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A Reliability and Validity Study of the Bergen Shift Work Sleep Questionnaire in Nurses Working Three-Shift Rotations

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The "Bergen Shift Work Sleep Questionnaire" (BSWSQ) was developed to systematically assess discrete sleep problems related to different work shifts (day, evening, night shifts) and rest days. In this study, we assessed the psychometric properties of the BSWSQ using a sample of 760 nurses, all working in a three-shift rotation schedule: day, evening, and night shifts. BSWSQ measures insomnia symptoms using seven questions: >30-min sleep onset latency, >30-min wake after sleep onset, >30-min premature awakenings, nonrestorative sleep, being tired/sleepy at work, during free time on work days, and when not working/on vacation. Symptoms are assessed separately for each work shift and rest days, as "never," "rarely," "sometimes," "often," "always," or "not applicable." We investigated the BSWSQ model fit, reliability (test-retest of a subsample, n = 234), and convergent and discriminant validity between the BSWSQ and Epworth Sleepiness Scale, Fatigue Questionnaire, and Hospital Anxiety Depression Scale. We also investigated differences in mean scores between the different insomnia symptoms with respect to different work shifts and rest days. BSWSQ demonstrated an adequate model fit using structural equation modeling: root mean square error of approximation = .071 (90% confidence interval [CI] = .066–.076), comparative fit index = .91, and chi-square/degrees of freedom = 4.41. The BSWSQ demonstrated good reliability (test-retest coefficients $p < .001$). We found good convergent and discriminant validity between BSWSQ and the other scales (all coefficients $p < .001$). There were significant differences between the overall/composite scores of the various work shifts. Night shift showed the highest score compared to day and evening shifts as well as to rest days (all post hoc comparisons $p < .001$). Mean scores of different symptoms also varied significantly within the individual work shifts. We conclude that the BSWSQ meets the necessary psychometric standards, enabling systematic study of discrete insomnia symptoms in different work shifts. (Author correspondence: elisabeth.flo@psykp.uib.no)

Keywords: Circadian rhythm sleep disturbance, Health care workers, Shiftwork, Sleepiness, Survey, Work schedule

INTRODUCTION

It has long been recognized that individuals working rotating shifts report more sleep disturbances than observed in the general population (Ursin et al., 2009). Further, as many as 39% of all employees in Europe are on an irregular work schedule (Parent-Thirion et al., 2007). There are methodological challenges in the investigation of the way in which varying work schedules affect sleep, since sleep problems may vary according to different shift types (Åkerstedt et al., 2008). Unfortunately, such variations will not be detected in general or global questionnaires on insomnia or sleepiness. Thus, there is a need for a questionnaire designed to systematically assess discrete insomnia symptoms in relation to different work shifts.

Day shifts, especially those starting early in the morning, and night shifts are especially associated with disturbed sleep (Åkerstedt et al., 2010a, 2010b). Night shifts have been related to difficulties in maintaining sleep (recorded by both objective and subjective measurements), shortened total sleep time, and subsequent feeling of not having slept enough (Åkerstedt et al., 1991; Sallinen & Kecklund, 2010). Day shifts have been associated with problems relating to shortened

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total sleep time and awakening with a feeling of inadequate rest (Åkerstedt, 2003; Åkerstedt et al., 1991; Härmä et al., 2002; Sallinen & Kecklund, 2010). Few studies have investigated different insomnia symptoms related to evening shifts, although this shift seems to be characterized by prolonged sleep onset. Nevertheless, evening shifts have been associated with longer total sleep time than night and day shifts (Åkerstedt, 2003). Sleep during rest days or vacations have generally been found to be longer than sleep on work days (Tepas & Carvalhais, 1990). With regard to wake-time impairment, studies of employees working three-shift rotations (day shifts, evening shifts, and night shifts) have shown that ~50% of them experience sleepiness related to night shifts, 25% in relation to early day shifts, whereas only 5% experience sleepiness in relation to evening shifts (Härmä et al., 2002).

Although a considerable body of literature attests to the adverse effects of shiftwork (Härmä & Kecklund, 2010), very few studies have systematically investigated distinct sleep patterns in different shifts (e.g., day, evening, and night shifts), or investigated long-term effects of shiftwork on sleep that may be manifested during rest days. Indeed, in a recent review, Sallinen and Kecklund (2010) identify this as a methodological limitation in the assessment of sleep and sleepiness in relation to different work shifts. The study of the characteristics of sleep problems among shiftworkers requires a questionnaire that distinguishes between different shifts in terms of sleep onset, maintenance, and quality, as well as subsequent wake-time impairment. It is essential that a questionnaire of this type be based on a theoretical framework and properly validated (DeVon et al., 2007; Rattray & Jones, 2007).

Consequently, the "Bergen Shift Work Sleep Questionnaire" (BSWSQ) was constructed for the purpose of assessing insomnia symptoms and tiredness/sleepiness *in relation to different work shifts*. The latter focus makes the BSWSQ different from general sleep/sleepiness questionnaires. The BSWSQ is (i) based upon the insomnia symptoms listed in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (American Psychiatric Association [APA], 2000), International Classification of Sleep Disorders (ICSD-2) (American Academy of Sleep Medicine [AASM], 2005), and International Statistical Classification of Diseases and Related Health Problems (ICD-10) (World Health Organization [WHO], 1992); (ii) uses a 30-min cutoff value to define wake time as insomnia; (iii) distinguishes between subtypes of insomnia symptoms (e.g., sleep-onset insomnia, maintenance insomnia, and premature awakening); (iv) distinguishes between different sleep and tiredness/sleepiness problems (e.g., tiredness/sleepiness during work hours or during free time on work days); and (iv) relates each symptom to different work shifts as well as to rest days.

In the present study, we aimed to investigate the psychometric properties of the BSWSQ in a sample of nurses working three-shift rotations (day shifts, evening shifts, and night shifts). We hypothesized that the BSWSQ would have a good psychometric fit with the data, i.e., demonstrate validity as to how well the BSWSQ reflects the sample data, based on evaluation criteria. We further studied reliability (test-retest), as well as convergent/discriminant validity with the Epworth Sleepiness Scale (ESS), Fatigue Questionnaire, and Hospital Anxiety and Depression Scale (HADS). Concerning the latter, we expected to find low coefficients implying discriminant validity. In addition, we expected that the BSWSQ would show discriminant validity, expressed as differences in mean composite scores, between day shifts, evening shifts, night shifts, and rest days/vacation.

METHODS

Procedure and Participants

The sample comprised nurses who participated in wave 2 of an ongoing longitudinal study of shiftwork, sleep, and health among nurses (SUSSH). The original survey population consisted of members of the Norwegian Nurses Organization. In each questionnaire wave, nurses receive a questionnaire by post, and subsequently two reminders. We received 2059 responses in wave 1 (response rate of 38.1%). In the second wave, we obtained 1580 responses, yielding a response rate of 80.9% when excluding returned letters due to wrong addresses.

The BSWSQ was included in the wave 2 questionnaire. Among the participants in wave 2, 760 nurses worked a three-shift rotation (day, evening, and night shifts), with 50–100% employment. As it was of interest to study insomnia symptoms across different work shifts and adequately evaluate all items in the questionnaire, we restricted our analyses to these three-shift rotation workers. Thus, the same individuals are compared across all shifts. Table 1 shows the demographic data for the nurses working a three-shift rotation schedule. Reliability was assessed in a randomly selected subsample of these three-shift rotation workers by a test-retest of the BSWSQ (n = 289 after 11 were returned due to unknown addresses). These nurses received the BSWSQ by post a second time, 3 mo after first having completed the wave 2 questionnaire. At the retest, the nurses were also asked whether they had made significant changes to their work schedule, weekly work hours, or life situation during the 3-mo period after first having completed the questionnaire. A total of 234 nurses (response rate 81.0%) responded to this second enquiry.

Measurements

Bergen Shift Work Sleep Questionnaire (BSWSQ)

The BSWSQ is based on the clinical symptoms of insomnia and tiredness/sleepiness. The symptoms are described in the DSM-IV-TR (APA, 2000), ICSD-2 (AASM, 2005), and ICS-10 (WHO, 1992). Each item is

TABLE 1. Demographic data for the three-shift rotation working nurses included in the present study

	Mean (SD)
Age	33.4 (7.6)
Number of years as nurse	6.0 (3.9)
	Prevalence
Sex (Female, %)	91.7
Fraction of full position (%)	
50–75%	26.2
76–90%	15.3
>90%	58.6

rated on a 5-point scale, ranging from 0 to 4 ("never," "rarely," "sometimes," "often," and "always"). "Not applicable" is also offered as a response alternative (scored as missing in the analyses). The reported frequency indicates the persistence of each symptom. If symptoms are rated to occur "often" or "always," this indicates more severe problems. One overall/composite score per work shift is calculated by adding the separate scores with a range from 0 to 24, whereas the score for rest-days/vacation ranges from 0 to 20. The rest-day composite score provides an opportunity to investigate the difference between sleep problems and sleepiness during days off compared to sleep problems and sleepiness during different shifts. The questionnaire is organized in such a way that each symptom is rated in relation to each of the separate shifts (see Appendix). All items concern the previous 3 mo. Questions 1–4 adhere to the DSM-IV-TR criterion A for insomnia: (1) difficulties initiating sleep, (2) difficulties maintaining sleep, (3) premature awakenings, and (4) nonrestorative sleep. Questions 5–7 adhere to the DSM-IV-TR criterion B for insomnia, namely, the degree of tiredness/sleepiness at work and tiredness/sleepiness while on free time on work days, as well as tiredness/sleepiness on rest days/vacations. As suggested by Pallesen and colleagues (2001), questions 1–3 employ a 30-min cutoff to define symptom severity.

Epworth Sleepiness Scale (ESS)

The ESS consists of eight items (Johns, 1991). Each item describes an everyday situation in which respondents are asked to consider how likely it is that they would fall asleep or doze off (ranging from 0 = would never doze to 3 = high chance of dozing). The ESS has demonstrated high validity and reliability in numerous studies (Smyth, 2009). A validated Norwegian version was used (Pallesen et al., 2007), and its Cronbach's α was .75 in the present study.

Hospital Anxiety and Depression Scale (HADS)

The HADS consists of 14 items in all. The alternative responses range from 0 (no symptomatology) to 3 (severe symptomatology). It has been found to perform well in assessing symptom load and caseness of anxiety (7 items) and depression (7 items) in the general population (Zigmond & Snaith, 1983). A Norwegian version was used (Bjelland et al., 2002). In this study, the Cronbach's αs for the depression and anxiety subscales were both .83.

Fatigue Questionnaire

The Fatigue Questionnaire is scored on a 4-point Likert scale, with responses ranging from 1 to 4 (Chalder et al., 1993). The first 11 items yield composite scores for two dimensions: physical fatigue, based on the first seven items (range: 0 to 21), and mental fatigue, based on four items (range: 0 to 12). A Norwegian version of the questionnaire was used (Loge et al., 1998). In the present study, the Cronbach's α was .89 for the physical fatigue subscale and .84 for the mental fatigue subscale.

Statistical Analyses

To investigate the assumed factor structure of BSWSQ, a confirmatory factor analysis was performed using structural equation modeling (SEM) with SPSS AMOS 18.0 (SPSS Inc., Chicago, IL, USA). We aimed to test the overall measurement model of the BSWSQ, examining the relationship between insomnia symptoms (observed variables) and the various shifts (latent variables; day, evening, night shifts, and rest days). We allowed for correlations between the latent constructs in our model. We also allowed for correlations between errors terms, as many items of the BSWSQ had similar phrasings. The confirmatory model contained the following latent factors: "day shift," "evening shifts," and "night shifts" (each with six indicators), and "rest days/vacation" (five indicators). In order to have an intact data set, participants with missing data were excluded, leaving 673 participants in the analysis. To evaluate the goodness of fit of the model, the following indices were applied: root mean square error of approximation (RMSEA), comparative fit index (CFI), and chi-square/degrees of freedom (χ^2/df). An RMSEA value < .05 indicates a good fit, whereas values as high as .08 represent reasonable errors of approximation in the population (Browne & Cudeck, 1993). A CFI cutoff value close to .95 is considered to be representative of a good fitting model, whereas .90 is acceptable (Bentler & Yuan, 1999). The χ^2/df should be ≤ 5.0 and ideally should not reach significance in order to indicate a good model fit. However, the significance level obtained is strongly dependent on the number of observations (Byrne, 2010). The evaluation of "goodness of fit" represents a complete analysis in which the combined structures of variables are evaluated. A "good fit" indicates that the relationship between variables, either between theoretical constructs and the measured data, between items, or between the latent variables, are plausibly designated in the proposed model. In this respect, an acceptable model fit signifies a high validity of the BSWSQ.

The descriptive and reliability analyses were performed using the SPSS 19 for PC (SPSS Inc.). The reliability (3-mo test-retest) was expressed by intraclass

correlation coefficients (ICCs). Subjects reporting that they had made significant changes to their work schedule 3 mo later, and those not responding to the question about changes in their work schedule, were excluded from the retest sample, leaving 197 participants for this specific analysis. We did not exclude subjects reporting changes in their weekly work hours (n = 23) or life situation (n = 34). Missing data entailed case-wise exclusion. Hence, between 163 and 169 participants were included in the test-retest ICC analyses with a one-way random model and type consistency (Yen & Lo, 2002).

In order to investigate the discriminant validity of the BSWSQ, Pearson product-moment correlations were calculated between the BSWSQ overall/composite scores and the summed scores of the ESS, Fatigue Questionnaire (mental and physical subscales), and HADS (depression and anxiety subscales). We subsequently analyzed the significance of the differences between the coefficients.

Analyses of variance (ANOVAs) with repeated measures were conducted to investigate differences in symptom composite mean scores between the different work shifts and rest days. We expected night shifts to show higher overall/composite scores than day and evening shifts (Sallinen & Kecklund, 2010). All shifts were expected to have higher overall/composite scores than rest days (Tepas & Carvalhais, 1990). Furthermore, we expected night shifts to yield more premature awakenings, nonrestorative sleep, and tiredness/sleepiness, both during work and during free periods on work days, compared to day shifts, evening shifts, and rest days (Sallinen & Kecklund, 2010).

We also conducted ANOVAs with repeated measures in order to examine differences, pertaining to mean scores on the different items, *within* each work shift and within rest days. In other words, we investigated how the symptoms were distributed within day shifts, evening shifts, and night shifts. We expected, for day shifts, higher scores regarding tiredness/sleepiness during work and free time on work days, as compared to premature awakenings and wake after sleep onset (Åkerstedt et al., 1991). For evening shifts, we expected sleep onset latency to have a higher score than wake after sleep onset (Sallinen & Kecklund, 2010). During night shifts, we expected tiredness/sleepiness during work hours to have a higher score compared to sleep onset latency and wake after sleep onset (Åkerstedt, 2003).

Missing data led to case-wise exclusion of participants in that specific ANOVA. This led to a slight variation of between 72 and 85 missing cases in each analysis (Table 5). We performed a total of 10 ANOVAs. As this may increase the risk of type I error, we applied Bonferroni corrections to counteract capitalizing on chance. As sphericity could not be assumed in the repeated-measures ANOVA, we used the Huynh-Feldt adjustment in our analyses. The number of participants in this study yielded sufficient statistical power and hence ensures statistical conclusion validity.

The study protocol was in accordance with the ethical standards for biological rhythm research on human beings (Portaluppi et al., 2010), and the project was approved by the Regional Committee for Medical and Health Research Ethics, Health Region West (REK-Vest, 2008, case number 088.08).

RESULTS

SEM Model Fit

Our model comprised loadings from the work shifts and rest days to the different insomnia symptoms. The model showed adequate fit: $\chi^2/df = 4.41$, CFI = .91, RMSEA = .071 (90% confidence interval [CI] = .066–.076). The standardized parameter estimates, as well as means and standard deviations, are presented in Table 2. Significant regression weights (all $p < .001$, positive paths) were found for day shifts, evening shifts, night shifts, as well as rest days/vacation (latent variables), and all the corresponding insomnia symptom ratings (observed variables). As shown in Table 2, path loadings between insomnia symptoms and work schedule ranged from .44 to .74.

BSWSQ Reliability

As shown in Table 3, the ICC was .69 for day shifts, .72 for evening shifts, .73 for night shifts, and .75 for rest periods. This indicated a moderate to high degree of retest reliability between the BSWSQ composite scores at time 1 and time 2.

Convergent/Discriminant Validity

The convergent validity analyses showed significant positive correlations between the BSWSQ overall/composite scores and ESS, HADS, and Fatigue Questionnaire (all $p < .001$). As shown in Table 4, the coefficients, although significantly correlated, showed divergence in terms of coefficient size. Within the BSWSQ, there were moderate correlation coefficients between day shifts, evening shifts, and night shifts, and rest days (shown in Table 4). Calculating the difference between the correlation coefficients, we found that free periods showed significant smaller correlation coefficients within the BSWSQ, in particular, compared to night shifts.

In relation to the day shift, the physical fatigue score showed significant higher correlation coefficients (.31) than all scales, except for the anxiety subscale (.24). Similarly, in relation to evening shifts, physical fatigue showed significant higher coefficients (.35) compared to the other scales, except for the sleepiness (ESS) score (.25). In relation to night shifts, the physical fatigue score (.31) showed higher correlation coefficients than the sleepiness (.19) and the depression (HADS) subscale score (.21). The free periods showed, in general, small correlation coefficients in relation to the other scales (ranging from .10 to .26). Concerning the free periods, physical fatigue showed higher correlation coefficients (.26) than all scales, except for the anxiety subscale

TABLE 2. Standardized regression weights (β) and mean values for each path between insomnia symptoms† and shift/rest period‡

	Day‡			Evening‡			Night‡			Rest days‡		
Insomnia symptoms†	β	Mean	SD	β	Mean	SD	β	Mean	SD	β	Mean	SD
How often has it taken you more than 30 minutes to fall asleep after the light is switched off	.60***	1.38	.97	.57***	2.46	1.11	.65***	1.63	1.24	.61	1.27	.90
How often are you awake for more than 30 minutes within your main sleep period	.71***	.92	.87	.68***	1.29	1.09	.48***	1.70	1.26	.73***	.82	.81
How often have you woken up more than 30 minutes earlier than you wished, without being able to fall asleep again	.56***	1.01	.94	.64***	1.12	1.01	.57***	1.92	1.28	.65***	.84	.78
How often have you not felt adequately rested following sleep	.45***	2.32	.90	.56***	2.27	1.00	.65***	2.75	1.01	.61***	1.22	.91
How often have you been tired/sleepy at work	.44***	1.95	.83	.56***	1.56	.79	.74***	2.94	.87	—		
How often have you been tired/sleepy on your free time on work days	.44	2.37	.87	.59	1.77	.85	.53	2.80	.93	—		
How often have been tired/sleepy on rest days/on vacation	—			—			—			.56***	1.44	.74

***$p < .001$.
†Observed variables, as items in questionnaire.
‡Latent construct.

TABLE 3. Reliability of the Bergen Shift Work Sleep Questionnaire —3-mo test-rest interclass correlation coefficients†

	Intraclass correlation	95% CI
Day shift	.69***	(.61–.77)
Evening shift	.72***	(.64–.79)
Night shift	.73***	(.65–.80)
Rest period	.75***	(.67–.81)

***F value $p < .001$.
†Overall/composite score of insomnia symptoms summarized for each shift/rest days separately.

score (.21). These results were satisfactory, confirming the BSWSQ convergent/discriminant validity.

Variation of Symptom Mean Scores Between Work Shifts

The BSWSQ revealed significant differences between the different work shifts and rest days, in terms of >30-min sleep onset latency, >30-min wake after sleep onset, >30-min premature awakenings, nonrestorative sleep, and being tired/sleepy at work and during free time on work days. All ANOVAs were significant ($p < .001$, with Huynh-Feldt corrections; Table 5).

The post hoc tests revealed that day, evening, and night shifts entailed more problems than rest days in terms of overall/composite scores for symptoms (all $p < .001$; Table 5). Night shifts entailed more problems in terms of maintenance insomnia, premature awakening, nonrestorative sleep, and tiredness/sleepiness, both during work and free time on work days, compared to day and evening shifts as well as to rest days (all $p < .001$). Day shifts showed more problems than evening shifts with regard to tiredness/sleepiness, both during work and free time on work days, and more problems than rest days in terms of nonrestorative sleep and tiredness/sleepiness.

Variation Between Symptom Mean Scores Within Each Work Shift

Within each shift, we found significant differences between symptom mean scores within day shifts ($F_{3.9,\ 2675.7} = 495.2$),

TABLE 4. Pearson product-moment correlation coefficients assessing discriminant and converging validity for the Bergen Shift Work Sleep Questionnaire overall/composite scores† and Epworth Sleepiness Scale, Hospital Anxiety Depression Scale, and Fatigue Questionnaire (mental/physical)

Evening†	.65							
Night†	.40	.63						
Rest days†	.63	.53	.32					
Physical fatigue	.31	.35	.31	.26				
Mental fatigue	.22	.25	.28	.15	.50			
Sleepiness	.23	.27	.19	.10	.26	.20		
Anxiety	.24	.27	.24	.21	.35	.39	.23	
Depression	.14	.23	.21	.15	.34	.33	.14	.43
	Day†	Evening†	Night†	Rest days†	Physical fatigue	Mental fatigue	Sleepiness	Anxiety

$p < .001$ in all correlations.
†Overall/composite scores per shift, adding the separate scores for each symptom (range from 0 to 24 for shifts, 0 to 20 for rest days).

TABLE 5. Comparison of differences in insomnia symptom scores in day shifts, evening shifts, night shifts, and rest days

	Day		Evening		Night		Rest days			
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	F values[†]	Post hoc[‡]
>30-min sleep onset latency (n = 691)	1.38	(.96)	2.46	(1.11)	1.63	(1.25)	1.26	(.89)	$F_{2.43,\ 1675.59} = 319.61$	E > N > D > R[§]
>30-min wake after sleep onset (n = 687)	.91	(.86)	1.27	(1.08)	1.69	(1.26)	.78	(.76)	$F_{2.12,\ 1456.71} = 250.24$	N > E > D > R
>30-min premature awakening (n = 685)	1.01	(.95)	1.11	(1.00)	1.90	(1.28)	.82	(.77)	$F_{2.42,\ 1656.22} = 279.55$	N > E > D > R
Nonrestorative sleep (n = 693)	2.33	(.90)	2.27	(1.00)	2.75	(1.01)	1.16	(.87)	$F_{2.83,\ 1957.69} = 471.71$	N > E/D > R
Tired/sleepy at work (n = 698)	1.95	(.83)	1.55	(.79)	2.94	(.87)			$F_{1.93,\ 1345.23} = 768.71$	N > D > E
Tired/sleepy during free time on work days (n = 695)	2.37	(.87)	1.77	(.85)	2.80	(.93)			$F_{1.99,\ 1378.65} = 399.47$	N > D > E
Tired/sleepy when not working/on vacation (n = 694)							1.38	(.71)		

[†]Repeated-measures ANOVA with Huynh-Feldt corrections.
[‡]Bonferroni-adjusted pairwise comparisons showing significant (" > "= $p < .05$; "/" = nonsignificant differences).
[§]D = day shift; E = evening shift; N = night shift; R = rest days/vacation.

evening shifts ($F_{4.2,\ 2882.1} = 319.4$), night shifts ($F_{4.3,\ 2881.0} = 308.6$), and rest days ($F_{3.6,\ 2598.8} = 127.4$) (all $p <$. 001). For day shifts, being sleepy/tired during free time on work days and sleepiness/tiredness during work hours had higher scores compared to problems with premature awakenings and wake after sleep onset (Bonferroni, all comparisons $p < .001$). Meanwhile, >30-min sleep onset latency had the highest score for evening shifts compared to wake after sleep onset (Bonferroni, $p < .001$). During night shifts, being tired/sleepy during work hours had a higher mean score compared to >30-min sleep onset latency and wake after sleep onset (Bonferroni, all comparisons $p < .001$).

DISCUSSION

The BSWSQ measures insomnia symptoms *in relation to different work shifts*, which makes the BSWSQ a unique tool compared to general sleep/sleepiness questionnaires. The BSWSQ is based on the theoretical assumption that different work shifts affect discrete insomnia symptoms differently. The analyses confirmed this assumption and our study hypotheses as discussed below.

With regard to model fit, a confirmatory factor analysis was employed in order to investigate whether the assumed factor structure had a good fit with the data. The χ^2/df, RMSEA, and the CFI were within the expected values for a reasonably good fit. However, the loadings for 4 of the 23 indicators were <.50. Significant regression weights were found for all shifts and for each corresponding insomnia symptom rating. Overall, we conclude that the model fit for the assumed factor structure for the BSWSQ was acceptable (Byrne, 2010).

We found significant reliabilities (test-retest) for day shifts, evening shifts, night shifts, and rest days/vacation. Insomnia symptoms have previously been found to vary over time, as well as according to season (Hohagen et al., 1994; Øyane et al., 2008). Whereas the first test was conducted in January/February, the second test was administered in April/May. Although subjects who had changed their work schedules were excluded, we did not exclude subjects reporting changes in their weekly work hours or life situation. When testing retest reliability, recall bias represents a potential confounding variable. Literature does, however, propose that 1–2 wks are sufficient to minimize participants' recall of prior responses to a questionnaire (Deyo et al., 1991). Still, a long time period between first and second test administration would normally decrease the correlation coefficient sizes. The BSWSQ aims to assess problems that are not either acute or endogenous to the participants, but rather that is the result of their work schedule. Thus, we would expect sleep problems to remain relatively stable as long as the work schedule remains the same. Our hypothesis regarding the temporal stability of the BSWSQ was confirmed, as all test-retest correlation coefficients were >.60.

As for the analyses of convergent/discriminant validity, it was expected that the correlation coefficients between BSWSQ and other scales (ESS, HADS, Fatigue Questionnaire) were significant and positive, but low. This hypothesis was confirmed and shows that the BSWSQ has adequate convergent/discriminant validity. Perhaps somewhat surprisingly, sleepiness as measured by the ESS did not show higher coefficients with the overall/composite scores of the different work shifts than depression, anxiety, or fatigue. In fact, subsequent analyses showed that the physical fatigue score was, in general, more correlated with the BSWSQ composite scores than the other symptom measures. In our case, this modest correlation may be related to the fact that in a normal population work shifts may lead to sleep symptomatology that is not particularly related to sleepiness in general. The symptoms described in the ESS do not correspond to work tasks but rather to behavior typically occurring outside work hours, i.e., watching TV, driving a car, etc. Also, insomnia has been linked to both anxiety/

depression (Ohayon et al., 1998) and fatigue (Åkerstedt et al., 2004). Positive correlations between insomnia symptoms and anxiety/depression as well as physical/mental fatigue were therefore expected.

We found moderate correlations between the overall/composite scores for the different shifts, whereas the correlations were lower between shifts and rest days reported in the BSWSQ. The smaller correlations between rest days and shifts, compared to correlations between the shifts, is in line with studies that have shown longer sleep time during rest days compared to work days (Tepas & Carvalhais, 1990).

Variations of Symptom Mean Scores Between Work Shifts

We found a significant symptom variation according to work shifts. The variations were in line with our hypotheses and previous studies, thus confirming the BSWSQ's discriminant validity. As hypothesized, all shifts entailed more sleep problems than rest days/vacation.

Night shifts showed an overall higher degree of symptoms, with more problems regarding sleep maintenance, premature awakenings, nonrestorative sleep, and being tired/sleepy, both during work and free time on work days, than day shifts, evening shifts, and rest days/vacation. This was in accordance with our initial hypotheses, and also with other studies (Sallinen & Kecklund, 2010)

Day shifts entailed more problems than evening shifts and rest days in terms of feelings of nonrestorative sleep and being tired/sleepy. Day shifts also yielded more problems than evening shifts in terms of tiredness/sleepiness at work and during free time on work days. This is in agreement with previous studies in which feelings of inadequate rest have been reported in relation to day shifts (Åkerstedt, 2003; Sallinen & Kecklund, 2010).

All shifts were associated with higher scores for symptoms compared to rest days/vacation. This is also consistent with findings of shorter sleep on work compared to rest-days (Tepas & Carvalhais, 1990).

Variations Between Symptom Mean Scores Within Each Work Shift

We also performed repeated-measures ANOVAs to investigate which symptoms showed the highest mean scores within each work shift. As different sleep problems have been predominately related to different shifts, we also expected differences in symptom/item mean scores within each work shift. With regard to day shifts, we expected that being tired/sleepy when working and during free time on work days would show higher scores compared to premature awakenings and wake after sleep onset. This hypothesis was supported. Problems with tiredness/sleepiness in relation to day shifts have in previous studies been related to shortened sleep time. In addition, reduction in slow wave sleep has been found to be related to rumination about the awaiting early day shift (Åkerstedt et al., 1991, 2003). Within evening shifts, the >30-min sleep onset latency showed higher score than wake after sleep onset. This is in line with previous studies that have shown evening shifts entail difficulties with falling asleep after coming home from work (Sallinen & Kecklund, 2010).

Within night shifts, tiredness/sleepiness during work hours showed higher scores compared to >30-min sleep onset latency and wake after sleep onset. Night work normally overlaps with the nadir (lowest point) of the core body temperature; thus, increased tiredness/sleepiness is expected. This is especially relevant regarding the participants in our study who worked three-shift rotations and were thus less likely to have adapted to the night-shift schedule (Åkerstedt, 2003). Also, the relatively low mean score for >30-min sleep onset latency is in accordance with earlier findings that workers usually fall asleep quickly following the night shift (Åkerstedt, 2003). For symptoms in relation to rest days/vacation, being tired/sleepy showed the highest mean score. It is possible that these rotating shiftworkers generally get less sleep than they need during the work periods, leaving them sleepy during vacation or rest days.

The findings from this new questionnaire, which separates symptoms according to shifts and within each shift, were by and large in line with our hypotheses and in accordance with findings from other studies (Åkerstedt, et al., 2008; Sallinen & Kecklund, 2010). Overall, we conclude that the BSWSQ has satisfactory discriminant validity, as it yields different scores between different work shifts as well as between different symptoms within work shifts. A challenging future endeavor could be to identify a cutoff for each shift indicating severity with regard to the specific shifts. However, scoring above, e.g., the cutoff for the night shift does not necessarily imply overall severe problems to a shiftworker who rarely works nights.

Strengths and Limitations

This study examined nurses on a three-shift rotating work schedule. This has both strengths and weaknesses. It allowed us to have an equal number of responses on all items, enabling a proper SEM analysis of the questionnaire structure. However, future studies are needed to test the validity of the BSWSQ across different work schedules and in other occupational samples. The specific time of the day that shifts are scheduled is not the only factor that impacts sleep in shiftworkers. There are a number of other important shift arrangement features. It is possible the participants were affected by other preceding work shifts, for example, evening shifts, when reporting their specific shift-related sleep problems, for example, regarding day shifts. However, a comprehensive study across different shift organizations is beyond the scope of this article.

Our sample had a skewed sex distribution. Yet, a 50/50 sex distribution would not reflect the general nursing population. According to the registered nurse survey done by the US Department of Health and Human Services, ~90% of the nursing population in the United

States is female (Health Resources and Services Administration, 2010). To ensure external validity, a future objective is to study the BSWSQ in males. In addition, as the present study sample had a relatively low mean age, it would be of interest to investigate the psychometric properties of the questionnaire in older segments of the workforce.

The BSWSQ relates specific insomnia symptoms to different shifts, but it does not assess whether the symptoms are related or unrelated to other sleep disorders, i.e., sleep apnea, or comorbid disorders, i.e., somatic conditions or psychopathology. However, as the participants were recruited from a relatively young, working population, severe levels of either somatic disease or psychopathology were unlikely. Regardless of the causes of the sleep problems, this questionnaire would still detect the differential symptomatology according to shifts. Finally, this validation study did not include subjective or objective measures of the sleep-wake cycle, such as sleep diary or actigraphy. Due to the large-scale epidemiological design of the present study, inclusion of sleep diary or actigraphical data was deemed unfeasible.

Although the use of objective and subjective field data in relation to the BSWSQ is beyond the scope of the present study, it represents a pertinent venue for future validation studies. Importantly, the BSWSQ is not intended to be a diagnostic tool, and the main application of this questionnaire is not to categorize responders as sick or healthy. Rather, the aim with the BSWSQ is to be able to assess shiftwork-related sleep problems in a comprehensive and systematic way. Thus, as the BSWSQ is not a diagnostic tool, we cannot investigate the specificity/sensitivity of the questionnaire. In addition, the nurses were healthy enough to work and did not represent any patient group. Neither did we have any specific diagnosis or objective criterion with which to compare the BSWSQ (as in receiver operating characteristic [ROC] analyses).

To conclude, this study demonstrated adequate psychometric properties of the Bergen Shift Work Sleep Questionnaire. This questionnaire is the first to differentiate between sleep problems in different shifts in detail: thus, it is an appropriate tool for the study of sleep in shiftworkers. As this validation study pertains only to nurses, it would be of interest to study the psychometric properties of the BSWSQ in other populations performing shiftwork.

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APPENDIX

Bergen Shift Work Sleep Questionnaire

Below are some questions about how your sleep and your wake-time functioning have been during the last three months in relation to different work schedules. If you have not worked a particular type of shift (day shift, evening shift, night shift) then tick off "not applicable (N/A)"

I How often has it taken you more than 30 minutes to fall asleep after the light is switched off (Tick off one alternative on each line)?

		Never	Rarely	Sometimes	Often	Always	N/A
a)	When you are working day shift/ordinary day work?	☐	☐	☐	☐	☐	☐
b)	When you are working evening shift/evening work?	☐	☐	☐	☐	☐	☐
c)	When you are working night shift/ night work?	☐	☐	☐	☐	☐	☐
d)	When you are not working (rest days /vacations)?	☐	☐	☐	☐	☐	

II How often are you awake for more than 30 minutes within your main sleep period (Tick off one alternative on each line)?

		Never	Rarely	Sometimes	Often	Always	N/A
a)	When you are working day shift/ ordinary day work?	☐	☐	☐	☐	☐	☐
b)	When you are working evening shift / evening work?	☐	☐	☐	☐	☐	☐
c)	When you are working night shift / night work?	☐	☐	☐	☐	☐	☐
d)	When you are not working (rest days / vacations)?	☐	☐	☐	☐	☐	

III How often have you woken up more than 30 minutes earlier than you wished, without being able to fall asleep again (Tick off one alternative on each line)?

		Never	Rarely	Sometimes	Often	Always	N/A
a)	When you are working day shift /ordinary day work?	☐	☐	☐	☐	☐	☐
b)	When you are working evening shift/ evening work?	☐	☐	☐	☐	☐	☐
c)	When you are working night shift/night work?	☐	☐	☐	☐	☐	☐
d)	When you are not working (rest days / vacations)?	☐	☐	☐	☐	☐	

IV How often have you not felt adequately rested following sleep? (Tick off one alternative on each line)?

		Never	Rarely	Sometimes	Often	Always	N/A
a)	When you are working day shift/ordinary day work?	☐	☐	☐	☐	☐	☐
b)	When you are working evening shift/evening work?	☐	☐	☐	☐	☐	☐
c)	When you are working night shift/night work?	☐	☐	☐	☐	☐	☐
d)	When you are not working (rest days /vacations)?	☐	☐	☐	☐	☐	

V How often have you been tired/sleepy at work (Tick off one alternative on each line)?

		Never	Rarely	Sometimes	Often	Always	N/A
a)	When you are working day shift/ordinary day work?	☐	☐	☐	☐	☐	☐
b)	When you are working evening shift/evening work?	☐	☐	☐	☐	☐	☐
c)	When you are working night shift/night work?	☐	☐	☐	☐	☐	☐

VI How often have you been tired/sleepy on your free time (time out of work) on workdays (Tick off one alternative on each line)?

		Never	Rarely	Sometimes	Often	Always	N/A
a)	When you are working day shift/ordinary day work?	☐	☐	☐	☐	☐	☐
b)	When you are working evening shift/evening work?	☐	☐	☐	☐	☐	☐
c)	When you are working night shift/night work?	☐	☐	☐	☐	☐	☐

VII How often have you been tired/sleepy on rest days/on vacation (Tick off one alternative)?

Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐