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## Office design's impact on sick leave rates

Christina Bodin Danielsson<sup>a\*</sup>, Holendro Singh Chungkham<sup>a1</sup>, Cornelia Wulfi<sup>b2</sup> and Hugo Westerlund<sup>a3</sup>

<sup>a</sup>The Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden; <sup>b</sup>The Psychology Department, Stockholm University, Stockholm, Sweden

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The effect of office type on sickness absence among office employees was studied prospectively in 1852 employees working in (1) cell-offices; (2) shared-room offices; (3) small, (4) medium-sized and (5) large open-plan offices; (6) flex-offices and (7) combi-offices. Sick leaves were self-reported two years later as number of (a) short and (b) long (medically certified) sick leave spells as well as (c) total number of sick leave days. Multivariate logistic regression analysis was used, with adjustment for background factors. A significant excess risk for sickness absence was found only in terms of short sick leave spells in the three open-plan offices. In the gender separate analysis, this remained for women, whereas men had a significantly increased risk in flex-offices. For long sick leave spells, a significantly higher risk was found among women in large open-plan offices and for total number of sick days among men in flex-offices.

**Practitioner Summary:** A prospective study of the office environment's effect on employees is motivated by the high rates of sick leaves in the workforce. The results indicate differences between office types, depending on the number of people sharing workspace and the opportunity to exert personal control as influenced by the features that define the office types.

**Keywords:** office design/office type; sick leaves; employees; prospective study; gender

### 1. Introduction

Although the different negative effects of sickness absence is fairly well researched (see, e.g. European Commission 2002; Milczarek, Schneider, and Rial González 2009; Mustard, Lavis, and Ostry 2006), there is a lack of studies concerning the determinants of sickness absence among white-collar workers, despite the fact that they make up the majority of the workforce in the Western world today (Brill et al. 2001; Duffy 1999). In particular, the possible relationship between the physical office environment and sick leave rates is under-studied. We know from empirical studies that absenteeism is related to job characteristics such as high work demands, poor job control, monotonous work and so on. (e.g. Allebeck and Mastekaasa 2004; Karasek and Theorell 1990; Vahtera, Pentti, and Utela 1996). There are gender differences in sickness absence – both in terms of risk factors (e.g. Kivimäki et al. 2007; Krantz 2003) and rates, with higher rates among women (Blank and Diderichsen 1995; Niedhammer et al. 1998).

When investigating the office environment's impact on employee health and well-being, the concept of personal control is of special interest since the need for personal control over the surrounding environment is considered fundamental for human well-being (see, e.g. Rothbaum, Weisz, and Snyder 1982; Ward 2012). Personal control is strongly related to office employees' environmental satisfaction (Bodin Danielsson and Bodin 2009), as well as perception of privacy (Haans, Kaiser, and de Kort 2007; Kupritz 1998) and distraction (Lee and Brand 2010). In the increasingly ubiquitous open-plan offices, the latter two factors are combined with noise and often hard to satisfy. The latter is considered the major stressor in open-plan offices when perceived as 'irrelevant sound' (Banbury and Berry 2005), with negative effects on both health outcomes and cognitive performance (Evans and Johnson 2000; Jahncke et al. 2011; Liebl et al. 2012). Since privacy besides acoustic also includes visual privacy, the architectural design of the office, including workstation design and office layout, is important (Charles and Veitch 2002; Lee 2010; Marquardt, Veitch, and Charles 2002). Office layout is highly related to office types; hence their defining features are important when investigating the office environment's possible impact on employees' health and well-being.

There are to our knowledge only a few studies that have investigated the office environment's relation to health among office employees, and sick leaves specifically. Differences in health status between employees in various office types have been found, with the best health among those in flex-offices and cell-offices, and the worst in medium-sized open-plan office (Bodin Danielsson and Bodin 2008). The explanation for the equally good health in the former two, very different, office types could be that they both enable personal control, albeit through different means. In a Dutch study, in which the researchers followed a company's move from cell-offices to flex-offices (called 'innovative office' in the article) over a

\*Corresponding author. Email: [christina.bodin.danielsson@stressforskning.su.se](mailto:christina.bodin.danielsson@stressforskning.su.se); [info@stressforskning.su.se](mailto:info@stressforskning.su.se)

period of 15 months, it was found that employees reported better general health and less complaints concerning upper extremities after the move (Meijer, Frings-Dresen, and Sluiter 2009). Here, the authors explained the result by the extra efforts put into the ergonomics of the workstations in the new flex-offices. Concerning gender differences, a cross-sectional study found differences regarding in which office types men and women reported the highest stress levels (Bodin Danielsson 2007). With regard to sick leave, a large longitudinal study found that employees in cell-offices reported lower rates than those working in open offices with more than six people (Pejtersen et al. 2011).

Beside the scarcity of health-related office research, there are substantial shortcomings in the existing office research, e.g. in most cases the definitions are too vague regarding the office environments studied. Many studies compare cell-offices with open-plan offices without any recognition of the fact that different types of open-plan offices exist which vary substantially in their spatial and functional arrangements (Hedge 1982; Pejtersen et al. 2011). In addition, most studies are post occupancy evaluations after relocation (Kaarlela-Tuomaala et al. 2009; Meijer, Frings-Dresen, and Sluiter 2009) or cross-sectional (e.g. Bodin Danielsson and Bodin 2008; Bodin Danielsson and Bodin 2009; Bodin Danielsson, Wulff, and Westerlund *in press*). A limitation in the former is that the actual shift of environment in itself may have a different impact on the outcomes than the office environment per se. In cross-sectional studies, no causal relations can be established. Despite this, the majority of office research is cross-sectional since office environments are difficult to study for a long period of time because offices, for symbolic reasons, are often relocated or redesigned in connection with the shift of management and leadership.

To the best of our knowledge, there are only two studies in which office employees' health has been studied over a longer period of time in relation to the office environment: Meijer, Frings-Dresen, and Sluiter's study (2009), which examined employee health status after a move from cell-office to flex-office, and Pejtersen et al.'s study (2011) of sickness absenteeism in relation to individuals sharing workspace. However, in the former study, the sample is small (138 subjects) and only two office types are studied. The second study has the benefit of being a large, longitudinal study; however, the offices are defined only by the number of people sharing workspace.

The purpose of this article was to investigate whether office type has a prospective effect on employees' sickness absence. The environmental factors in an office can be classified as physical, psychosocial and organisational, which may interact in their impact on employees. Recognising this, this study applies a more comprehensive definition of office type that in addition to the number of employees sharing workspace also studies the opportunity to exert personal control in the different office type. Our hypothesis was that sick leave rates differ between office types due to difference in terms of the two former conditions.

## 2. Methods

### 2.1. Sample

Our sample comes from the 2010 and 2012 waves of the Swedish Longitudinal Occupational Survey of Health (SLOSH). These respondents originally participated in the Swedish Work Environment Survey (SWES) in the years 2003 or 2005, when they were gainfully employed and 16–64 years of age. SLOSH is a nationally representative longitudinal cohort study of work environment and health covering different aspects of the general life situation and working life, including organisational aspects as well as the physical work environment with questions about office types. The fact that SLOSH covers office types makes it useful for the purpose of this article. To our knowledge no other large survey does this. The survey is conducted every second year. Data are collected by paper-and-pencil questionnaires (Hanson et al. 2011; Magnusson Hanson et al. 2009), but with an internet questionnaire option offered in 2012. Participation is voluntary. In the 2010 wave, 20,291 persons were asked to participate, with a total response rate of 56.8%.

We restricted our sample to those employees who worked at both waves, i.e. in SLOSH 2010 and 2012, and did not change their job in-between since the objective of the article was to understand the prospective association between office type and sickness absence. We thus followed the individuals from 2010 and studied the association between the exposure to office type in this year and the outcome, i.e. sickness absence measured in 2012 and referring to the last 12 months before the measurement. With these exclusion criteria a total of 1852 participants remained in the analytic sample (Figure 1). Employees who stated that they worked in a cell-office, but also worked 20% or more in team work elsewhere in the office were excluded since it was unclear whether they worked in combi-offices or not.

### 2.2. Office definitions

The study is based on the seven office types that have been identified in contemporary office design. These are: (1) cell-office, (2) shared-room office, (3) small open-plan office, (4) medium-sized open-plan office, (5) large open-plan office, (6) flex-office and (7) combi-office (Bodin Danielsson 2007; Bodin Danielsson and Bodin 2008). These seven office types are

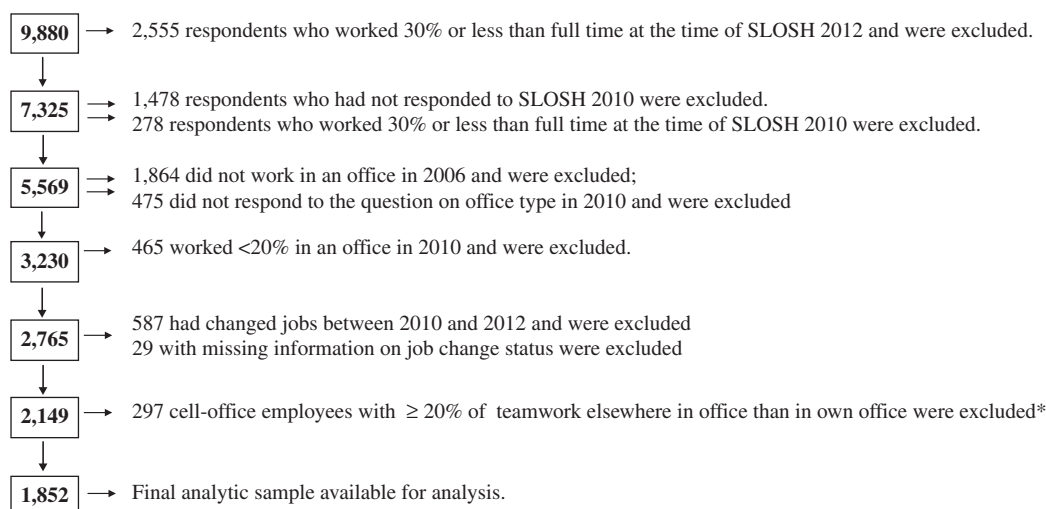


Figure 1. Exclusion of subjects from study base for the analysis. A total of 9880 people (44.2% men, 55.8% women) responded to SLOSH 2012.

defined by their unique combinations of architectural and functional features (Table 1). The architectural features are the physical features of an office type, such as access to windows, spatial arrangements of rooms (e.g. corridors or open-plan layout) and furniture arrangements which are partly given by the spatial organisation. Of the architectural features, the plan layout is the most prominent. The functional features of an office type are determined by the work taking place and how it is organised, i.e. the use of the office and functions related to this. These features are in turn determined by factors such as functional needs, technical feasibility (information communication technology [ICT]) and so on. But it also works vice versa, as technical and functional possibilities can lead to new organisation of work that affects the architectural design. The seven office types should be viewed as both prototypes and 'ideal' office types, since there exists of the office that differs to the described definitions.

SLOSH does not enable a detailed analysis of one particular functional feature, the individual employee's decision making power, which is an important functional feature that defines the different office types (see Bodin Danielsson & Bodin 2008, 2009). Thus a descriptive analysis based on mean values of employees' degree of decision-making power in work was done in the various office types (see Table A1 in Appendix). The degree of decision-making power in work was measured by the three items of decision latitude dimension developed for the demand-control-support questionnaire (Theorell et al. 1988) included in SLOSH.

### 2.3. Socio-demographics

Background data on sex, age, job rank, income and labour market sector, i.e. if the individual works in private or public sector are given in Table 2 split by office type. Age is shown for the year 2010, job rank, income and labour market sector in both 2010 and 2012.

The demographic data show some overall distinguishing characteristics in the sample. It shows that there are no significant differences with respect to office type in the gender distribution or income in 2010. However, in 2012 there are significant differences with respect to office type in terms of income. There are more women than men in the sample, and the most equal gender distribution is found in medium-sized and large open-plan office together with flex-office. The highest incomes are in both 2010 and 2012 found in medium-sized open-plan office followed by large open-plan office and the lowest incomes in flex-office. The age distribution differs significantly between the office types with the highest proportion of young people in small open-plan office and of old people in cell-office. Overall, there are fewer people in the youngest age group than in the older age groups. The traditional open-plan offices (small, medium-sized and large open-plan) are more common in the private than the public sector. The most common office type in the public sector is the combi-office. Flex-office has also a larger representation in this sector. There are significant differences with respect to office type in distribution of job rank in both 2010 and 2012. Lowest job ranks (unskilled and skilled manual workers combined with non-manual workers) are in both years found in shared-room office and flex-office. The highest job rank (professional and higher managers) has 2010 as its largest representation in combi-office followed by cell-office. It is the largest representation found in medium-sized open-plan office followed by cell-office again.

Table 1. Office types – prototypes defined by architectural and functional features.

Office type: architectural features	Functional features
<p>1. <i>Cell-office</i>: single room office</p> <ul style="list-style-type: none"> <li>– The plan layout is characterised by corridors, either a single or double corridor system</li> <li>– Individual room has access to a window</li> </ul>	<ul style="list-style-type: none"> <li>– Most equipment is in the own room</li> <li>– Work is concentrated and independent</li> </ul>
<p>2. <i>Shared-room office</i>: 2–3 people/room</p> <p>An office type sometimes a consequence of lack of workspace.</p> <ul style="list-style-type: none"> <li>– Workstations freely arranged in the room</li> <li>– For privacy reasons sometimes screens or other divisional elements between workstations</li> <li>– No individual window, shares with roommate(s)</li> </ul> <p><i>Traditional open-plan offices</i>: Groups of employees sharing a common workspace in different configurations.</p> <p>Found in following three sub-categories:</p>	<ul style="list-style-type: none"> <li>– Team-based work or people with similar work assignment share room</li> <li>– Most equipment outside of room, team-based shared room tends to have own</li> </ul>
<p>3. <i>Small open-plan office</i>: 4–9 people per room</p> <p>4. <i>Medium-sized open-plan office</i>: 10–24 people per room</p> <p>5. <i>Large open-plan office</i>: &gt; 24 people per room</p> <ul style="list-style-type: none"> <li>– Shared workspaces within the office</li> <li>– Plan layout is open, based on an open flow of workspaces instead of corridor systems</li> <li>– Workstations freely arranged in the room or in rows in a larger workspace</li> </ul> <p><i>More flexible and activity based office types</i>:</p>	<ul style="list-style-type: none"> <li>– Flexible for organisational changes</li> <li>– Routine-based work</li> <li>– Low level of interaction between employees</li> <li>– Often no amenities at workstation</li> </ul>
<p>6. <i>Flex-office</i>: no individual workstation</p> <ul style="list-style-type: none"> <li>– Plan layout is open, based on an open flow of workspaces instead of corridor systems</li> <li>– Back up spaces for work activities not suitable to carry out at the personal workstation, e.g. rooms for concentrated work, telephone calls, different type of meeting rooms</li> </ul>	<ul style="list-style-type: none"> <li>– Flexible for organisational changes</li> <li>– Dimensioned for &lt;70% of the workforce</li> <li>– The choice of workstation is free, has the option to work outside of office as well</li> <li>– Good ICT is a necessity as the common computer system is accessible from all workstations within the office</li> <li>– Mainly independent work, sometimes project based</li> </ul>
<p>7. <i>Combi-office</i>: &gt; 20% of the work in the office not at the personal workstation, team-based work</p> <ul style="list-style-type: none"> <li>– No strict spatial definition, personal workstations can be either individual rooms or open-plan office</li> <li>– Back up spaces for work activities not suitable to carry out at the personal workstation. Extra focus on rooms for group activities such as meeting and project rooms (booked for longer periods)</li> </ul>	<ul style="list-style-type: none"> <li>– Sharing of common amenities in common spaces</li> <li>– Work is both independent and interactive team work with colleagues</li> <li>– The team move around in the office on an ‘as-needed basis’ using the wide range of common facilities</li> </ul>

#### 2.4. Descriptions of outcome variables

The following three dimensions were used as outcomes:

- (a) *Number of short sick leave spells* was assessed by the question: ‘How many times have you taken sick leave for a week or less during the past 12 months? Do not count care of a sick child.’ The responses were dichotomised into *one or no short absences* (‘not at all or 1 spell’) vs. *more than 2 spells* (‘2 or more spells’).
- (b) *Number of long (medically certified) sick leave spells* was assessed by the question: ‘How many times have you taken sick leave for longer than a week during the past 12 months? Do not count care of a sick child.’ The response was dichotomised into *no long absences* (‘On no occasion’) vs. *all other categories*. Sick leaves of longer than a week require a certificate from a physician.
- (c) *Total number of sick leave days* was measured by the response to the question: ‘Approximately how many days have you in total been on sick leave during the last 12 months?’ The response was dichotomised into *7 days or less* (‘not at all’ or ‘1–7 days’) vs. *more than 7 days* (‘8–30 days’, ‘31–90 days’ and ‘91 days or more’).

#### 2.5. Confounders

In the multivariate analysis, sex, age, labour market sector and job rank were treated as confounders (Table 2). All confounders were treated as categorical variables. Age was divided into < 34 years, 35–49 years and > 49 years (consistent

Table 2. Socio-demographic characteristics participants by office types.

Office types	Cell-office $n_1 = 851$	Shared-room office $n_2 = 243$	Small open- plan office $n_3 = 124$	Medium-sized open-plan office $n_4 = 84$	Large open- plan office $n_5 = 144$	Flex- office $n_6 = 91$	Combi- office $n_7 = 315$	Sign. difference between office types $n = 1852$
<i>Gender</i>								0.220
Female	485 (57)	157 (65)	75 (60.5)	44 (52)	77 (53.5)	48 (53)	182 (58)	
Male	366 (43)	86 (35)	49 (39.5)	40 (48)	67 (46.5)	43 (47)	289 (45)	
<i>Age group (years)</i>								$\leq 0.001$
$\geq 34$	34 (4)	15 (6)	21 (17)	8 (9.5)	14 (10)	5 (5.5)	22 (7)	
35–48	283 (33)	86 (35)	42 (34)	25 (30)	68 (47)	40 (44)	129 (41)	
$\leq 49$	534 (63)	142 (58)	61 (49)	51 (61)	62 (43)	46 (50.5)	164 (52)	
<i>Income (USD)</i>								0.047
Income 2010	56.4	52.1	49.2	59.5	57.7	48.0	56.1	
Income 2012	63.5 <sup>(2)**</sup>	54.8 <sup>(1)**,(4)**</sup>	56.1 <sup>(4)*</sup>	69.2 <sup>(2)**,(3)*,(6)*</sup>	64.4	54.5 <sup>(4)*</sup>	62.2	$\leq 0.001$
<i>Labour market sector</i>								$\leq 0.001$
Private	384 (50)	118 (54)	82 (71)	63 (79)	111 (79)	36 (44)	132 (45)	
Public	375 (49)	100 (46)	34 (29)	18 (22)	29 (21)	46 (56)	162 (55)	
<i>Job rank 2010</i>								$\leq 0.001$
Unskilled manual workers	11 (1)	6 (3)	3 (2)	0 (0)	0 (0)	6 (7.0)	16 (5)	
Skilled manual workers	5 (1)	4 (2)	2 (2)	1 (1)	3 (2)	8 (9)	16 (5)	
Non-manual workers	204 (25)	84 (37)	36 (30)	24 (29)	25 (18)	19 (22)	38 (13)	
Intermediate/lower managers	298 (36)	83 (36)	51 (42)	32 (39)	74 (52)	33 (38)	140 (47)	
Professionals and higher managers	299 (37)	53 (23)	29 (24)	25 (30.5)	40 (28)	20 (23)	255 (42.1)	
<i>Job rank 2012</i>								$\leq 0.001$
Unskilled manual workers	10 (1)	6 (2.5)	0 (0)	0 (0)	0 (0)	7 (8)	16 (5)	
Skilled manual workers	6 (1)	2 (1)	3 (2.5)	1 (1)	2 (1)	8 (9)	18 (6)	
Non-manual workers	216 (26)	84 (36)	37 (31)	18 (22)	25 (18)	20 (23)	33 (11)	
Intermediate/lower managers	298 (36)	95 (40)	48 (20)	33 (27)	30 (37)	36 (41)	137 (44)	
Professionals and higher managers	303 (36)	48 (20)	33 (27)	30 (37)	45 (32)	17 (19)	103 (34)	

Note: Post-hoc (Sidak) tests for mean differences are indicated  $X^{(1)-(4), (6)}$ , \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . Figures in parentheses are percentages. Values in bold indicate significances reported in SPSS as 0.000.

with Bodin Danielsson and Bodin 2008) in order to account for possible nonlinear effects. Sector of business was categorised into private and public. Job rank was categorised into (1) unskilled manual work, (2) skilled manual workers, (3) non-manual workers, (4) intermediate/lower managers and (5) professionals and higher managers. These were formed by combining the Swedish Socio-economic (SEI) code and the job rank classification used by Magnusson Hanson et al. (2009).

## 2.6. Data analyses

To understand the prospective association between office types in 2010 and sickness absences in 2012, we applied logistic regression models controlling for several background characteristics in 2010. In accordance with the aim of the study, the main explanatory variable of office type was used. For this, the seven office type categories defined previously were used. Cell-office was chosen to represent the reference category with which the other office types were compared.

The results are presented as odds ratios (ORs) with 95% confidence intervals. An OR greater than one indicates a higher risk for sickness absence for the particular office type compared with the reference category. The statistical significance level was fixed at  $p < 0.05$ . For each of the outcomes analysed in this article, three models were shown – total sample, male and female separately.



Table 3. Prospective associations between office types in 2010 and sickness absence outcomes in 2012 expressed as ORs from logistic models adjusted for background factors.<sup>a</sup>

Office types <i>n</i> = 1852	Cell-office <sup>R</sup> <i>n</i> <sub>1</sub> = 851	Shared-room office <i>n</i> <sub>2</sub> = 243	Small open-plan office <i>n</i> <sub>3</sub> = 124	Medium-sized open-plan office <i>n</i> <sub>4</sub> = 84	Large open-plan office <i>n</i> <sub>5</sub> = 144	Flex-office <i>n</i> <sub>6</sub> = 91	Combi-office <i>n</i> <sub>7</sub> = 315
Outcome							
<i>Short sick leave spells (≥2 spells)</i>							
Total sample	1.00	1.23 (0.81–1.86)	<b>1.9** (1.16–3.1)</b>	<b>1.92* (1.08–3.4)</b>	<b>1.82** (1.14–2.88)</b>	1.69 (0.95–3.01)	0.95 (0.63–1.42)
Women	1.00	1.48 (0.91–2.42)	<b>1.97* (1.08–3.6)</b>	<b>2.28* (1.11–4.67)</b>	<b>1.86* (1.04–3.35)</b>	1.56 (0.73–3.34)	1.0 (0.62–1.61)
Men	1.00	0.77 (0.32–1.84)	1.92 (0.83–4.47)	1.48 (0.56–3.95)	1.8 (0.84–3.85)	<b>2.56* (1.04–6.34)</b>	0.78 (0.37–1.68)
<i>Long sick leave spells (medically certified)</i>							
Total sample	1.00	0.79 (0.46–1.36)	0.7 (0.32–1.5)	0.51 (0.18–1.44)	1.1 (0.59–2.05)	0.89 (0.56–1.42)	0.73 (0.50–1.07)
Women	1.00	1.02 (0.55–1.93)	0.53 (0.18–1.54)	0.42 (0.98–1.83)	<b>2.14* (1.08–4.26)</b>	1.97 (0.87–4.44)	1.08 (0.61–1.90)
Men	1.00	0.37 (0.11–1.26)	0.97 (0.32–2.98)	0.56 (0.12–2.5)	– <sup>b</sup>	1.5 (0.51–4.28)	0.68 (0.30–1.53)
<i>Total number of days (≥8 days)</i>							
Total sample	1.00	1.37 (0.92–2.04)	1.02 (0.59–1.79)	0.88 (0.44–1.78)	1.29 (0.78–2.14)	1.58 (0.89–2.81)	1.05 (0.71–1.54)
Women	1.00	1.54 (0.96–2.47)	0.94 (0.47–1.87)	0.52 (0.18–1.51)	1.71 (0.94–3.11)	1.16 (0.54–2.5)	1.07 (0.67–1.7)
Men	1.00	1.0 (0.46–2.22)	1.21 (0.47–3.11)	1.59 (0.61–4.17)	0.69 (0.25–1.87)	<b>2.63* (1.11–6.26)</b>	1.0 (0.5–1.98)

Note: <sup>R</sup>Reference category. Figures in brackets are confidence intervals; \* $p \leq 0.05$ , \*\* $p \leq 0.01$ , \*\*\* $p \leq 0.001$ .

<sup>a</sup> Adjusted for age, sex, job rank and labour market sector in 2010.

<sup>b</sup> ORs are not reported due to empty cells.

### 3. Results

The results from the multivariate logistic analyses in Table 3 showed a clear difference in prospective risks for sickness absence between the three outcomes used. With regard to short sick leave spells ( $\geq 2$  spells), a significant association with office type was found in the analysis of the total sample as well as in the separate analyses for men and women. In the total sample, elevated risks were found among employees in all three traditional open-plan offices in comparison with cell-offices. The highest significant risk for short sick leave spells was found among employees in small (OR = 1.9,  $p \leq 0.001$ ) and large open-plan office (OR = 1.82,  $p \leq 0.001$ ) followed by medium-sized open-plan offices (OR = 1.22,  $p \leq 0.05$ ). The same office types had the highest risk also in the women-only analysis, although less significantly than in the total sample, with ORs of 1.97, 2.28 and 1.86, respectively,  $p \leq 0.05$ . For men-only analysis, flex-offices were associated with a significantly higher risk for short sick leave spells (OR = 2.56,  $p \leq 0.05$ ). In terms of less negative outcomes, there was a non-significant tendency towards lower rates of short sick leave spells in cell- and combi-offices.

With regard to long (medically certified) sick leave spells and total number of sick days ( $\geq 8$  days), the only significant associations were found in the separate analyses for men and women. Here a significantly higher risk of long sick leave spells was found among women in large open-plan offices (OR = 2.14,  $p \leq 0.05$ ) than in cell-office. In men the risk of a high total number of sick days was significantly higher in flex-offices (OR = 2.63,  $p \leq 0.05$ ).

### 4. Discussion

This study of the prospective effect of office environment on sickness absence showed very different results for our three outcomes, with a significant association found mainly in terms of short sick leave spells. In this regard, the three traditional open-plan offices stood out negatively for both the total sample and women separately. For men, short sick leave spells were significantly more common in flex-offices. In addition, women had higher risk of long sick leave spells in large open-plan offices, and in men the total number of sick days was higher in flex-offices.

We found an excess risk of short sick leave spells in the same office types, which in other studies were found less conducive to employee health. That employees in traditional open-plan offices have a significantly highest risk for ill-health was for instance found in a cross-sectional study (Bodin Danielsson and Bodin 2008), but also in a large longitudinal study (Pejtersen et al. 2011).

The cumulative evidence thus indicates that traditional open-plan offices are less good for employee health. There could be several explanations for this. The risk of infection could be higher among people sharing workspace, the exposure to environmental stressors, such as noise and less ability for personal control in traditional office open-plan offices. Group dynamics could also explain the negative outcomes in traditional open-plan offices, particularly large open-plan offices. Strong group identity is after all more likely to develop in a smaller group of people (Svedberg 1992) as well as the peer control among employees working in close collaboration with each other (Barker 1993). The non-significant tendency for better outcomes on sickness absence in cell-offices and combi-offices could indicate that high personal control and low risks for infection in the former and strong social coherence and peer control in the latter may decrease the risk of absenteeism. Positive aspect of social control could be that people are more missed when absent in a small group due to a better visual overlook and a greater concern for team members. It could also be that the individual's work effort is more noticeable or that the individual is less easily replaceable in a smaller workgroup or team, due to a greater dependence of each other. The latter hypothesis is supported by research on sickness presenteeism, i.e. being present at work despite being sick, which has found that people who work collectively have more sickness presenteeism (Aronsson and Gustafsson 2005). According to this hypothesis, the social control and group dynamics of the teams would then have a preventive effect on sick leaves prospectively.

Some gender differences were found. The association between short sick leave spells and office type was stronger among women than among men working in the three traditional open-plan offices, and for long sick leave spells among women in large open-plan offices. This may be due to a higher sensitivity to physical stimuli or a greater importance of social support at work among women. Support for the latter hypothesis may be found in that women appear to receive more social support than men at work (Plaisier et al. 2007; Winter et al. 2006). Additional explanations may be that the well-established excess risk for sick leaves among women overall, which was found also in this study, may indicate a greater vulnerability to the negative environmental stimuli that may be found in traditional open-plan offices. For men, there is instead a stronger association between flex-office and risk of short sick leave spells and total sick days. This difference between men and women indicates a possible larger importance of a personal workstation for the welfare of men than of women, which in turn could depend on factors such as social status and so on. Flex-offices stood out as a less good office type from a sick leave perspective than other office types independently of gender.

#### 4.1. Concluding remarks and limitations

The fact that the study is based solely on self-reported data is a limitation that comes with most surveys and could lead to spurious findings, especially if dissatisfaction with the office environment influences ratings of health. However, self-reported sickness absence should be less affected than direct ratings of health, since the questions are about factual phenomena, although these can be misremembered or consciously inflated to express dissatisfaction. Additional observations of the employees' office environments would have been beneficial, although difficult to perform in a large national survey such as SLOSH. Another weakness is that we have not adjusted for baseline health, which means that we cannot rule out reverse causality. However, adjusting for baseline health could also lead to over adjustment, as long-term exposure to a certain office environment could already have affected health at baseline. We therefore chose not to adjust for baseline health on the assumption that selection into particular office types based on health would be rare and less of a problem than over adjustment. The major limitation in our opinion is that the definition of office type based on the SLOSH 2010 is not precise enough to accurately define office type, since the questionnaire contained only a couple of items on the office environment such as employee's office type and degree of collaboration and work at workstation but lack many environmental factors. The respondents may thus have misunderstood the purpose of the questions on the office environment, which in turn may explain why (a) critical items concerning the office type often were not filled in and (b) the responses were not always consistent. This, in turn, may lead to an imprecision in the exposure measure and possibly lead to an underestimation of the effect of office design on health.

Whether or not sickness absence is a good measure of employee health and well-being can also be discussed, since it measures health-related behaviour rather than health per se. Sickness absence could thus also be influenced by factors such as attitudes towards health and work, as well as, e.g. job control and adjustment latitude (Kivimäki et al. 2003). The different association between office type and the risk of short versus long sick leave spells could, therefore, be due to differences in attitudes towards the different types of absence and not on employee health, meaning that short spells of sick leaves are more accepted or easier 'to get away with' in certain offices types than others. When discussing how good an indicator absenteeism is of employee health and well-being, it should be noted that medically certified sickness absence is considered a good predictor of poor health (Kivimäki et al. 2003). However, regardless of these considerations, sickness absence is a relevant factor since it negatively impacts on productivity and increases costs for businesses and put a pressure on the social insurance system.

In conclusion, the results of this prospective study indicate a higher 12-month prevalence of short sick leave spells among employees in traditional open-plan offices, especially among women. The study also indicates a higher prevalence of both short sick leave spells and more than eight days of total number of sick days among men in flex-offices. All together,



the results indicate lower odds of sick leave in office types with high personal control and a lower degree of environmental stressors or more collaboration in teams with colleagues. There could be several explanations for these results. For example, the lower potential to exert personal control in traditional open-plan offices associated with architectural features that lead to a lack of visual and acoustic privacy in combination with the functional features that are related to job characteristics such as lack of autonomy, freedom and so on. (e.g. Bodin Danielsson 2007, 2008; Evans and Johnson 2000). This, combined with the fact that social cohesion is more likely to develop in office types with a lot of team work, is thus in our opinion possible explanations for the difference in short sick leave spells between the different office types.

To summarise, the results of this explorative study should only be viewed a first step in the investigation of the long-term effect of the office environment's impact on employee sickness absence. These results can thus only be viewed as indications of the possible effect of office type on sickness absence. Future studies need a more precise study design focused on the office environment in order to establish if these preliminary results on a prospective association between office type and sickness absence hold true or not. Also studying the possible effect of office environment on health over a longer period of time than 2 years would be beneficial since it is our firm belief that with such knowledge of the office environment's influence on different dimensions of employee health, important gains can be achieved in the long run.

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### Notes

1. Email: [holendro.chungkham@stressforskning.su.se](mailto:holendro.chungkham@stressforskning.su.se)
2. Email: [cwf@psychology.su.se](mailto:cwf@psychology.su.se)
3. Email: [hugo.westerlund@stressforskning.su.se](mailto:hugo.westerlund@stressforskning.su.se)

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## Appendix

Table A1. Mean values of routine-based work, freedom to plan and freedom to decide by office types in 2010.

Office types $N_1 = 1852$	Cell-office $n_1 = 851$	Shared room $n_2 = 243$	Small open-plan office $n_3 = 124$	Medium-sized open-plan office $n_4 = 84$	Large open- plan office $N_5 = 144$	Flex-office $n_6 = 91$	Combi-office $N_7 = 315$
Routine-based work [1: often; 4: rarely]	2.2	2.1	<i>2.01</i>	2.12	2.31	2.22	<b>2.37</b>
Freedom to plan (How to do your work) [1: rarely; 4: often]	<b>3.52</b>	3.41	3.3	3.23	3.21	3.12	3.47
Freedom to decide (What to do) [1: rarely; 4: often]	<b>3.01</b>	2.87	2.77	2.69	2.76	2.55	2.92

Note: Highest mean value is reported in bold and lowest mean value in italics.