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Effects of co-sleeping with a shift worker on sleep, mood and cognition

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ABSTRACT

Objective: Although the negative effects of shift work on workers' sleep and mood are well-known, the effects of shift work on their sleep partners' sleep and mood have rarely been investigated. The current study explored the effects of co-sleeping with a shift worker (SW) on the partner's subjective sleep quality, daytime sleepiness, depressive symptoms, and cognitive disturbances.

Methods: Online sleep and work-environment self-report questionnaires (e.g., including the presence of co-sleepers, work schedules of the co-sleepers, and their work schedules) were administered. The questionnaires also included the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), the Cognitive Failures Questionnaire (CFQ), and the short-term Center for Epidemiologic Studies-Depression scale (CES-D). Participants consisted of co-sleepers of SWs (n = 657), co-sleepers of non-SWs (n = 2186), and solo sleepers (n = 2432).

Results: Significant between-group differences in the PSQI, ESS, CFQ, and CES-D were observed after controlling for age, gender, work shift, and parenting ($p < 0.001$). Co-sleepers of SWs showed higher PSQI, ESS, CFQ, and CES-D scores than co-sleepers of non-SWs and solo sleepers. Solo sleepers reported significantly higher PSQI and CES-D scores than co-sleepers of non-SWs. The PSQI, ESS, CFQ, and CES-D scores were significantly correlated in all groups. The association between the ESS and PSQI was stronger in co-sleepers of SWs than in solo sleepers. The association between the ESS and CES-D was stronger in co-sleepers of SWs than in solo sleepers.

Conclusions: Co-sleeping with SWs is associated with poor sleep quality, daytime sleepiness, depressive symptoms, and cognitive disturbances in the partner.

1. Introduction

The number of shift workers (SWs) is increasing; 10–40% of workers are exposed to shift work (Aleksynska et al., 2019). Shift work means working a schedule that differs from the standard daylight working hours, although the specific definition of working time varies among studies (Knutsson, 2004). Shift work disrupts the worker's sleep, mood, and cognitive function (Wickwire et al., 2017; Wright et al., 2013). The negative effects of shift work on the SW's health, including 'shift work disorder', have been studied extensively (Wickwire et al., 2017; Wright et al., 2013).

Studies have reported both negative and positive effects of co-sleeping on behavioral, chronobiological, psychological, and neurobiological aspects of sleep (Troxel, 2010). Therefore, co-sleeping is an important factor to consider when analyzing the relationships of sleep with physical and psychological health (Richter et al., 2016). In some circumstances, a bed partner may disrupt sleep and mood. Sleep has been reported to be disrupted in the bed partners of patients with medical conditions such as epilepsy (Hamamcı et al., 2019), arthritis (Martire et al., 2013), dementia (Gao et al., 2019), obstructive sleep apnea (Luyster, 2017), and snoring (Baptista et al., 2021; Ulfberg et al., 2000). Sleep can also be influenced by sexual activity (Sprajcer et al., 2022) and physical contact (Roberts et al., 2022) with a bed partner. These studies indicate that co-sleeping with someone whose sleep is disturbed can be a risk factor for impaired sleep and mood. As shift work is a risk factor for poor sleep, mood, and cognition, co-sleeping with a SW could have the capacity to disrupt sleep and mood.

The effects of co-sleeping with a SW on the partner's health have been rarely studied. A few studies have explored the perceptions and feelings of the partners of SWs. Those studies reported that shift work caused partner fatigue, stress, and sleep disturbances in 74 partners (Smith & Folkard, 1993) and 59 spouses (Newey & Hood, 2004). SWs and their partners share the same perceptions about the impact of shift work on fatigue, sleep, health, stress, and social/family disruption. The

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partner's perception of the lifestyle disruption critically affects the adaptability of the SW to shift work, even more than biological disruption of the SW (Newey & Hood, 2004).

However, to the best of our knowledge, no study has compared co-sleeping with a SW and co-sleeping with a non-SW or sleeping alone. In addition, previous studies on the effects of co-sleeping with a SW had very small sample sizes, did not use a validated sleep or mood scale, and did not consider whether the spouse shared a bed or not. Furthermore, the effects of co-sleeping on the association between sleep and mood have not been investigated, even though there is a widely known association between sleep and mood (Riemann et al., 2020; Watling et al., 2017; Yu et al., 2021).

The current study investigated the effects of co-sleeping with a SW on sleep, mood, and cognition among a large population. We hypothesized that people who sleep with a SW (co-sleepers of a SW) would experience more disruption in sleep quality, mood, and cognitive disturbances than people who sleep with a non-SW (co-sleepers of a non-SW) or people who sleep alone. In addition, we explored whether the association between sleep and mood would be influenced by co-sleeping or the co-sleeper's work schedule.

2. Method

2.1. Participants

The current study is part of a research project originally designed to investigate sleep and mental health of SWs (Lee et al., 2023; Yeo et al., 2022). Initially, 1265 participants were enrolled through online and offline channels, including via in-hospital bulletin board messages at Samsung Medical Center written in Korean. Using snowball sampling, respondents were encouraged to refer others using KakaoTalk, the most popular social networking site in South Korea. Although the in-hospital bulletin board messages helped us recruit many healthcare workers, other SWs were also recruited, such as police officers, drivers, firefighters, and factory workers. Interested participants received a URL containing a consent form and online questionnaires. As young female workers dominated the sample (mean age, 32.58 ± 7.94 years; 456 men and 809 women), we requested that an online survey company (Macromill Embrain Co. Ltd.) enroll additional participants. The company has its own research panel comprising >1 million South Koreans, with an even distribution in terms of sex, age, and geographic region (Macromill Embrain, 2023). Participants recruited from this panel either directly volunteered to participate in our study or were enrolled through referrals from existing panel members. The profiles of all panel members are updated each year; if contact cannot established at those times, they are excluded. A total of 5400 participants (mean age, 38.33 ± 9.89 years; 2693 men and 2707 women) were recruited in this manner. In total, 6665 subjects completed the self-report questionnaires regarding sleep and work environments. We excluded 392 participants who were taking medications significantly affecting sleep, 68 who failed to provide details concerning their bed-partners' work schedule, and 960 who responded inconsistently (e.g., answering the question regarding their bed partner's work schedule having previously indicated that they had no bed partner). Furthermore, we excluded 27 participants with important missing data, and 57 participants who reported using sleeping pills and responded inconsistently. Consequently, 1390 (960 + 392 + 68 + 27–57) participants were excluded from the analysis. Ultimately, data from 5275 participants were included in the final analysis.

The participants were classified into three groups: people who slept with a SW (co-sleepers of a SW, n = 657); people who slept with a non-SW (co-sleepers of a non-SW, n = 2186), and people who slept alone (solo sleepers, n = 2432). Participants were requested to answer whether they shared a bed with someone; the work schedules of any co-sleeping partners were also investigated. Co-sleepers were classified as SWs or non-SWs. Non-SWs were defined as those who worked only standard daytime hours (7:00 a.m. to 6:00 p.m.) according to a fixed schedule or were unemployed. SWs were defined as those who worked outside of standard daytime hours (6:00 p.m. to 7:00 a.m.) or had an inconsistent work schedule (e.g., a regularly or irregularly rotating shift pattern or an unpredictable schedule). Co-sleepers of a SW were defined as those who shared a bed with a SW. Co-sleepers of non-SWs were defined as those who shared a bed with a non-SW. Solo sleepers were defined as people who slept alone or did not share a bed. All procedures were conducted following the ethical standards of our national and institutional committees on human experimentation and the 1964 Declaration of Helsinki (as revised in 2013). This study protocol was approved by the Institutional Review Board of Samsung Medical Center (approval no. 2019-04-095). All participants gave written informed consent online.

2.2. Questionnaires

The online questionnaires enquired about age, gender, work schedule, the presence of co-sleepers, the work schedules of their co-sleepers, and the number of preschool-age children (≤5 years of age) in the household. Parenting was defined as living with preschool-age children (≤5 years of age). The sleep characteristics of children undergo significant changes after the first 5 years of life, including longer nighttime sleep and fewer naps (Bathory & Tomopoulos, 2017).

The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate sleep quality. The PSQI, which is a self-report questionnaire consisting of 19 items distributed among seven components, measures sleep quality and disturbance. Each component is scored using a Likert scale (range: 0–3), and summed scores are thus in the range of 0–21. Higher scores indicate poorer sleep quality (Buysse et al., 1989). The Korean version of the PSQI is reliable and valid, with Cronbach's α coefficients of 0.84 and 0.65 for internal consistency and test–retest reliability, respectively (Sohn et al., 2012).

The Epworth Sleepiness Scale (ESS) was used to evaluate daytime sleepiness. It is also a self-reporting questionnaire consisting of eight situations: (1) sitting and reading; (2) watching TV; (3) sitting inactively in a public place; (4) as a car passenger for 1 h without a break; (5) lying down to rest in the afternoon when circumstances permit; (6) sitting and talking to someone; (7) sitting quietly after lunch without alcohol; and (8) in a car stopped for a few minutes in traffic. Each situation is scored from 0 (would never doze) to 3 (high chance of dozing) on a Likert scale. Higher scores on the ESS indicate higher levels of sleepiness (Johns, 1991). The Korean version of the ESS is reliable and valid, with Cronbach's α coefficients of 0.90 and 0.86 for internal consistency and test–retest reliability, respectively (Cho et al., 2011).

The Cognitive Failures Questionnaire (CFQ) is a 25-item self-report questionnaire that assesses mistakes in memory, perception, and motor function. The frequency of various cognitive problems is assessed using Likert scales (range: 0–4). Higher CFQ scores indicate more frequent cognitive failure (Bridger et al., 2013). Although the CFQ is typically used for neurodegenerative or psychiatric patients, it has also been used for assessing subjective cognitive impairment among workers (Bridger et al., 2010; Ross et al., 2013; Yeo et al., 2022). The Korean version of the CFQ is reliable and valid, with Cronbach's α coefficients of 0.88 and 0.81 for internal consistency and test–retest reliability, respectively (Lee & Kim, 2011).

The short form of the Center for Epidemiologic Studies-Depression scale (CES-D) was used to evaluate depressive symptoms. The original CES-D is a 20-item questionnaire that measures depressive symptoms experienced during the past week. The short form of the CES-D consists of 11 items, which share the same factor structure as the original CES-D. Each item is scored from 0 to 3 points using a Likert scale. Higher CES-D scores indicate more severe depressive symptoms (Park & Yu, 2021). The Korean version of the CES-D is reliable and valid, with Cronbach's α coefficients of 0.98 and 0.68 for internal consistency and test–retest reliability, respectively (Cho & Kim, 1998; Lee et al., 2016).

2.3. Statistical methods

Group differences in the demographic variables (e.g., age, gender, parenting, and their work shift) were compared using a one-way analysis of variance. The Kolmogorov–Smirnov test was used to evaluate the normality of the data. PSQI, ESS, CFQ, and CES-D scores were compared among groups using the Kruskal–Wallis test. Demographic variables were adjusted for in multiple regression analyses. The simple contrast method and Bonferroni correction were used for post-hoc analysis. In additional analyses, certain variables, including demographic variables, were treated as covariates, and the remaining variables were compared among the groups. Pearson's correlation analysis was performed to examine the associations between the PSQI, ESS, CFQ, and CES-D in each group. Regression analysis was used to assess the interactive effects of the groups for the associations among the PSQI, ESS, CFQ, and CES-D after controlling for age, gender, parenting, and work shift. Dummy variables were generated for each group. Independent variables and covariates were included or excluded from the analyses using the stepwise method. All statistical analyses were performed using SPSS software (version 27.0; SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Group comparison

Significant differences in age ($F = 399.99$, $p < 0.001$), gender ($F = 12.88$, $p < 0.001$), parenting preschool children ($F = 257.81$, $p < 0.001$), and work shift ($F = 64.40$, $p < 0.001$) were detected among the three groups. Co-sleepers of a non-SW were older than co-sleepers of a SW ($p < 0.001$). Co-sleepers of a SW were older than solo sleepers ($p < 0.001$). More men were present in the co-sleepers of a non-SW group than in the co-sleepers of a SW and solo sleepers groups (all $p < 0.01$). Significantly more parents were present in the co-sleepers of a SW and non-SW groups than in the solo sleeper group ($p < 0.001$). More SWs were with co-sleepers of a SW than solo sleepers ($p < 0.001$). More SWs were detected in the solo sleeper group compared to the co-sleepers of a non-SW group ($p < 0.001$).

Significant differences in the PSQI were observed among the groups after controlling for age, gender, parenting, and work shift (chi-square $= 42.717$, $p < 0.001$; Table 1, Fig. 1). The PSQI scores of co-sleepers of non-SWs were significantly lower than those of co-sleepers of SWs and solo sleepers ($p < 0.001$). No significant difference in PSQI score was observed between the co-sleepers of a SW and solo sleepers.

Significant differences in the ESS score were observed among the groups after controlling for age, gender, parenting, and work shift (chi-square $= 36.490$, $p < 0.001$; Table 1, Fig. 1). Co-sleepers of a SW had significantly higher ESS scores than solo sleepers and co-sleepers of a non-SW ($p < 0.001$).

Significant differences in the CFQ were observed among the groups after controlling for age, gender, parenting, and work shift (chi-square $= 37.702$, $p < 0.001$; Table 1, Fig. 1). Co-sleepers of SWs had significantly higher CFQ scores than solo sleepers and co-sleepers of non-SWs ($p < 0.001$).

Significant differences were observed in CES-D scores among the groups after controlling for age, gender, parenting, and work shift (chi-square $= 77.899$, $p < 0.001$; Table 1, Fig. 1). Co-sleepers of SWs had significantly higher CES-D scores than solo sleepers ($p < 0.001$), and solo sleepers had significantly higher CES-D scores than co-sleepers of non-SWs ($p < 0.001$).

In the analysis additionally controlling for PSQI or CES-D scores along with demographic variables, all group differences remained significant. In contrast, after additionally controlling for ESS or CFQ scores, the differences in CES-D scores between solo sleepers and co-sleepers of SWs were no longer significant.

Table 1
Group comparison of sleep quality, sleepiness, depressive symptoms, and cognitive failure among co-sleepers of a SW, co-sleepers of a non-SW, and solo sleepers.

	Groups			Kruskal–Wallis H test		Post-hoc analysis of three groups, adjusted for age, gender, work shift, and parenting status
	Co-sleepers of a SW (n = 657)	Co-sleepers of a non-SW (n = 2186)	Solo sleepers (n = 2432)	Chi-square	p	
PSQI	7.23 ± 3.30	6.40 ± 3.19	6.85 ± 3.33	42.717	<0.001***	**Co-sleepers of SWs = Solo sleepers > Co-sleepers of non-SWs**
CFQ	29.70 ± 19.09	24.81 ± 17.40	24.97 ± 17.50	37.702	<0.001***	**Co-sleepers of SWs > Solo sleepers = Co-sleepers of non-SWs**
ESS	8.94 ± 4.08	7.83 ± 3.76	8.04 ± 3.82	36.490	<0.001***	**Co-sleepers of SWs > Solo sleepers = Co-sleepers of non-SWs**
CES-D	9.00 ± 6.06	7.00 ± 5.70	8.06 ± 6.09	77.899	<0.001***	**Co-sleepers of SWs > Solo sleepers > Co-sleepers of non-SWs**

*p < 0.05, **p < 0.01, ***p < 0.001.
Abbreviations: PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CES-D, Center for Epidemiologic Studies Depression Scale; CFQ, Cognitive Failures Questionnaire; SWs, shift workers.

3.2. Correlation analysis

The PSQI, ESS, CFQ, and CES-D scores were all significantly correlated. Significant correlations were detected between the PSQI and ESS ($r = 0.25$, $p < 0.001$), the PSQI and CES-D ($r = 0.50$, $p < 0.001$), the PSQI and CFQ ($r = 0.31$, $p < 0.001$), the ESS and CES-D ($r = 0.26$, $p < 0.001$), the ESS and CFQ ($r = 0.35$, $p < 0.001$), and the CFQ and CES-D ($r = 0.51$, $p < 0.001$). These correlations were also significant for all three groups, i.e., co-sleepers of a SW, co-sleepers of a non-SW, and solo sleepers (Supplementary Table 2).

Significant interactive effects of group were detected for the association between the PSQI and ESS (Table 2, Fig. 2). Co-sleepers of a SW showed a stronger association between the PSQI and ESS than the other groups ($\beta = 0.09$, $p < 0.001$). In contrast, solo sleepers had a weaker association between the PSQI and ESS than other groups ($\beta = -0.07$, $p < 0.001$). Significant interactive effects of group were detected on the association between the CES-D and the ESS (Table 2, Fig. 2). Co-sleepers

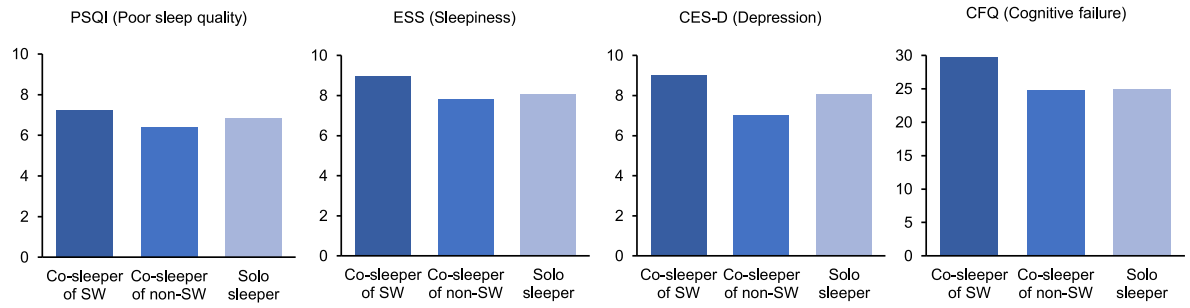

Fig. 1. Sleep quality, sleepiness, depressive symptoms, and cognitive failure of co-sleepers of SWs, co-sleepers of non-SWs, and solo sleepers. The data are descriptive.
Abbreviations: PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CES-D, Center for Epidemiologic Studies Depression Scale; CFQ, the Cognitive Failures Questionnaire; SWs, shift workers.

Table 2
Interactions among sleep quality, sleepiness, depressive symptoms, and cognitive failure in co-sleepers of a SW, co-sleepers of a non-SW, and solo sleepers, controlling for age, gender, work shift, and parenting.

		ESS	CFQ	CES-D
PSQI	Co-sleepers of SWs	$\beta = 0.09$***	NS	NS
	Co-sleepers of non-SWs	NS	NS	NS
	Solo sleepers	$\beta = 0.07$***	NS	NS
ESS	Co-sleepers of SWs		NS	$\beta = 0.06$***
	Co-sleepers of a non-SW		NS	NS
	Solo sleepers		$\beta = 0.05$**	$\beta = 0.10$**
CFQ	Co-sleepers of SWs			NS
	Co-sleepers of non-SWs			NS
	Solo sleepers			NS

***$p < 0.001$, **$p < 0.01$.
Abbreviations: PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CES-D, Center for Epidemiologic Studies Depression Scale; CFQ, the Cognitive Failures Questionnaire; SWs, shift workers; NS, non-significant.

of SWs showed a stronger association between CES-D and ESS scores than the other groups ($\beta = 0.06$, $p < 0.001$), whereas solo sleepers showed a weaker association between CES-D and ESS scores than the other groups ($\beta = -0.10$, $p < 0.01$). Fig. 2 compares the associations of the scores among the groups. Solo sleepers showed a weaker association between ESS and CFQ scores ($\beta = -0.05$, $p < 0.01$) than the other groups. No significant interaction was found in any of the other associations among the PSQI, ESS, CFQ, or CES-D.

4. Discussion

4.1. Sleep and depressive symptoms among co-sleepers of SWs

Co-sleepers of a SW experienced poorer sleep quality, more daytime sleepiness, more depressive symptoms, and more cognitive failure compared to co-sleepers of a non-SW or those who slept alone. Poor sleep, sleepiness, depressive symptoms, and cognitive failure of co-sleepers of a SW were all associated with each other. The association between sleep and mood was stronger in co-sleepers of a SW than in the other groups. To the best of our knowledge, this is the first large sample-sized study to compare the sleep and mood of co-sleepers of a SW to co-sleepers of a non-SW or those who sleep alone.

We hypothesized that co-sleepers of a SW would experience more depressive symptoms, daytime sleepiness, and cognitive failure. Co-sleepers of a SW reported poorer sleep quality than co-sleepers of a non-SW regardless of depressive symptoms. The difference in sleep quality between sleeping with a SW or a non-SW may be due to sleep hygiene. It is difficult to synchronize sleep initiation and termination if one's co-sleeper works a shift and does not follow a normal circadian rhythm. Sleep initiation and termination necessarily make noise (especially when co-sleepers wake up with an alarm, take a shower, dry their hair, pack things, and open/close doors), such as shaking the bed or turning on a light. Although discrepancies in sleep initiation and termination when co-sleeping with a SW are one possible explanation, other factors could also disrupt the sleep environment - such as co-sleeper being a shift worker himself or herself, co-sleeper sleeping with children younger or older than 5 years, co-sleeper having disrupted sleep because of a medical or psychiatric condition, etc.

The more severe depressive symptoms of the co-sleepers of SWs than

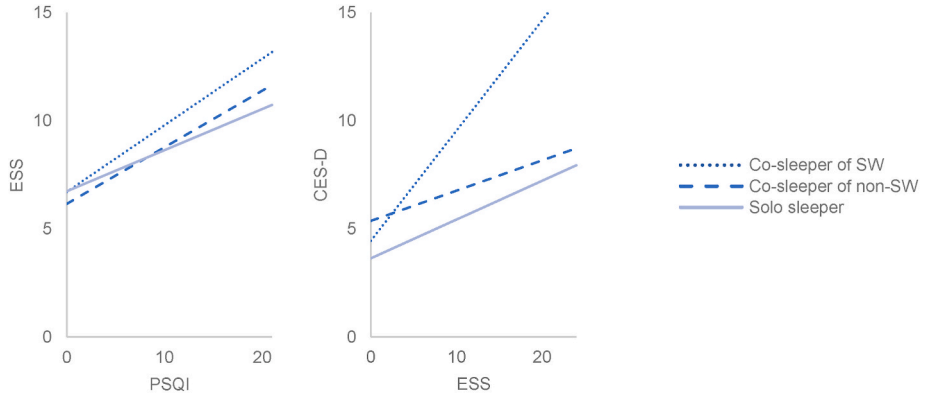

Fig. 2. Association between the ESS and PSQI or the CES-D. The interactions for co-sleepers of SWs were larger than those of solo sleepers.
The data are descriptive. Abbreviations: PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CES-D, Center for Epidemiologic Studies Depression Scale; SWs, shift workers.

co-sleepers of non-SWs in this study may be attributed to the poor sleep quality of the former group, as sleep and depressive symptoms were closely correlated with each other in both the current study and previous studies (Riemann et al., 2020; Watling et al., 2017; Yu et al., 2021). The disruption of mood that occurs by co-sleeping with a SW may also accelerate poor sleep quality and can create a vicious cycle between poor sleep and a depressed mood. In this study, after controlling for sleepiness and cognitive function, depressive symptoms showed no significant group difference. This suggests that increased depressive symptoms in co-sleepers of SWs might be mediated by daytime sleepiness and cognitive function.

4.2. Daytime sleepiness and cognition of co-sleepers of SWs

The co-sleepers of SWs in this study displayed higher levels of daytime sleepiness and cognitive failure than those without SW co-sleepers. This aligns with previous studies in which poor sleep quality induced daytime sleepiness and impaired cognitive function (Brossoit et al., 2019; Chellappa et al., 2009). In another study, depressed mood was an independent cause of cognitive failure, which was attributed to psychomotor agitation/retardation and diminished ability to think and concentrate (Culpepper et al., 2017), while daytime sleepiness was reported as a major risk factor for cognitive failure (Killgore, 2010). Finally, it has been suggested that long-term sleep insufficiency associated with co-sleeping with a SW might lead to brain damage-associated cognitive decline (Zhao et al., 2017).

4.3. Solo sleepers and co-sleepers of non-SWs

In the current study, solo sleepers reported a more depressed mood and poorer sleep quality than co-sleepers of a non-SW. According to previous studies, intimate relationships, such as marriage and cohabitation, improve mental health (Whisman & Baucom, 2012; Whisman et al., 2021). Improved mood of co-sleepers of a non-SW might enhance sleep quality. In this study, after controlling for depressive symptoms, differences in sleep quality remained among the groups. One reason why co-sleepers of non-SWs slept better than solo sleepers might be related to social cues provided by the co-sleepers, where social entrainment may function as a social zeitgeber (Mistlberger & Skene, 2004). Non-SWs with a regular daytime work schedule might synchronize sleep–wake cycles with their co-sleepers to maintain a normal circadian rhythm. However, non-SWs can also disrupt the sleep–wake cycles of co-sleepers if there is a chronotype mismatch. Further studies considering chronotypes are needed to confirm whether co-sleeping with partners with a regular daytime schedule is beneficial for maintenance of the circadian rhythm.

4.4. Interactions among sleep quality, daytime sleepiness, cognition, and depressive symptoms

Sleep quality, sleepiness, depressive symptoms, and cognition were all correlated. Poor sleep quality, daytime sleepiness, depressed mood, and cognitive failure can disrupt each other. These factors may also affect work functioning, perception of life quality, and happiness (Steptoe, 2019).

In this study, the association between sleep quality and daytime sleepiness was stronger in the co-sleepers of SWs compared to solo sleepers. As mentioned in the Introduction, co-sleeping can influence sleep quality (Cartwright & Knight, 1987; Gao et al., 2019; Hamamcı et al., 2019; Martire et al., 2013; Ulfberg et al., 2000). The daytime sleepiness observed in co-sleepers of SWs may be associated with nocturnal sleep disturbances caused by their SW partners, leading to sleep deprivation. Although daytime sleepiness can demonstrate significant associations with medical conditions, no such associations were observed in this study, as the level of sleepiness reported was below the clinically significant threshold. Factors such as hyperarousal can also disrupt sleep; hyperarousal is closely related to insomnia, as well as anxiety. The effects of insomnia- and anxiety-related hyperarousal may be independent of co-sleeping, and the strength of the association between nocturnal sleep disturbances and hyperarousal may be similar between solo sleepers and co-sleepers. However, co-sleepers of SWs might experience anxiety after being awakened by a co-sleeping partner and may have difficulty returning to sleep. Therefore, it remains unclear why the association between sleep quality and daytime sleepiness is more prominent in co-sleepers of SWs. Future studies should compare the characteristics of sleep disturbance between solo sleepers and co-sleepers of SWs.

In this study, the association between daytime sleepiness and depressive symptoms was stronger in co-sleepers of SWs than in solo sleepers. Factors unrelated to sleepiness might have stronger associations with depressive symptoms in solo sleepers, such as a lack of intimate relationships (Whisman et al., 2021).

4.5. Implications and limitations

The current results suggest that the sleep, mood, and cognition of co-sleepers of a SW should be considered along with those of the SW. As SWs consider their partner's sleep more critical than their sleep (Newey & Hood, 2004), managing the sleep and mood of co-sleepers of a SW may also be an effective way to improve the SW's quality of life. Therefore, the optimal arrangement of the work schedule would be beneficial for the sleep and mood of SWs and their co-sleepers.

The current study had several limitations. First, this was a cross-sectional study, so the causal or temporal relationships between sleep, mood, and co-sleeping could not be assessed. Second, this study relied on online self-report questionnaires; objective assessments of sleep and mood, such as polysomnography or a structured interview, were not used. A future study using objective assessments should explore whether the present results can be replicated. Third, variables that were not measured (e.g., the length and quality of the relationship between bed partners) could have affected the results. Furthermore, parenting was defined as living with a child aged <5 years. However, the impact of caregiving on sleep would likely differ between the parents of infants and preschoolers. Additionally, children above preschool age can also disrupt the sleep of their parents. Fourth, the generalizability of the results is limited because all participants were from South Korea. Moreover, many of the participants with SW co-sleepers were themselves SWs. Although we adjusted for SW status, further studies should recruit participants from among the general populations of other countries. Finally, although our study results were statistically significant, they were not clinically significant, which might be attributable to the fact that all groups reported only mild disruption in sleep while scores for daytime sleepiness, depressive symptoms, and cognitive failures were all within normal limits.

5. Conclusion

In conclusion, co-sleeping with a SW resulted in more sleep disturbances, daytime sleepiness, cognitive failure, and depressive symptoms. Associations were observed among sleep disturbance, daytime sleepiness, cognitive failure, and depressive symptoms. The association between mood and sleep was stronger in co-sleepers of a SW than in the other groups. The current study suggests that the work schedule of SWs may, directly and indirectly, disrupt the mood and sleep of their co-sleepers.

Ethical statements

All procedures were conducted following the ethical standards of our national and institutional committees on human experimentation and the 1964 Declaration of Helsinki (as revised in 2013). This study protocol was approved by the Institutional Review Board of Samsung

Medical Center (approval no. 2019-04-095). All participants gave written informed consent online.

All authors have seen and approved the final version of the manuscript being submitted.

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Declaration of competing interestCOI

The authors have no conflicts of interest to disclose.

Author statement

Joonyoung Lim: Conceptualization; Data curation; Formal analysis; Visualization; Roles/Writing - original draft. **Jooyoung Lee:** Data curation, Validation, Writing - review & editing. **Sehyun Jeon:** Conceptualization, Investigation, Methodology, Validation; Writing - review & editing. **Somi Lee:** Data curation, Investigation, Software, Writing - review & editing. **Seog Ju Kim:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing - review & editing.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2023.101530.

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