# Work Stressors, Perseverative Cognition and Objective Sleep Quality: A Longitudinal Study among Dutch Helicopter Emergency Medical Service (HEMS) Pilots

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**Abstract: Work Stressors, Perseverative Cognition and Objective Sleep Quality: A Longitudinal Study among Dutch Helicopter Emergency Medical Service (HEMS) Pilots: Mirjam Radstaak, *et al*. Behavioural Science Institute, Radboud University Nijmegen, The Netherlands—Objectives:** This longitudinal study examined the associations between work stressors, perseverative cognition and subjective and objective sleep quality. We hypothesized work stressors to be associated with (i) poor nocturnal sleep quality and (ii) higher levels of perseverative cognition during a free evening. We further hypothesized (iii) perseverative cognition to be associated with poor nocturnal sleep quality and (iv) the association between work stressors and sleep quality to be mediated by perseverative cognition. **Methods:** The participants were 24 pilots working for the Dutch Helicopter Emergency Medical Service (HEMS). They completed six questionnaires: at the end of three consecutive day shifts and each morning following the shifts. The questionnaires addressed work stressors (workload, distressing shifts and work-related conflicts), subjective sleep quality and perseverative cognition. Participants wore actigraphs to assess sleep onset latency, total sleep time and number of awakenings. **Results:** Correlation analysis revealed that (i) distressing shifts were related to delayed sleep onset ($r$=0.50, $p$=0.026) and that workload was related to impaired sleep quality (e.g., subjective sleep quality: $r$=−0.42, $p$=0.044). Moreover, (ii) distressing shifts were positively related to perseverative cognition ($r$=0.62, $p$=0.002), (iii) perseverative cognition delayed sleep onset ($r$=0.74, $p$<0.001) and (iv) mediated the association between distressing shifts and sleep onset latency. **Conclusions:** Perseverative cognition may be an explanatory mechanism in the association between work stressors and poor sleep.
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**Key words:** Actigraph, Recovery, Rumination, Shift work, Stress, Worrying

Recovering from stress is essential to uphold health and well-being[1]. Research has shown that poor recovery is related to serious health threats such as hypertension[2] and even cardiovascular death[3]. The crucial role of incomplete recovery can be understood from the perspective of the Effort-Recovery (E-R) theory[4]. This theory suggests that people invest effort when dealing with work-related demands or stressors. This effort investment is associated with psychophysiological load effects, such as fatigue, from which people need to recover. As long as complete recovery occurs, that is, psychophysiological activation returns to baseline levels before effort is required again, health is not at risk. However, when psychophysiological activation is prolonged and does not return to baseline levels, load effects may accumulate over time and may jeopardize the precarious internal equilibrium, which could be a serious health risk[4, 5].

Sleep is the most important recovery opportunity and essential to restore energy and replenish psychophysiological resources[6]. Previous research has shown that a good night's sleep was associated with lower levels of negative affect and fatigue and a higher degree of positive affect and serenity in the morning[7], whereas poor sleep quality has been associated with severe health impairments such as reduced immune

functioning[8], heart diseases[9], and even mortality[10]. Sleep deprivation is also a major cause of errors and accidents during work time[11].

Work stress can be an important cause of poor sleep quality, but there are surprisingly few studies examining the causal relationship between work stressors and sleep problems[12]. There are, however, quite a number cross-sectional studies providing support for an association between work stress and impaired sleep[13–16]. For instance, high work strain, defined as the combination of high work demands and low job control, has been associated with a higher prevalence of disturbed sleep[13] and more sleep complaints[14, 15], and high cognitive and emotional demands at work have been associated with an increase in sleep problems[16].

Another study examining the associations between work strain and sleep quality found that the most important correlates of sleep quality were not job demands or job control but the inability to stop thinking about work[17]. These results suggest that the inability to mentally switch off from work during leisure time may be an important factor in the relationship between work stressors and impaired sleep. This inability has also been referred to as perseverative cognition[18]. Perseverative cognition, the repeated or chronic activation of the cognitive representation of one or more psychological stressors, keeps the stressors "alive" and thereby the individual in a prolonged or reactivated state of psychophysiological arousal[18]. This state can be expected to interfere with sleep[19].

As yet, surprisingly few studies have actually examined the role of perseverative cognition in the relationship between work stressors and impaired sleep. A recent cross-sectional study revealed that work stressors and perseverative cognition were negatively related to subjective sleep quality[20]. Another cross-sectional study with effort-reward imbalance and time pressure as work stressors and subjective sleep quality as the dependent variable, found that perseverative cognition mediated the association between work stressors and subjective sleep quality[21]. A longitudinal study among school teachers found that teachers in high strain jobs ruminated more after work and reported poorer subjective sleep quality as compared with their counterparts in low strain jobs. However, rumination was not a mediator in the relationship between job strain and sleep quality[22]. More recently, a longitudinal study that examined work-related worrying as a mediator in the association between social exclusion at work and an objective measure of sleep quality, that is, sleep fragmentation, did not find proof for mediation either[23].

In sum, there are only a few studies examining the associations between work stressors, perseverative cognition and sleep disturbances, most of which built upon cross-sectional designs and the results are inconclusive. The aim of the current study was to better understand the relations between work stressors, perseverative cognition and sleep by using a longitudinal design with repeated measures and a multifaceted sleep quality measure, including subjective and objective sleep quality indicators. In this study, we will specifically focus on sleep onset latency because the association between perseverative cognition and delayed sleep onset has been consistently shown in previous research[24].
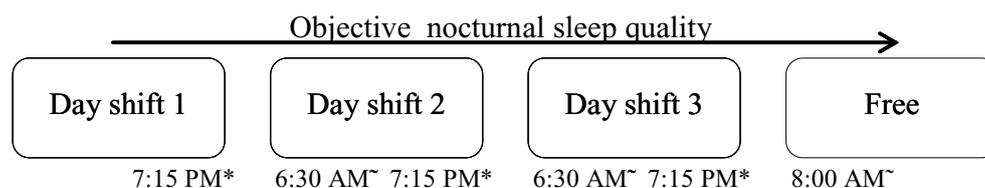
We hypothesized that exposure to daily work stressors is associated (i) with poor nocturnal sleep quality (Hypothesis 1) and (ii) with higher levels of perseverative cognition during a free evening (Hypothesis 2). We further hypothesize that (iii) perseverative cognition is associated with poor nocturnal sleep quality (Hypothesis 3) and that (iv) the negative impact of work stressors on nocturnal sleep quality is mediated by perseverative cognition during a free evening (Hypothesis 4).

The participants included in our study were Dutch Helicopter Emergency Medical Service (HEMS) pilots. HEMS provides 24/7 on-scene assistance to trauma patients. To provide this assistance, HEMS pilots work according to a compressed work schedule for approximately 40 hours over the course of three consecutive days, with each shift being almost 13 hours and modest time to recover between shifts. HEMS pilots were considered an appropriate population for this study's purposes because of their demanding psychosocial work environment. Their work requires high cognitive effort[25] and includes high emotional demands[26] and a highly unpredictable workload. Irrespective of their demanding work characteristics, HEMS pilots reported relatively high levels of well-being in a previous study which suggests that they were healthy and felt competent to do their jobs[27].

## Method

### Participants

This study was part of a larger study into well-being and stress recovery among Dutch HEMS pilots[27]. The general aim of the study and the importance of participation were explained to the total population of 27 HEMS employees during an introductory meeting. Participation in this study was voluntary. Twenty-four employees agreed to participate (response rate=89%). One employee took part in the pilot study to test the procedure. Therefore, the data of 23 employees are reported here. One participant was female and the mean age of the participants was 44.1 years (SD=5.97). All participants had a college or university degree. Participants worked according to

Objective nocturnal sleep quality →

| Day shift 1 | Day shift 2 | Day shift 3 | Free |
|---|---|---|---|
| 7:15 PM* | 6:30 AM˜ 7:15 PM* | 6:30 AM˜ 7:15 PM* | 8:00 AM˜ |

**Fig. 1.** Schematic overview of the procedure.

*Measurement of work stressors (workload, distressing shifts and work-related conflicts). ˜Measurement of perseverative cognition and subjective sleep quality.

a compressed shift work schedule for three consecutive day or night shifts with at least three free days between series of shifts. In the current study, we concentrated on day shifts because we were interested in the determinants of sleep quality within a normal sleep pattern (i.e., nocturnal sleep quality). All day shifts started at 6.30 AM. Participants worked during the first shift on average 13.15 hours (SD=0.40), during the second day shift on average 12.75 hours (SD=0.33) and during the third day on average 12.70 hours (SD=0.52). This resulted in an average number of contractual hours per week of 38.6 hours (SD=0.82), with a minimum of 37.0 and a maximum of 39.5 hours. The mean number of flight missions were 2.39 (SD=1.69), M=2.74 (SD=1.60) and 2.83 (SD=1.64) during the first, second and third day shifts, respectively. When the pilots were not called upon, they engaged in other work activities such as tracking flight and weather conditions and administrative work. They also had the opportunity to rest.

*Procedure*

For a schematic overview of the procedure, see Fig. 1. Note that the design only involves day shifts because we concentrated on nocturnal sleep quality in this study. At least two weeks before the selected series of day shifts, participants received an e-mail in which they were informed in detail about the procedure of the study. It included an overview of the measurement dates, an individual log-in code to complete online questionnaires and an invitation to fill out a general questionnaire. This online questionnaire covered age, gender, education level and number of contractual work hours. After agreeing to participate on their respective measurement dates, the participants were given a tailor-made time schedule with an overview of their individual measurement dates and times.

Participants completed short questionnaires at the end of each day shift for three consecutive days and also in the three mornings following the day shifts (see Fig. 1). Workload, distressing shifts and work-related conflicts were measured at the end of the three day shifts. Perseverative cognition and subjective sleep quality were measured before the start of the second

and third day shifts and in the morning of a succeeding day off. This resulted in a total of six measurements per participant.

On each measurement occasion, the participants received an e-mail with a link to the questionnaire and a reminder text message on their cell phones at the exact moment when they had to complete the questionnaire. One and a half hours after sending the e-mail and text message, we checked whether the participants had completed the questionnaire. If they had not, they received a second text message that reminded them to fill out the questionnaire. After the participants had completed the last questionnaire, they were thanked for their participation and informed about when preliminary results were expected. This procedure resulted in 100% of the questionnaires being completed. The data were collected from March to August 2012.

*Diary questionnaire measures*

For all measurements, except the measurement of work-related conflicts, we used response-scales based on the Dutch grade notation system ranging from 1 (extremely low/negative) to 10 (extremely high/positive) and verbally anchored the first and last grades.

Single-item measures were used to ensure user-friendliness by minimizing the effort required to complete the questionnaires at each measurement moment. When one-dimensional unambiguous constructs are measured, single-item measures are a legitimate alternative to multiple-item measures[28].

1) Workload

Workload was measured at the end of each day shift, resulting in a total of three measurements, using the following item: "How busy were you during your shift?". This item was rated on a 10-point Likert scale (1=*not busy at all*, 10=*very busy*).

2) Distressing shifts

Distress during shifts was measured three times. At the end of each day shift, participants answered the following item: "How distressing was your shift?". This item was rated on a 10-point Likert scale (1=*not distressing at all*, 10=*very much distressing*).

3) Work-related conflicts

Participants indicated whether they experienced a conflict during their shift by answering the following question at the end of each shift, resulting in three measurements: "Did you experience a conflict during your shift?". Participants responded to this question with *yes* (1) or *no* (0).

4) Perseverative cognition

Two items were used to measure perseverative cognition: "Yesterday evening, did you ruminate about your work?" and "Yesterday evening, did you worry about your work?". Items were rated on a 10-point Likert scale (1=*not at all*, 10=*very much*). For each participant, perseverative cognition was measured in the morning after each day shift, resulting in a total of three measurements, and the mean of the two items was calculated per measurement moment. With the exception of the first measurement (Cronbach's $\alpha$=0.47), the scale showed good reliability (Cronbach's $\alpha$=0.94 to 0.97).

5) Subjective sleep quality

Sleep quality was measured in the morning after each day shift, resulting in a total of three measurements. Participants indicated on a 10-point Likert scale (1=*extremely poor*, 10=*extremely good*) how they slept by answering the following question: "How well did you sleep last night?".

*Objective sleep quality*

A SenseWear Pro 3 Armband (BodyMedia, Inc., Pittsburgh, PA, USA) was used to measure sleep quality. The SenseWear armband is a multisensory body monitor, including a two-axis accelerometer and sensors measuring heat flux, galvanic skin response, skin temperature and near body ambient temperature. The device was worn over the triceps muscle of the right arm for the three consecutive days, both during the day and night, on which the questionnaires were administered. The data from the sensors were combined, using algorithms developed by the manufacturer (SenseWear professional software, version 6.1), to estimate sleep characteristics in one minute epochs. The SenseWear data were reduced to binary forms for "lying down" ("0"=no, "1"=yes) and "sleeping" ("0" =no, "1"=yes). The recommendations for standard sleep research were used to determine sleep onset latency, total sleep time and number of awakenings[29]. The SenseWear armband has been validated against polysomnography, which is considered to be the gold standard for the measurement of sleep quality. It has proven to be a reliable measurement of sleep quality in a healthy population and patients with obstructive sleep apnea[30]. The sleep quality data of 20 participants are reported here because three participants had trouble wearing the SenseWear armband (i.e., irritation of the skin).

1) Sleep onset latency

Sleep onset latency was measured as the time lag between lying down (i.e., change from "0" to "1" for "lying") to the start of the sleep onset (i.e., change from "0" to "1" for "sleeping").

2) Total sleep time

Total sleep time was defined as the total sum of the hours scored sleeping from sleep onset to the end of the sleeping episode.

3) Number of awakenings

The number of awakenings was the number of awake periods of at least one minute, excluding the final awaking before getting up.

*Statistical analyses*

Statistical analyses were performed with SPSS 19.0. First, the aggregated means were calculated. Next, we calculated the zero-order correlations between all study variables to examine the first three hypotheses. Given the limited number of observations, meaningful associations could easily be missed if statistical significance would be chosen as the sole criterion. Therefore, correlations >0.30, representing a medium effect size[31], were considered meaningful and practically relevant. To test Hypothesis 4, significant associations between work stressors, perseverative cognition and sleep quality were examined using a bootstrap mediation procedure[32]. The estimate of the indirect effect was derived from the mean of 5,000 bootstraps samples, which established a confidence interval for multiple indirect effects. Mediation was established when the confidence interval of the indirect effect did not include zero[32].

## Results

*Descriptives*

The descriptive statistics of work stressors, perseverative cognition and sleep quality are presented in Table 1. In general, participants reported intermediate levels of workload (*M* range 4.91−5.04), low levels of distress during shifts (*M*<3.10) and very few work-related conflicts (total N=3). Because only three persons experienced conflicts, the prevalence was too low to draw valid conclusions, and work-related conflicts were excluded from further analysis. In general, participants reported low levels of perseverative cognition (*M*<1.90). On average, it took participants less than ten minutes to fall asleep. In general, they awoke on average eight times during their sleep and slept less time during the first two day shifts (*M*<5.69 hours) when compared with the third day shift (*M*=6.61 hours).

1) Test of study hypotheses

Table 2 shows the zero-order correlations between

**Table 1.** Descriptive statistics for work stressors, perseverative cognition and sleep quality

| | Day shift 1 | | Day shift 2 | | Day shift 3 | | Total | |
|---|---|---|---|---|---|---|---|---|
| | N | *M (SD)* | N | *M (SD)* | N | *M (SD)* | N | *M (SD)* |
| Workload (1–10) | 23 | 4.91 (2.70) | 23 | 5.04 (2.55) | 23 | 4.74 (2.49) | 23 | 4.90 (2.00) |
| Distressing shifts (1–10) | 23 | 2.74 (1.96) | 23 | 3.09 (2.61) | 23 | 2.83 (1.77) | 23 | 2.88 (1.19) |
| Work-related conflicts (0–1) | 23 | 0 (0.00) | 23 | 0.09 (0.29) | 23 | 0.04 (0.21) | 23 | 0.04 (0.11) |
| Perseverative cognition (1–10) | 23 | 1.57 (0.61) | 23 | 1.85 (1.74) | 23 | 1.89 (1.61) | 23 | 1.77 (1.04) |
| Subjective sleep quality (1–10) | 23 | 6.70 (1.74) | 23 | 7.37 (1.11) | 23 | 7.65 (0.98) | 23 | 7.24 (0.93) |
| Sleep onset latency (minutes) | 20 | 9.50 (13.34) | 20 | 8.05 (9.21) | 20 | 7.15 (7.09) | 20 | 8.23 (6.80) |
| Total sleep time (hours) | 20 | 5.68 (1.10) | 20 | 5.39 (1.27) | 20 | 6.61 (1.72) | 20 | 5.89 (1.04) |
| Number of awakenings | 20 | 7.55 (4.80) | 20 | 6.45 (3.46) | 20 | 10.85 (6.51) | 20 | 8.28 (3.58) |

**Table 2.** Zero-order correlations between work stressors, perseverative cognition, and subjective and objective sleep

| | | N | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Workload (1–10) | 23 | — | | | | | | |
| 2. | Distressing shifts (1–10) | 23 | 0.44* | — | | | | | |
| 3. | Perseverative cognition (1–10) | 23 | 0.19 | 0.62** | — | | | | |
| 4. | Subjective sleep (1–10) | 23 | −0.42* | 0.05 | 0.18 | — | | | |
| 5. | Sleep onset latency (min) | 20 | 0.37 | 0.50* | 0.74** | −0.33 | — | | |
| 6. | Total sleep time (hrs) | 20 | −0.33 | −0.24 | −0.25 | 0.11 | −0.23 | — | |
| 7. | Number of awakenings | 20 | −0.07 | 0.16 | 0.21 | −0.11 | 0.23 | −0.36 | — |

*$p<0.05$, **$p<0.01$.

the work stressors, perseverative cognition and subjective and objective sleep.

2) Work stressors are associated with poor nocturnal sleep quality (Hypothesis 1)

Workload was associated with poor nocturnal subjective sleep quality ($r=-0.42$, $p=0.044$) and, though to a lesser extent, with sleep onset latency ($r=0.37$, $p=0.11$) and total sleep time ($r=-0.33$, $p=0.16$). Workload was not associated with number of awakenings ($r=-0.07$, $p=0.77$). Distressing shifts were significantly associated with a longer nocturnal sleep onset latency ($r=0.50$, $p=0.026$), but not with subjective sleep quality ($r=0.05$, $p=0.82$), total sleep time ($r=-0.24$, $p=0.30$) or number of awakenings ($r=-0.07$, $p=0.77$).

3) Work stressors are positively associated with perseverative cognition (Hypothesis 2)

Distressing shifts were positively associated with perseverative cognition during a free evening ($r=0.62$, $p=0.002$). Workload, however, was not significantly associated with perseverative cognition during a free evening ($r=0.19$, $p=0.35$).

4) Perseverative cognition is associated with poor nocturnal sleep quality (Hypothesis 3)

Perseverative cognition was associated with a longer nocturnal sleep onset latency ($r=0.74$, $p<0.001$) but was not significantly associated with any other of the

sleep quality indicators ($r=0.18$, $p=0.41$ for subjective sleep quality; $r=-0.25$, $p=0.29$ for total sleep time; $r=0.21$, $p=0.38$ for number of awakenings).

5) Perseverative cognition mediates the association between work stressors and sleep quality (Hypothesis 4)

Both distressing shifts and perseverative cognition were positively related to nocturnal sleep onset latency. Therefore, the mediation model was examined with distressing shifts as the "independent variable", perseverative cognition as a mediator and sleep onset latency as the "dependent variable".

Replicating the correlation analysis, the mediation analysis revealed significant associations between distressing shifts and perseverative cognition (B=0.34, $p=0.005$), between perseverative cognition and sleep onset latency (B=7.68, $p=0.004$) and between distressing shifts and sleep onset latency (i.e., "the direct effect": B=3.09, $p=0.026$). This latter association was no longer significant when perseverative cognition was controlled for (i.e., "the indirect effect": B=0.49, $p=0.70$). The 95% bias-corrected confidence interval for the size of the total indirect effect excludes zero [0.02, 5.99], suggesting a significant indirect effect[32]. In other words and in support of our fourth hypothesis, perseverative cognition mediates the association between distressing shifts and sleep onset latency.
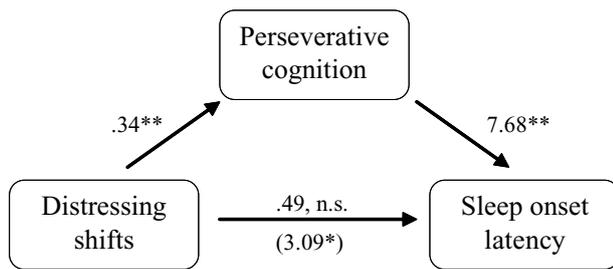
**Fig. 2.** Mediation model.
*p<0.05, **p<0.01. The value in parentheses indicates the "direct effect".

## Discussion

Not being able to "cognitively switch off" after a stressful workday may impede the most important recovery opportunity, that is, sleep. This study aimed to clarify this process by examining the associations between work stressors, perseverative cognition and objective and subjective sleep quality among a population with a demanding psychosocial work environment, that is, Helicopter Emergency Medical Service pilots who provide on-scene assistance to trauma patients.

Our first hypothesis was supported because we found distressing shifts to be associated with a longer time to fall asleep and workload to be associated with poorer subjective sleep quality, a longer time to fall asleep and shorter total sleep time. To our knowledge, there are only two previous field studies that have examined the associations between work stressors and an objective measurement of sleep quality, such as sleep actigraphy[23, 33]. However, the different operationalizations of the sleep quality indicators make a comparison of the results with and between the studies a difficult task. In our study, we found work stressors to be most strongly associated with sleep onset latency. Sleep onset latency was, however, not measured by Dahlgren and colleagues[33]. Pereira and colleagues[23] did measure sleep onset latency in their study examining the associations between workplace social exclusion, worries and sleep. In their study, workplace social exclusion was not related to sleep onset latency, whereas it was positively related to fragmented sleep[23]. Because they used a different conceptualization of sleep fragmentation (i.e., the number of awakenings lasting five minutes or longer) than we did in the current study (i.e., the number of awake periods of at least one minute), it is hard to compare the results of both studies. Whereas it may be tempting to conclude that the occurrence of stressful workplace characteristics especially impacts sleep onset latency, further research with standardized oper-

ationalizations of crucial sleep parameters is needed to shed more light on this topic. Notwithstanding the need for more research examining work stressors in relation to objective sleep quality using the same conceptualization and utilization of different sleep quality indicators, research has consistently shown that work stress impairs sleep quality.

In support of the second hypothesis, distressing shifts were positively related to higher levels of perseverative cognition during a free evening. Workload was only weakly related to perseverative cognition (r=0.19). These findings suggest that it is harder to unwind and recover from a distressing shift than from a busy shift. A possible explanation for why distressing shifts elicited higher levels of perseverative cognition is that distressing shifts are more emotionally charged than workload and induce a higher degree of negative affect. Research has shown that daily events that evoke a higher degree of negative affect induce a higher level of perseverative cognition too[34].

In line with our third hypothesis, perseverative cognition was associated with delayed sleep onset. It was not related to total sleep time or number of awakenings. The association between perseverative cognition and delayed sleep onset has been consistently shown in previous research[24]. For instance, it took good sleepers who were told to give a speech after their sleep period a longer time to fall asleep than those who did not have this assignment[35]. In a similar vein, perseverative cognition about a stressor was associated with longer sleep onset latency but not with wake time, sleep duration or sleep fragmentation[36]. These results support the assumption that perseverative cognition is primarily related to sleep-onset difficulties.

In support of our fourth hypothesis, we found perseverative cognition to be a mediator in the association between distressing shifts and sleep onset latency. Taken together, these associations support the "perseverative cognition hypothesis" which states that repetitive thoughts about stressful events impede stress recovery[18]. Work stressors increase psychophysiological activation not only during but also after work and in anticipation of a new work period. Accordingly, they deplete psychophysiological resources and cause a high need for recovery[4]. At the same time, work stressors also induce perseverative cognition that impairs sleep quality. To break this vicious circle, employers should provide sufficient possibilities to recover during work time by ensuring employees have a variety of job-related duties, providing sufficient breaks, controlling the number of hours employees work and after work time by providing sufficient time to recover between shifts and series of shifts. Employees should preferably engage in activities that

benefit recovery such as activities that induce positive affect[37] and prevent thoughts about work stressors. Distraction has been shown to decrease physiological arousal after a stressful event[38] and shorten sleep onset latency[39].

*Strong points and limitations*

We believe that this study contributes to the literature on work stressors and sleep because it examines the associations between work stressors, perseverative cognition and objective sleep quality. It has high ecological validity because the use of actigraphy allowed us to examine sleep more objectively in a natural setting and in a minimally invasive manner. Another strength is that our sample covered almost the entire population of HEMS pilots in the Netherlands. The absence of attrition supports the validity of our results as well. All questionnaires were completed. This is probably due to proper introduction of the study and the use of short and user-friendly questionnaires with unambiguous and straightforward items to measure our constructs.

A limitation is that we measured perseverative cognition the morning after a night of sleep. Even though we asked the participants to indicate levels of perseverative cognition during the free evening and not when lying in bed, longer sleep onset latency could influence subsequent evaluations of perseverative cognition during the preceding evening. Also, we have no knowledge about the experiences participants had after they left the workplace. Social support from a spouse, for instance, may breach the association between work stressors and rumination[40]. Therefore, future research should preferably study employees' experiences, activities and levels of perseverative cognition during off-job time in more detail by adding a measurement of these constructs before going to sleep.

HEMS pilots reported relatively low levels of total sleep time during the day shifts. These low levels raise the question of whether the pilots suffered from sleep deprivation. However, their relatively high levels of well-being at the start and at the end of the day shifts suggest that they felt healthy and capable of doing their jobs and that they did not suffer from sleep deprivation[27]. Nevertheless, in follow-up research, it would be interesting to study their objective sleep quality and duration during recovery time, in other words, during their days off.

It is also important to note that we examined the associations between work stressors and sleep quality without appreciating the possibility of reverse causation. When an employee has sleep problems, there may be consequences for the psychosocial work environment. For instance, sleep problems may deplete energy recourses and intensify the consequences of work stressors[41]. Fatigued employees may also perform less well, make more mistakes and therefore receive criticism and less support[42]. A lack of sleep may also influence the perceptions of stressors during a shift, even if the actual levels of stressors are the same. Thus, poor sleep quality might influence either the objective or perceived work environment. Still, even though sleep quality could influence work stressors, this does not refute our finding that work stressors are related to nocturnal sleep quality.

This study's focus on a specific group of employees raises the question of external validity of our findings. HEMS employees appeared to experience low levels of distress during their shifts and low levels of perseverative cognition during a free evening. However, that these low levels of work stressors and perseverative cognition were still significantly related to sleep onset latency only underlines the important role of work stressors and perseverative cognition for sleep quality.

## Conclusion

This study indicates that perseverative cognition is an explanatory mechanism in the association between distressing work and poor sleep quality. Therefore, it is important to detach from stressful work experiences during leisure time because not being able to "cognitively switch off" will impair sleep, the best recovery opportunity available. In practice, this implies that after a stressful workday, it is important to engage in activities that distract thoughts from the work stressors and prevent perseverative cognition.

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