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Sleep quality and duration during pandemic uninvolved to impaired fasting glucose and hyperuricemia among health care practitioners

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ABSTRACT

Sleep quality and sleep duration might be more disturbed throughout the pandemic of Covid-19 among health care practitioners (HCPs). It could influence impaired fasting glucose (IFG) and hyperuricemia. Therefore, the objective of this study was to assess the association between sleep with IFG and hyperuricemia among HCPs throughout the pandemic of Covid-19. We conducted a cross-sectional study that enrolled 58 HCPs in the tertiary hospital. Self-reported questionnaire related to their sleep quality and duration using the Pittsburg Sleep Quality Index (PSQI) were performed by participants. Fasting plasma glucose (FPG) and uric acid (UA) were examined after 10-12 hours of fasting to define IFG and hyperuricemia. A total of 58 HCPs detected 34.5% had IFG and 24.1% had hyperuricemia. We could not identify any statistically significant participants characteristic based on IFG. HCPs who shift workers were 21.4% hyperuricemia compared to 54.4 non-hyperuricemia ($p=0.03$). There were no different characteristics according to the quality and duration of sleep, where 72.4% HCPs had good quality and duration of sleep. However, we found that sleep medication used scores were higher in IFG group (0.30 ± 0.57) than non-IFG (0.03 ± 0.16) ($p<0.01$). This study could not detect a significant relationship between quality and/or duration of sleep, with IFG and hyperuricemia. Shift worker significant associated with hyperuricemia ($p<0.05$). The association between quality and duration of sleep with IFG and hyperuricemia was not found among HCPs, especially during the Covid-19 pandemic. An alert where the IFG group had high sleep medication used scores, and shift workers had a lower risk of hyperuricemia.

Keywords: sleep quality, sleep duration, impaired fasting glucose, hyperuricemia, health care practitioners, Covid-19

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INTRODUCTION

The Covid-19 pandemic significantly impacts sleep disorders, especially among healthcare practitioners (HCPs) (Gupta et al., 2020; Krupa et al., 2021). A similar report confirmed that sleep disruption had been found among health care practitioners, especially physicians, in the Kingdom of Saudi Arabia (Alnofaiey et al., 2020), Kuwait (Abbas et al., 2021), and China (Zhou et al., 2021). It might be caused by an overload of work hours. Eventually, many HCPs tend to have poor sleep quality and become worst by the Covid-19 pandemic (Ferini et al., 2020). Stress, anxiety, and depression were contributed to negative impacts on sleep quality, especially among frontline HCPs (Shreffler et al., 2020). A previous study found that even good-sleeper before pandemic did become severe insomnia during pandemic (Kocevska et al., 2020). Moreover, sleep disorders were poorly detected even in the general population (Ohayon, 2011).

Moreover, impaired fasting glucose (IFG) as including the prediabetes criteria, could rise type 2 diabetes mellitus risk (American Diabetes Association, 2020). Interestingly, several observational studies have reported that poor sleep quality could enhance prediabetes risk (Hung et al., 2013; Qin et al., 2016). Similarly, many meta-analysis studies had revealed that sleep quality and quantity assist to insulin sensitivity, glucose tolerance, and risk of diabetes (Chattu et al., 2019; Kothari et al., 2021). In addition, hyperuricemia had been found among poor sleepers (Roddy et al., 2013). A cross-sectional study reported that a night's sleep duration had an inverse correlation with serum uric acid (Papandreou et al., 2019). A study among Taiwanese found that poor sleep quality affected lower uric acid (UA) than good sleep quality, but short sleep duration could enhance UA (Chou et al., 2020). Sleep affects catecholamine levels whereas it contributed to UA level. The prior study found a significant association between hyperuricemia and IFG, where both are metabolic diseases (Billiet et al., 2014; Binh et al., 2019). Therefore, HCPs who had sleep disturbance, especially by the Covid-19 pandemic, might develop IFG and hyperuricemia risks.

One sleep quality questionnaire that could allow participants to self-rate is the Pittsburg Sleep Quality Index (PSQI). The PSQI contains of 19 items categorized into seven aspects of sleep, and it could appraise sleep quality around a one-month time interval. A total PSQI score more than 5 is defined as a poor sleeper (Buysse et al., 1989). Several studies confirmed that PSQI had strong reliability and validity as a tool for sleep quality assessment (Mollayeva et al., 2016). Sleep duration has been examined as metabolic diseases risk factor, including diabetes and hyperuricemia (Chou et al., 2020; Kim et al., 2018). A review asserted that integrating the quality and duration of sleep are required to enhance health outcomes (Bin, 2016). Indeed, early detection of quality and duration of sleep in HCPs, extremely during the pandemic, is required to diminish any health issues in the future.

However, there still remains little study about the relationship between sleep quality and duration to IFG and hyperuricemia, especially during the pandemic. Hence, the aim of our study was to detect possible association between the quality and duration of sleep related to experiencing IFG and hyperuricemia.

MATERIALS AND METHODS

Materials

Online questionnaire consisted of PSQI question. Fasting blood glucose was determined by the hexokinase method and UA was assayed using uricase peroxidase. All clinical laboratory has been examined in accredited laboratory at private hospital.

Methods

An observational research with a cross-sectional design was applied to observe sleep quality, sleep duration, IFG, and hyperuricemia among HCPs during February and April 2021. All HCPs in the private tertiary hospital at Sleman District, Yogyakarta, Indonesia, were invited to fill out the online questionnaire after signing the electronic informed consent. Participants were recruited through announcements in hospital staff which the hospital secretary managed. Inclusion criteria are age older than 30 years old, capable of reading, signed informed consent, and willing to have fast at least 10 hours.

We excluded participants who had missed any sleep quality information. A total of 58 participants who were eligible completed laboratory measurements based on computed sample size using https://www.openepi.com/SampleSize/SSPropor.htm. We considered N=66, p=50%, d=5%, dan DEFF=1%.

Participants underwent to fill characteristics (age, sex, education, salary, years of experience, marital status, shift work, high intensity of physical activity, and sitting time) and self-reported sleep quality questionnaire by online system. The physical activity was ascertained with our local criteria by the Ministry of Health and was assessed employing the international physical activity questionnaire short form (IPAQ-SF). In addition, sleep quality was appraised by the PSQI score. The PSQI reveals seven main aspects of sleep, including duration, habitual efficiency, latency, subjective quality, consumption of sleep medications, sleep disruptions, and daylight impairment. The PSQI scores range from 0 to 21 points totally, where better sleep quality is indicated through lower total PSQI scores. Poor sleepers were categorized when the PSQI scored > 5. Participants reporting sleep duration fewer than 6 hours/night were grouped into short sleep duration. Respondents did self-report to answer demographic questions, IPAQ-SF, and PSQI through electronic form. IPAQ-SF and PSQI have been validated and done the reliability test from the previous studies (Sukmawati & Putra, 2019; Suyoto et al., 2016).

After fulfilling the online questionnaire, participants underwent a laboratory examination that required fast 10-12 hours. IFG based on the the American Diabetes Association criteria, where fasting plasma glucose (FPG) >110 mg/dL (American Diabetes Association, 2020). We defined hyperuricemia when UA levels are more than 7 mg/dL for men and UA levels are more than 6 mg/dL for women (Woyesa et al., 2017).

The ethics committee of Fakultas Ilmu Kesehatan Universitas Respati Yogyakarta approved our study protocol with reference number: 013.3/FIKES/PL/I/2021. All eligible participants had signed the informed consent. This study followed in accordance Helsinki Declaration.

Data Analysis

For this study, data were presented as number (percentage) or mean ± SD. An independent t-test was applied to compare the mean of the age, sitting time, FPG, and UA on those groups. We did a chi-square test to compare the proportion of categorical variables, including sex, education, salary, years of experience, marital status, shift work, and high intensity of physical activity, between groups. The odds ratio (OR) was calculated using logistic regression (model 1). Multiple regression modelling was carried out to calculate the adjusted odds ratio (AOR). We restated the analysis after adjusting for age and sex on IFG and hyperuricemia (model 2). In addition, we created model 3 on hyperuricemia analysis further adjusted for shift workers as significantly correlated variables. Statistically significant was defined through $P < 0.05$. We performed all analyses applying SPSS version 25.0.

RESULT AND DISCUSSION

There were totally 58 health care practitioners enrolled in our study after fulfilled inclusion and exclusion criteria. Of 58 participants, 20 (34.5%) detected as IFG, 14 (24.1%) were hyperuricemia, and only 16 (27.6%) HCPs reported short sleep duration and poor sleep quality. Briefly, a quarter of HCP in that hospital have health status disturbance. Table 1. displayed the participant's characteristics according to IFG and hyperuricemia. As shown, there was no statistically significant of participants characteristics based on IFG group ($p > 0.05$). We found that those who shift worker had a higher proportion of hyperuricemia than non-hyperuricemia (21.4% versus 54.5%, $p = 0.03$). In addition, we failed to find any relationship between physical activities with IFG and hyperuricemia as presented in the Table 1 ($p>0.05$).

Table 1. Characteristics of participants based on IFG and hyperuricemia

Variables	IFG		p-value	Hyperuricemia		p-value
	Yes (n=20)	No (n=38)		Yes (n=14)	No (n=44)	
Age, years	37.65 ± 5.95	36.29 ± 6.30	0.43	35.14 ± 6.01	37.37 ± 6.19	0.26
Sex, male	3 (15.0)	6 (15.8)	0.94	4 (28.6)	5 (11.4)	0.12
Education:						
Senior high school	2 (10.0)	0 (0)		0 (0)	2 (4.5)	
Diploma	10 (50.0)	28 (73.7)	0.09	9 (64.3)	29 (65.9)	0.30
Bachelor degree	5 (25.0)	8 (21.1)		5 (35.7)	8 (18.2)	
Master degree	3 (15.0)	2 (5.3)		0 (0)	5 (11.4)	
Salary, < 3 million IDR in a month	14 (70.0)	28 (73.7)	0.55	10 (71.4)	32 (72.7)	0.99
Years of experience, >5 years	16 (80.0)	33 (86.8)	0.49	10 (71.4)	39 (88.6)	0.12
Marital status, married	17 (85.0)	33 (86.8)	0.85	12 (85.7)	38 (86.4)	0.95
Shift worker, yes	7 (35.0)	20 (52.6)	0.20	3 (21.4)	24 (54.5)	0.03*
High intensity physical activities, yes	11 (55.0)	18 (47.4)	0.58	7 (50.0)	22 (50.0)	1.00
Sitting time, hours	3.59 ± 1.91	3.11 ± 1.51	0.30	2.79 ± 1.40	3.43 ± 1.71	0.21
Sleep quality, poor	11 (55.0)	18 (47.4)	0.58	5 (35.7)	24 (54.5)	0.22
Sleep duration, < 6 hours	15 (75.0)	23 (60.5)	0.27	9 (64.3)	29 (65.9)	0.91

*p<0.05
Data are presented in mean±SD and n (%)
IFG: impaired fasting glucose, IDR: Indonesia Rupiah

Comparison of the participant's characteristics regarding as good sleep quality and sleep duration more than 6 h was listed in Table 2. We could not detect any difference of mean or proportion between groups as statistically significant (p>0.05). The mean±standard deviation of PSQI dimension and total PSQI scores by IFG and hyperuricemia category were reported in Table 3. Only sleep medication used dimension score differed between IFG group (p<0.01) where IFG group (0.30 ± 0.57) tend to have a higher score than non-IFG (0.03 ± 0.16). There were no statistically difference sleep quality scores by hyperuricemia category.

Table 2. Comparison of demographic and clinical characteristics with adequate sleep quality and sleep duration ≥ 6 hours

Variables	Good sleep quality and sleep duration ≥ 6 h		p-value
	Yes (n=42)	No (n=16)	
Age, years	36.81 ± 5.97	36.63 ± 6.86	0.91
Sex, male	7 (16.7)	2 (12.5)	0.70
Education:			
Senior high school	2 (4.8)	0 (0)	
Diploma	25 (59.5)	13 (81.3)	0.44
Bachelor degree	11 (26.2)	2 (12.5)	
Master degree	4 (9.5)	1 (6.2)	
Salary, < 3 million IDR in a month	32 (76.2)	10 (62.5)	0.05
Years of experience, >5 years	37 (88.1)	12 (75.0)	0.22
Marital status, married	35 (83.3)	15 (93.8)	0.30
Shift worker, yes	9 (56.3)	18 (42.9)	0.36
High intensity physical activities, yes	9 (56.3)	20 (47.6)	0.56
Sitting time	3.40 ± 1.67	2.94 ± 1.62	0.35
FPG	99.38 ± 11.33	94.25 ± 8.35	0.11
Uric acid	5.43 ± 1.69	5.13 ± 1.13	0.51

Data are presented in mean±SD and n (%)
IDR: Indonesia Rupiah, FPG: fasting plasma glucose

Table 3. The difference of PSQI scores between participants with IFG or hyperuricemia and healthy controls

Variables	IFG		p-value	Hyperuricemia		p-value
	Yes (n=20)	No (n=38)		Yes (n=14)	No (n=44)	
Subjective sleep quality	1.20 ± 0.52	0.97 ± 0.59	0.17	1.00 ± 0.55	1.07 ± 0.59	0.71
Sleep latency	1.15 ± 0.93	1.11 ± 0.89	0.86	0.86 ± 0.77	1.20 ± 0.93	0.21
Sleep duration	1.45 ± 0.76	1.26 ± 0.83	0.41	1.29 ± 0.91	1.34 ± 0.78	0.83
Sleep efficiency	0.05 ± 0.22	0.29 ± 0.77	0.08	0.43 ± 0.94	0.14 ± 0.51	0.28
Sleep disturbance	1.10 ± 0.55	1.03 ± 0.64	0.66	0.86 ± 0.36	1.11 ± 0.65	0.17
Sleep medication used	0.30 ± 0.57	0.03 ± 0.16	0.01**	0.07 ± 0.27	0.14 ± 0.41	0.58
Daytime dysfunction	0.90 ± 0.72	0.95 ± 0.77	0.82	1.00 ± 0.88	0.91 ± 0.71	0.69
Total PSQI scores	6.15 ± 2.39	5.63 ± 2.89	0.50	5.50 ± 2.62	5.91 ± 2.77	0.63

**p<0.01
PSQI: Pittsburg Sleep Quality Index, IFG: impaired fasting glucose

Table 4. The association between sleep quality and sleep duration with IFG

Model	Variable	OR (95% CI)	p-value
1	Sleep quality, poor	1.36 (0.46 – 4.03)	0.58
	Sleep duration, < 6 h	1.96 (0.59 – 6.52)	0.27
	Poor sleep quality with short sleep duration	2.95 (0.73 – 11.93)	0.13
2a	Sleep quality, poor	1.49 (0.48 – 4.65)	0.50
	age	1.04 (0.95 – 1.14)	0.38
	sex, male	0.94 (0.19 – 4.59)	0.94
2b	Sleep duration, < 6 h	1.96 (0.58 – 6.57)	0.28
	age	1.04 (0.95 – 1.14)	0.43
	sex, male	1.04 (0.22 – 4.97)	0.96
2c	Poor sleep quality with short sleep duration	2.97 (0.73 – 12.18)	0.13
	age	1.04 (0.95 – 1.14)	0.43
	sex, male	0.98 (0.20 – 4.74)	0.98

Table 4 presents our findings of the bivariate and multivariate analysis using logistic regression to detect any relationship of IFG with sleep quality and duration. We failed to detect any significant relationship between sleep quality, duration, both of them, with IFG. After combining sleep quality and sleep duration, it showed that HCP who had poor sleep quality and sleep duration of fewer than 6 h had a higher OR and lower p-value (OR: 2.95, 95%CI: 0.73 – 11.93, p = 0.13) to become IFG than considering it separately. Nonetheless, it remained not statistically significant. The addition of age and sex as basic characteristics in the model 2 had no effect on the association between sleep and IFG.

The findings in the Table 5 expresses statistically insignificant association between sleep and hyperuricemia. After adjusting for covariate variable, including age and sex (model 2), the predictive role of noticed sleep quality, sleep duration, and combination of quality and duration remained insignificant to hyperuricemia ($p \geq 0.05$). Interestingly, the results of model 3 adjusting for age, sex, and shift worker, demonstrated that shift worker significant associated with hyperuricemia. However, our findings were conflicting where shift workers tend to have hyperuricemia than non-shift workers. Shift worker contributed to lower the risk of hyperuricemia by 0.19 (95%CI: 0.04 – 0.88), 0.20 (95%CI: 0.05 – 0.87), and 0.17 (95%CI: 0.04 – 0.79) for adjusted in poor sleep quality, sleep duration of fewer than 6 hours, and poor sleep quality with short sleep duration, respectively. Furthermore, we remained failure to detect any relationship between the quality and duration of sleep with hyperuricemia ($p \geq 0.05$).

Table 5. The association between sleep quality and sleep duration with hyperuricemia

Model	Variable	OR (95% CI)	p-value
1	Sleep quality, poor	0.46 (0.13 – 1.61)	0.23
	Sleep duration, < 6 h	0.93 (0.27 – 3.33)	0.91
	Poor sleep quality with short sleep duration	0.60 (0.17 – 2.18)	0.44
2a	Sleep quality, poor	0.29 (0.07 – 1.21)	0.09
	age	0.94 (0.84 – 1.06)	0.94
	sex, male	4.41 (0.77 – 25.26)	0.10
2b	Sleep duration, < 6 h	0.94 (0.26 – 3.44)	0.93
	age	0.95 (0.85 – 1.07)	0.39
	sex, male	2.71 (0.59 – 12.46)	0.20
2c	Poor sleep quality with short sleep duration	0.56 (0.15 – 2.15)	0.40
	age	0.95 (0.85 – 1.07)	0.40
	sex, male	2.87 (0.61 – 13.52)	0.18
3a	Sleep quality, poor	0.27 (0.06 – 1.23)	0.09
	age	0.93 (0.82 – 1.06)	0.27
	sex, male	4.86 (0.77 – 30.81)	0.09
	shift worker, yes	0.19 (0.04 – 0.88)	0.03*
3b	Sleep duration, < 6 h	0.86 (0.22 – 3.40)	0.83
	age	0.94 (0.83 – 1.06)	0.29
	sex, male	2.87 (0.56 – 14.75)	0.21
	shift worker, yes	0.20 (0.05 – 0.87)	0.03*
3c	Poor sleep quality with short sleep duration	0.40 (0.09 – 1.74)	0.22
	age	0.93 (0.82 – 1.06)	0.28
	sex, male	3.15 (0.59 – 16.95)	0.18
	shift worker, yes	0.17 (0.04 – 0.79)	0.02*

*p<0.05

Discussion

The current study observed the relationship between sleep-IFG and sleep-hyperuricemia in HCPs through the Covid-19 pandemic for the first time. We detected that more than a quarter of our HCPs participants had IFG, and almost a quarter had hyperuricemia. In contradiction to the previous findings that confirmed HCPs tend to have worse sleep quality and duration (Abbas et al., 2021; Gupta et al., 2020; Krupa et al., 2021; Morisky et al., 2008; Zhou et al., 2021), our results showed that 72.4% of HCPs had a good sleep quality accompanied by a sleep duration of more than 6 hours. It seemed that the Covid19 pandemic did not affect the HCP's sleep quality and duration.

Participants who got IFG likely had higher sleep medication used scores, as one of PSQI dimension, than non-IFG. The study among diabetes patients showed no difference in higher sleep medication used scores compared to our findings. They claimed that their participants who had sleep disturbance alleviated through traditional medicines (Zhu et al., 2014). Since our participants were HCPs, they have knowledgeable and accessible to obtain sleeping medication (Schmidt et al., 2015). Other studies confirmed that sleeping pills consumption denoted severe insomnia (Pagel et al., 2018; Proctor & Bianchi, 2012). Thus, they indeed had poor sleep quality. However, the information of active ingredients in the sleeping medication and whether they self-medicated or prescribed is disputed by our data.

Irrespective of the previous findings (Chou et al., 2020; Hung et al., 2013; Kim et al., 2018; Qin et al., 2016; Roddy et al., 2013), we could not demonstrate any association of the quality and duration of sleep, and the combination of both of them with IFG and hyperuricemia. Even after adjusting the predictive model using age and gender (IFG and hyperuricemia) and shift worker (only hyperuricemia), we remained failure to detect any significant association. Lack of such association might be caused by different measurement methods, populations, and pandemic conditions.

Why might poor sleep quality and/or short sleep duration patients have a greater IFG relative to their non-IFG counterparts? The potential explanation is related to the interference of circadian pace-

markers, metabolism in adipose tissue, disruption of the hypothalamic-pituitary-adrenal axis, reducing insulin sensitivity, oxidative stress, and hampered pancreatic function (Briançon et al., 2015; Buxton et al., 2010; Kalsbeek et al., 2014). Sleeping disturbance but not sleep duration is presumed to contribute to enhancing systemic inflammation (Irwin et al., 2016). Consequently, a high systemic inflammation marker could escalate the risk of diabetes (Tsalamandris et al., 2019). Since diabetes and sleeping quality had an interlinking effect where diabetes patients could increase the risk of sleep disturbance (Khandelwal et al., 2017), it is still questioned which one would have happened first.

Moreover, the biological plausibility mechanism to explain disturbance of the quality and duration of sleep with hyperuricemia remains unclear. Increasing catecholamine levels had been detected among poor sleep quality (Zhang et al., 2011), which may contribute to the elevating of nucleotide turnover, hence it escalates uric acid production (Tovchiga & Shtrygol', 2014). The cardiometabolic disease seemed to play a role in the sleep-hyperuricemia pathway. Since several studies have explored that disruption of the quality and duration of sleep could elevate dyslipidemia, obesity, hypertension, and T2DM risk (Woyesa et al., 2017; Zhou et al., 2021), which are all contributing hyperuricemia risk factors. Thus, it had been recognized an interplay between inflammation response and greater levels of UA (Kushiyama et al., 2016; Lyngdoh et al., 2011). Correspondingly, sleep disturbance had increased the production of the inflammatory response (Irwin et al., 2016).

Remarkably, we revealed that shift workers had a significant relationship with hyperuricemia after adjusted in each sleep quality, sleep duration, and combination of both of them. The potential mechanism for shift workers and hyperuricemia warrants some further discussion. Notably, shift workers more dominant affected hyperuricemia than sleep quality and sleep duration (Table 5). We found that shift workers had less risk of getting hyperuricemia. In contrast, a Korean study reported that shift workers had a greater risk of gaining hyperuricemia compared to non-shift workers (Oh et al., 2014). The light-sensitive central pacemaker was expected as a factor that affected shift worker metabolism (Kalsbeek et al., 2014). Enhancing of the inflammatory marker was detected among shift workers (Kim et al., 2016), and inflammation performs an important role in the hyperuricemia pathogenesis (Zhou et al., 2018).

However, this study should consider several limitations. First, characteristics and sleep quality data were obtained from the self-reported questionnaire. Therefore, further study needs to apply precise and direct measurements methods, such as polysomnography. Second, data on current disease especially T2DM and hyperuricemia, sleep quality and duration history, and other risk factors involving obesity status, hypertension, alcohol consumption, smoking habits, medications taken, were not gathered in the current study. In fact, those factors affect sleep quality, sleep duration, IFG, and hyperuricemia. Finally, as participants were only recruited from one tertiary hospital in Yogyakarta, our findings could not be generalized among HCPs in our nations.

CONCLUSION

In summary, this study discovered that the Covid-19 pandemic among HCP did not alter the relationship between the quality and duration of sleep with IFG and hyperuricemia. Sleep medication used score was higher in the IFG group, while shift workers tend to have a lower risk of hyperuricemia.

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