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The mutual relationship between shift work and depressive complaints – a prospective cohort study

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Objective The aim of this study was to examine the mutual relationship between shift work and depressive complaints longitudinally.

Methods Data from the ongoing Maastricht cohort study (1998–2008) were used. Firstly, the impact of shift work on the development of depressive complaints, defined as depressed mood, was studied. Both prospective and retrospective approaches were used, conducting, respectively, survival and logistic regression analyses, correcting for possible confounding factors. Secondly, the impact of depressed mood on changes in shift work at one-year follow-up was studied. All analyses were stratified for men and women and, where possible, for age (<45 versus ≥45 years).

Results Overall, the impact of shift work on the development of depressed mood over a ten-year period was rather small, although, male shift workers ≥45 years did contribute to a higher risk of developing depressed mood [hazard risk (HR) 1.37, 95% confidence interval (95% CI) 1.01–1.86]. Retrospective analyses found higher odds of depressed mood and depressive disorder among former or current male shift workers than “never shift workers” [odds ratio (OR) 1.39, 95% CI 1.09–1.79 and OR 1.79, 95% CI 1.32–2.42, respectively]. Results lacked significance when correcting for demographic and work-related factors. Analyses studying the impact of depressed mood on changes in work schedules showed that the risk to change from shift to day work or from shift work to sick leave was higher when depressed mood was reported at baseline [relative risk (RR) shift to day work 1.98, 95% CI 1.13–3.47; RR shift work to sick leave 2.96, 95% CI 2.00–4.29].

Conclusions Although shift work did not have a large impact on the development of depressed mood, results might be underestimated due to selection processes and possibly overcorrection.

Key terms cohort study; epidemiology; irregular work hour; mental health.

Many work situations require flexibility in working time arrangements because of technical and organizational innovations and high employer demands (1). Shift work is an important part of organizing the working time to meet these demands and has increased substantially during the last decades (2), with prevalences reaching more than 35% in certain sectors of the labor market (3). While shift work contributes to economic development, the shift worker him- or herself does not always benefit from it. Shift work has been frequently studied in association with several health outcomes, such as cardiovascular (4, 5) and gastrointestinal (6) diseases and fatigue (7). However, few studies have focused on the impact of shift work on the development of mental health problems in

general and depressive complaints in particular. Previous studies have shown that mild depressive complaints are frequently reported in an active working population, with prevalences ranging from 15.8–22.4% (8), and impairment and disability significantly increase with increasing severity of the depressive disorder (9, 10). Additionally, subjects with symptoms of a depressive disorder or mild depressive complaints face a higher risk of developing a depressive disorder compared to those without such symptoms (11, 12). Depressive disorder is one of the most common disorders in the working population and contributes most to the rise in long-term sickness absence and work disability (13, 14), which is associated with high costs for society (15, 16).

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In a review, it was shown that shift work is often associated with a disturbance of the 24-hour circadian rhythm, which includes amongst others the sleep–wake cycle (17). Among shift workers who regularly work at night, there is a conflict between the day-oriented circadian physiology and the requirement for work and sleep at the “wrong” biological time of the day (18). This is associated with sleep loss and a decreased sleep quality (19–22), which may lead to an increased risk of developing depressive disorders (16). Furthermore, shift work is associated with disruptions in social and domestic role patterns (23). Working in shifts is known to hamper social life and leisure time activities, because employees working in shifts are working at irregular times of the day and therefore often have time off when others are working. This may lead to a lack of social support, which is an important risk factor for depressive disorder (24, 25).

Despite the number of studies that point to a relationship between shift work and depressive complaints, there is limited evidence available to demonstrate this. One study has shown that shift workers experience depressive complaints to different degrees of severity, but this study was cross-sectional and did not include non-shift worker controls (26). A longitudinal study also found a differential impact on mental health with different types of shift work, varying according to gender (27). However, this study neither gathered information on other work-related factors nor differentiated between depressive and anxiety disorders.

If we want to investigate whether shift workers form a group at high risk to develop depressive complaints, the influence of possible confounding factors (for example, psychosocial work-related factors) and effect-modifiers (for example, gender/sex, age) need to be taken into account. Previous studies have shown that depressive complaints are associated with job characteristics, such as psychological job demands, decision latitude, and emotional and physical demands (8, 28). Moreover, job characteristics often differ between shift- and day workers (29). Additionally, the relationship between shift work and depressive complaints may differ between men and women because they have different roles in family life and society, and therefore occupy different types of work (30, 31), which may have a differential impact on depressive complaints. Furthermore, women can be more vulnerable to the adverse effects of shift work due to their more complex circadian and hormonal rhythms (32).

Because higher levels of depressive complaints are associated with long-term sickness absence and work disability (13, 14), it is likely that employees who are still active at work will rather be in the preliminary stage of depressive disorder. Depressed mood is often described as one of the core symptoms of depressive disorders when it

is clinically diagnosed (33). Previous research has found evidence that subjects with a depressed mood carry a higher risk to develop a depressive disorder compared to those without (Driesen K, Van Amelsvoort LG, Jansen N, Mohren D, Kant I. Value of a depressed mood question to study depressive complaints in a working population: cross-sectional and longitudinal associations. Revised and resubmitted on 28/03/2011 to Int Arch Occup Environ Health). As such, in order to prevent a depressive disorder from developing in an active working population, a selective preventive approach is important. This means that the focus must be on investigating groups at high risk for developing a depressive disorder, particularly employees with depressive complaints that are present in neither sufficient number nor severity to qualify (yet) as a depressive disorder (ie, depressed mood). In a cross-sectional study, an association was found between working in shifts and depressed mood (34). To our knowledge, prospective studies on the association between shift work and depressive complaints, particularly depressed mood, are non-existent.

Studying the relationship between shift work and depressed mood is rather complex because one feature of epidemiologic studies in a working population is the lower morbidity rate accompanying several disorders as compared to the morbidity rate in the general population. This is called the “healthy worker effect” and can be explained by selection processes that might bias the results (35). A distinction can be made between primary selection processes, which involve anticipating an event, and secondary selection processes, which involve changes in the work situation after an event has occurred (36). The healthy worker effect may occur when for example, only fit and healthy employees start working in shifts (primary selection process). The healthy worker effect may also be the consequence of secondary selection processes. Research has found evidence that employees who leave shift work are significantly less healthy than those who remain in it (37). In both cases, it is possible that studies investigating shift workers may be sampling a self-selected and robust group of subjects who are either more able or determined to adapt to shift work (37) or more able to manage the adverse effects that accompany such work. Therefore, an important part of our study is the investigation of a possible mutual relationship between shift work and adverse health effects, such as depressed mood.

In this study, we hypothesized that there is a mutual relationship between shift work and depressive complaints. Firstly, we examined whether shift work is a risk factor for developing depressed mood. This was studied both prospectively and retrospectively. Using the prospective approach, it is assumed that shift workers have a higher risk to develop depressed mood over time than day workers. Using the retrospective approach, we examined whether former or current shift work

employees have a higher probability to report depressed mood than employees who have never worked in shifts. Secondly, we hypothesized that depressed mood is a risk factor for changes in the shift work schedule: it is assumed that employees with depressed mood at baseline have a higher risk to change their work schedule than to remain in the shift work schedule.

The aim of this study was to examine the mutual relationship between shift work and depressed mood and between shift work and depressive disorder over time, including day workers as controls, separately for men and women, stratifying for age, while controlling for a range of possible confounding factors in different time windows.

Methods

Study population

Data were used from the ongoing Maastricht cohort study, which had several follow-up measurements after the baseline measurement in 1998 (36). The last follow-up questionnaire to date was sent out in 2008. The study surveys a large heterogeneous population of men and women working in different sectors and trades. The baseline population consisted of >12 000 employees from 45 different companies and organizations. In the prospective approach, we used baseline data and data from 1-, 2-, and 10-year follow-up measurements because only at these time-points the questionnaires contained data on

both shift work and depressed mood. In the retrospective approach, information about shift work was gathered from the whole study period between 1998–2008. Depressed mood and depressive disorder were assessed in 2008. To study the mutual relationship between shift work and depressed mood, the latter was measured at baseline (1998) and a change in shift work was measured between baseline and 1-year follow-up. All questionnaires contained items which inventoried information on demographic and work-related factors that might be important confounders or effect-modifiers. Detailed information on the design and demographic and work-related factors has been reported elsewhere (36).

From the Maastricht cohort, we selected different sub-samples due to the different approaches necessary to answer the various research questions. In our study, participants were excluded when they: (i) were working <26 hours a week (to establish more comparable working hours between day and shift workers) (N=1 510); (ii) had multiple jobs (because information about the work characteristics of the other job(s) was lacking) (N=338); (iii) were pregnant or on pregnancy leave during baseline and/or on one of the follow-up moments (as the focus was not on pregnancy-related mental health problems) (N=189); (iv) had been absent from work at baseline for >4 weeks or when they only partially resumed work (N=342); and (v) were working in a shift work schedule, without working regularly at night (N=825). This resulted in a baseline population of 8890 employees, including 6438 day workers and 2452 shift workers working at night regularly. Table 1 shows descriptive characteristics of the study population at baseline. There were significant

Table 1. Descriptive characteristics of the study population at baseline [SD=standard deviation; DW=day work; SW=shift work].

Variable	Day work (N=6438)			Shift work including nights (N=2452)			P-value (DW versus SW)
	%	Mean	SD	%	Mean	SD	
Demographic characteristics							
Gender (male)	82.0			89.7			<0.001
Age		42.7	8.7		37.5	8.6	<0.001
Highest educational level							
Low	10.9			41.1			<0.001
Medium	39.4			53.2			
High	49.1			5.7			
Living alone	11.7			10.4			0.077
Work characteristics							
Psychological job demands (12–48) ^a		33.4	5.6		33.4	6.0	0.840
Decision latitude (24–96) ^a		74.7	10.2		66.8	12.5	<0.001
Emotional demands (0–5) ^a		0.9	1.2		1.5	1.4	<0.001
Co-worker social support (4–16) ^a		11.8	1.5		11.8	1.8	0.571
Supervisor social support (4–16) ^a		10.6	2.2		9.9	2.6	<0.001
Physical demands	12.0			47.6			<0.001
Health status							
Long-term illness	21.3			21.4			0.931
Depressed mood	6.8			11.6			<0.001

^a Scale range

differences in demographic characteristics (age, education and gender), work-related characteristics (decision latitude, emotional demands and physical demands), and depressed mood between shift workers and day workers.

Additional selections were made in the prospective approach. To investigate the impact of shift work on the development of depressed mood, participants were excluded when they reported depressed mood at baseline (N=795), because in this part of the study, the object was to investigate incident depressed mood cases only. After applying these exclusion criteria, the study population consisted of 8178 employees.

The relationship between shift work and depressed mood was also investigated retrospectively. In the retrospective approach, all employees completing the 10-year follow-up questionnaire (N=6073) were included to investigate if depressed mood was more prevalent among employees "who had ever worked in shifts" compared with those "who had never worked in shifts". The 10-year follow-up questionnaire also contained items that made it possible to investigate shift work in relation to depressive disorder.

Measures

Working time arrangements. In our study, shift work captured different types of shift work schedules (ie, 2-, 3-, 4-, and 5-shift and irregular shift work) including working at night regularly. Day work was defined as normal working hours between 07:00–19:00 hours. The distribution of participants in the Maastricht cohort study according to different sectors and trades is described elsewhere (36). As a rule, shift workers alternate between morning, evening, and night shifts. The precise start and end times of the different shifts varied between the participating companies. However, in the Netherlands, the start of a morning shift generally is between 06:00–08:00 hours, evening shifts begin between 14:00–16:00 hours, and night shifts commence between 22:00–24:00 hours (38). Employees working irregular shifts are involved in frequently deviating work hours, which can vary substantially every week. Shift work schedules were characterized by forward- and backward-rotating schemes with different speeds of rotation.

Changes in work schedules were defined as: (i) a change from shift to day work, (ii) a change from shift work including frequent night work, to shift work without frequent night work, and (iii) a change from shift work to sick leave.

Depressed mood and depressive disorder. Depressed mood was assessed using a single, dichotomous question formulated by a trained psychiatrist: "Did you feel down every day over the last two weeks?" This item has been previously applied in a work setting (34). Using the retrospective approach, it was also possible to study depressive

disorder with items derived from the World Health Organization's health and work performance questionnaire (HPQ) (39). The HPQ is a self-report instrument designed to estimate the workplace costs of health problems in terms of reduced job performance, sickness absence, and work-related accident injuries. In our study, this checklist was used to inventory whether a chronic condition such as a depressive disorder is present and being treated (yes/no). Respondents were classified as a case if they confirmed that they had a depressive disorder, were currently being treated or had been treated in the past.

Statistical analysis

One-way analysis of variance (ANOVA) and chi-square tests were used for cross-sectional analyses. In the prospective approach, survival analyses using Cox regression were performed to examine the role of shift work, measured at baseline (time 0, 1998) in the onset of depressed mood over a time period of 10 years, while taking possible confounding factors into account. In a first step, crude hazard risks (HR) with 95% confidence intervals (95% CI) were calculated. In a second step, adjustments were made for demographic factors (educational level and living alone). The third step additionally adjusted for work-related characteristics (ie, decision latitude, co-worker and supervisor social support, physical and emotional demands and psychological job demands).

In the retrospective approach, logistic regression analyses were performed to investigate whether the odds of depressed mood and depressive disorder (measured in 2008, 10-year follow-up) were higher among employees who reported working in a shift work schedule at a certain point in time between 1998–2008 than those who reported never having worked shifts during this period. In a first step, crude odds ratios (OR) with 95% CI were calculated and in a second step corrections were made for age and educational level.

To estimate whether depressed mood was a predictor for transitions in the shift work schedule, relative risks (RR) with 95% CI were calculated. Depressed mood was measured at baseline and a change in shift work was measured between baseline and 1-year follow-up, and between baseline and 2-year follow-up.

All analyses were stratified for men and women and, where possible, for age (<45 versus ≥45 years) (40). All data were analyzed using SPSS 15.0 (SPSS Inc, Chicago, IL, USA).

Results

Table 2 shows the overall HR of developing depressed mood over a time period of 10 years when shift work

employees were compared with day workers at baseline. The results show that men working in shifts had a significantly higher risk of developing depressed mood at follow up than male day workers, especially ≥ 45 -year-old male shift workers (HR 1.37, 95% CI 1.01–1.86, uncorrected model). However, the risks for developing depressed mood among shift workers decreased and lacked significance when adjusting for potential confounding factors. Young (<45 years), male shift workers even had a significant decreased risk for the development of depressed mood compared to young, male day workers when adjusting for a range of potential confounding factors (HR 0.69, 95% CI 0.52–0.92). In addition, among shift working women, there was a (non-significant) tendency towards a systematically lower HR for developing depressed mood compared to women in day work.

The RR of depressed mood at each follow-up measurement were also calculated. Results show that the RR of developing depressed mood was highest at 10-year follow up (2008) among men working in shifts at baseline [RR (10-year follow-up) 1.69, 95% CI 1.16–2.45; RR (1-year follow-up) 1.19, 95% CI 0.94–1.52; RR (2-year follow-up) 1.12, 95% CI 0.83–1.52].

As shown in table 3, employees formerly or currently working in shifts have significantly higher odds of experiencing depressed mood and/or depressive disorder (measured at 10-year follow-up in 2008) than employees

who never worked in shifts. These increased odds were found among both male and female employees. After applying correction steps, the OR decreased and became non-significant.

The results in table 4 show that employees experiencing depressed mood at baseline measurement have a higher probability to change from shift to day work or from shift work to sick leave at 1-year follow-up measurement.

Discussion

This study contributes to a still-limited research area investigating the relationship between shift work and mental health. It studies the mutual relationship between shift work and depressive complaints, particularly depressed mood. Firstly, shift work was studied as a possible risk factor for the development of depressed mood and depressive disorder. Secondly, the impact of depressed mood on changes in the work schedule was studied as selection processes might have biased the results.

The strengths of this study include the large heterogeneous working population, the long-term follow-up, the frequent measurements during this follow-up period,

Table 2. Prospective approach: shift work as a risk factor for the development of incident depressed mood cases over time [IDMC= Incident depressed mood cases; HR=hazard ratio; 95% CI=95% confidence interval; **bold** denotes significance.]

	Day work [reference (ref)]				Shift work							
	IDMC	N	HR ^{a b c}	95% CI	IDMC	N	HR ^a	95% CI	HR ^b	95% CI	HR ^c	95% CI
Women (total)	124	1059	1.00	ref	14	216	0.67	0.35–1.28	0.75	0.39–1.46	0.60	0.30–1.20
Men (total)	440	4947	1.00	ref	181	1944	1.22	1.02–1.46	1.05	0.84–1.30	0.86	0.69–1.08
Men <45 years	218	2587	1.00	ref	125	1486	1.16	0.92–1.47	0.83	0.63–1.09	0.69	0.52–0.92
Men ≥ 45 years	222	2359	1.00	ref	56	470	1.37	1.01–1.86	1.33	0.95–1.86	1.11	0.78–1.75

^a Crude HR.

^b HR corrected for demographic factors: education, living alone.

^c HR corrected for demographic factors + psychosocial work-related factors: decision latitude, social support supervisors, social support coworkers, psychological job demands, emotional job demands, physical demanding work.

Table 3. Odds ratio (OR) for depressed mood and depressive disorder among former or/and current shift workers versus never shift workers. [95% CI=95% confidence interval; ref=reference.]

Former or current shift work	N	Depressed mood					Depressive disorder				
		N	OR ^a	95% CI	OR ^b	95% CI	N	OR ^a	95% CI	OR ^b	95% CI
Men	4474	321				194					
Day work	3335		1.00	ref	1.00	ref	1.00	ref	1.00	ref	
Shift work with night	1139		1.39	1.09–1.79	1.02	0.76–1.36	1.79	1.32–2.42	1.16	0.81–1.65	
Women	1569	127				121					
Day work	1225		1.00	ref	1.00	ref	1.00	ref	1.00	ref	
Shift work with night	334		1.69	1.12–2.54	1.51	0.98–2.34	1.70	1.12–2.58	1.63	1.05–2.55	

^a Crude OR.

^b OR corrected for demographic factors: age, education.

Table 4. Probability of changes in shift work schedule 1 year after reporting depressed mood. [RR=risk ratio; 95% CI=95% confidence interval; → denotes “change to”; ref=reference; **bold** denotes significance.]

Work schedule time 0 → 1 year follow up	Total	Depressed mood cases	RR	95% CI
Women				
Shift → Shift	141	20	1.00	ref
Shift → Day	11	5	3.20	1.49–6.88
Shift → Sick leave	47	9	1.35	0.66–2.76
Shift → Shift, without night	8	0		No cases
Men				
Shift → Shift	1362	124	1.00	ref
Shift → Day	61	11	1.98	1.13–3.47
Shift → Sick leave	90	24	2.96	2.00–4.29
Shift → Shift, without night	119	17	1.57	0.98–2.51

and the assessment of both depressive complaints (ie, depressed mood) as well as depressive disorder.

The majority of studies examining the relationship between shift work and health have focused on health outcomes other than depressive complaints (4, 6, 41, 42), and are based on cross-sectional study designs (43). Consequently, no causal conclusions can be drawn. The few longitudinal studies that have investigated the relationship between working in shifts and mental health did not, however, focus on depressive complaints (7, 37, 44). These studies pointed towards a direction of a poorer mental health among shift compared to day workers, which is in line with results from our study findings regarding male shift workers ≥ 45 years having a higher risk to develop depressed mood than male day workers in the same age category (in an uncorrected model). In the literature, one longitudinal study was found that investigated the impact of shift work on the development of depressive disorder (26). In that study, results showed that men who undertake night work for >4 years have an increased risk of reporting anxiety/depressive disorder (OR 6.08, 95% CI 2.06–17.92). Although our study found a higher odds for depressed mood as well as for depressive disorder (measured in 2008) among former/current shift workers (measured between 1998–2008), there was no detailed information on the years of experience in shift work, which makes it difficult to compare these results with the study conducted by Bara & Arber (27). Still, it is important to take shift work experience into account when studying the impact of shift work on health because results from previous studies found stronger associations between shift work and adverse health effects when a change in the shift work schedule took place than when the schedule did not change (7, 37, 44). Although the HR in our study showed that the impact of shift work on the development of depressed mood over time was rather small, the crude RR estimates for developing depressed mood in shift work (at 1-, 2- and 10-year follow-up) showed that the risk was highest at the 10-year follow up measurement (RR 1.69, 95% CI

1.16–2.45). These results indicate that the impact of shift work on the development of depressed mood increases rather slowly over time. This is contrary to the findings of previous studies that indicated a quick increase in fatigue (7) and poorer psychological well-being (37) after starting to work in a shift work job, but also a fast decrease of the fatigue level and a better level of psychological well-being (similar to the baseline level) over time (after some shift work experience).

The results from the prospective analyses were confirmed when analyzing the data with a retrospective study design. Using the retrospective approach, it was feasible to investigate the association between shift work and depressive disorder. Results from the uncorrected model showed that the odds of a depressive disorder was higher among employees formerly or currently working in shifts than employees who never worked in shifts (between 1998–2008). In the retrospective study design, no correction for work-related characteristics was applied because it was theoretically assumed that current psychosocial work-related factors (measured at 10-year follow-up) were probably not associated with former shift work.

It should be mentioned, however, that there was no restriction formulated regarding the minimum duration of shift work experience in the operationalization of former/current shift workers. It is possible that the sample of former/current shift workers included employees with a minimal exposure, which in turn may reduce the sensitivity of the comparison with day workers.

Although both approaches showed an impact of shift work on depressed mood among male employees in an uncorrected model, after adjusting for demographic factors and work-related factors, all risks estimates decreased for shift work employees. Findings from shift work studies may be distorted if the sample includes a variety of occupational groups (which is the case in our study) and the effects of job differences are not controlled for in the analysis (45). Because psychosocial work-related factors were measured in the current study, it was possible to control for some of the possible

job differences that probably exist between the different occupational groups. However, work schedules are closely interrelated with certain psychosocial work-related factors (43). This indicates that shift work might even act as a proxy for actual differences in work characteristics between shift and day workers. In this study, correcting for these work characteristics might have led to an adjustment for the work schedule itself. Furthermore, it is possible that shift workers perceive their work as more demanding as compared to day workers. This points towards a direction that psychosocial work-related factors also might act as intermediary factors. As such, adjusting for these work characteristics might have resulted in an over-correction and an underestimation of the impact of shift work on depressed mood.

Another explanation for the rather low association between shift work and the development of depressed mood, is the possibility that a healthy worker effect has biased the results. To figure this out, the impact of depressed mood on changes in the work schedule was studied. Results showed that employees experiencing depressed mood at the baseline measurement were at a higher risk for changing from shift to day work or from shift work to sick leave at 1-year follow-up measurement. This is in line with research conducted by de Raeye et al (46) who found that a deterioration in mental health was associated with subsequent change in working time arrangements. This indicates that only employees who are able to withstand the negative effects that accompany shift work, in terms of depressed mood, remain in shift work. This also means that employees, who are unable to deal with the adverse effects of shift work, might change their work situation. Because employees change their work situation rather fast after experiencing depressed mood (1-year follow-up measurement in the current study), these results indicate that selection effects might have already taken place before the first measurement moment in the current study. The mean age of the study population at baseline was 41 years. In this respect, participants had a certain employment history at baseline and may have already adapted to their work schedule before the start of the Maastricht cohort study. Hence, cohort participants still working in shifts might be shift work “survivors”. Therefore, the results from the prospective analyses that investigated the impact of shift work on the development of depressed mood may be underestimated. It is also possible that primary selection processes have led to an underestimation of the current results if employees decided to start working in shifts based on their estimation of the ability to withstand adverse effects of shift work. As such, it is possible that they differ in terms of health (ie, depressed mood) from those choosing not to start working in shifts (47). However, there is no empirical evidence available to support the proposition that primary selection processes took place. In the future, research on

selection into shift work and day work is needed.

Although the risk to develop depressed mood increased between 1- and 10-year follow-up, it was not possible to investigate if there was a linear trend in the course of depressed mood, because no information on depressed mood was available between the 2- and 10-year follow-up measurement. Results from a previous study indicated that depressed mood on average lasts for one year and almost two months, which is an estimate for the stability of depressed mood when present (34). Furthermore, depressed mood was measured with a dichotomous item, which makes it unfeasible to account for possible mood changes. To be able to measure a change in depressed mood, very strict selection criteria at baseline were formulated regarding psychological health problems. Employees were excluded when they reported (i) depressed mood at baseline, (ii) ill due to depressive complaints, and (iii) experiencing overall psychological health problems. By doing so, it was very unlikely that employees with depressive complaints participated at baseline. Hence, it was possible to investigate the causality between shift work as the risk factor and the development of a depressed mood as a consequence. Furthermore, because the focus was on the risk to develop depressed mood, it was possible to detect high risk groups regarding the development of a complete depressive disorder. Previous research found evidence for the value of the depressed mood question, used in this study, to predict a depressive disorder to develop (Driesen K et al, submitted manuscript). In future research, it would be interesting to focus on other depressive complaints as a consequence of shift work, associated with a higher risk to develop a depressive disorder (for example, loss of interest, loss of energy, insomnia, and concentration problems, all of which are also symptoms of a depressive disorder) (33).

Because differences in the characteristics of the shift work exposure were not taken into account, no conclusions could be drawn regarding, for example, the type of shift work schedule, the rotating scheme, the speed of rotation, and the association with the development of depressed mood. Previous research has found evidence that a backward-rotating schedule was prospectively related to an increased need for recovery and poor general health as compared to employees in a forward-rotating schedule. Furthermore, a forward-rotating schedule was prospectively related to less work–family conflict and better sleep quality over the follow-up period (38). Another prospective study investigating the impact of shift work on fatigue found that the fatigue levels among employees fatigued at baseline, decreased significantly faster over time among 5-shift compared to day workers, while there was no significant difference in change of fatigue levels over time between day and 3-shift worker who were fatigued at baseline (7). In future research, it would be interesting to investigate specific aspects of

shift work, such as rotation schemes and different types of shift work in relation to the development of depressive complaints, such as depressed mood.

To our knowledge, this is the first study to investigate the longitudinal relationship between shift work and depressive complaints, particularly depressed mood. Results showed that depressed mood among shift workers develops slowly over time. This is opposite to previous studies investigating the impact of shift work on mental health outcomes other than depressive complaints. However, once depressed mood is present, shift work employees change their shift work situation rather fast in time. The consequence for this finding is that studying the impact of shift work on depressed mood is possible with a long-term follow-up. In addition, the results of this study indicate that it is important to differentiate between symptoms that might be risk factors for chronic mental disorders because the course of the development of these symptoms might be different. In future research, it is essential to differentiate between the severity of depressed mood and measure depressed mood with shorter time-intervals than was done in our current study to improve the evidence. This study also found evidence that certain selection processes were present and that there was a mutual relationship between shift work and depressed mood (reversed causation). Selection processes might have biased the results and, therefore, might be responsible for an underestimation of the results regarding the impact of shift work on the development of depressed mood. In the future, we recommended to focus on specific aspects of shift work and underlying mechanisms that might explain the relationship between shift work and depressive complaints, while taking into account the possibility that selection processes are present.

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