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Prevalence of Common Infections Among Employees in Different Work Schedules

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Learning Objectives

- Discuss possible mechanisms through which the work schedule—particularly “shift work,” which includes nighttime work—might influence the risk of contracting common infections.
- Compare the demographic and behavioral features of day workers and shift workers.
- Contrast the prevalence of common infections in day and shift workers, adjusting for type of work.

Abstract

This study examined the prevalence of common infections among employees in different work schedules. Self-administered questionnaire data from the Maastricht Cohort Study on “Fatigue at Work” (n = 12,140) were used. Job title was used as a matching variable between day and shift workers to control for their different work environment. We used a multilevel analysis of a two-level structure, in which the individual employees (level 1) were nested within job titles (level 2), adjusted for demographics, longstanding disease, health behavior, work-related factors, fatigue and sleep quality. Results from the multilevel analyses showed that, compared to day work, shift work was associated with a higher risk for common infections, with the highest risk in three-shift workers. Compared to day work, shift work was further associated with differences in health, health behavior, sleep, fatigue and perceived job characteristics, factors that may influence the occurrence of infections and should be taken into account in future studies as well. (J Occup Environ Med. 2002; 44:1003–1011)

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Common infections like common cold, flu-like illness, and gastroenteritis are endemic in the general population thereby causing considerable discomfort and absence from work. In a study by Feeney et al¹ it was found that respiratory disorders and gastroenteritis accounted for 50 to 60% of all spells of absence. In recent years, evidence has accumulated that stress influences the susceptibility to and duration of infections. Several psychosocial factors have been linked to an increased risk for infections. Daily hassles and major life events have been connected to a higher risk for upper respiratory tract infections.^{2–6} Family functioning, measured with scales covering among others cohesion, adaptability and recent events within a family,⁷ has been associated with a higher risk for influenza-like illnesses. Also work-related stressors may play a role in the susceptibility to infections and several studies have demonstrated a link between the experience of work-related stressors and changes in immune activity.^{8–10} Psychological job demands, for example, have been described as a possible risk factor for the common cold.¹¹

Another work-related factor that is likely to be associated with common infections, constitutes shift work. Shift work can have a negative impact on the health and well-being of workers.¹² Problems related to shift work fall into three main areas.¹³ First, biological disruption of physiological processes, including the sleep-wake cycle^{14,15} can result from shift work. Second, the impairment

of physical health and psychological well-being¹⁶ and third the disruption of social and domestic life^{17,18} have been associated with shift work as well. Studies have shown that shift workers have an increased risk of cardio-vascular diseases,^{19–23} gastro-intestinal diseases,^{12,24,25} and diminished well-being.¹²

A few studies have reported depressed immune function in relation to shift work, which may explain an increased susceptibility to infections.^{26,27} Further, depression of immune function has been attributed to a disturbed circadian rhythm²⁸ caused by periodic shifting of the light-dark, wake-sleep-cycles.²⁶ Shift work may be a major cause of suboptimal sleep quality²⁹ and has been related to a greater amount of insomnia, sleep deprivation, and daytime sleepiness.¹⁵ Cohen et al³⁰ found that inefficient sleep is associated with an increased risk of colds. Moreover, we found that fatigue is associated with common infections.³¹ Fatigue can be regarded as a common complaint during infection, which afterwards can persist for months. On the other hand, it was found that fatigue can also precede a common infection.

The prevalence of infections may further be influenced by health behavior like smoking, drinking habits, and limited exercise. Increased smoking, drinking,³² and limited exercise³³ can influence the immune response. Both smoking and alcohol consumption are believed to suppress host resistance and thereby increase the risk of upper respiratory tract infections.³⁴ Health behavior may also differ between day and shift workers and may possibly account for differences in infection rates. One of the most important physiological problems associated with shift work and the night shift in particular, is that working, eating, and sleeping phases are changed.²⁵

Strong differences between day and shift workers have also been reported concerning other work conditions, such as, for example, deci-

sion latitude and conflicts at work,³⁵ as well as emotional, physical and psychological job demands.^{36,37} This emphasizes the need to control for differences in the work environment when examining work schedules. Approaches to take into account these confounders, are to include measures of perceived job characteristics in the analysis of shift work effects³⁸ and/or use job title as a matching variable in the analyses.

We are currently interested in the associations between work schedules and the prevalence of infections. The present study is part of the large scale Maastricht Cohort Study on “Fatigue at Work,” in which work-related and nonwork-related factors as well as the occurrence of common infections were measured on an individual level by means of self-administered questionnaires. The aim of the present study was to investigate whether shift work is associated with a higher prevalence of common infections, such as common cold, flu-like illness, and gastroenteritis compared to day work, with day and shift workers matched on job title. We differentiated day workers from employees working three-shift, five-shift, or irregular-shift systems, while taking into account the role of demographics, health, health behavior, perceived job characteristics, sleep quality, and fatigue.

Methods

Maastricht Cohort Study

At baseline the Maastricht Cohort Study surveyed a large heterogeneous population of employees working in 45 different companies and organizations.^{39,40} Temporary employees, as well as employees with an employment of less than 50%, were excluded. A total of 12,161 employees completed the baseline questionnaire. Written consent was obtained from all participants. The overall response was 45%. Twenty-one questionnaires were discarded because of technical reasons,⁴¹ resulting in a study popu-

lation of 12,140 employees. Included were men and women, aged 18 to 65 years ($n = 12,095$).

The participants of the Maastricht Cohort Study received nine questionnaires at four-monthly intervals, with a total observation period of three years (1998–2001). The results of the present study are based on the first (baseline) questionnaire (May 1998). At baseline, exposures (work-related factors, individual characteristics, domestic and social factors as well as information on job title) and outcomes were measured on an individual level using self-administered questionnaires.

The Study Population

For the present study we further excluded employees with multiple jobs ($n = 497$), since we have no information available on the content and work schedule of the other job. To study the effects of work schedules, employees involved in day work, three-shift, five-shift, or irregular-shift work were selected. All employees involved in other work schedules or those who did not provide information on their work schedule were excluded, resulting in a final study population of 8255 employees.

The questions ‘What is your job in the company/organization?’ and ‘What is your most important task?’ were used to assess an employees’ job title in the current job. The responses to these open-ended questions were used by trained coders to assign a job title, with a five-digit code, based on The Netherlands Standard Classification of Occupations 1992.⁴² From the employees, 88 did not indicate their function or most important task. These employees were excluded from further analyses. At baseline in 1998, the Maastricht Cohort Study captured 687 different job titles. Job title was used to match the employees in the different work schedule groups. For example, employees working three-shift systems were matched with a reference group of day workers with sim-

ilar job titles. For each distinguished job title, there was a minimum of two employees in each work schedule. For the comparison of three-shift workers with day workers, 47 job titles were identified ($n = 753$ for three-shift workers, $n = 1114$ for day workers). Examples of job titles represented in both day work and three-shift systems were: production planner, operator, engine/bench fitter. For comparing five-shift workers and matched day workers, 58 job titles were identified ($n = 947$ for five-shift workers, $n = 1609$ for day workers). Examples of job titles represented in both day work and five-shift systems were: machine operator, controller or tester electric-machinery, maintenance electrician. As regards irregular shift workers and matched day workers, 28 job titles were identified ($n = 329$ for irregular shift workers, $n = 573$ for day workers). Examples of job titles represented in both day work and irregular shift systems were mailman, enrolled nurse, care taker of the mentally handicapped or elderly.

Work Schedules

Regarding work schedules, employees were asked whether they were involved in irregular shifts, two-shift, three-shift, four-shift, or five-shift work, exclusively evening or night work, or whether they worked daytime only. In our study, the term shift work is used for a work schedule that includes night work. In the present study only day workers, three-shift, five-shift or irregular shift workers were included for investigating differences between the schedules. The direction of the shifts (clockwise, counterclockwise) varied between the companies. In the present study three-shift work involves three alternating teams, with a semi-continuous schedule, in which a weekly interruption of the production, mainly in the weekends, takes place. Five-shift work involves full continuous shift work, spread over 7 days including five alternating teams. Concerning working hours a

week, five-shift work generally comprises 33 to 34 hours a week, whereas three-shift work comprises 38 to 40 hours a week. Employees working irregular shifts are involved in frequently deviating work hours, which can vary substantially every week. In the present study for irregular shifts we included only those employees reporting frequent night work within their shift.

Infections

The 4-month prevalence of infections was also determined using self-administered questionnaires. Three common infections: common cold, flu-like illness, and gastroenteritis were inventoried as separate items in the questionnaires asking employees about the occurrence of common infections in the past four months. For clarification, a brief description of the infection was included in the question. This description mainly contained the typical symptoms of the infection. For common cold these symptoms were: clogged or running nose, a sore throat, coughing, and slight or no fever (temperature less than 38°C), for flu-like illness: fever (temperature 38°C or more), with at least four of the following six complaints, muscular pain, fatigue, sore throat, clogged or running nose, coughing, headache. For gastroenteritis these symptoms included: slight or no fever, gastritis, nausea, vomiting, and/or diarrhea.

Work Environment

In this study we included measures regarding the experience of several demands at work. Decision latitude was assessed with the Dutch version of the Job Content Questionnaire using the scale Decision Latitude.^{43,44} The level of psychological job demands was measured with the Dutch version of the Psychological Job Demands scale of the Job Content Questionnaire.^{43,44} The level of emotional demanding work was measured using a five item scale consisting of two items of the Questionnaire Experience and Assessment of Work

(VBBA),⁴⁵ two items of the Questionnaire on Work and Health (VAG)⁴⁶ and one self-formulated item. Physical demands were measured using a dichotomous item of the Dutch questionnaire on Work and Health (VAG).⁴⁶

Demographics and Health Variables

Information on age, gender, the presence of a long-term disease, smoking, and drinking habits, was obtained through self-report in the baseline questionnaire. Information on the quality of sleep was obtained through one item asking employees "Did you sleep well in the past four months?" This item was scored on a four point scale (never, sometimes, usually, always). The Checklist Individual Strength (CIS) was used to measure prolonged fatigue.⁴⁷ The CIS is a 20-item questionnaire developed to measure several aspects of prolonged fatigue. The CIS is a self-report instrument consisting of four factors: subjective experience of fatigue, concentration, motivation, and physical activity level. Higher scores indicate a higher degree of fatigue, more concentration problems, reduced motivation or less activity. A composite CIS-total score, ranging from 20 to 140, can be constructed by adding the individual's scores on the four factors. The Cronbach's alpha of the total scale is 0.93. The cut-off point for case classification used in the present study was CIS total >76. This cut-off point was established in a separate pilot study by means of defined samples with differences in fatigue levels.⁴⁸ All those employees scoring >76 were considered to be probable fatigue cases.⁴¹

Statistical Methods

We calculated crude and adjusted odds ratios (ORs) and 95% confidence intervals (CI) for associations between each of the three common infections (common cold, flu-like illness, and gastroenteritis) and each work schedule. The ORs were ad-

TABLE 1
Descriptive Characteristics Study Population

		Day Work [†]	Three-shift Work	Five-shift Work	Irregular Shift Work
Demographics	N (number of organizations)	5,899 (45)	878 (19)	1,058 (11)	420 (25)
	Gender % female	32.6	11.6***	6.1***	39.5**
	Age mean	42.38	35.72***	37.96***	37.87***
Health behavior	Smoking %	22.5	46.7***	35.3***	37.1***
	Alcohol use % (glasses/wk)		***	*	***
	- none	24.4	37.1	28.8	34.3
	- 1–14	64.2	52.5	59.9	57.6
	- 15–21	8.6	7.1	8.0	5.5
	- ≥22	2.8	3.3	3.3	2.6
	Exercise %		***	**	
Work-related factors	- 0–1 times/wk	30.5	44.1	36.3	32.6
	- 2–7 times/wk	62.4	50.3	57.6	58.1
	- >7 times/wk	7.1	5.5	6.1	9.3
	Physically demanding work %	11.8	51.6***	34.8***	71.9***
	Psychological job demands (12–48) [‡]	32.73	34.69***	32.17**	34.34***
Health	Decision latitude (24–96) [‡]	73.19	64.15***	67.73***	68.79***
	Emotional demands (0–5) [‡]	0.90	1.61***	1.18***	1.93***
	Long-term disease %	24.7	26.2	21.7*	25.7
	Good sleep in past 4 months		***	***	**
	- never	2.5	5.4	2.7	3.4
	- sometimes	12.9	28.5	21.0	19.2
	- usually	56.7	46.8	53.0	52.9
- always	27.9	19.2	23.3	24.5	
Fatigue (CIS > 76) %	20.7	32.2***	25.9***	21.2	

Significant difference with day work: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

[†] Reference group for all three types of shift work.

[‡] Scale range.

justed in several steps for demographics, longstanding disease, health behavior, psychological job demands (continuous variable), decision latitude (continuous variable), emotional demands (continuous variable), physical demands, and fatigue (continuous variable) and sleep quality. Each shift work type (three-shift, five-shift, and irregular-shift work) was compared with a reference group of day workers with respect to the prevalence of common infections. We used a multilevel analysis of a two-level structure, in which the individual employees (level 1) were nested within job titles (level 2). Additionally *t* tests and Chi-square tests were used to test univariate differences between employees in the different shift work types versus day workers. All procedures were performed using SPSS for Windows release 9.0.0, SAS release 8.02, and GLIMMIX, a SAS Macro for the multilevel analyses.

Results

Table 1 shows descriptive characteristics of the study population before matching on job title. The percentage of women involved in three- and five-shift work was significantly lower compared to day work, whereas the percentage of women was significantly higher in irregular shift work compared to day work. Shift workers were on average younger of age compared to day workers. Smoking was significantly more prevalent in shift workers as compared to day workers, with the highest percentage of smokers (46.7%) observed in three-shift workers. Differences in alcohol use were also found between day and shift workers. The highest percentage of employees who reported to exercise never or only once a week was found in three-shift workers. With regard to job characteristics substantial differences emerged be-

tween day and shift workers. For example, the percentage of employees reporting their work to be physically demanding was substantially and significantly higher in all types of shift work compared to day work. Overall, the prevalence of employees reporting a long-term disease did not substantially differ between the work schedules, although the prevalence of a long-term disease was somewhat lower in five-shift work ($P < 0.05$) compared to day work. We found significant differences in sleep quality between employees in shift work and day work. Three-shift workers reported the highest percentage of poor sleep quality in the past 4 months. Compared to day work, the prevalence of fatigue was substantially higher in most shift work groups, with three-shift workers reporting the highest prevalence (32.2%).

Table 2 shows the prevalence at baseline of common infections

TABLE 2
Prevalence of Common Infections Among Different Work Schedules

	Day Work	Three-shift Work	Five-shift Work	Irregular Shift Work
N (number of organizations)	5,899 (45)	878 (19)	1,058 (11)	420 (25)
Common cold %	53.0	57.5*	51.0	55.5
Flu-like illness %	22.4	31.2***	22.1	30.5***
Gastroenteritis %	11.8	18.2***	15.4**	15.1*

Significant difference with day work: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

TABLE 3
Odds Ratios and 95% Confidence Intervals for Common Infections by Shift Type Multilevel GLIMMIX Models

	OR	95% CI	OR*	95% CI	OR†	95% CI	OR‡	95% CI	OR§	95% CI
Common cold										
3-shift work	1.42	1.14–1.76	1.16	0.91–1.48	1.14	0.88–1.46	1.03	0.78–1.35	1.03	0.78–1.36
5-shift work	1.00	0.85–1.19	0.83	0.69–0.99	0.79	0.66–0.95	0.77	0.63–0.95	0.79	0.64–0.98
Irregular shift work	1.09	0.83–1.44	1.02	0.76–1.37	1.01	0.75–1.36	0.92	0.66–1.27	0.95	0.68–1.32
Flu-like illness										
3-shift work	1.72	1.34–2.20	1.52	1.16–2.00	1.41	1.07–1.87	1.23	0.90–1.68	1.23	0.90–1.70
5-shift work	1.06	0.84–1.34	0.92	0.72–1.17	0.88	0.69–1.12	0.82	0.64–1.06	0.82	0.63–1.07
Irregular shift work	1.51	1.11–2.05	1.40	1.01–1.95	1.39	0.96–1.94	1.52	1.06–2.18	1.63	1.13–2.36
Gastroenteritis										
3-shift work	1.83	1.40–2.38	1.25	0.92–1.70	1.15	0.84–1.59	1.05	0.73–1.51	1.06	0.73–1.54
5-shift work	1.64	1.29–2.08	1.39	1.08–1.80	1.34	1.03–1.74	1.38	1.03–1.85	1.42	1.05–1.91
Irregular shift work	1.40	0.95–2.06	1.28	0.85–1.93	1.22	0.80–1.86	1.15	0.73–1.81	1.17	0.73–1.88

For every shift type, the reference group consisted of employees in day work with comparable occupations.

* Corrected for age, gender, longstanding disease.

† Additionally corrected for smoking, drinking habits and exercise.

‡ Additionally corrected for psychological job demands, decision latitude, physical demands, and emotional demands.

§ Additionally corrected for sleep quality and fatigue.

among employees working in different work schedules. The occurrence of common cold is highest among three-shift workers (57.5%) and irregular shift workers (55.5%). Flu-like illness is also most frequently reported by three-shift workers (31.2%) and irregular shift workers (30.5%). Finally, the highest prevalence for gastroenteritis was found among three-shift workers (18.2%).

Because of the large differences observed between day and shift workers with regard to the perceived work-related demands, job title was used as a matching variable in multilevel analysis. Table 3 shows the ORs for the three distinguished common infections by shift type, using multilevel GLIMMIX models in which the individual employees were nested within job titles. Three-shift work was significantly associated with all three common infections (OR 1.42; CI 1.14–1.76 for common

cold, OR 1.72; CI 1.34–2.20 for flu-like illness, OR 1.83; CI 1.40–2.38 for gastroenteritis). In general, for irregular shift workers similar but lower associations were observed. Five-shift work was only significantly associated with gastroenteritis (OR 1.64; CI 1.29–2.08). No significant differences were found for the prevalence of common cold and flu-like illness, when comparing five-shift workers with day workers. Adjusting for demographics and health factors (age, gender and long-term disease) and for health behavior (smoking, drinking habits, and exercise) resulted in weaker associations for all work schedules, except for the association between five-shift work and common cold. Compared to day work, five-shift work was then associated with a lower risk for common cold (OR 0.79; CI 0.66–0.95). Subsequently, the ORs for common infections were additionally adjusted

for several work-related demands, which resulted in changes of the ORs for the association between work schedules and common infections as well. Most ORs decreased, whereas the OR regarding the association between irregular shift work and flu-like illness increased (OR 1.52; CI 1.06–2.18). Also, the OR for the association between five-shift work and gastroenteritis increased (OR 1.38; CI 1.03–1.85). In the final analyses, the ORs were additionally adjusted for sleep quality and fatigue levels, which resulted in only slight changes of the ORs for all three common infections. Statistically significant ORs remained for the associations between five-shift work and common cold (OR 0.79 CI; 0.64–0.98); five-shift work and gastroenteritis (OR 1.42 CI 1.05–1.91), and irregular shift work and flu-like illness (OR 1.63; CI 1.13–2.36).

Finally, to study the role of fatigue and sleep quality in the relationship between work schedules and common infections separately, we conducted an additional analysis, in which we adjusted the ORs only for demographics, the presence of a longstanding disease, fatigue and sleep quality. These analyses (specific data not shown) revealed that sleep quality and fatigue influenced the strength of the associations as well, although in general to a lesser extent as compared to the effect of perceived job demands.

Discussion

In this study we found that the prevalence of three common infections (common cold, flu-like illness, and gastroenteritis) differed significantly between employees involved in different work schedules. Three-shift workers reported the highest prevalence for all three infections. Taking into account the high prevalence of common infections and the fact that work schedules are not the primary 'etiological agent', the observed associations are quite large, moreover when considering the loss of productive work hours when infections result in employee absenteeism.

Because differences in work-related factors are often large between day and shift workers, in this study job title was used as a matching variable. Employees with similar job titles in different work schedules were matched to account for differences in the work-environment. The crude ORs in the multilevel analyses revealed that shift work was clearly associated with a higher odds of common infections compared to day work. Three-shift work was strongly associated with all three infections. Compared to five-shift workers, three-shift workers have a working week comprising more hours. In addition, three-shift workers generally only have two (weekend) days available to recuperate before they switch to a new shift cycle. Others have observed that recovery from a shift

did not occur by the end of the first rest day but might have occurred only by the end of the second rest day.⁴⁹ The traditional weekly change of shifts, as for example seen in three-shift work, is often reported to be the worst solution.^{50,51}

To elucidate possible underlying mechanisms relating work schedules to common infections, we adjusted in several steps consecutively for demographics, health, health behavior, job characteristics, sleep quality and fatigue. Adjustments for demographics, health status and health behavior resulted in lower odds for the association between work schedules and infections. This emphasizes the importance of correction for the above mentioned factors, since they are related both to infections and work schedules.

Subsequently, we corrected for several work-related demands. Although job title was used as a matching variable to take into account possible differences in demands, we still observed a change in the association between work schedules and infections after adjustment for work-related demands. Though the day and shift workers were in comparable job titles, there were still differences with regard to the perceived demands of the individual worker. Compared to day workers, shift workers may perceive these job characteristics as more demanding possibly since they are fighting their sleep. Another possibility is that job demands in similar jobs actually are more demanding, when performed in shift work. We are aware that adjustment for job characteristics may constitute over control and thus could lead to underestimation of risks, because these job characteristics may be part of the causal pathway linking work schedules to common infections. Therefore, we assume that the relatively crude results, only adjusted for age, gender and long-term disease, are more likely to represent the actual effect of shift work on the prevalence of common infections. The analyses with adjustments for

job characteristics, however, provided important additional information to disentangle possible mechanisms linking work schedules to common infections. This is in line with other studies showing an association between work-related stressors and immune function.^{9-11,52,53}

Further, evidence supports the view that lack of sleep lowers resistance to infection and that during periods of sleep deprivation, respiratory tract infections occur more frequently.²⁸ Shift work has been clearly related to disturbed sleep.^{15,54} First, their unusual work hours prevent shift workers from sleeping at the normal time. Second, when shift workers do have an opportunity to sleep, they have to do so in an environment that is geared toward the awakened state. Third, night work and day sleep affect the circadian rhythm.⁵⁵ In a study by Härmä et al,¹⁵ for example, sleep complaints were more common in two- and three-shift workers as well as in irregular shift workers compared to day workers. In our study, shift work was also associated with poorer quality of sleep. In addition, shift workers had a significantly higher prevalence of fatigue. Higher fatigue levels are related to common infections as well.³¹ When controlling for sleep quality and fatigue levels, only minor changes appeared in the association between work schedules and common infections. A possible explanation for these small effects could be that perceived work demands next to sleep quality and fatigue, play a dominant role in the mechanism to explain the association between work schedules and common infections. Thus, because we corrected for perceived demands in our analysis before we corrected in the last step for sleep quality and fatigue, a large part of the association may already have been explained by the level of perceived work demands. Additional analyses in which we corrected for fatigue and sleep quality, but not for work demands, resulted in general in a decrease of the associa-

tion between work schedules and common infections. These changes were smaller as compared to the effects of adjusting for work-related demands. Because perceived work demands are related to fatigue in other studies,⁵⁶ we feel that sleep disturbances and fatigue could constitute another pathway linking work schedules to common infections. Because sleep deprivation may result in increased susceptibility, shift workers may experience more infections compared to day-workers. Altered light-dark cycles, which occur during shift work, are associated with disruptions of normal sleep patterns.⁵⁷ Common perceptions that lack of sleep lowers resistance to infections and that infections develop during or after periods of sleep loss suggest that sleep deprivation is likely to impair immune function.⁵⁸ Disorganization or disturbance of the sleep-wake system interferes with the immunological, neuroendocrine, and thermal systems and contributes to pathological processes. Disruption of these systems is evident in diseases, such as infections.⁵⁹

The data presented in the study have been collected in a large-scale cohort study among employees from 45 different companies. Despite the almost inevitable shortcoming of large cohort studies using questionnaires,¹¹ this study gave us the opportunity to study the relationship between common infections and different types of work schedules in a nonexperimental setting with participants observed in a natural environment with all the normal every day hassles. The items in the questionnaire concerning the common infections cover representative symptoms for common cold, flu-like illness and gastroenteritis. However, self-reports of gastroenteritis may also include reports of gastrointestinal disturbances in addition to actual infections, which are common complaints among shift workers. We are aware of the fact that self-reported illnesses may lead to under or over reporting. A study on the comparison between

self-assessed and observer-assessed presence of colds, however, has demonstrated strong convergence between self-assessments of colds and physician ratings.⁶⁰ With regard to work schedules, selection into shift work and outflow of less healthy shift workers moving from shift to daytime work might lead to an underestimation of the effects of shift work.^{19,23}

Future studies could aim at the incidence of common infections among employees in different work schedules. Furthermore, it might be relevant to study effects of the direction of shift rotation in relation to the occurrence of infections, because it is argued that systems with a forward rotation may result in fewer problems for the shift worker than systems with a backward rotation.⁶¹ A forward rotating system is considered to be healthier because in the absence of external cues the sleep-wake and other circadian rhythms run with a period of approximately 25 hours so sleep occurs later and later.^{61,62}

In summary, the present study showed that shift work is associated with a higher prevalence of common cold, flu-like illness, and gastroenteritis compared to day work. Shift work was further associated with differences in health, health behavior, sleep, fatigue and perceived job characteristics, which constitute factors that should be taken into account in future studies examining the relationship between work schedules and health outcomes. More insight in these factors can be a starting point for interventions, when it is not feasible to change work schedules.

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