Meta-Analysis: Effects of Night Shift Work on Hypertension and Sleep Patterns in Factory Workers

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ABSTRACT

Background: Night shift work has an impact on the health of factory workers. One of the impacts of night shift work is the risk of hypertension and disturbed sleep patterns. The purpose of this study was to determine how big the effect of night shift work on hypertension and sleep patterns in factory workers.

Subjects and Method: This was a meta-analysis and systematic study with the population: factory workers. Intervention: night shift work. Comparation: morning and afternoon shift work. Outcome: hypertension and sleep patterns. The article search process was carried out according to the PRISMA Flow Diagram and searched through several indexes such as PubMed, ScienceDirect, Google Scholar, and Springer Link with the search keywords “Night Shift” AND “Hypertension” AND “Sleep” AND “Worker”. The articles used are articles from 2013-2022 and are written in English.

Results: A total of 11 articles originating from the Asian continent (China, Indonesia, South Korea, Malaysia, and Japan) were considered suitable for meta-analysis. From the results of data analysis that has been carried out, it is known that factory workers who work night shifts have a risk of experiencing hypertension (aOR= 3.43; 95% CI= 2.48 to 4.72; p<0.001), and disturbed sleep patterns (aOR= 3.63; 95% CI= 2.66 to 4.95; p<0.001) compared with morning and afternoon shift workers and the results were statistically significant.

Conclusion: Night shifts can increase the risk of hypertension and sleep disturbances in factory workers.

Keywords: Night shift, hypertension, sleep pattern, factory worker

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BACKGROUND

The industrial sector in Indonesia is very diverse, ranging from the food industry, cosmetics, textiles, transportation, electronics, energy generation, upstream, metals to the chemical industry. In the national industrial development master plan for 2015-2035, Indonesia targets to strengthen all fields in the industrial sector as a goal to realize the Vision of becoming a Resilient Industrial State (Ministry of Industry, 2019). The production process in the industrial sector generally runs continuously and without stopping, resulting in the need for a good and effective division of working hours so that workers do not work excessi-
vely and get bad effects such as psychological disorders and body functional disorders.

Generally, the application of work shifts will affect several things in the lives of workers such as sleeping hours, meal times, activity times, rest periods, and energy use (Hemmer et al., 2021). Shift work, especially night shifts, can cause disturbances in sleep patterns and rest periods, where sleep disturbances and rest periods have an impact on changes in sleeping hours and disturbances in sleep. Chronic sleep disturbances can impair blood circulation, increase blood pressure and increase heart rate. Some of these disorders will result in the risk of hypertension (Park et al., 2019).

The implementation of work shifts is important to do, especially for companies that carry out work processes or production processes that continue for 24 hours. However, seeing the negative impact of implementing this shift, it is necessary to make efforts to minimize this impact. So, the important role of experts, ranging from health workers, health promotion experts, occupational health and safety experts, the government to the company to make efforts to reduce the negative impact of implementing shift work.

The most common impacts due to the implementation of work shifts, especially on night shifts, are disturbances in sleep patterns and the risk of hypertension. To avoid and reduce this impact, it is recommended to check blood pressure regularly, maintain a healthy diet, lead a healthy lifestyle and not delay work so that there are no night work hours (Yeom et al., 2017).

Based on (IARC, 2010) shift work is a system of applying different working hours to normal working hours, which is outside 7 or 8 am to 5 or 6 pm every day. Shift work is the application of working hours that are not bound by the same time or can be adjusted as needed, have several variations of working hours and are not the same as the usual working hours.

Normal human blood pressure for systolic pressure is 110 mmHg while for diastolic blood pressure is 90 mmHg. Meanwhile, for someone who has a history of hypertension, systolic blood pressure is more than 140 mmHg and diastolic blood pressure is more than 90 mmHg. Hypertension can be influenced by many things such as heredity, gender, age and lifestyle, where lifestyles such as exercise habits, healthy eating patterns, age and lifestyle, where lifestyles greatly affect the incidence of hypertension (Hastuti, 2019). Sleep can be defined as a behavior when physical activity is reduced, there is reduced interaction with living things and with the environment, and is generally characterized by positions such as lying down, sitting and eyes closed. Functional sleep can help grow and develop as well as to maximize the learning process (Muniz, 2012).

Various studies have been conducted to determine the effect of night shift work on hypertension and sleep patterns, but the results of these studies are still inconsistent. In research conducted by (Guo et al., 2013) and (Yeom et al., 2017) (Yeom et al., 2017) it is known that night shift work is one of the risk factors for hypertension and disrupts worker patterns. Meanwhile, according to (Lu et al., 2017) and (Ceide et al., 2015) stated that there is no relationship between hypertension and sleep patterns with night shift work. Therefore, the purpose of this study was to determine the effect of night shift work on hypertension and sleep patterns in factory workers.
**SUBJECTS AND METHOD**

1. **Study Design**
This research is a meta-analysis and systematic study. Article searches were conducted based on the PRISM Flow Diagram and through several indexes such as PubMed, ScienceDirect, Google Scholar, and Springer Link. The research articles used are research from 2013-2013. The keywords used in the article search were “Night Shift” AND “Hypertension” AND “Sleep” AND “Worker”.

2. **Inclusion Criteria**
The inclusion criteria in this study were the articles used were primary studies with a cross sectional study design, research related to the effect of shift work on hypertension and sleep patterns in factory workers, and a quantitative study that had statistical values of OR/mean/median/SD/95% CI, written in both English and Indonesian, published articles from 2013-2022.

3. **Exclusion Criteria**
The exclusion criteria for this research are qualitative research articles, using a non-cross sectional study design, research conducted before 2013 and written in languages other than English and Indonesian.

4. **Operational Definition of Variables**
This research is a meta-analysis and systematic study written based on the predetermined PICO formula. The PICO formulation in this study is population: factory workers, intervention: night shift work, comparison: morning and afternoon shift work and outcome: hypertension and sleep patterns.

   Shift work is a night shift work hours carried out to meet the company’s operational needs for 24 hours. The night shift pattern usually applies at 20.00 – 03.00 or 23.00 – 07.00 am.

Hypertension is a condition where the blood pressure value reaches 140/90 mmHg or more.

Sleep pattern is a good quality of sleep measured by the duration of sleep and the presence or absence of disturbances during sleep.

5. **Study Instruments**
This research was conducted using the PRISMA Flow Diagram guide for article search and using the Critical Appraisal Checklist for Analytical Cross-sectional Studies (Joanna Briggs Institute 2017).

6. **Data Analysis**
Data analysis was carried out with the help of computer software, namely the review manager application (RevMan 5.3). Forest plots and Funnel plots will be used to determine the size of the effect of the effect of night shift work on hypertension and sleep patterns in factory workers and also to determine the heterogeneity of the data. Fixed effect model is used for homogeneous data, while random effect is used for heterogeneous data across sectors.

**RESULTS**
The article search process in this study was carried out using the PRISMA Flow Diagram guide and through several indexing such as PubMed, ScienceDirect, Google Scholar, and Springer Link which can be seen in Figure 1. In the early stages of article search, 629 articles were found. Then from that stage, checks for duplication, suitability of titles, abstracts to full articles are conducted. So, in the end, 11 articles were obtained for 2 outcomes in this study, namely hypertension and sleep patterns. The research articles used are primary research that has been carried out in various countries such as China, Indonesia, Japan, South Korea, and Malaysia, this can be seen in Figure 2.
The articles that will be used for meta-analysis and systematic studies have previously gone through the process of assessing the quality of the articles which can be seen in table 1. Then in table 2 it can be seen about the details of the articles used in this study, such as the study population, intervention, comparison, and the results of the research. Each study. All articles used in this study were articles with a cross-sectional study design and were written in English.

Figure 1. PRISMA Flowchart

Figure 2. Map of study area
Table 1. Assessment of study quality using the Critical Appraisal Checklist for Cross-sectional published by Checklist for Cross-sectional Study published (CEBM)

| No | Indicators                                                                 | Yang et al. (2021) | Debora et al. (2020) | Lu et al. (2017) | Kawabe et al. (2014) | Lim et al. (2020) | Yeom et al. (2017) | Sheon et al. (2016) | Kim et al. (2015) | Oh et al. (2014) |
|----|---------------------------------------------------------------------------|-------------------|---------------------|----------------|---------------------|-----------------|-----------------|-----------------|----------------|----------------|
| 1  | Were the inclusion criteria well explained?                               | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
| 2  | Is the subject and location of the research clear?                        | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
| 3  | Is the measurement of the independent variable valid and reliable?        | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
| 4  | Is there a standard of measurement in the study?                          | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
| 5  | Is there a confounding factor?                                            | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
| 6  | Is there control over the confounding factors?                            | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 0              | 1              |
| 7  | Is the measurement of the dependent variable valid and reliable?          | 1                 | 0                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
| 8  | Was a good data analysis done?                                            | 1                 | 1                   | 1              | 1                   | 1               | 1               | 1               | 1              | 1              |
|    | **Total**                                                                 | **8**             | **7**               | **8**          | **8**               | **8**           | **8**           | **8**           | **7**          | **8**          |

Note: 1: Yes; 0: No
Table 2. Description of primary studies included in the meta-analysis

| Author (Year)          | Country     | Study Design     | Sample | Population                      | Intervention       | Comparison                  | Outcome                                | aOR (95%CI)                |
|------------------------|-------------|------------------|--------|---------------------------------|--------------------|-----------------------------|----------------------------------------|---------------------------|
| Yang et al. (2021)     | China       | Cross sectional  | 3040   | Oil Factory Workers             | Night Work Shift   | Morning and Afternoon Shift | Sleep Patterns and Hypertension        | 1.70 (1.17 to 2.47)       |
| Debora and Widanarko   | Indonesia   | Cross sectional  | 107    | Construction company workers    | Night Work Shift   | Morning and Afternoon Shift | Hypertension                          | 7.47 (2.48 to 4.32)       |
| Lu et al. (2017)       | China       | Cross sectional  | 4519   | Stone Factory Workers           | Night Work Shift   | Morning and Afternoon Shift | Sleep Patterns                         | 1.97 (1.40 to 2.79)       |
| Kawabe et al. (2014)   | Japan       | Cross sectional  | 4427   | Factory worker                  | Shift work         | Non-Shift Work              | Hypertension                           | 1.51 (0.98 to 1.97)       |
| Lim et al. (2018)      | China       | Cross sectional  | 494    | Manufacturing Factory Workers   | Night Work Shift   | Morning and Afternoon Shift | Sleep Pattern                          | -1.43 (-2.15 to -0.84)    |
| Yeom et al. (2017)     | South Korea | Cross sectional  | 1953   | Chemical Factory Workers        | Night Work Shift   | Morning and Afternoon Shift | Hypertension                           | 1.51 (1.11 to 2.06)       |
| Shon et al. (2016)     | South Korea | Cross sectional  | 4750   | Electronics Factory Workers     | Shift work         | Non-Shift Work              | Sleep Pattern                          | 1.95 (1.58 to 2.41)       |
| Kim et al. (2015)      | South Korea | Cross sectional  | 2818   | Manufacturing Factory Workers   | Night Work Shift   | Morning and Afternoon Shift | Sleep Pattern                          | 1.42 (1.13 to 1.77)       |
Table 2. Cont.

| Author (Year)     | Country     | Study Design       | Sample | Population               | Intervention       | Comparison         | Outcome          | aOR (95%CI)       |
|-------------------|-------------|--------------------|--------|--------------------------|--------------------|--------------------|------------------|------------------|
| Oh et al. (2014)  | South Korea | Cross-sectional    | 1029   | Aluminum Factory Workers | Shift work         | Non-Shift Work     | Hypertension      | 1.39 (0.91 to 2.13) |
| Itani et al. (2022) | Japan       | Cross-sectional    | 2375   | Factory worker           | Shift work         | Non-Shift Work     | Sleep Pattern    | 0.90 (0.60 to 1.36) |
| Wang et al. (2022) | China       | Cross-sectional    | 3240   | Aluminum Factory Workers | Night Work Shift   | Morning and Afternoon Shift | Sleep Pattern    | 1.64 (1.10 to 2.46) |
| Anane et al. (2015) | Japan       | Cross-sectional    | 200    | Chocolate Factory Workers | Night Work Shift   | Morning and Afternoon Shift | Hypertension      | 0.40 (0.13 to 0.73)  |
a. Forest plot
The results of the meta-analysis of the effects of night shift work on hypertension can be seen through the forest plot in Figure 3, where from these results it is known that night shift work affects the risk of increasing hypertension. Factory workers who work on night shifts have a risk of experiencing hypertension by 3.43 times compared to morning and afternoon shifts and is statistically significant (aOR=3.43; 95% CI=2.48 to 4.72; p<0.001). The heterogeneity of the data I²=85% so that the distribution of the data is declared heterogeneous (random effect model).

b. Funnel plot
Based on Figure 4, it shows that there is a publication bias which is indicated by the asymmetry of the right and left plots where 5 plots are on the right and 2 plots are on the left. The plot on the right of the graph appears to have a standard error (SE) between 0.2 and 0.5. The plot on the left of the graph appears to have a standard error (SE) between 0 and 0.2. Bias also occurs from the imbalance between the distances between studies on both the right and left sides of the funnel plot.
The results of the meta-analysis of the effects of night shift work on sleep patterns can be seen through the forest plot of Figure 5, where from these results it is known that night shift work affects workers' sleep patterns. Factory workers who work on night shifts have a 3.63 times risk of disturbed sleep patterns compared to morning and afternoon shifts and are statistically significant (aOR = 3.63; 95% CI = 2.66 to 4.95; p < 0.001). The heterogeneity of the research data showed $I^2 = 86\%$ so that the distribution of the data was declared heterogeneous (random effect model).

b. Funnel plot

Figure 6 shows that there is a publication bias which is indicated by the asymmetry of the right and left plots, where 4 plots are on the right and 3 plots are on the left. The plot on the right of the graph appears to have a standard error (SE) between 0.1 and 0.3. The plot on the left of the graph appears to have a standard error (SE) between 0 and 0.4. Bias also occurs from the imbalance between the distances...
This research is a meta-analysis and systematic study, with the final result knowing how much effect night shift work has on hypertension and sleep patterns in factory workers. The data collection process uses the PRISMA Flow Diagram guide. Data analysis was carried out with the help of computer software, namely the review manager application (RevMan 5.3). The final result of this research is displayed in the form of forest and funnel plots.

The forest plot shows information about each study and visually shows the magnitude of variation or heterogeneity of the study results, while the funnel plot is later used to show the magnitude of the study effect from various studies measured in different ways (Murti, 2018).

From the article search process, 11 primary research articles were found regarding the effects of night shift work on hypertension and sleep patterns in factory workers. The research was conducted in various countries such as China, Indonesia, South Korea, Japan and Malaysia.

The search and determination of the articles used were carried out in accordance with the PRISMA Flow Diagram and the inclusion and exclusion criteria that had been previously determined. The inclusion criteria in this study are research articles published in 2013-2022, research with a cross-sectional study design, written in English or Indonesian and have statistical values in the form of adjusted odds ratio (aOR) and confident interval (CI).

In this study, a cross-sectional study design was used to determine the effect of night shift work (Intervention) on hypertension and sleep patterns (Outcome) in the research subject, namely factory workers. In the research, factory workers are referred to not only from one type of factory work but from several types of work, such as motorcycle factory workers, industrial factory workers, chemical factory workers, stone, and aluminum factory workers. The similarity of characteristics in the research population is regarding the duration of working hours and also work shifts, namely night shift workers and working for 8 hours per day.

1. Effects of night shift work on hypertension

Night shift work has an effect on the risk of increasing hypertension. Factory workers who work on night shifts have a 3.43 times higher risk of developing hypertension compared to morning and afternoon shifts. The effect between night shift work and hypertension was shown to be significant (aOR= 3.43; 95% CI= 2.48 to 4.72; p <0.001). The heterogeneity of the research data shows I²= 85% so that the distribution of the data is declared heterogeneous (random effect model).

The results of the effect of night shift work on hypertension are in line with research conducted by (Yeom et al, 2017) regarding the relationship between work shifts and the incidence of hypertension in factory workers in South Korea, it is known that work shifts are associated with the incidence of hypertension. In his research, it was explained that work shifts can affect hypertension from 2 things, the first is the duration of work and the length of work of...
workers. The longer the duration and working period of a person, the higher the risk of hypertension. On average, shift workers who are affected by hypertension due to their working hours have a working period of about 20 years, but it also does not rule out the possibility of a lower working period of <10 years having a risk of developing hypertension. Blood pressure in shift workers will be more difficult to regulate than non-shift workers. Therefore, it is necessary to have regular blood pressure measurements and maintain a healthy lifestyle to avoid the risk of hypertension. In a study conducted by (Anane et al, 2015) it was also explained that work shifts can increase stress on workers. Work stress will lead to unhealthy lifestyles and patterns, such as alcohol consumption. Work stress is also a risk factor for hypertension. This study also explained that there was a decrease in the trend of hypertension in shift workers aged 50-59 years, this was because the company provided a heavier workload at a more productive age and caused the elderly to have lower stress levels.

Shift work, especially night shifts, can affect the incidence of hypertension in workers, but there are also other things that make it worse, such as alcohol consumption, physical activity, exercise habits, and most importantly good sleep habits and patterns.

2. The effect of night shift work on sleep patterns

Based on the primary research used, 2 measurements were used to measure sleep patterns of workers, namely PSQI and AIS. Poor sleep patterns such as the habit of waking up during sleep, short sleep duration and poor sleep quality can have an impact on increasing the risk of hypertension, this can be exacerbated if you are a shift worker, especially the night shift (Yang et al, 2021). Night shifts can affect sleep patterns and disrupt circadian rhythms. Where this can be a risk factor for hypertension. The mechanism of night shift work can affect the sympathetic nervous system, endothelial dysfunction, and kidney work (Guo et al, 2013).

The results of the analysis of the effect of night shift work on sleep patterns in factory workers are also in line with research conducted by (Kim et al., 2015). It was explained in the study that night shifts affect a person's sleep quality. As for things that also affect work shifts, such as type of work, work shift rotation patterns, number of night shifts, and rest periods and holidays. In general, night shift workers have less sleep and lower levels of concentration than non-shift workers. Where things like lack of sleep and low concentration of workers are things that must be considered so as not to cause accidents.

Disruptions to sleep patterns due to night shifts are generally in the form of difficulty sleeping, insomnia, waking at night, and drowsiness during the day (Wang et al., 2022). Sleep disturbances due to shift work can be exacerbated by several factors such as length of work, alcohol consumption, duration of work shifts, working hours per week, smoking habits, physical activity, and rest periods (Shon et al., 2016). Based on tests that have been carried out on animals and people suffering from insomnia, lack of sleep can increase sympathetic activity and cause vascular endothelial dysfunction. Insomnia can also
lead to higher systolic blood pressure, a higher risk of developing hypertension, diabetes and dyslipidemia (Wang et al., 2022).

**AUTHOR CONTRIBUTION**
Amanda Kesli Ramadhani as the main writer who determines the topic, searches for and determines the article, Hanung Prasetya and Bhisma Murti conduct data analysis and conduct a writing review.

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**CONFLICT INTEREST**
There is no conflict of interest in this study.

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