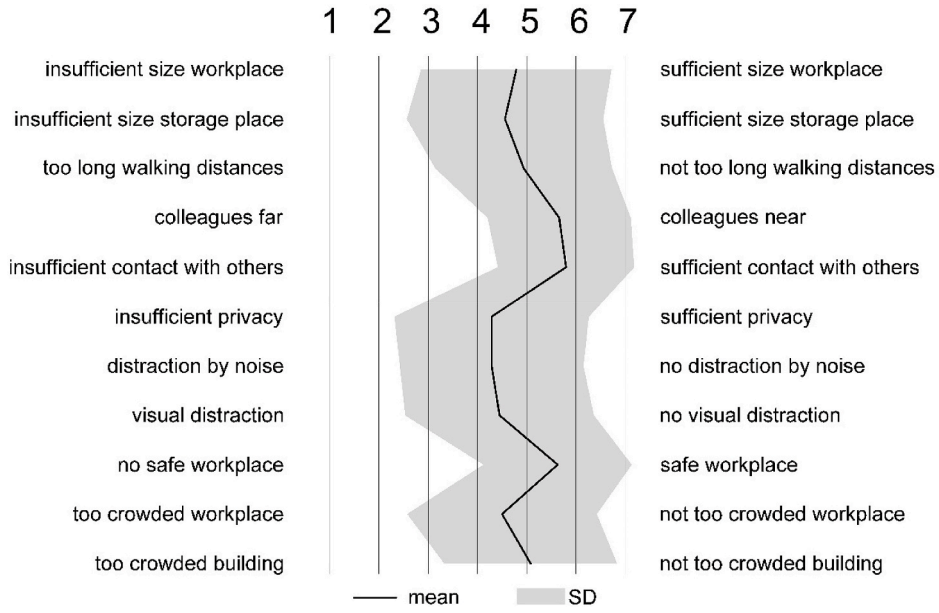


**Fig. 2.** Self-reported comfort of social aspects.

the three most selected aspects that were regarded to be important to work performance varied widely. Thus, not one combination of the three aspects was selected by a large part of the outpatient workers. For example, the combination "cleanliness" with "fresh air" and "sufficient daylight" was selected most, but only by 16 respondents (3%). Almost all respondents (94%) selected "control of temperature", "not too cold or hot", "control of ventilation", "fresh air", "no hinder from noise" or "sufficient daylight". As shown in Fig. 3, sufficient daylight was selected by the largest proportion of the responding outpatient staff (39%). The second in the ranking of preferences were the aspects related to temperature: control of temperature by 34%, not too cold or hot by 29%. Third were aspects related to indoor air quality: sufficient fresh air and control of ventilation was selected by 27%. Noise was regarded important for fewer outpatient workers than the other IEQ-aspects (18%). Because of the large proportion of respondents that selected "control of temperature", "not too cold or hot", "control of ventilation", "fresh air", "no hinder from noise" and/or "sufficient daylight", and because there were no combinations of three aspects with a substantial prevalence, it was decided that these aspects were relevant to include in the TwoStep Cluster analysis.

The outpatient workers could select three out of 12 social aspects that they regarded to be most important for their work performance. The aspects that were selected by more than 25% were "contact with patients and colleagues" (67%), "safe workplace" (52%), "sufficient privacy for patients" (41%), and "no distraction by noise" (27%), see Fig. 4. 95% of the participants selected at least one of these aspects; the combinations varied widely. The most selected combination was "contact with patients and colleagues", "safe workplace", "sufficient privacy for patients" (16%). The second most selected combination, "contact with patients and colleagues", "safe workplace", and "no distraction by noise", was selected by 5%. Third was "contact with patients and colleagues", "no distraction by noise", and "sufficient privacy for patients", selected by 4%. As the four variables were selected by a substantial part and the combinations varied largely, the variables were considered relevant to

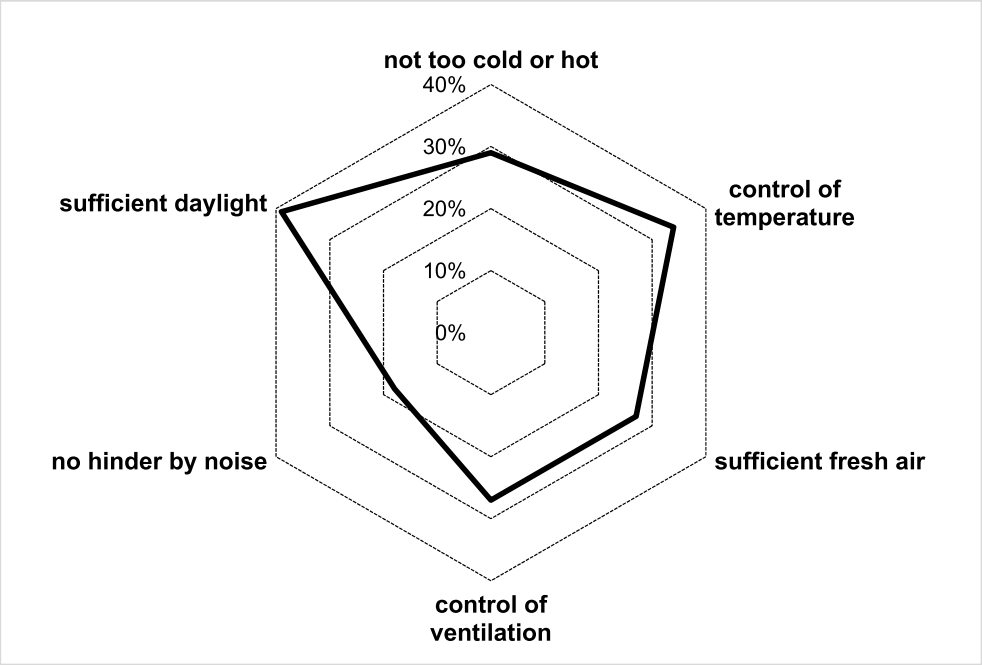


**Fig. 3.** IEQ-aspects that were regarded to be important for work performance.

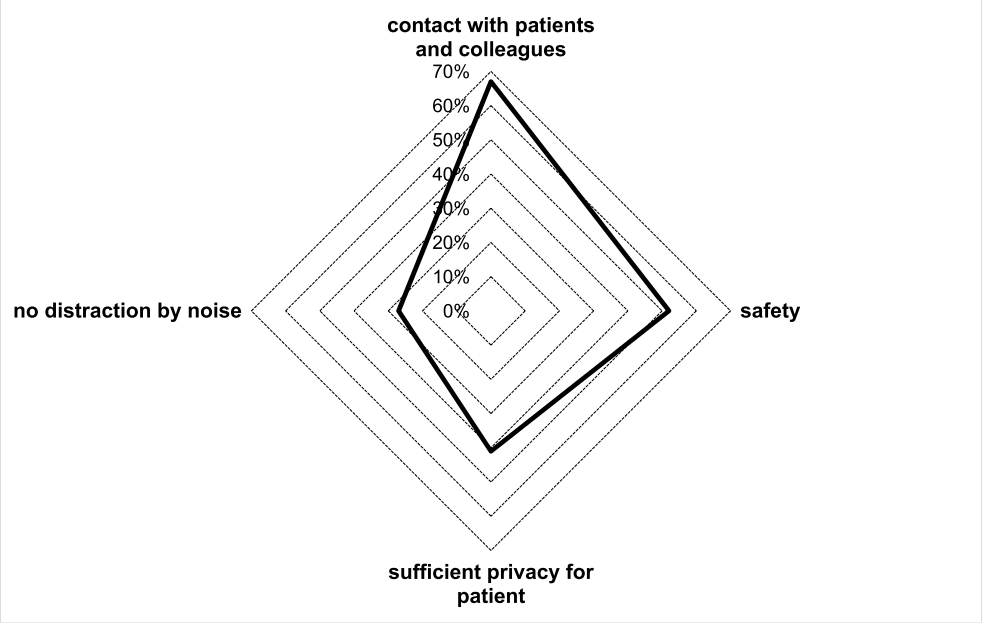


**Fig. 4.** Social aspects that were regarded to be important for work performance.

include in TwoStep Cluster analysis.

### 3.3. Correlations between comfort and preferences

Several statistically significant correlations between comfort aspects and preferences ($P < 0.05$) were found, but the effect size was generally negligible (Phi <0.2), see Table 2. The only correlation with a small effect was the perception of distraction by noise with the preference for no distraction by noise. Multicollinearity was limited, both preferences and percieved comfort could be included in the cluster analysis.

### 3.4. Principal component analysis

To reduce the number of variables, the perceived comfort responses to IEQ and social comfort were reduced separately with principal component analysis. For IEQ four components were identified. Component IEQ1 comprised of “noise from building services”, “noise from apparatus” and “noise from other people” and was labelled as “noise-related discomfort”. Component IEQ2 comprised of “natural light” and “artificial light” and was therefore labelled as “light-related discomfort”. The variables of component IEQ3 were “dry air”, “air movement” and “stuffy air” and was labelled as “discomfort indoor air”. Component IEQ4 was labelled as “thermal discomfort”, with excellent loadings to “cold temperature” and “variation of temperature”.

**Table 2**
Correlations between perceived comfort and preferences.

| Preferences | Perceived comfort | Phi | P |
|---|---|---|---|
| Sufficient daylight | Satisfaction with daylight | 0.124 | **0.004** |
| | Satisfaction with artificial light | 0.103 | **0.017** |
| Not too cold or too hot | Cold temperature | 0.131 | **0.002** |
| | Hot temperature | 0.016 | 0.714 |
| | Large temperature variation | −0.001 | 0.981 |
| | Small temperature variation | 0.119 | **0.006** |
| | Draught | 0.097 | **0.025** |
| | Still air | −0.085 | **0.048** |
| Control temperature | Cold temperature | 0.135 | **0.002** |
| | Hot temperature | 0.105 | **0.012** |
| | Large temperature variation | 0.164 | **<0.001** |
| | Small temperature variation | 0.075 | 0.081 |
| | Draught | 0.066 | 0.127 |
| | Too still air | −0.056 | 0.195 |
| Sufficient fresh air | Stuffy air | −0.051 | 0.240 |
| | Dry air | 0.032 | 0.458 |
| | Draught | −0.061 | 0.157 |
| | Too still air | 0.107 | **0.013** |
| Control ventilation | Stuffy air | 0.086 | **0.047** |
| | Dry air | 0.091 | **0.034** |
| | Draught | 0.030 | 0.486 |
| | Still air | 0.096 | **0.025** |
| No hinder from noise | Noise from building services | −0.018 | 0.682 |
| | Noise from apparatus | 0.054 | 0.210 |
| | Noise from other people | 0.129 | **0.003** |
| Contact with patients and colleagues | Satisfied with contact | 0.058 | 0.179 |
| Safe workplace | Feeling safe | 0.038 | 0.383 |
| Sufficient privacy for patient | Satisfactory privacy self | 0.024 | 0.576 |
| | Satisfactory privacy patients | 0.039 | 0.447 |
| No distraction by noise | Not distracted by noise | 0.217 | **<0.001** |

*Note: P-* value < 0.05 in bold. N between 537 and 554, N = 382 for the question on satisfactory privacy of patients, as it was only exposed to those working in reception areas, consultation or treatment rooms.

For social comfort, three components were identified. To create a representative overview, the question on privacy for patients was not included, as it was not presented to those working only in offices. Component SOC1 comprised of "no distraction by noise", "no visual distraction", "no crowding at the workplace", "no crowding at the building" and was therefore labelled as "disturbance". The loadings for SOC2 ("size workplace", "size storage", "privacy self", "safe workplace", "walking distances") were all related to perception of the layout and therefore labelled as "sense of space". The variables of the third component, SOC3, were "proximity of colleagues" and "contact with others" and was therefore called "interaction". The factor-score of each component was composed of the sum of each variable divided by the number of the included variables. Therefore, the following aspects, suggested by Di Stefano et al. [33], were taken into consideration: a clear structure, all cross loadings <0.4 and a small variation in weight.

### 3.5. TwoStep cluster analysis

TwoStep cluster analysis was conducted for IEQ and social comfort separately, to reduce the number of variables for analysis. The starting point for the IEQ-clusters were the four components of PCA and six main IEQ-preferences. After iteratively removing variables with a score lower than 0.02, nine variables were included in the final model. Six clusters were produced for 519 outpatient workers, representing 93% of the total sample. The silhouette measure of cohesion and separation of the clusters in the final model was 0.2, which indicates, according to Tkaczynski (2017) a *"fair separation"* between the clusters [32]. The predictor importance of the preference variables "sufficient fresh air" was 1.00; for "control of ventilation" 0.99, for "not too cold or hot" 0.81; for "sufficient daylight" 0.59: for "control of temperature" 0.41; and for "no hinder from noise" 0.29. The predictor importance of "thermal discomfort" was 0.17, for "discomfort from indoor air" 0.04 and for "discomfort from light" 0.03. All variables varied statistically significantly between clusters. In the last step of the validation, 70% of the sample was randomly extracted twice, only minor changes occurred (Table 3).

For the social clusters, the procedure was similar to that of the IEQ-clusters. Initially, there were seven variables included, the final model comprised of five variables. The silhouette measure of cohesion and separation was fair: 0.4. The predictor importance of the preference variable "privacy for patient" was 1.0, "safe workplace" 0.74, "distraction by noise" 0.36, and "sufficient contact" 0.04. The predictor importance of the component called "disturbance" was 0.02. All variables varied statistically significantly between clusters. In the last step of the validation, 70% of the sample was randomly extracted twice. Again, all variables had a good predictor importance, some changes occurred (see Table 3).

### 3.6. Profiles of the six IEQ-clusters and the three social clusters

The IEQ and social clusters were labelled with a code and name, as presented in Table 4. The names were based on general satisfaction with

**Table 3**
Comparison of predictor importance of the total sample and two random samples of 70%.

| Predictor importance | Total sample | First set of 70% | Second set of 70% |
|---|---|---|---|
| IEQ | | | |
| 0.68–1.00 | Pref. Fresh air (1.00)<br>Pref. Control of ventilation (0.99)<br>Pref. Not too cold or hot (0.81) | Pref. No hinder from noise (1.00) | Pref. No hinder from noise (1.00)<br>Pref. Control of ventilation (0.85)<br>Pref. Control of temperature (0.73) |
| 0.34–0.67 | | Pref. Not too cold or hot (0.67)<br>Pref. Sufficient daylight (0.57) | Pref. Not too cold or hot (0.64) |
| | Pref. Sufficient daylight (0.59)<br>Pref. Control of temperature (0.41) | Pref. Control of temperature (0.48)<br>Pref. Control of ventilation (0.42) | Pref. Fresh air (0.53) |
| 0.00–0.33 | Pref. No hinder from noise (0.29)<br>Thermal discomfort (0.17)<br>Discomfort indoor air (0.04)<br>Light-related discomfort (0.03) | Pref. Fresh air (0.27)<br>Thermal discomfort (0.06)<br>Light-related discomfort (0.05)<br>Discomfort indoor air (0.02) | Pref. Sufficient daylight (0.19)<br>Thermal discomfort (0.05)<br>Discomfort indoor air (0.02)<br>Light-related discomfort (0.02) |
| Social | | | |
| 0.68–1.00 | Pref. Privacy patient (1.0)<br>Pref. Safe workplace (0.74) | Pref. Privacy patient (1.0)<br>Pref. Safe workplace (1.0)<br>Pref. Distraction by noise (1.0)<br>Pref. Contact (0.96) | Pref. Privacy patient (1.0)<br>Pref. Safe workplace (1.0)<br>Pref. Distraction by noise (0.99)<br>Pref. Contact (0.98) |
| 0.34–0.67 | Pref. Distraction by noise (0.36) | | |
| 0.00–0.33 | Pref. Contact (0.04)<br>Disturbance (0.02) | Disturbance (0.02) | Disturbance (0.02) |

Pref. = preference for.

**Table 4**
Cluster codes, names and number of respondents per cluster.

| Cluster | Code | Name | N |
|---|---|---|---|
| IEQ | IC1 | Uncomfortable with air, preference for control of ventilation | 107 |
| | IC2 | Moderately comfortable, preference for fresh air | 104 |
| | IC3 | Moderately thermally uncomfortable, preference for control of temperature | 94 |
| | IC4 | Comfortable, preference for good acoustics | 85 |
| | IC5 | Uncomfortable, preference for not too cold or hot temperature | 81 |
| | IC6 | Moderately uncomfortable, preference for daylight | 48 |
| Social | SC1 | Distracted by noise, preference for no distraction | 165 |
| | SC2 | Uncomfortable with walking distances, preference for privacy of patients | 198 |
| | SC3 | Moderately comfortable, preference for safe workplace | 175 |

comfort and the most distinguishable preferences.

The description of the IEQ and social clusters is presented in Appendix A and Tables 5 and 6. Appendix B presents the personal, workplace- and building related aspects, that did not vary significantly between the clusters. The description of the IEQ- and social clusters was based on statistically significant differences of personal and work-related aspects, as well as comfort, health, preferences and building characteristics, based on the building inspection (seeTable 5 and Table 6).

## 4. Discussion

### 4.1. Profiling of outpatient staff

The profiles of the clusters show specific characteristics regarding the perception of comfort and importance of IEQ and social aspects. Additionally, there were similarities within the clusters for some personal, work-related, and building-related aspects. Furthermore, the aspects that varied between the IEQ-clusters were different from the aspects that varied between the social clusters, except for the importance of noise, dissatisfaction with natural light and the presence of a façade window.

Those in IC1, who were dissatisfied with indoor air-related aspects and preferred control of ventilation, were more likely to suffer from building-related symptoms, to take sick-leave days, to stay longer at their workplace, to work in enclosed rooms (no reception area) and to

**Table 5**
Preferences and self-reported comfort of IEQ and social clusters.

| | IC1 | IC2 | IC3 | IC4 | IC5 | IC6 | *P*-value | SC1 | SC2 | SC3 | *P*-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Preferences** | | | | | | | | | | | |
| Control of temperature | 46.2 | 24.3 | 100 | 0 | 21.2 | 44.4 | **<0.001** | 32.3 | 31.1 | 39.1 | 0.231 |
| Control of ventilation | 100 | 0 | 10.4 | 7.4 | 28.2 | 0 | **<0.001** | 29.2 | 25.5 | 24.7 | 0.612 |
| Not too cold or hot | 0 | 19.6 | 0 | 41.5 | 100 | 3.7 | **<0.001** | 27.3 | 27.6 | 31.6 | 0.610 |
| Fresh air | 13.5 | 100 | 2.1 | 18.1 | 0 | 0 | **<0.001** | 26.7 | 29.1 | 26.4 | 0.821 |
| Daylight | 30.8 | 41.1 | 0 | 0 | 54.1 | 100 | **<0.001** | 37.3 | 43.9 | 35.1 | 0.192 |
| No hinder from noise | 7.7 | 0.9 | 41.7 | 46.8 | 1.2 | 22.2 | **<0.001** | 29.8 | 9.2 | 16.1 | **<0.001** |
| Control of view | 3.8 | 6.5 | 12.5 | 16.0 | 7.1 | 6.2 | **0.032** | 9.9 | 8.2 | 7.5 | 0.707 |
| Size room | 5.8 | 11.2 | 8.3 | 22.3 | 9.4 | 13.6 | **0.011** | 11.8 | 12.2 | 10.9 | 0.923 |
| Cleanliness | 38.5 | 43.9 | 50.0 | 58.5 | 40.0 | 44.4 | 0.073 | 34.8 | 54.6 | 46.6 | **0.001** |
| Aesthetics | 12.5 | 4.7 | 12.5 | 25.5 | 5.9 | 13.6 | **<0.001** | 12.4 | 13.3 | 9.8 | 0.564 |
| Proximity colleagues | 15.5 | 15.0 | 20.8 | 16.1 | 12.9 | 20.0 | 0.789 | 27.3 | 7.1 | 17.6 | **<0.001** |
| Contact with colleagues | 26.2 | 20.6 | 18.8 | 25.8 | 28.2 | 26.3 | 0.736 | 35.2 | 14.1 | 25.0 | **<0.001** |
| Contact with patients and colleagues | 66.0 | 68.2 | 58.3 | 59.1 | 67.1 | 70.0 | 0.563 | 56.4 | 76.3 | 65.9 | **<0.001** |
| Safe workplace | 49.5 | 58.9 | 56.3 | 47.3 | 54.1 | 47.5 | 0.514 | 0.6 | 52.5 | 100 | **<0.001** |
| No distraction by noise | 23.3 | 28.0 | 25.0 | 33.3 | 24.7 | 16.3 | 0.200 | 58.8 | 0.0 | 24.4 | **<0.001** |
| No visual distraction | 5.8 | 10.3 | 10.4 | 10.8 | 8.2 | 10.0 | 0.838 | 18.8 | 6.6 | 5.7 | **<0.001** |
| No crowding at the workplace | 22.3 | 17.8 | 29.2 | 30.1 | 18.8 | 20.0 | 0.249 | 38.8 | 13.1 | 19.3 | **<0.001** |
| Privacy for patient | 45.6 | 46.7 | 33.3 | 35.5 | 37.6 | 42.5 | 0.396 | 14.5 | 100 | 0 | **<0.001** |
| **Dissatisfaction** | | | | | | | | | | | |
| Overall comfort | 22.1 | 10.3 | 25.0 | 14.0 | 14.1 | 14.8 | 0.110 | 23.6 | 10.7 | 14.9 | **0.003** |
| Overall temperature | 53.8 | 44.9 | 64.6 | 22.3 | 70.6 | 44.4 | **<0.001** | 45.5 | 57.6 | 51.4 | 0.070 |
| Cold temperature | 26.9 | 17.8 | 47.9 | 23.4 | 52.9 | 23.5 | **<0.001** | 31.3 | 30.3 | 27.8 | 0.771 |
| Hot temperature | 14.4 | 19.6 | 10.4 | 8.5 | 4.7 | 7.4 | **0.016** | 15.3 | 9.6 | 11.9 | 0.249 |
| Large temperature variation | 17.3 | 22.4 | 27.1 | 13.8 | 37.6 | 17.3 | **0.002** | 24.7 | 21.3 | 23.0 | 0.751 |
| Small temperature variation | 19.2 | 15.0 | 29.2 | 5.3 | 17.6 | 7.4 | **0.001** | 14.8 | 13.2 | 16.1 | 0.731 |
| Draught | 16.3 | 13.1 | 18.8 | 7.4 | 28.2 | 16.0 | **0.009** | 11.5 | 20.5 | 14.2 | 0.052 |
| Too still air | 27.9 | 25.2 | 14.6 | 16.0 | 12.9 | 14.8 | **0.037** | 24.8 | 16.4 | 18.2 | 0.112 |
| Overall indoor air | 61.5 | 52.3 | 47.9 | 24.5 | 49.4 | 39.5 | **<0.001** | 47.3 | 44.9 | 44.6 | 0.863 |
| Dry air | 66.3 | 57.0 | 58.3 | 38.3 | 58.8 | 58.0 | **0.004** | 55.8 | 57.4 | 52.6 | 0.637 |
| Stuffy air | 40.4 | 25.2 | 29.2 | 37.2 | 32.9 | 34.6 | 0.257 | 35.4 | 27.6 | 38.9 | 0.061 |
| Overall light | 39.4 | 34.6 | 22.9 | 14.9 | 36.5 | 34.6 | **0.002** | 26.8 | 34.8 | 32.0 | 0.258 |
| Natural light | 49.0 | 46.7 | 39.6 | 34.0 | 58.8 | 50.6 | **0.026** | 46.1 | 54.0 | 40.2 | **0.027** |
| Artificial light | 42.3 | 32.7 | 20.8 | 12.8 | 29.4 | 35.8 | **<0.001** | 26.1 | 33.3 | 29.9 | 0.322 |
| Overall noise | 33.7 | 27.1 | 35.4 | 33.0 | 25.9 | 28.4 | 0.713 | 41.8 | 25.3 | 27.4 | **0.001** |
| Noise from building services | 23.1 | 17.8 | 8.3 | 14.9 | 30.6 | 12.3 | **0.008** | 23.6 | 15.7 | 16.6 | 0.111 |
| Noise from other people | 41.3 | 30.8 | 50.0 | 42.6 | 43.5 | 34.6 | 0.187 | 52.7 | 36.9 | 29.7 | **<0.001** |
| Walking distances | 18.3 | 19.6 | 14.6 | 28.0 | 27.1 | 20.0 | 0.292 | 15.2 | 25.8 | 22.2 | **0.050** |
| Contact with others | 11.5 | 7.5 | 10.4 | 7.5 | 3.5 | 4.9 | 0.335 | 10.9 | 7.1 | 2.8 | **0.013** |
| No distraction by noise | 33.7 | 33.6 | 41.7 | 29.0 | 42.4 | 42.0 | 0.322 | 49.1 | 26.8 | 34.1 | **<0.001** |
| No visual distraction | 31.7 | 21.5 | 39.6 | 32.3 | 40.0 | 37.0 | 0.077 | 41.8 | 27.3 | 27.8 | **0.005** |
| No crowded workplace | 26.9 | 29.9 | 37.5 | 32.3 | 31.8 | 34.6 | 0.804 | 40.6 | 28.3 | 29.0 | **0.023** |
| PEQ (12–84) | 46.8 (12.9) | 48.9 (12.0) | 52.3 (13.1) | 48.2 (14.2) | 51.6 (12.8) | 50.3 (13.8) | 0.079 | 46.2 (13.7) | 51.1 (13.3) | 50.1 (12.3) | **0.002** |

*Note* Perceived Esthetical Quality (PEQ) was the sum of twelve questions on a scale from 1 to 7, after recoding the scale from negative to positive. 12 was regarded as low perceived quality and 84 as high [34].

**Table 6**
Personal, health, work and building-related aspects of IEQ and social clusters.

| | | IC1 | IC2 | IC3 | IC4 | IC5 | IC6 | *P*-value | SC1 | SC2 | SC3 | *P*-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Personal** | | | | | | | | | | | | |
| Sex | Women | 93.3 | 91.6 | 89.6 | 84.0 | 96.5 | 88.9 | 0.086 | 86.7 | 93.4 | 93.2 | **0.041** |
| Education level | MSc, PhD | 19.4 | 17.9 | 18.8 | 16.1 | 5.9 | 15.0 | 0.151 | 20.6 | 15.2 | 8.7 | **0.008** |
| | Applied | 16.5 | 18.9 | 25.0 | 25.8 | 18.8 | 23.8 | 0.509 | 23.0 | 18.3 | 21.4 | 0.522 |
| | Intermediate | 53.4 | 52.8 | 45.8 | 50.5 | 58.8 | 52.5 | 0.794 | 44.8 | 55.8 | 59.5 | **0.019** |
| | Secondary | 10.7 | 10.4 | 10.4 | 7.5 | 16.5 | 8.8 | 0.562 | 11.5 | 10.7 | 10.4 | 0.943 |
| Nightshift | Yes | 5.8 | 8.5 | 6.3 | 7.4 | 1.2 | 11.1 | 0.195 | 9.8 | 7.1 | 2.3 | **0.016** |
| ERI (mean, sd) | (3−15)/(7−35) *7/3 | 1.3 (0.4) | 1.4 (0.5) | 1.3 (0.4) | 1.5 (0.5) | 1.4 (0.4) | 1.5 (0.5) | **0.050** | 1.4 (0.5) | 1.4 (0.5) | 1.4 (0.5) | 0.529 |
| Sick leave | None | 32.7 | 36.4 | 45.8 | 57.4 | 47.1 | 38.8 | **0.008** | 48.5 | 40.3 | 40.9 | 0.232 |
| Years in building | | 9.6 (8.6) | 11.5 (9.0) | 11.2 (8.6) | 10.4 (8.5) | 10.7 (8.5) | 11.2 (9.3) | 0.710 | 11.9 (8.7) | 10.9 (8.7) | 9.5 (8.9) | **0.038** |
| **Health** | | | | | | | | | | | | |
| Symptom index | PSI14 | 3.0 (2.3) | 2.5 (2.3) | 1.7 (2.1) | 1.5 (2.3) | 2.7 (2.7) | 2.3 (2.0) | **<0.001** | 2.3 (2.4) | 2.2 (2.1) | 2.4 (2.4) | 0.812 |
| Symptoms | Dry eyes | 68.0 | 50.9 | 43.8 | 30.9 | 57.6 | 48.1 | **<0.001** | 49.4 | 50.8 | 50.3 | 0.966 |
| | Watering eyes | 22.3 | 15.9 | 2.1 | 7.4 | 14.1 | 8.8 | **0.003** | 10.4 | 13.1 | 15.9 | 0.320 |
| | Dry throat | 27.5 | 26.2 | 10.4 | 11.7 | 22.6 | 28.4 | **0.014** | 26.4 | 18.3 | 19.4 | 0.138 |
| | Cough | 12.6 | 10.4 | 4.2 | 4.3 | 10.6 | 16.0 | 0.096 | 11.6 | 5.6 | 12.5 | **0.048** |
| | Headache | 50.5 | 45.8 | 31.3 | 25.5 | 37.6 | 32.1 | **0.003** | 37.8 | 37.4 | 38.1 | 0.990 |
| **Work** | | | | | | | | | | | | |
| Used room types | >1 | 70.9 | 79.4 | 70.8 | 70.2 | 75.3 | 67.9 | 0.516 | 64.2 | 80.3 | 74.3 | **0.002** |
| Mostly used room | Office | 39.4 | 32.0 | 27.7 | 29.5 | 26.5 | 24.4 | 0.303 | 38.4 | 17.6 | 35.5 | **<0.001** |
| | Reception | 11.1 | 16.5 | 25.5 | 18.2 | 31.3 | 24.4 | **0.015** | 17.0 | 23.4 | 24.9 | 0.186 |
| | Consultation | 39.4 | 45.6 | 44.7 | 44.3 | 31.3 | 43.6 | 0.407 | 38.4 | 49.5 | 32.5 | **0.004** |
| | Treatment | 10.1 | 5.8 | 2.1 | 8.0 | 10.8 | 7.7 | 0.487 | 6.3 | 9.6 | 7.1 | 0.485 |
| Duration of stay | <4 h | 32.7 | 53.3 | 29.2 | 40.4 | 41.2 | 32.1 | **0.012** | 34.5 | 40.9 | 40.3 | 0.406 |
| Flexibility workplace | Flexible | 71.9 | 67.3 | 58.7 | 65.5 | 62.7 | 66.7 | 0.686 | 65.0 | 74.3 | 60.0 | **0.014** |
| Persons in the room | 1 person | 11.5 | 10.3 | 14.6 | 13.8 | 8.2 | 13.6 | 0.811 | 16.4 | 7.6 | 10.8 | **0.032** |
| | 2-4 persons | 53.8 | 47.7 | 56.3 | 35.1 | 37.6 | 50.6 | **0.031** | 46.7 | 50.8 | 40.9 | 0.162 |
| | >4 persons | 34.6 | 42.1 | 29.2 | 51.1 | 54.1 | 35.8 | **0.010** | 37.0 | 41.6 | 48.3 | 0.103 |
| Activities with patient | Diagnosis, meeting | 42.7 | 43.9 | 45.8 | 50.0 | 40.0 | 49.4 | 0.745 | 47.3 | 56.6 | 29.7 | **<0.001** |
| | Get patient | 37.9 | 37.4 | 45.8 | 40.4 | 37.6 | 39.5 | 0.939 | 32.1 | 48.5 | 34.9 | **0.002** |
| | Appointment | 64.1 | 66.4 | 72.9 | 58.5 | 71.8 | 61.7 | 0.383 | 55.2 | 70.2 | 72.6 | **0.001** |
| | Tele consult | 38.8 | 42.1 | 33.3 | 50.0 | 27.1 | 38.3 | 0.052 | 38.8 | 47.0 | 32.0 | **0.012** |
| | Physical investigation | 31.1 | 31.8 | 35.4 | 38.3 | 21.2 | 35.8 | 0.212 | 32.7 | 39.4 | 21.7 | **0.001** |
| | Medical treatment | 40.8 | 51.4 | 39.6 | 39.4 | 38.8 | 46.9 | 0.402 | 37.0 | 52.0 | 40.6 | **0.010** |
| Activities without patient | Planned meeting | 35.9 | 38.3 | 45.8 | 45.7 | 30.6 | 38.3 | 0.336 | 44.8 | 39.4 | 29.7 | **0.014** |
| | Unplanned meeting | 32.0 | 38.3 | 35.4 | 31.9 | 28.2 | 34.6 | 0.777 | 40.0 | 34.3 | 24.6 | **0.009** |
| | Concentrated office work | 63.1 | 69.2 | 83.3 | 66.0 | 67.1 | 63.0 | 0.194 | 75.2 | 60.1 | 68.6 | **0.009** |
| | Routine office work | 53.4 | 60.7 | 68.8 | 50.0 | 58.8 | 55.6 | 0.314 | 55.8 | 51.0 | 65.1 | **0.021** |
| | Prepare, cleaning up | 48.5 | 55.1 | 47.9 | 47.9 | 63.5 | 59.3 | 0.191 | 43.0 | 68.2 | 53.1 | **<0.001** |
| **Building** | | | | | | | | | | | | |
| Building or renovation year | 1980–1999 | 29.8 | 33.3 | 35.6 | 24.4 | 30.0 | 38.5 | 0.485 | 37.2 | 27.3 | 31.7 | 0.152 |
| 2000–2009 | 36.2 | 38.6 | 15.6 | 26.7 | 25.0 | 28.2 | **0.012** | 25.6 | 34.4 | 29.9 | 0.607 | |
| 2010–2018 | 34.0 | 28.7 | 48.9 | 48.8 | 45.0 | 33.3 | **0.020** | 37.2 | 38.3 | 38.3 | 0.972 | |
| Outpatient size | <15.000 $m^2$ | 29.3 | 19.2 | 19.6 | 25.6 | 20.5 | 25.3 | 0.540 | 16.0 | 22.8 | 30.0 | **0.010** |
| | >15.000 $m^2$ | 70.7 | 80.8 | 80.4 | 74.4 | 79.5 | 74.7 | | 84.0 | 77.2 | 70.0 | |
| Façade window* | Present | 74.0 | 78.5 | 81.3 | 88.3 | 66.7 | 80.2 | **0.018** | 79.4 | 71.7 | 82.3 | **0.040** |
| Control heating | On heater | 57.7 | 66.4 | 62.5 | 71.3 | 52.9 | 59.3 | 0.139 | 68.5 | 57.6 | 60.2 | 0.091 |
| | Thermostat | 22.1 | 15.0 | 18.8 | 22.3 | 23.5 | 24.7 | 0.597 | 16.4 | 22.2 | 23.3 | 0.273 |
| | None | 20.2 | 18.7 | 18.8 | 6.4 | 23.5 | 16.0 | **0.049** | 15.2 | 20.2 | 16.5 | 0.414 |
| Control view | Present | 74.7 | 81.0 | 87.2 | 71.1 | 75.0 | 75.4 | 0.413 | 68.7 | 81.6 | 73.8 | **0.048** |
| Direction art. light | Only direct | 75.7 | 73.3 | 61.7 | 73.9 | 61.9 | 68.8 | 0.215 | 73.9 | 59.6 | 76.9 | **0.001** |
| Cleaning protocol floors | 5x per week | 79.8 | 82.2 | 72.9 | 84.0 | 83.5 | 87.7 | 0.390 | 81.2 | 88.9 | 76.7 | **0.007** |
| 1x per week | 20.2 | 17.8 | 27.1 | 16.0 | 16.5 | 12.3 | | 18.8 | 11.1 | 23.3 | | |

*Note.* Effort reward imbalance (ERI) was the sum of 7 questions on effort divided by the sum of 3 questions on reward multiplied by 3/7, after recoding scales from negative to positive [35]. Building-related symptoms were identified as symptoms that improved when away from the building and occurred at least 1–3 days in the last four weeks. The personal symptom index (PSI14) was the sum of the prevalence of all 14 questioned symptoms per person. *Based on self-report of staff, other building-related aspects retrieved from building inspection or hospital organizations.

experience less work pressure (ERI) than most others. It should be noted that the work pressure of all clusters was high in comparison to other studies [1–3]. They were more likely to work in moderately old or renovated building (wings) than those in other clusters. All outpatient workers of IC2 preferred fresh air and were more likely to perceive hot temperature. They were moderately dissatisfied with IEQ aspects, suffering from symptoms, taking sick leave, and experiencing work pressure. The workers of IC2 were more likely to stay shorter than 4 h at their workplace and to work in moderately old or renovated building (wings) than those in other clusters. IC3 was moderately thermally uncomfortable, all preferred control of temperature. They tended to be healthy, slightly suffering from symptoms, taking moderate number of

sick-leave days, and experiencing relatively low work pressure. They were likely to stay more than 4 h per day at their most frequently used room type, to work with 2–4 persons in the room, and work in new or recently renovated building (wings). Those in IC4 were most comfortable; they preferred good acoustics and preferred aesthetics, a view from the window, and an appropriate size of their workplace more than the others. They tended to experience higher work pressure, to suffer less from symptoms and to take fewer sick-leave days. They worked in recently built or renovated building (wings), had more than others a window in the façade and an appliance to control manually the heating of their workplace. In contrast to IC4, the outpatient workers of IC5 were uncomfortable and regarded important not too cold or hot temperatures. There was a tendency of moderate work pressure and a slightly high prevalence of symptoms. They were more likely than the others to work in semi-enclosed rooms (reception areas), in rooms without windows and in rooms without appliances to control heating. IC6 was moderately comfortable, generally slightly more than IC2. They preferred daylight, tended to experience high work pressure, to suffer moderately from symptoms, and to stay longer at their workplace.

Those in SC1, who were dissatisfied with crowding and preferred absence of acoustic distraction and crowding, were more likely to be male, highly educated, working nightshifts, and working since a longer time in the building than those in SC2 and SC3. They tended to work more than the others in one room type, in private rooms, and in large buildings. All workers in SC2 preferred privacy for patients. They were overall comfortable, but less comfortable with walking distances and natural light than the outpatient workers of SC1 and SC3. They were less likely to suffer from cough, to work in one room type, to work in offices, at a fixed working place, and in private rooms. Those of SC2 tended to work more in rooms that were cleaned daily, rooms without a window, with control of the view and with indirect lighting than the others. All outpatient workers of SC3 regarded safety as important, but no one regarded privacy for patients important. They were generally moderately comfortable, but more satisfied with daylight and noise from other people than SC1 and SC2. The cluster represented the largest proportion of intermediate educated outpatient workers, without nightshifts, with fixed working places, working since a shorter time in the building and suffering from cough. A relatively large percentage worked in smaller buildings, had a workplace with a window, only direct artificial lighting, and that was cleaned once per week.

### 4.2. Comparison to other studies

The clusters reveal the complexity of associations between preferences and workplace-related aspects. For example, those in IC1, who all preferred control of ventilation, and those in IC3, who all preferred control of temperature, tended to work in rooms with 2–4 persons, while those in IC5, who preferred not too cold or hot temperature, tended to work in rooms with more than 4 persons. The outpatient workers of IC2, who all preferred fresh air, worked equally in rooms with 2–4 persons and rooms with more than 4 persons. As suggested by O'Brien and Gunay (2014) [36], the presence of others could have affected the motivation to control the indoor environment. Some give up adjusting their comfort to avoid conflicts with others, while others do not. This finding is supported by Hong et al. (2020) [21]. They determined behavioural differences in control of the indoor climate, related to personal traits, such as agreeableness or extraversion. Differences in personal traits may have contributed latently to the clusters in the present study and explain why the preference for control for only IC1, IC3 and IC5 was associated with the number of occupants in the rooms.

The clusters indicate that the preference for control of the indoor climate can also be related to the daily duration of stay in the more frequently used rooms. For example, those in IC1 and in IC3, who preferred control of ventilation and temperature, tended to work relatively longer at their workplace than those in IC2. Those in IC2 were more likely to prefer fresh air, than control of ventilation. In a previous study in offices, Rothe et al. (2011) [16] found that the importance of control of the indoor environment was related to the time spent at the office. However, Rothe et al. indicated that female and older occupants tend to prefer more control than males or younger occupants. The present study does not confirm these differences in demographic variables, or the differences in preferences between females and males as indicated by Mourshed and Zhao (2012) [13]. In the present study, age was similar among clusters, while sex only varied in the social clusters. As reported in Ref. [8], there were differences in age and sex related to the perception of comfort of the outpatient staff. However, the clusters indicate that the mean age and sex do not differ between the groups that vary in their preferences and perception of IEQ. The differences in sex in the social clusters can be explained by differences in performed activities as reported in Ref. [8]; men were generally highly educated, and performed more concentrated work.

Furthermore, the social clusters revealed relations between preferences and activities. For example, those in SC2, were more likely than others to prepare materials for patients and clean up, and they regarded cleanliness as most important. Other similarities were concentrated work with the preference for limited crowding and distraction (SC1); activities with patients and the preference for patient privacy and contact with colleagues and patients (SC2), (versus contact with colleagues (SC1)). These findings corroborate with the findings of the study of Van den Berg et al. (2020) [17] on preferences in offices, clustered by activities. They found that the preferences for psychosocial aspects, including noise and visual privacy, were related to activities, but preferences for thermal and lighting aspects did not vary.

The clusters suggest that relations between IEQ-preferences of the outpatient workers and inspected building aspects are limited. For example, all of IC6 regarded daylight important versus none of IC3 and IC4, while the proportions of those with a window at their workplace were similar for IC1 and IC3 (80%, 81%) and larger for IC4 (88%). The preferences for daylight did not vary between SC1, SC2 and SC3, while the presence of a window did. Furthermore, all respondents in IC1 preferred control of ventilation, and no one did in IC2 and IC6, while the presence of appliances for manual control of mechanical ventilation (16%, 12%, 19%) or operable windows (64%, 63%, 51%) was similar for the clusters. Moreover, the presence of vertical slats or curtains to control the view was similar for IC1 and IC4 (75%, 71%), while the preference to control the view varied (4%, 16%). These findings do not confirm the general notion that user preferences are associated with building-related aspects of their actual workplace.

Differences between the social clusters and building aspects can be explained when work-related aspects are taken into consideration. For example, although the presence of curtains or vertical slats varied between SC1 And SC2, the preference to control the view did not vary, but the preference to secure privacy of patients varied. Vertical slats or curtains were present in all the inspected treatment and consultation rooms, to ensure the privacy of patients. Those in SC2, who performed most activities with patients, were more likely to work in rooms with curtains and vertical slats and concerned with the patients' privacy. Furthermore, the outpatient workers in SC2 were more likely than the others to work in daily cleaned rooms. The cleaning protocols were related to room types, the floors of treatment and consultation rooms were cleaned daily in every hospital, according to Dutch guidelines [28], while the cleaning protocols for the floors of reception areas and offices varied between the hospital organizations between once a week and daily. Thus, the preference for cleaning can be associated with the activities and the more frequently used room type of the outpatient workers and can be indirectly related to the cleaning protocol.

The presence of a window and manual control of heating varied between IC1, IC4 and IC5. This confirms previous studies that found positive relations between environmental control and comfort (e.g. Ref. [37]), and positive relations between comfort, health and exposure to daylight (e.g. Ref. [38–40]). Also, perceived operability of the windows (64%, 64%, 56%) and perceived control of temperature (36%,

45%, 27%) did not vary between the clusters. In short, the absence of a window and of an appliance to manually control temperature are likely to be related to discomfort, but not to the perception of control of heating and window operability. These findings confirm previous studies in offices [41,42]. Hellwig (2015) [43] suggested that the discrepancy between perceived control and available control can be caused by limited knowledge of the occupants, limited responsiveness of the building systems and the social environment.

Similar to the study of Kim and Bluyssen (2020) [24], was that those in an IEQ-cluster who were dissatisfied with indoor air-related aspects, were also more likely to suffer from symptoms. Also, those in a cluster that were satisfied with comfort, were less likely to suffer from symptoms. As opposed to the aforementioned study, in the present study no differences in education or gender were found between the IEQ clusters. Furthermore, there were only a few building-related aspects that varied for the IEQ-clusters in the present study, in contrast to the office study. These differences can be related to context or study design, as preferences were included only in the present study.

The clusters contribute to a better understanding of why the satisfaction with IEQ-aspects is overall low and the prevalence of building-related symptoms is overall high in hospitals. This is because most outpatient staff members perform their activities in different room types and most rooms are shared with others, while the needs of individuals seem to vary. The differences between the clusters imply that an innovative approach in current planning and design processes is required, beyond the focus on current guidelines and design of generic structures, customized for only specific places. The clusters revealed a discrepancy between the perception of comfort and preferences. For example, the preference for fresh air and control of ventilation varied between the clusters, while the perception of stuffy air did not vary between the clusters. And the proportion of those who were dissatisfied with daylight was higher in IC5, while the preference for daylight was higher in IC6. Furthermore, the limited relations between the preferences and the building aspects imply that the outpatient workers can express their needs, independently of the characteristics of the actual building, where they work. Therefore, it seems possible and important to enhance insight in the preferences of the future occupants in the design practice in order to design an environment that fits best. For example, by development of structured processess for involvement of the future occupants in programming and design phases.

### 4.3. Limitations

One of the limitations of this study is that, due to privacy and practical reasons, it was unknown for which room specifically the outpatient staff reported their comfort. This was accounted for in the study design, as the participants were asked in which department they worked, in which room type and whether they had a window to the façade and corridor to allocate their area. However, a discrepancy is possible between building aspects of the inspection and the exact location of the outpatient workers. For example, Verderber (1986) [44] found in a study with photographs that hospital staff perceived rooms with a window smaller than 15% of the façade as windowless. However, in this study, the windows to the façade of all buildings were generally larger than 15%.

Another limitation is the influence of outdoor climate, which could have affected the perception of comfort and preferences. The study was conducted from February to April, during the heating season, therefore no comparisons with other seasons were allowed to assess seasonal effects on comfort or the perceived importance of building aspects. Furthermore, caution is needed for generalization of the results; as especially the social clusters were related to work-related aspects and activities, generalization for office workers or hospital workers in other areas, e.g. inpatient areas, is difficult.

## 5. Conclusions

In conclusion, profiles were determined, differing in personal, work-related and a few building-related aspects. For IEQ six clusters were identified and for social aspects three clusters were identified. The clusters indicate that preferences and comfort of IEQ are related to health. Respondents in clusters IC1 and IC5 suffered most from building-related symptoms. Their preferences were related to the indoor climate; everyone in IC1 regarded control of ventilation most important, while everyone in IC5 regarded to have a good temperature as most important. The social clusters varied in the activities of outpatient staff. Those in SC1, who preferred a quiet workplace, tended to perform more concentrated office work than those in SC2, who tended to perform activities with patients. They regarded the privacy of patients as important. As the aspects on which IEQ-clusters and social clusters varied were limited, it is important to study IEQ- and social aspects simultaneously in future studies. In both sets of clusters, preferences had a higher importance index than comfort. The finding that the relations of both cluster-sets with building-related aspects were limited to only a few building aspects was surprising. This suggests that outpatient staff members do not relate their preferences to the actual building where they are working. Although further studies are needed to elaborate on these results, the independency of preferences and the actual building might be used in design processes and future research.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Annex A. Description of clusters

### A1.IEQ clusters

1. IC1 Uncomfortable with air, preference for control of ventilation

IC1 is the largest cluster with 107 outpatient workers, representing 21% of all outpatient workers included in the TwoStep cluster Analysis.

*Comfort.* The outpatient workers in IC1 were generally dissatisfied with indoor air related aspects. The proportion of those who were dissatisfied with the overall quality of indoor air (62%) was higher than in the other clusters. Dissatisfaction with the overall quality of light was similar to IC2, IC5 and IC6 (39%, 35%, 37%, 35%) and higher than in the other clusters; dissatisfaction with artificial light was similar to IC2 and IC6 (42%, 33%, 36%) and higher than in the other clusters. This cluster represented the largest proportion of those who perceived dry air (66%) and too still air (28%).

*Preferences.* The three most important aspects of the workplace were control of ventilation (100%), control of temperature (46%) and cleanliness

(39%). None of the outpatient workers in this cluster found "not too cold or too hot" one of the three most important aspects. IC1 represented the smallest proportion of those who found control of the view (4%) and the size of the workplace (6%) important.

*Personal aspects.* The effort reward imbalance (ERI), which is a scale for perceived work pressure and reciprocity at work,[1] was equal to IC3 (1.3 (SD 0.4)) and lower than in the other clusters. The percentage of those who did not take sick leave in the past year (33%) was lower than in the other clusters; the outpatient workers in this cluster tend to take more sick leave than those in other clusters.

*Health-related aspects.* The perceived symptom index (PSI14) of the outpatient workers in IC1was the highest of all clusters (3 (SD 2.3)). PSI 14 was calculated as the mean number of reported symptoms, which occurred in the last four weeks while they were working in the building and improved when they were not in the building. In this cluster the largest proportion reported suffering from dry eyes (68%) and watering eyes (22%). The percentage of those who reported headache was similar to IC2 (51%, 46%) and higher than in other clusters. The prevalence of dry throat was similar to IC2 and IC6 (respectively 28%, 26%, 28%), and higher than in the other clusters.

*Workplace-related aspects.* The cluster represented the smallest proportion of those who work mostly in reception areas (11%), the variation of consultation, offices and treatment rooms did not vary between the clusters. Most (67%) stayed more than 4 h per day at their mostly used workplace. The largest proportion stayed with 2–4 persons in the room.

*Building-related aspects.* The proportion of those who worked in a new building or renovated building (wing), which was built or renovated between 2010 and 2018, was in IC1 lower than in IC3, IC4 and IC5.

2. IC2 Moderately comfortable, preference for fresh air

IC2 comprises of 104 workers, 20% of the total sample.

*Comfort.* Those in IC2 were generally most dissatisfied with indoor air aspects and daylight. The percentage of outpatient workers who were dissatisfied with comfort aspects was generally similar to the mean of all clusters, except the perception of hot and cold temperature. The cluster represented the lowest percentage of those who perceived cold temperature (18%) and the highest percentage of those who perceived hot temperature (20%).

*Preferences.* The three most important aspects in this cluster were sufficient fresh air (100%), cleanliness (44%) and sufficient daylight (41%). Control of ventilation was for none of those in IC2 regarded as one of the three most important aspects. The proportion of those who found no hinder from noise (1%) and aesthetics (5%) important was similar to IC5 and lower than the other clusters.

*Personal aspects.* The average ERI was 1.4 (SD 0.49), which was similar to the mean (1.4 ± 0.46). The percentage of those who did not have sick leave days (36%) was lower than the mean of all clusters (43%).

*Workplace-related aspects.* The percentage of those who stayed shorter than 4 h in their room was the highest (53%).

*Health-related aspects.* The mean number of symptoms was slightly higher than the mean of all clusters (respectively 2.5 ± 2.26, 2.4 ± 2.34). The proportion of those who suffered from headache (46%) was similar to IC1(51%) and higher than in the other clusters. The prevalence of dry throat was similar to IC1 and IC6 and higher than in the other clusters.

*Building-related aspects.* The outpatient workers of IC2 worked in relatively old building (wings), the cluster represented the smallest proportion of workers in building (wings), which were built or renovated between 2010 and 2018.

3. IC3 Moderately thermally uncomfortable, preference for control of temperature

The sample size of IC3 was 94, comprising 18% of the clustered outpatient workers.

*Comfort.* In general, the outpatient workers in IC3 were most dissatisfied with the overall temperature (65%), and noise from other people (50%). The main complaints were cold temperature (48%) and dry indoor air (58%). The percentage of outpatient workers who perceived a small variation of temperature (29%) was larger than of the other clusters. The proportion of those who were dissatisfied with noise from building services (8%) was smaller than of the other clusters.

*Preferences.* All outpatient workers in IC3 regarded control of temperature as one of the three most important aspects, half of them (50%) regarded cleanliness important and 42% regarded no hinder from noise as one of the three most important aspects of their workplace. Among the least important aspects were *"not too hot or cold"* (0%), *"sufficient daylight"* (0%) and *"sufficient fresh air"* (0%).

*Personal aspects.* The ERI was similar to IC1 and lower than in all the other clusters.

*Health-related aspects.* The PSI14, which was the second lowest of all clusters, was 1.7 (SD 2.13). The proportion of those who suffered from watering eyes was the lowest (2%); the proportion of those suffering from a dry throat was similar to IC4 (10%, 12%) and lower than the other clusters.

*Workplace-related aspects.* The proportion of outpatient workers who stayed shorter than 4 h in their room was similar to IC1 and IC6 and smaller than in the other clusters.

*Building-related aspects.* Most of those in IC2 (49%) worked in building (wings), which were built or renovated between 2010 and 2018; the cluster represented the smallest proportion of outpatient workers of building (wings) from between 2000 and 2009 (16%).

4. IC4 Comfortable, preference for good acoustics

IC4 comprised of 85 outpatient workers, representing 16% of the total sample.

*Comfort.* The outpatient workers in IC4 were generally more satisfied with comfort than those in other clusters. IC4 represented the smallest percentage of those who were dissatisfied with the overall temperature (22%), overall quality of indoor air (25%), overall quality of light (15%), natural light (34%) and artificial light (13%). The percentage of those who perceived large and small temperature variation (14%, 5%), draught (7%) and dry air (38%) was lower than in the other clusters.

*Preferences.* The three aspects which were regarded important by the largest percentage in this cluster were cleanliness (59%), no hinder from noise (47%) and not too cold or hot temperature (42%).

[1] Siegrist, J., *Adverse health effects of high-effort/low-reward conditions*. Journal of Occupational Health Psychology, 1996.**1**(1): p. 27–41. DOI: https://doi.org/10.1037/1076-8998.1.1.27.

None of the outpatient workers found control of temperature and daylight important. A larger percentage of the outpatient workers in IC2 found control of the view (16%), aesthetics (26%) and the size of the workplace 22%) important than outpatient workers in the other clusters.

*Personal aspects.* The ERI in IC4 was similar to C6 ($1.5 \pm 0.48$, $1.5 \pm 0.50$), and higher than in the other clusters. The proportion of those who did not have sick leave was the largest (57%).

*Health-related aspects.* IC4 represented the lowest PSI14, the average number of symptoms in this cluster was 1.5 (SD 2.25). The percentage of outpatient workers who suffered from dry eyes (31%) and headache (26%) were the lowest percentages of all clusters. The proportion of those suffering from dry throat was similar to IC4 (10%, 11%) and lower than in the other clusters.

*Workplace-related aspects.* IC4 represented, similar to IC1, the smallest proportion of outpatient workers who worked in rooms with 2–4 persons and the largest proportion of outpatient workers in rooms with more than 4 persons.

*Building-related aspects.* Almost half of the workers (49%) worked in building (wings), which were built or renovated between 2010 and 2018. The cluster represented the largest proportion of those working mostly in a room with a window to the façade (88%). 6% had no appliance for manual control of the temperature in the room (e.g. button on radiator or thermostat), which was less than in the other clusters.

5. IC5 Uncomfortable, preference for not too cold or hot temperature.

The sample size of IC5 was 81, representing 16% of all outpatient workers included in the analysis.

*Comfort.* The outpatient workers in IC5 were generally dissatisfied with IEQ aspects. The cluster represented the largest proportion of those who were dissatisfied with the overall temperature (71%), natural light (59%) and noise from building services (31%). The proportion of those who perceived cold temperature (53%), large temperature variation (38%), draught (28%) was larger than in the other clusters. IC5 represented the smallest proportion of those who perceived still air (13%).

*Preferences.* The three most important aspects for the outpatient workers in this cluster were not too cold or hot temperature (100%), sufficient daylight (54%) and cleanliness (40%). None of them regarded sufficient fresh air important, no hinder of noise was for 1% important. The importance of aesthetics was similar to IC2 (6%, 5%) and less important than in all other clusters.

*Personal aspects.* The average ERI, days of sick-leave and duration of stay were similar to the mean. Similar to IC4 worked the largest proportion (54%) mostly in a room with more than 4 persons.

*Health-related aspects.* PSI14 was second highest ($2.7 \pm 2.65$). The percentage of those suffering from dry eyes (58%) was higher than the average (51%), the percentage of those suffering from watering eyes (14%), dry throat (23%) and headache (38%) was similar to the average (respectively 13%, 22% and 38%).

*Workplace-related aspects.* Almost one third (31%) worked at reception areas, which was the highest percentage of all clusters.

*Building-related aspects.* Almost half of the workers (49%) worked in building (wings), which were built or renovated between 2010 and 2018. The cluster represented the smallest proportion of those working mostly in a room with a window to the façade (67%). 24% had no appliance for manual control of the temperature in the room (e.g. button on radiator or thermostat), which was most of all clusters.

6. IC6 Moderately comfortable, preference for daylight

IC6 was the smallest cluster, comprising of 48 outpatient workers (9%).

*Comfort.* The outpatient workers in IC6 were generally moderately comfortable, except for light related aspects. Dissatisfaction with overall light quality was similar to IC1, IC2, IC5 and higher than in IC3 and IC4. The proportion of those who were dissatisfied with artificial light was larger than in IC3, IC4, IC5 and similar to IC1 and IC2.

*Preferences.* All outpatient workers in IC6 selected daylight as one of the three most important building or dose related aspects of their workplace, almost half of them regarded control of temperature and cleanliness important (respectively 44%, 44%). No outpatient worker in this cluster regarded fresh air and control of ventilation important, 4% regarded not too cold or hot temperature important.

*Personal aspects.* The average ERI of the outpatient workers in IC6 was similar to the ERI in IC4 and higher than in all other clusters.

*Health-related aspects.* The mean number of symptoms was in IC6 similar to the average of all clusters. The prevalence of dry throat was similar to IC1 and IC2 and higher than the average of all clusters.

*Workplace-related aspects.* 32% stayed shorter than 4 h in their room, which was similar to IC1 and IC3 and a lower percentage than in the other clusters.

*Building-related aspects.* The proportion of those who worked in new building (wings) was similar to IC1 and lower than IC3, IC4 and IC5. 80% had a window to the façade, 84% control of the heating at the workplace.

*A2. Social clusters*

1. SC1 Distracted from noise, preference for no distraction

SC1 was the smallest cluster, comprising of 165 outpatient workers.

*Comfort.* The outpatient workers in SC1 were in comparison to the other two clusters more dissatisfied with distraction, crowding and contact with others. Furthermore, were they less satisfied with overall comfort, overall noise and noise from others. The PEQ, a scale of 12 questions about the perceived esthetical quality [34], was the lowest (14%).

*Preferences.* They tended to prefer mostly no distraction by noise, no crowding and contact with colleagues and patients. The proportion of those who regarded contact with patients and colleagues important was smaller and contact with only colleagues was larger than of the other clusters. Furthermore, was it more likely that nearness of other colleagues and noise were important and less likely that cleanliness was important for those in SC1 than SC2 and SC3.

*Personal aspects.* The percentage of women (87%) was smaller than in the other clusters (93%, 93%). The majority had an intermediate education level (45%), but the percentage was lower than in the other clusters and a larger percentage was highly educated (21%). The cluster represented the largest part of nightshift workers (10%). They worked averagely 12 years in the building, which was relatively long.

*Health-related aspects.* The PSI14 and prevalence of symptoms did not vary between the clusters, except cough. The prevalence of cough was in SC1

moderately (12%).

*Workplace-related aspects.* Those in SC1 tended to work more in 1 room type than the others (64%, 80%, 74%). Two of five worked mostly in offices, two of five mostly in consultation rooms. The cluster represented the largest proportion of workers in a private room (16%). SC1 had the largest proportion of those who had meetings and performed concentrated work.

*Building-related aspects.* The proportion of those who worked in a large building was larger than the others (84%, 77%, 70%). Of those with a window at the workplace (79%) had a smaller proportion control of the view with curtains or vertical slats (69%) than in SC2 and SC3.

2. SC2 Uncomfortable with walking distances, preference for privacy of patients

SC2 was the largest cluster, comprising of 198 outpatient workers.

*Comfort.* The outpatient workers in SC2 tended to be more dissatisfied with walking distances and less dissatisfied with distraction by noise than the others. Furthermore, they were least dissatisfied with overall comfort, with natural light and the PEQ was the highest.

*Preferences.* All outpatient workers of SC2 regarded the privacy of patients as one of the three most important aspects, three of four regarded contact with colleagues and patients important, more than half cleanliness. All these aspects were more likely to be important for SC2 than SC1 and SC3. Noise, distraction from noise, crowding, nearness of colleagues and contact with colleagues tended to be less important than in the other clusters.

*Personal aspects.* The percentage of women was 93%. The majority had an intermediate education level (56%).

*Health-related aspects.* The prevalence of cough was in SC2 the lowest (6%).

*Workplace-related aspects.* Those in SC2 tended to work more in different room types than the others. The cluster represented the smallest percentage of office workers (18%), and the largest percentage of those who worked mostly in consultation rooms (50%). The cluster represented the largest proportion of workers who did not have an assigned workplace, but worked at flexible workplaces, and the smallest proportion of workers in a private room (8%). SC2 represented the largest proportion of those who worked with patients.

*Building-related aspects.* The workers of SC2 were more likely to work in a room without a window (28%) and have a combination of direct and indirect lighting (40%). Of those with a window had a larger proportion control of the view with curtains or vertical slats (82%) than in SC1 and SC3. With regards to the cleaning protocol represented the cluster the largest group of those working in rooms were the floors were cleaned daily.

3. SC3 Moderately social comfortable, preference for safe workplace

SC3 comprised of 175 outpatient workers.

*Comfort.* The outpatient workers in SC3 tended to be overall moderately comfortable. They were similarly to IC2 dissatisfied with visual distraction, crowing and overall noise, and least dissatisfied with noise from other people and natural light.

*Preferences.* All outpatient workers of SC3 regarded safety important, two third contact with patients and colleagues, almost half cleanliness. None regarded privacy for patients important.

*Personal aspects.* The percentage of women was 93%. The majority had an intermediate education level (60%), which was a larger percentage than in IC1 and IC2. A minority was highly educated (9%), which was a lower percentage than in IC1, IC2. IC2 represented the smallest percentage of nightshift workers (2%). They worked relatively short in the building, for 10 years.

*Health-related aspects.* The prevalence of cough was in SC3 the highest (13%).

*Workplace-related aspects.* One in three worked mostly in an office and one in three mostly in a consultation room. The proportion of those who had flexible workplaces was the smallest (60%). This cluster represented the largest proportion of workers who performed routine office work.

*Building-related aspects.* 30% of SC3 worked in a small building, which was more than in the other clusters. They were most likely to have a window at their mostly used workplace (82%) and have only direct lighting (77%). The cluster represented the percentage of workers in rooms which were cleaned 1x per week (23%).

## Annex B. Variables which do not differ between clusters

| Personal data | | IC1 | IC2 | IC3 | IC4 | IC5 | IC6 | *P*-value | SC1 | SC2 | SC3 | *P*-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Mean | 45.3 | 43.7 | 47.3 | 47.4 | 46.3 | 47.3 | 0.183 | 47.3 | 45.3 | 45.2 | 0.200 |
| | (SD) | (11.7) | (12.1) | (12.1) | (11.3) | (11.4) | (10.7) | | (11.2) | (11.8) | (11.9) | |
| Mood | Negative | 18.6 | 10.8 | 15.6 | 13.0 | 15.7 | 18.2 | 0.645 | 19.4 | 10.4 | 15.0 | 0.060 |
| | Neutral | 8.8 | 12.7 | 11.1 | 9.8 | 6.0 | 2.6 | 0.220 | 9.4 | 9.4 | 9.0 | 0.990 |
| | Positive | 72.5 | 76.5 | 73.3 | 77.2 | 78.3 | 79.2 | 0.901 | 71.3 | 80.2 | 76.0 | 0.146 |
| Positive affect | Mean | 20.3 | 19.8 | 20.1 | 20.2 | 20.0 | 20.2 | 0.604 | 19.8 | 20.2 | 20.1 | 0.222 |
| | (SD) | (2.4) | (2.6) | (2.7) | (2.7) | (2.7) | (2.5) | | (2.5) | (2.5) | (2.8) | |
| Negative affect | Mean | 8.3 ( | 7.7 | 8.2 | 8.1 | 8.1 | 8.1 | 0.836 | 8.2 | 7.8 | 8.0 | 0.662 |
| | (SD) | (2.6) | (2.3) | (2.9) | (2.2) | (2.6) | (2.2) | | (2.6) | (2.3) | (2.4) | |
| Medical condition (most prevalent) | Migraine | 10.6 | 11.2 | 2.1 | 7.4 | 14.1 | 13.6 | 0.247 | 9.1 | 12.1 | 9.7 | 0.595 |
| | Asthma | 8.7 | 4.7 | 8.3 | 9.6 | 4.7 | 6.2 | 0.667 | 5.5 | 9.1 | 4.5 | 0.166 |
| | Eczema | 8.7 | 7.5 | 8.3 | 5.3 | 7.1 | 6.2 | 0.957 | 6.1 | 7.6 | 5.7 | 0.732 |
| | Allergy | 21.2 | 18.7 | 27.1 | 18.1 | 18.8 | 11.1 | 0.334 | 19.4 | 14.6 | 21.0 | 0.249 |
| | High blood pressure | 13.5 | 9.3 | 8.3 | 19.1 | 7.1 | 11.1 | 0.144 | 10.9 | 14.6 | 12.5 | 0.563 |
| Symptoms | Burning eyes | 34.0 | 28.0 | 16.7 | 22.3 | 34.1 | 25.9 | 0.148 | 25.0 | 27.8 | 28.4 | 0.754 |
| | Blocked nose | 18.4 | 14.2 | 10.4 | 12.8 | 16.4 | 14.8 | 0.801 | 12.2 | 12.6 | 16.6 | 0.424 |
| | Dry skin | 19.6 | 16.0 | 12.5 | 7.4 | 22.4 | 18.5 | 0.097 | 14.0 | 16.2 | 16.0 | 0.823 |
| | Lethargy | 19.4 | 13.1 | 12.5 | 8.5 | 23.5 | 18.5 | 0.078 | 14.0 | 17.2 | 14.8 | 0.681 |
| ***Work*** | | | | | | | | | | | | |
| Contract | Part-time | 76.7 | 82.2 | 68.8 | 72.3 | 82.4 | 71.6 | 0.209 | 70.9 | 79.8 | 78.3 | 0.112 |
| Overcommitment | Mean | 17.2 | 17.3 | 17.0 | 16.7 | 17.1 | 16.7 | 0.894 | 16.6 | 17.2 | 17.4 | 0.216 |
| | (SD) | (3.5) | (3.1) | (4.1) | (3.4) | (3.5) | (3.5) | | (3.6) | (3.2) | (3.5) | |

(*continued on next page*)

(*continued*)

| Personal data | | IC1 | IC2 | IC3 | IC4 | IC5 | IC6 | *P*-value | SC1 | SC2 | SC3 | *P*-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Satisfaction with | Mean | 7.6 | 7.7 | 7.5 | 7.8 | 7.5 | 7.8 | 0.595 | 7.5 | 7.8 | 7.6 | 0.317 |
| Work | (SD) | (1.5) | (1.1) | (1.7) | (1.0) | (1.5) | (1.2) | | (1.4) | (1.2) | (1.4) | |
| Working hours at outpatient | <17 h | 15.5 | 23.4 | 22.9 | 22.3 | 11.8 | 11.1 | 0.094 | 20.6 | 16.7 | 17.1 | 0.582 |
| | 17–32 h | 68.9 | 67.3 | 60.4 | 59.6 | 74.1 | 71.6 | 0.288 | 65.5 | 68.7 | 66.3 | 0.790 |
| | >32 h | 15.5 | 9.3 | 16.7 | 18.1 | 14.1 | 17.3 | 0.561 | 13.9 | 14.6 | 16.6 | 0.778 |
| **Building aspects** | | | | | | | | | | | | |
| Hospital organization | H1 | 34.6 | 27.1 | 41.7 | 31.9 | 27.1 | 27.2 | 0.396 | 30.3 | 26.8 | 33.5 | 0.363 |
| | H2 | 29.8 | 32.7 | 27.1 | 28.7 | 36.5 | 40.7 | 0.456 | 29.7 | 35.9 | 34.7 | 0.434 |
| | H3 | 35.6 | 40.2 | 31.3 | 39.4 | 36.5 | 32.1 | 0.814 | 40.0 | 37.4 | 31.8 | 0.272 |
| ***Building location*** | | | | | | | | | | | | |
| Highway <100 m or industry <10 km | Yes | 46.5 | 40.0 | 43.5 | 46.2 | 45.8 | 51.9 | 0.744 | 39.3 | 48.9 | 48.8 | 0.123 |
| Forest nearby | Yes | 29.8 | 36.4 | 31.3 | 37.2 | 35.3 | 32.1 | 0.863 | 38.8 | 33.8 | 29.5 | 0.197 |
| Attached parking garage | Yes | 31.3 | 25.7 | 39.1 | 28.6 | 25.3 | 25.3 | 0.528 | 28.8 | 23.7 | 31.2 | 0.265 |
| ***Building layout*** | | | | | | | | | | | | |
| Number of building levels | 1 to 4 | 33.7 | 42.3 | 41.3 | 31.8 | 43.2 | 41.8 | 0.478 | 41.0 | 33.9 | 42.6 | 0.197 |
| 5 to 12 | 66.3 | 57.7 | 58.7 | 68.2 | 56.8 | 58.2 | | 59.0 | 66.1 | 57.4 | | |
| Depth building wing | 12 < 15 m | 27.3 | 18.3 | 26.1 | 30.0 | 19.8 | 26.6 | 0.380 | 19.3 | 27.1 | 25.9 | 0.240 |
| | 15 < 20 m | 25.3 | 32.7 | 37.0 | 21.1 | 32.1 | 26.6 | 0.194 | 33.5 | 25.5 | 27.6 | 0.819 |
| | >20 m | 47.5 | 49.0 | 37.0 | 48.9 | 48.1 | 46.8 | 0.297 | 47.2 | 47.3 | 46.5 | 0.985 |
| Building level | level 0 | 51.1 | 57.3 | 48.9 | 45.3 | 64.6 | 50.0 | 0.159 | 55.4 | 47.8 | 57.2 | 0.171 |
| Most frequently used room type | level 1 | 35.1 | 30.1 | 44.4 | 39.5 | 25.6 | 34.6 | 0.244 | 32.5 | 40.9 | 28.9 | 0.052 |
| >level 1 | 13.8 | 12.6 | 6.7 | 15.1 | 9.8 | 15.4 | 0.671 | 12.1 | 11.3 | 13.9 | 0.760 | |
| ***HVAC*** | | | | | | | | | | | | |
| Building ventilation | Mechanical exhaust + supply | 92.3 | 93.5 | 97.9 | 94.7 | 92.9 | 88.9 | 0.488 | 95.2 | 94.4 | 89.2 | 0.059 |
| | Mechanical supply | 7.7 | 6.5 | 2.1 | 5.3 | 7.1 | 11.1 | | 4.8 | 5.6 | 10.8 | |
| Operable window* | Yes | 63.6 | 63.1 | 66.7 | 63.9 | 56.1 | 50.8 | 0.467 | 61.8 | 57.0 | 61.4 | 0.665 |
| Control manual ventilation | Automatic | 85.4 | 87.9 | 83.7 | 82.9 | 87.8 | 80.3 | 0.757 | 86.9 | 83.1 | 85.8 | 0.630 |
| Heating | Radiator | 55.1 | 62.9 | 60.9 | 69.7 | 52.4 | 57.0 | 0.218 | 66.9 | 56.4 | 56.5 | 0.081 |
| | Floor | 8.2 | 7.6 | 4.3 | 9.0 | 11.0 | 13.9 | 0.527 | 6.7 | 7.4 | 13.7 | 0.053 |
| | Air | 36.7 | 29.5 | 34.8 | 21.3 | 36.6 | 29.1 | 0.212 | 26.4 | 36.2 | 29.8 | 0.129 |
| Cooling | Top cooling | 86.7 | 91.4 | 84.8 | 82.0 | 90.4 | 88.6 | 0.413 | 90.2 | 88.3 | 85.8 | 0.465 |
| | Airconditioning | 13.3 | 8.6 | 15.2 | 18.0 | 9.6 | 11.4 | | 9.8 | 11.7 | 14.2 | |
| ***Visual*** | | | | | | | | | | | | |
| Height parapet | <20 cm | 15.5 | 8.8 | 18.9 | 12.7 | 10.9 | 11.1 | 0.661 | 9.4 | 14.3 | 12.3 | 0.485 |
| | 20 < 90 cm | 70.4 | 70.0 | 67.6 | 70.9 | 72.7 | 65.1 | 0.960 | 74.8 | 66.2 | 66.7 | 0.240 |
| | >90 cm | 14.1 | 21.3 | 13.5 | 16.5 | 16.4 | 23.8 | 0.624 | 15.7 | 19.5 | 21.0 | 0.531 |
| Window to corridor* | Present | 47.1 | 57.0 | 56.3 | 57.4 | 55.3 | 58.0 | 0.647 | 57.0 | 51.0 | 59.1 | 0.262 |
| Control solar shading | No solar shading | 13.7 | 11.3 | 10.8 | 9.6 | 10.7 | 17.2 | 0.792 | 10.1 | 15.6 | 12.0 | 0.392 |
| | Automatic | 52.1 | 43.8 | 48.6 | 60.2 | 51.8 | 39.1 | 0.157 | 51.2 | 51.1 | 43.7 | 0.356 |
| | Individual control | 34.2 | 45.0 | 40.5 | 30.1 | 37.5 | 43.8 | 0.383 | 38.8 | 33.3 | 44.4 | 0.170 |
| Control lighting | Manual control | 74.7 | 85.8 | 71.7 | 73.6 | 73.5 | 83.5 | 0.117 | 82.8 | 75.8 | 77.2 | 0.247 |
| | Automatic | 25.3 | 14.2 | 28.3 | 26.4 | 26.5 | 16.5 | | 17.2 | 24.2 | 22.8 | |
| ***Acoustic (acoustic ceilings in all rooms)*** | | | | | | | | | | | | |
| Presence dropseal | Mainly present | 50.5 | 51.4 | 67.4 | 56.3 | 53.7 | 62.0 | 0.327 | 56.2 | 52.4 | 60.2 | 0.334 |
| ***Perceived control**** | | | | | | | | | | | | |
| Temperature | Control | 35.6 | 41.1 | 39.6 | 44.7 | 27.1 | 30.9 | 0.140 | 34.5 | 31.8 | 42.0 | 0.108 |
| Ventilation | Control | 26.9 | 20.6 | 22.9 | 33.0 | 18.8 | 13.6 | **0.043** | 20.7 | 20.2 | 26.7 | 0.262 |
| Solar shading | Control | 41.3 | 37.4 | 43.8 | 47.9 | 29.4 | 37.0 | 0.199 | 40.5 | 34.3 | 41.1 | 0.327 |
| Lighting | Control | 48.1 | 53.3 | 62.5 | 68.1 | 50.6 | 53.1 | 0.062 | 55.2 | 53.3 | 57.1 | 0.758 |
| View | Control | 31.7 | 28.0 | 41.7 | 33.0 | 17.6 | 29.6 | 0.073 | 27.3 | 30.3 | 29.5 | 0.810 |
| Noise | Control | 34.6 | 25.2 | 41.7 | 28.7 | 20.0 | 23.5 | 0.059 | 21.3 | 27.3 | 32.4 | 0.073 |
| ***Maintenance*** | | | | | | | | | | | | |
| Cleaning protocol walls | 1x per week or more | 34.6 | 27.1 | 41.7 | 31.9 | 27.1 | 27.2 | 0.396 | 30.3 | 26.8 | 33.5 | 0.363 |
| | 1–2x per month | 35.6 | 40.2 | 31.3 | 39.4 | 36.5 | 32.1 | 0.814 | 40.0 | 37.4 | 31.8 | 0.272 |
| | 2–6x per year | 15.4 | 16.8 | 10.4 | 18.1 | 12.9 | 22.2 | 0.509 | 16.4 | 16.7 | 14.8 | 0.870 |
| | no protocol | 14.4 | 15.9 | 16.7 | 10.6 | 23.5 | 18.5 | 0.304 | 13.3 | 19.2 | 19.9 | 0.218 |
| Cleaning protocol furniture | 5x per week | 72.1 | 68.2 | 72.9 | 77.7 | 67.1 | 64.2 | 0.434 | 73.9 | 66.7 | 67.6 | 0.280 |
| | 2x per week | 13.5 | 15.9 | 10.4 | 11.7 | 9.4 | 17.3 | 0.637 | 12.7 | 14.1 | 12.5 | 0.878 |
| | no protocol | 14.4 | 15.9 | 16.7 | 10.6 | 23.5 | 18.5 | 0.304 | 13.3 | 19.2 | 19.9 | 0.218 |
| Visible dust/dirt | Yes | 37.9 | 35.9 | 39.1 | 34.9 | 33.8 | 39.7 | 0.968 | 41.8 | 32.8 | 37.5 | 0.229 |
| Visible damp spots | Yes | 16.2 | 19.0 | 23.9 | 13.2 | 16.9 | 15.2 | 0.692 | 20.2 | 12.1 | 18.2 | 0.097 |

*Based on self-report of staff, other building aspects retrieved from building inspection or hospital organizations.

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