Impact of Risk Factors and Components of Metabolic Syndrome for Sleep Disorder of Korean Workers: Preliminary Study

Sook Hee Sung[a*], Nam Hee Kim [a], So Ra Ahn [a], Yong Hwan Lee [a], Sun Pyo Hong [a], Seung Jin Choi[a]
[a]*Radiation Health Institute, Korea Hydro and Nuclear Power Co., Ltd., 38, Seosomun-ro, Jung-gu, Seoul*
[*]*Corresponding author: sjchoice@naver.com*

1. Introduction

Homocysteine (Hcy) is a risk factor for arteriosclerosis, causes endothelial cell dysfunction, and may cause cardiovascular disease and cerebrovascular disease due to smooth muscle cell proliferation, oxidative stress, and blood flow stagnation. It is also associated with insulin resistance and metabolic syndrome[1].
C-reactive protein (CRP) is associated with diabetes and is an essential factor in insulin resistance [2]. It is associated with endothelial cell dysfunction, induces atherosclerosis, and is associated with metabolic syndrome. Sleep disorders are associated with obesity, cardiovascular disease, and diabetes [3]. Therefore, we conducted a sleep evaluation on workers and investigated the relationship between sleep disorders and homocysteine, CRP, the components of metabolic syndrome.

2. Methods

2.1 Subjects

This cross-sectional study enrolled male Korean industrial workers who underwent an annual health check-up in 2017. The study population included 10,936 men. Of those, participants unexamined sleep evaluation or blood chemistry examination including homocysteine and hs-CRP were excluded. A total of 10,455 men were included in this analysis. The study was approved by the Institutional Review Board of Hanil Hospital, Seoul, Korea (2016-H-001), and written informed consent was obtained from each participant.

2.2 Measurements

Participants fasted for at least 8 hours before the study. Body weight, height, and blood pressure (BP) were measured using standard techniques. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Waist circumference (WC) was measured at the level midway between the lowest rib and the iliac crest. Fasting blood samples were collected from the antecubital vein and analyzed biochemically and immunologically using a Cobas c702 module (Cobas, Roche Diagnostics, Basel, Switzerland). Fasting plasma glucose (FPG) levels were measured using an enzymatic reference method with hexokinase. Triglyceride (TG) levels were measured using an enzymatic colorimetric method. Low density lipoprotein cholesterol (LDL-C) and Low density lipoprotein cholesterol (HDL-C) levels were assessed using a homogeneous, enzymatic, colorimetric assay. Serum high-sensitivity C-reactive protein (hs-CRP) levels were assayed by particle-enhanced immunoturbidimetry. Liquid stable 2-part homocysteine reagent kits and an Axis-Shield Calibrator (Axis-Shield Diagnostics Ltd., Dundee, Scotland United Kingdom) were used to determine serum Hcy levels. The intra-assay and inter-assay CV was 1.3% to 2.1% and 1.1% to 1.3%, respectively. Insulin levels were measured using [^{125}I] immunoradiometric assay (IRMA) Kits. Homeostasis model assessment of insulin resistance (HOMA-IR) was calculated using the following equation: [glucose (mg/dL)×insulin (μU/mL)]/405.

2.3 Sleep evaluation questionnaire

Insomnia Severity Index (ISI) is used to measure the severity of insomnia felt subjectively and consists of a total of 7 items, with a total score of 0-28, the higher the score, the more severe insomnia symptoms. Good sleep quality and poor sleep quality as score was $\leq$ 14 and $\geq$15, respectively. Pittsburgh Sleep Quality Index (PSQI) subjectively evaluate the quality of sleep over the past month, it consists of 19 items with a total score of 0-21, and the higher the score, the lower the quality of sleep. Good sleep quality score was $\leq$ 5. Epworth Sleepiness Scale (ESS) is an 8-question scale indicating the degree of subjective daytime sleepiness, with a total score of 0-24, which means that the higher the score, the more severe daytime sleepiness (EDS) is, and if the score is 10 or higher, there is excessive daytime sleepiness (EDS). In this study, the score $\leq$ 11 was considered as good sleep quality.

2.4 Statistical analysis

The characteristics of participants are summarized as mean±standard deviation for continuous variables. Comparisons of participants underwent PSQI were performed using the Student *t* tests for continuous variables. All analyses were conducted using SPSS for Windows version 15.0 (SPSS Inc., Chicago, IL, USA). *P* values <0.05 were considered statistically significant.

3. Results

In the three questionnaires, age, LDL, and FPG were significantly increased in the group with good sleep quality, compared to the group with poor sleep quality and there were no significant differences in homocysteine, hs-CRP, and HOMA-IR [Table 1-3]. In another study of women, homocysteine and hs-CRP were significantly increased in the group with PSQI cutoff score or higher [4]. This difference is that nuclear power plant workers are more likely to have relatively reduced risk factors due to regular medical checkups. In general, the significant increase of age in the group with good sleep quality despite being associated with risk factors of metabolic syndrome and metabolic components in the group with poor sleep quality is considered as the reason for the increase in the metabolic components including LDL and FPG.

Therefore, the relationship between the results of the evaluation of sleep disorders through three questionnaires and the risk factors and components of metabolic syndrome is uncertain.

However, this study has not yet considered variables such as marriage, education, alcohol, smoking, and exercise as a preliminary study, and it is necessary to compare workers separately by working hours.

4. Conclusion

The relationship between sleep disorder and risk factors and components of metabolic syndrome in nuclear power plant workes is uncertain, but further research is needed in the future.

REFERENCES

[1] Sreckovic B, Sreckovic VD, Soldatovic I, Colak E, Sumarac-Dumanovic M, Janeski H, Janeski N, Gacic J, Mrdovic I. Homocysteine is a marker for metabolic syndrome and atherosclerosis. Diabetes Metab Syndr. 2017;11(3):179-182.

[2] Ishikawa S, Kayaba K, Gotoh T, Nakamura Y, Kajii E. Metabolic syndrome and C-reactive protein in the general population: JMS Cohort Study. Circ J. 2007;71(1):26-31.

[3] Reutrakul S, Van Cauter E. Sleep influences on obesity, insulin resistance, and risk of type 2 diabetes. Metabolism. 2018 Jul;84:56-66.

[4] Zhang H, Wang Q, Deng M, Chen Y, Liu W, Huang J, Zhang Z. Association between homocysteine, C-reactive protein, lipid level, and sleep quality in perimenopausal and postmenopausal women. Medicine (Baltimore). 2021;100(51):e28408.

Table 1. Characteristics of two groups by Insomnia Severity Index (ISI)

	ISI ≤ 14 (n=9,887)	**ISI ≥ 15 (n=568)**	***P* value**
Age (year)	40.8±8.7	37.8±8.2	<0.01
Hcy (μmol/L)	10.9±2.4	10.7±2.4	0.260
BMI (kg/m^2)	24.4±2.4	24.1±2.7	<0.01
WC (cm)	83.1±6.9	82.0±7.8	<0.01
SBP (mmHg)	118.5±8.7	117.3±8.2	<0.05
DBP (mmHg)	76.6±7.0	75.8±7.0	<0.05
HOMA-IR	1.78±0.9	1.97±1.1	0.204
hs-CRP (mg/dL)	0.101±0.1	0.102±0.1	0.937
HDL (mg/dL)	53.9±11.3	55.4±11.2	<0.05
LDL (mg/dL)	125.2±25.1	119.8±27.2	<0.01
TG (mg/dL)	130.9±59.2	133.5±64.7	0.534
FPG (mg/dL)	97.6±9.4	96.2±9.8	<0.05

Table 2. Characteristics of two groups by Pittsburgh Sleep Quality Index (PSQI)

	PSQI ≤ 5 (n=5,241)	**PSQI ≥ 6 (n=5,214)**	***P* value**
Age (year)	42.8±8.7	38.5±8.2	<0.01
Hcy (μmol/L)	10.9±2.4	10.9±2.5	0.789
BMI (kg/m^2)	24.4±2.4	24.4±2.5	0.752
WC (cm)	83.2±6.8	83.0±7.1	0.181
SBP (mmHg)	118.9±8.8	117.9±8.5	<0.01
DBP (mmHg)	77.0±6.9	76.2±7.0	0.497
HOMA-IR	1.82±0.9	1.87±0.95	0.300
hs-CRP (mg/dL)	0.102±0.1	0.099±0.1	0.818
HDL (mg/dL)	53.8±11.3	54.3±11.2	0.054
LDL (mg/dL)	125.9±25.3	123.9±24.9	0.002
TG (mg/dL)	133.7±60.7	128.3±58.0	0.004
FPG (mg/dL)	98.9±10.1	96.3±8.7	<0.01

Table 3. Characteristics of two groups by Epworth Sleepiness Scale (ESS)

	ESS ≤ 11 (n=9,882)	**ESS ≥ 12 (n=573)**	***P* value**
Age (year)	40.8±8.6	35.0±7.4	<0.01
Hcy (μmol/L)	10.9±2.4	10.9±2.5	0.789
BMI (kg/m^2)	24.4±2.4	24.4±2.7	0.530
WC (cm)	83.1±6.9	82.4±7.9	0.054
SBP (mmHg)	118.5±8.7	116.4±8.4	<0.01
DBP (mmHg)	76.7±7.0	74.6±6.9	<0.01
HOMA-IR	1.84±0.9	2.00±1.25	0.103
hs-CRP (mg/dL)	0.100±0.1	0.122±0.1	0.195
HDL (mg/dL)	54.0±11.3	55.3±11.4	<0.05
LDL (mg/dL)	125.2±25.2	120.2±25.4	<0.01
TG (mg/dL)	131.6±59.5	122.8±59.3	<0.05
FPG (mg/dL)	97.7±9.5	94.8±8.5	<0.01