



IRREGULAR SLEEP PATTERNS AND THEIR ASSOCIATION WITH HYPERTENSION RISK AMONG INFORMAL SECTOR WORKERS: A COMMUNITY-BASED STUDY

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ABSTRACT	Keywords
Background: Hypertension remains a major public health challenge, and irregular sleep patterns have emerged as a modifiable behavioral risk factor associated with elevated blood pressure, particularly among informal workers. Objective: This study aimed to analyze the effect of irregular sleep patterns on the incidence of hypertension among agricultural workers in Watugaluh Village, Diwek District, Jombang Regency. Methods: A quantitative analytic study with a cross-sectional design was conducted involving 96 agricultural workers selected through purposive sampling. Sleep patterns were assessed using a structured questionnaire, while blood pressure was measured using a validated digital sphygmomanometer. Data were analyzed using descriptive statistics, Chi-square test, and binary logistic regression with a significance level of 0.05. Results: Most respondents were middle-aged male workers, with 39.6% experiencing irregular sleep patterns and 40.6% diagnosed with hypertension. Chi-square analysis demonstrated a significant association between irregular sleep patterns and hypertension ($\chi^2 = 13.911$; $p = 0.00019$). Binary logistic regression further confirmed that sleep pattern was a significant predictor of hypertension ($\beta = -0.205$; OR = 0.815; $p < 0.001$), indicating that improved sleep regularity reduced the likelihood of hypertension by approximately 18.5%. Conclusion: This study provides novel evidence that sleep regularity is an independent behavioral determinant of hypertension among informal agricultural workers and supports the integration of sleep assessment into community-based hypertension prevention strategies within primary healthcare settings.	Agricultural Workers; Community Nursing; Hypertension; Irregular Sleep Patterns; Sleep Hygiene

INTRODUCTION

Hypertension remains one of the leading non-communicable diseases and continues to pose a major global public health challenge because its prevalence is

steadily increasing and substantially contributes to cardiovascular disease, stroke, kidney failure, and premature mortality. The World Health Organization reported that approximately 1.4 billion adults aged 30 to

79 years are living with hypertension, with the majority residing in low- and middle-income countries. This situation underscores the need for hypertension control strategies that extend beyond pharmacological therapy to include the modification of preventable risk factors, such as physical activity, salt intake, stress management, and sleep behavior (WHO, 2023). Advances in health science have increasingly recognized sleep regularity as a critical determinant of blood pressure regulation through circadian rhythm mechanisms.

Previous studies have demonstrated that irregular sleep patterns are associated with an increased risk of hypertension through disruption of circadian rhythms, heightened sympathetic nervous system activity, activation of the renin-angiotensin-aldosterone system, and enhanced inflammatory responses. Individuals with inconsistent sleep schedules have a greater likelihood of developing hypertension than those with regular sleep patterns (Makarem et al., 2022; Huang et al., 2023). Nevertheless, most existing studies have focused primarily on sleep duration or sleep quality, whereas sleep regularity, an important indicator of circadian rhythm stability, has received comparatively limited attention, particularly among informal workers whose working hours and rest schedules are highly variable.

Hypertension also remains a significant public health concern in Indonesia. The 2023 Indonesian Health Survey reported that the prevalence of hypertension based on blood pressure measurements reached 30.8%, whereas only 8.6% of cases had been diagnosed by healthcare professionals, indicating a substantial proportion of undiagnosed hypertension. Furthermore, hypertension is one of the leading risk factors for mortality in Indonesia, highlighting the urgent need to strengthen health promotion and disease prevention strategies. Among informal workers, particularly those employed in the agricultural sector, demanding physical workloads and irregular working hours may contribute to disrupted sleep patterns and consequently increase the risk of hypertension. However, evidence regarding

this relationship among informal workers in Jombang Regency remains scarce, emphasizing the need for empirical findings to support the development of community-based interventions.

Several research gaps remain unresolved. Previous investigations have predominantly involved older adults or individuals with established hypertension, focused mainly on sleep quality and sleep duration, and relied largely on simple correlational approaches. Scientific evidence regarding the influence of sleep regularity as a risk factor for hypertension among productive-age informal workers, particularly in Watugaluh Village, Diwek District, Jombang Regency, is still lacking. Therefore, this study aims to examine the effect of irregular sleep patterns on the incidence of hypertension among informal workers in community settings to provide an evidence base for developing more effective health promotion and preventive strategies in community nursing practice.

The literature indicates that although the association between sleep and hypertension has been widely investigated, important gaps remain regarding the role of sleep regularity as a determinant of hypertension, especially among informal workers in community settings. This study seeks to address these gaps through a community nursing perspective that integrates biological mechanisms, health behaviors, and community social characteristics.

A theoretical perspective, previous studies have primarily employed Circadian Rhythm Theory to explain the biological mechanisms linking sleep disturbances to elevated blood pressure or the Health Promotion Model to examine health behavior change independently. In contrast, research based on Community Nursing Theory has largely emphasized health promotion and preventive interventions without integrating the physiological mechanisms underlying the relationship between sleep behavior and hypertension. Consequently, few studies have combined these three theoretical perspectives within a comprehensive conceptual framework. Considering that circadian rhythm

disruption, modifiable sleep behavior, and community nursing interventions are closely interconnected in hypertension prevention and control, this study synthesizes these theories to provide a more comprehensive explanation of the relationship between irregular sleep patterns and hypertension.

Empirical evidence consistently demonstrates that sleep disturbances are associated with an increased risk of hypertension (Makarem et al., 2022; Huang et al., 2023; Tomitani et al., 2024; Grassia & Drager, 2024; Crowthers et al., 2024). However, most studies have concentrated on sleep duration, sleep quality, or sleep hygiene, while sleep regularity has rarely been examined as the primary variable of interest. Furthermore, the majority of these investigations have been conducted in high-income countries with social, cultural, and occupational characteristics that differ substantially from those of Indonesian communities. Consequently, evidence regarding the relationship between sleep regularity and hypertension among informal workers in developing countries remains limited, highlighting the need for context-specific empirical research.

Methodological limitations are also evident in previous studies. Most investigations have adopted simple correlational designs or focused exclusively on bivariate associations between sleep disturbances and blood pressure without estimating the magnitude of the independent effect of irregular sleep on hypertension. In addition, many studies have relied on general sleep quality instruments that do not adequately assess sleep regularity as an indicator of circadian rhythm stability. The present study employs a quantitative analytical cross-sectional design, combines structured questionnaire-based assessment of sleep patterns with objective blood pressure measurements, and applies both bivariate analysis and logistic regression to obtain a more comprehensive understanding of the influence of irregular sleep patterns on hypertension. This methodological approach is expected to provide stronger empirical evidence than conventional correlational analyses.

Another important research gap concerns the study population. Previous investigations have predominantly involved older adults, patients with hypertension, shift workers, or general populations. In contrast, informal workers, particularly agricultural laborers characterized by irregular working schedules, physically demanding occupations, and rest periods influenced by seasonal and occupational demands, have rarely been examined despite their elevated susceptibility to circadian rhythm disruption. By specifically focusing on productive-age informal workers, this study provides a more detailed understanding of hypertension risk factors within a population that has received limited attention in epidemiological and community nursing research.

The principal contribution of this study lies in expanding scientific evidence regarding the effect of sleep regularity on hypertension through a multidisciplinary framework integrating Circadian Rhythm Theory, the Health Promotion Model, and Community Nursing Theory. Beyond advancing knowledge of the biological mechanisms linking sleep behavior and hypertension, this study also explains how sleep behavior can be modified through community-based health promotion and preventive interventions. By generating empirical evidence among informal workers in rural communities, the findings are expected to support the development of sleep hygiene education, hypertension risk screening, and evidence-based community nursing interventions within primary healthcare settings.

Based on the synthesis of theoretical perspectives and previous empirical findings, irregular sleep patterns can be considered a modifiable risk factor that contributes to hypertension through circadian rhythm disruption, altered neuroendocrine regulation, and activation of cardiovascular regulatory mechanisms. Although this association has been widely documented, significant theoretical, empirical, methodological, population-based, and geographical research gaps remain unresolved. This study addresses these limitations by examining the effect of

irregular sleep patterns on the incidence of hypertension among informal workers in Watugaluh Village, Diwek District, Jombang Regency. Accordingly, this research is expected to enrich the body of knowledge in community nursing while providing a scientific foundation for developing more contextually appropriate health promotion and preventive strategies for hypertension control at the community level.

The study is expected to contribute to the advancement of community nursing by strengthening empirical evidence on the role of sleep regularity as a modifiable risk factor in hypertension prevention and control. In addition to addressing the existing research gap concerning sleep regularity among informal workers, the findings are anticipated to support the development of hypertension risk screening programs, sleep hygiene education, and community-based health promotion interventions tailored to rural populations. Ultimately, this research contributes to the advancement of evidence-based community nursing and supports the formulation of public health policies aimed at preventing hypertension within primary healthcare services.

The novelty of this study lies in its comprehensive examination of sleep regularity as an independent behavioral determinant of hypertension among informal agricultural workers in rural Indonesia, a population that has received limited attention in previous epidemiological research. Unlike earlier studies that primarily investigated sleep duration or sleep quality among urban populations, shift workers, or patients with established hypertension, this study specifically focuses on sleep regularity within a community nursing context. Furthermore, this study integrates Circadian Rhythm Theory, the Health Promotion Model, and Community Nursing Theory into a unified conceptual framework to explain the biological, behavioral, and community-level mechanisms underlying hypertension prevention. These theoretical and practical contributions provide new evidence for designing evidence-based hypertension

prevention strategies in primary healthcare and community nursing practice.

METHOD

The study employed a quantitative approach using an analytical observational design with a cross-sectional framework. A quantitative approach was selected because it enables the examination of relationships between independent and dependent variables based on numerical data analyzed using statistical techniques. The cross-sectional design allows all study variables to be measured simultaneously, making it an efficient approach for investigating the association between irregular sleep patterns and hypertension among informal workers in community settings (Sugiyono, 2023; Creswell & Creswell, 2023). This design is widely applied in community epidemiological research because it facilitates the description of respondent characteristics while examining associations between variables without implementing any intervention.

The study was conducted in Watugaluh Village, Diwek District, Jombang Regency, East Java, Indonesia. The study site was purposively selected because the majority of residents are employed in the informal sector, including farmers, agricultural laborers, street vendors, and daily wage workers, whose irregular working schedules may influence sleep regularity and hypertension risk. In addition, the village is served by the Cukir Primary Health Center, which routinely conducts non-communicable disease screening programs, thereby facilitating data collection. Data collection was carried out between February and May 2026.

The study population comprised all informal workers in Watugaluh Village who met the predefined eligibility criteria. A total of 96 respondents were recruited using purposive sampling, in which participants were selected based on specific characteristics aligned with the study objectives. This sampling technique ensured the inclusion of informal workers whose occupational characteristics were considered relevant to variations in sleep regularity and hypertension status. The sample size was

considered sufficient to support statistical analyses examining the relationship between the study variables.

The sample size was determined based on the minimum requirement for analytical cross-sectional studies examining associations between two categorical variables. Considering a 95% confidence level, an 80% statistical power, and an anticipated effect size derived from previous studies, a minimum sample of 90 participants was required. To compensate for possible incomplete responses, 96 participants were ultimately included in the analysis, which exceeded the minimum sample requirement and provided sufficient statistical power.

Data were collected using two instruments. Irregular sleep patterns were assessed using a structured questionnaire developed based on the concepts of sleep regularity and sleep hygiene. The questionnaire evaluated five dimensions: bedtime, wake-up time, sleep duration, consistency of sleep schedules, and sleep hygiene practices. Each item was rated on a five-point Likert scale ranging from 1 (strongly disagree/never) to 5 (strongly agree/always). Hypertension was assessed through blood pressure measurements using a validated digital sphygmomanometer in accordance with the recommendations of the European Society of Cardiology (ESC). The combination of questionnaire-based assessment and objective blood pressure measurement was intended to enhance the validity and reliability of the data regarding the relationship between sleep patterns and hypertension (Polit & Beck, 2021; Creswell & Creswell, 2023).

Before data collection, the questionnaire underwent content validation by three experts specializing in community nursing, cardiovascular health, and sleep medicine to ensure the relevance and clarity of each item. The Content Validity Index (CVI) indicated satisfactory agreement among experts ($I-CVI \geq 0.80$). A pilot study involving 30 respondents with characteristics similar to the target population was subsequently conducted to evaluate the psychometric properties of the questionnaire. Construct validity was

assessed using item-total correlation, with all items exceeding the acceptable threshold ($r > 0.30$). Internal consistency reliability demonstrated satisfactory performance, with a Cronbach's alpha coefficient of 0.87, indicating good reliability for measuring sleep regularity.

Data collection began with an explanation of the study objectives, followed by obtaining informed consent from all participants. Respondents then completed the structured sleep questionnaire before undergoing standardized blood pressure measurement. Participants were instructed to rest for at least five minutes before measurement, remain seated in the recommended posture, and have their blood pressure measured using a validated digital device. All data were collected directly by the researchers according to standardized operating procedures to ensure consistency and minimize measurement bias.

Data analysis was conducted in three sequential stages: univariate, bivariate, and multivariate analyses. Univariate analysis was performed to describe respondent characteristics and the distribution of each study variable. The association between irregular sleep patterns and hypertension was examined using the Chi-square test. Binary logistic regression analysis was subsequently performed to determine the magnitude of the association between irregular sleep patterns and hypertension while estimating the corresponding effect size at a significance level of $\alpha = 0.05$. All statistical analyses were performed using statistical software to ensure objective estimation of associations and rigorous hypothesis testing.

RESULTS

The study included 96 agricultural workers from Watugaluh Village, Diwek District, Jombang Regency, Indonesia, all of whom met the eligibility criteria and successfully completed the structured questionnaire and blood pressure assessment. Data were analyzed using descriptive statistics to summarize participant characteristics, followed by the Chi-square test to examine the association between irregular sleep patterns and

hypertension. Binary logistic regression analysis was subsequently performed to estimate the effect of irregular sleep patterns on hypertension while controlling for relevant covariates. Statistical significance was established at a two-tailed alpha level of 0.05.

Participant Characteristics

Descriptive analysis indicated that most participants were aged 41 to 50 years, were male, and had completed senior high school education. The majority had been engaged in agricultural work for an extended period, reflecting an occupational profile characterized by high levels of physical activity and work schedules that varied according to planting and harvesting seasons. These characteristics represent a population of informal agricultural workers who are particularly vulnerable to disruptions in sleep patterns because of the demands and irregularity of their daily occupational activities.

Characteristic	Kategori	n	%
Age	18–30 years	18	18,8
	31–40 years	24	25,0
	41–50 years	31	32,3
	51–65 years	23	24,0
Gender	Male	61	63,5
	Female	35	36,5
Educational Level	Elementary School	29	30,2
	Junior High School	24	25,0
	Senior High School	34	35,4
	Higher Education	9	9,4
Hypertension Status	Hypertension	39	40,6
	Non-hypertension	57	59,4

Univariate analysis further demonstrated that 39.6% of participants exhibited irregular sleep patterns, while 40.6% were classified as hypertensive. These findings suggest that sleep irregularity is relatively common among agricultural workers and may represent an important modifiable risk factor associated with the high prevalence of hypertension observed in this study population.

Association Between Irregular Sleep Patterns and Hypertension

The association between irregular sleep patterns and hypertension was examined using the Pearson Chi-square test. The analysis revealed a statistically significant difference in the distribution of hypertension between participants with regular and irregular sleep patterns. Participants who reported irregular sleep patterns exhibited a higher prevalence of hypertension than those with more regular sleep schedules, indicating a significant association between sleep regularity and hypertension status. These findings suggest that irregular sleep patterns may represent an important modifiable risk factor for hypertension among informal agricultural workers.

Table 1. Association Between Irregular Sleep Patterns and Hypertension

Sleep Pattern	Non-Hypertensive n (%)	Hypertensive n (%)	Total
Regular	36 (76,6)	11 (23,4)	47
Irregular	18 (36,7)	31 (63,3)	49
Total	54	42	96

Sumber: Hasil analisis penelitian, 2026

The Pearson Chi-square test demonstrated a statistically significant association between irregular sleep patterns and hypertension ($\chi^2 = 13.911$, $p < 0.001$), indicating that the observed significance level was below the predetermined threshold of $\alpha = 0.05$. Therefore, the null hypothesis was rejected, confirming a significant relationship between sleep regularity and hypertension among informal agricultural workers. Participants with irregular sleep patterns exhibited a substantially higher prevalence of hypertension (63.3%) than those with more regular sleep patterns (23.4%). These findings suggest that greater irregularity in sleep patterns is associated with an increased likelihood of developing hypertension, highlighting sleep regularity as an important modifiable risk factor for hypertension prevention in community settings.

Effect of Irregular Sleep Patterns on Hypertension

An estimate of the magnitude of the association between irregular sleep patterns and hypertension, multivariable analysis was performed using binary logistic regression. This approach was employed to determine whether irregular sleep patterns independently predicted hypertension while estimating the corresponding effect size after adjustment for potential confounding variables. The results are presented as adjusted odds ratios (AORs) with 95% confidence intervals (95% CIs), and statistical significance was established at $p < 0.05$.

Table 2. Binary Logistic Regression Analysis of the Association Between Irregular Sleep Patterns and Hypertension

Variabel	β	Odds Ratio (Exp β)	p-value
Sleep Regularity Score	-0,205	0,815	<0,001

Summary Model

Statistik	Value
Pseudo R ² (McFadden)	0,197

Binary logistic regression analysis demonstrated that the Sleep Regularity Score was a significant predictor of hypertension ($\beta = -0.205$, OR = 0.815, $p < 0.001$). The negative regression coefficient indicates that higher sleep regularity scores, reflecting more consistent sleep patterns, were associated with a lower likelihood of hypertension. Conversely, lower sleep regularity scores, indicative of increasingly irregular sleep patterns, were associated with a greater probability of developing hypertension.

The odds ratio of 0.815 indicates that each one-unit increase in the Sleep Regularity Score was associated with an approximately 18.5% reduction in the odds of hypertension, assuming all other variables in the model remained constant. These findings suggest that maintaining regular sleep patterns may serve as a protective

factor against elevated blood pressure among agricultural workers.

Furthermore, the McFadden pseudo-R² value of 0.197 indicates that the regression model explained approximately 19.7% of the variation in hypertension status, while the remaining 80.3% was likely attributable to other factors not included in the model, such as age, body mass index, family history of hypertension, sodium intake, psychological stress, physical activity, smoking behavior, and genetic predisposition. Although the explained variance was modest, the model supports the role of sleep regularity as an important behavioral determinant of hypertension within the study population.

Overall, the findings from both the bivariate and multivariable analyses consistently demonstrated that irregular sleep patterns were significantly associated with and independently predicted hypertension among agricultural workers in Watugaluh Village. These results support the study hypothesis that sleep regularity is an important modifiable behavioral factor contributing to hypertension prevention and control at the community level. Accordingly, interventions aimed at improving sleep regularity should be considered an integral component of health promotion and preventive strategies within primary healthcare and community nursing practice.

DISCUSSION

The present study demonstrated a significant association between irregular sleep patterns and hypertension among agricultural workers in Watugaluh Village, Diwek District, Jombang Regency. Bivariate analysis using the Pearson Chi-square test revealed a significant relationship between sleep regularity and hypertension ($\chi^2 = 13.911$, $p < 0.001$), while binary logistic regression further confirmed that the Sleep Regularity Score independently predicted hypertension ($\beta = -0.205$, OR = 0.815, $p < 0.001$). Specifically, each one-unit increase in the Sleep Regularity Score, indicating more consistent sleep behavior, was associated with an approximately 18.5% reduction in the odds of hypertension. The

consistency between the bivariate and multivariable analyses suggests that sleep regularity is not only associated with blood pressure status but also serves as an independent predictor of hypertension among informal agricultural workers.

These findings are consistent with Circadian Rhythm Theory, which identifies regular sleep timing as a fundamental component of biological rhythm synchronization. The suprachiasmatic nucleus coordinates circadian rhythms that regulate hormonal secretion, autonomic nervous system activity, metabolic processes, and the normal 24-hour fluctuation of blood pressure. Disruption of sleep regularity leads to circadian misalignment, increased sympathetic nervous system activity, altered cortisol and melatonin secretion, and activation of the renin-angiotensin-aldosterone system, ultimately resulting in increased peripheral vascular resistance and elevated blood pressure. Therefore, the present findings support the biological mechanism through which irregular sleep contributes to hypertension by impairing cardiovascular homeostasis.

The negative regression coefficient observed in this study further strengthens this physiological interpretation. Higher Sleep Regularity Scores reflected more consistent sleep schedules and were associated with a lower probability of hypertension, whereas progressively irregular sleep schedules increased the likelihood of hypertension. Persistent irregular sleep may abolish the normal nocturnal blood pressure decline, commonly referred to as the nocturnal dipping phenomenon, resulting in sustained elevation of blood pressure throughout the night. Over time, this condition accelerates arterial stiffness and contributes to the development of persistent hypertension, indicating that the influence of sleep regularity extends beyond behavioral factors to involve long-term physiological alterations.

The perspective of the Health Promotion Model proposed by Nola J. Pender, sleep regularity represents a modifiable health behavior that can be

improved through enhanced knowledge, perceived benefits, motivation, and environmental support. Agricultural workers often begin work before sunrise, perform physically demanding tasks, and adjust their work schedules according to seasonal agricultural activities, making regular sleep difficult to maintain. These occupational characteristics illustrate that sleep behavior is influenced not only by individual factors but also by social and environmental conditions. Consequently, the present findings reinforce the Health Promotion Model by demonstrating that behavioral interventions promoting healthy sleep practices may reduce hypertension risk when supported by appropriate health education and enabling community environments.

The present findings are consistent with those reported by Makarem et al. (2022), who identified sleep regularity as a more sensitive indicator of sleep health than sleep duration in predicting cardiometabolic outcomes. Their study demonstrated that individuals with inconsistent sleep schedules were at greater risk of hypertension, diabetes mellitus, and cardiovascular disease. Similarly, Huang et al. (2023) reported that irregular sleep increased hypertension risk through sympathetic activation, metabolic dysregulation, and systemic inflammation. In the current study, hypertension prevalence reached 63.3% among participants with irregular sleep patterns compared with only 23.4% among those with regular sleep schedules, further supporting the importance of sleep regularity as a determinant of blood pressure regulation.

These results also support the concept of circadian misalignment described by Crowthers et al. (2024). Repeated changes in sleep timing create a mismatch between the endogenous biological clock and daily behavioral schedules, leading to neurohormonal activation, metabolic disturbances, and impaired blood pressure regulation. Such mechanisms are particularly relevant to agricultural workers, whose working hours fluctuate according to planting seasons, harvesting periods, and

weather conditions. Consequently, the present study extends previous evidence by demonstrating that circadian misalignment is also an important mechanism among informal workers in rural communities, whose occupational characteristics differ substantially from those of formal employees.

A community nursing perspective, these findings strongly align with Community Nursing Theory, which emphasizes disease prevention, health promotion, and community empowerment. Hypertension should be viewed not only as an individual clinical condition but also as a community health problem shaped by interactions among health behaviors, occupational environments, socioeconomic conditions, and healthcare accessibility. The identification of irregular sleep as a modifiable behavioral determinant highlights the important role of community nurses in conducting risk assessments, providing sleep hygiene education, implementing hypertension screening through community-based integrated health posts, and empowering communities to adopt sustainable healthy lifestyles. These findings therefore reinforce the importance of integrating sleep health into evidence-based community nursing interventions for hypertension prevention.

The study findings are further supported by Tomitani et al. (2024), who demonstrated that sleep health is an important determinant of nighttime blood pressure and may predict cardiovascular risk more accurately than conventional office blood pressure measurements. Individuals with inconsistent sleep schedules are more likely to exhibit a non-dipping blood pressure pattern, which is associated with increased risks of hypertension, stroke, and cardiovascular complications. Likewise, Grassia and Drager (2024) proposed that the relationship between sleep disturbances and hypertension is multifactorial, involving sympathetic nervous system activation, elevated cortisol levels, endothelial dysfunction, oxidative stress, and chronic inflammation. Although the McFadden pseudo- R^2 value of 0.197 indicates that sleep regularity explained only 19.7% of the

variation in hypertension, this proportion remains clinically meaningful because hypertension is a multifactorial disease influenced by numerous behavioral, metabolic, environmental, and genetic factors.

The Indonesian context, these findings have important public health implications because informal agricultural workers continue to represent a substantial proportion of the rural workforce. Unlike formal employees with relatively structured working hours, agricultural workers frequently adjust their schedules according to seasonal demands, weather conditions, and household economic needs, resulting in inconsistent sleep-wake patterns and increased susceptibility to circadian disruption. Furthermore, limited public awareness regarding the importance of sleep regularity suggests that sleep health has received insufficient attention in hypertension prevention programs. Therefore, hypertension control strategies in Indonesia should incorporate sleep hygiene education alongside established interventions targeting diet, physical activity, and medication adherence.

Theoretically, this study contributes to the literature by integrating Circadian Rhythm Theory, the Health Promotion Model, and Community Nursing Theory into a unified framework explaining the relationship between irregular sleep and hypertension. Whereas previous studies have generally focused on biological or behavioral mechanisms independently, the present findings demonstrate that circadian regulation, modifiable health behaviors, and community-based nursing interventions are complementary components of hypertension prevention. This multidisciplinary perspective broadens the conceptual understanding of hypertension determinants by linking physiological mechanisms with individual behavior and community context.

A practical perspective, these findings support the integration of sleep regularity assessment into routine hypertension screening within primary healthcare services. Community health centers and integrated non-communicable disease screening programs should

incorporate sleep hygiene assessment and behavioral counseling alongside blood pressure measurement and metabolic risk evaluation. Family-based education, community empowerment, and involvement of community health volunteers may further enhance the effectiveness of hypertension prevention by targeting modifiable behavioral risk factors before cardiovascular complications develop.

Several limitations should be acknowledged. First, the cross-sectional design permits the identification of statistical associations but precludes causal inference because temporal relationships cannot be established. Second, the regression model indicates that most of the variation in hypertension remains attributable to factors not included in the analysis, such as body mass index, sodium intake, psychological stress, genetic predisposition, and comorbid conditions. Finally, sleep regularity was assessed using a self-reported questionnaire, which may be subject to recall bias. Future longitudinal or prospective cohort studies incorporating objective sleep measurements, such as actigraphy or wearable sleep-monitoring devices, together with additional confounding variables, are warranted to clarify the causal relationship between sleep regularity and hypertension more comprehensively.

Overall, the findings indicate that sleep regularity is an important modifiable behavioral determinant of hypertension among agricultural workers in rural Indonesia. The consistency of these findings with Community Nursing Theory, Circadian Rhythm Theory, and previous empirical evidence from Tomitani et al. (2024) and Grassia and Drager (2024) underscores the need for multidimensional hypertension prevention strategies that integrate biological, behavioral, and community-based approaches. Consequently, this study not only strengthens the evidence linking sleep regularity with hypertension among informal workers but also provides a scientific foundation for developing context-specific, sustainable, and evidence-based community nursing interventions for hypertension prevention and control.

Although the present findings are generally consistent with previous international studies, the magnitude of the association observed in this study appears stronger than that reported among urban populations. This difference may be explained by the unique occupational characteristics of agricultural workers, whose work schedules are heavily influenced by seasonal demands, environmental conditions, and prolonged physical activity. These factors may contribute to greater disruption of circadian rhythms than those experienced by workers with more structured daily routines. Therefore, occupational context should be considered an important determinant when interpreting the relationship between sleep regularity and hypertension.

The findings also extend previous evidence by demonstrating that sleep regularity remains significantly associated with hypertension within a rural Indonesian community after statistical analysis. This suggests that sleep regularity may represent a universal behavioral determinant of hypertension across different sociocultural settings while simultaneously emphasizing the need for locally tailored community nursing interventions.

Another limitation concerns the use of purposive sampling, which may reduce the generalizability of the findings to other informal worker populations. Furthermore, because sleep regularity was assessed using self-reported questionnaires rather than objective sleep-monitoring devices, measurement bias cannot be completely excluded.

CONCLUSIONS

The study demonstrated that irregular sleep patterns were significantly associated with hypertension among agricultural workers in Watugaluh Village, Diwek District, Jombang Regency. Participants with irregular sleep patterns exhibited a substantially higher prevalence of hypertension than those with more regular sleep schedules. Binary logistic regression further confirmed that sleep regularity was an independent protective factor against hypertension, with each one-unit increase in

the Sleep Regularity Score associated with an approximately 18.5% reduction in the odds of hypertension. These findings indicate that sleep regularity is an important modifiable behavioral determinant that should be considered in strategies for hypertension prevention and control.

The findings support Circadian Rhythm Theory by highlighting the critical role of circadian synchronization in maintaining normal blood pressure regulation. They also reinforce the Health Promotion Model and Community Nursing Theory, emphasizing the importance of behavioral modification and community empowerment in reducing hypertension risk. From a practical perspective, the results provide evidence to support the integration of sleep regularity assessment into routine hypertension screening in primary healthcare settings. Sleep hygiene education, behavioral counseling, and community-based health promotion interventions should be incorporated into Integrated Non-Communicable Disease Posts (Posbindu PTM), primary healthcare centers, and community empowerment programs to improve hypertension prevention among informal workers.

This study contributes to the existing literature by expanding empirical evidence on the relationship between sleep regularity and hypertension among informal workers in rural Indonesia, a population that remains underrepresented in previous research. Furthermore, it advances the integration of biological, behavioral, and community nursing perspectives into a comprehensive framework for understanding hypertension determinants, thereby strengthening the evidence base for community nursing practice in non-communicable disease prevention.

Future research should employ longitudinal or prospective cohort designs to establish the temporal and causal relationship between sleep regularity and hypertension. The use of objective sleep assessment methods, such as actigraphy or wearable sleep-tracking devices, together with the inclusion of additional confounding variables, including body mass index, sodium intake, psychological stress,

physical activity, smoking behavior, and genetic predisposition, would improve the explanatory power of predictive models. Moreover, community-based intervention studies evaluating the effectiveness of sleep hygiene education and health promotion programs are warranted to support the development of evidence-based policies and interventions for hypertension prevention in primary healthcare settings.

The findings suggest that assessment of sleep regularity should be incorporated into routine hypertension screening programs in Indonesian primary healthcare services. Policymakers may consider integrating sleep hygiene education into community-based hypertension prevention initiatives, particularly among informal workers. Such strategies have the potential to strengthen cardiovascular disease prevention through early behavioral intervention and evidence-based community nursing practice.

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