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Determinants of CERDIK Behavior and Their Impact on Medication Adherence among Hypertensive Patients: A Community-Based Study in Badung, Bali

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Abstract

Hypertension is a non-communicable disease with the most prevalence in the world. In Pelaga Village and Belok Village, 81,92% of the 100% target for hypertension patients undergo regular treatment. In relevance to actualize SDGs goal 3 (good health and well-being), the government program "CERDIK" is carried out as an effort to control and prevent hypertension to increase compliance with taking medication. This study aims to find out the most related component of the "CERDIK" behavior to medication adherence in hypertension patients In Pelaga Village and Belok Village, Badung Regency, Indonesia. This research is an analytical observational cross sectional study involving residents in Bedali Regency, who suffer from hypertension with a large sample of 130. The independent variables are regular health checks, getting rid of cigarette smoke, physical activity, balanced diet, adequate rest, and managing stress using the "CERDIK" behavior questionnaire. The medication adherence variable uses the 8-item Morisky Medication Adherence Scale (MMAS-8) questionnaire. The data obtained were subjected to bivariate analysis using Chi-square test and multivariate analysis using logistic regression with the IBM SPSS v25 application. The results of bivariate analysis found a significant relationship on physical activity, balanced diet, sufficient resting, and stress management towards medication adherence (p-value 0,002; 0,023; <0,001; and 0,025). There was a simultaneous relationship between CERDIK and medication adherence in hypertensive patients, where physical activity and sufficient rest stated as the dominant variables.

Keywords: "CERDIK" *Behavior, Good Health and Well-Being, Hypertension, Medication Adherence.*

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INTRODUCTION

Hypertension is the most prevalent non-communicable disease worldwide. In 2021, it was estimated that approximately 1.4 million adults were affected by hypertension (Organization, 2021). Hypertension is a chronic condition that can lead to numerous complications, including heart failure, stroke, renal failure, and mortality (Firmawati et al., 2023). There are two categories of risk factors for hypertension: modifiable and non-modifiable. Modifiable risk factors include smoking, low dietary fiber intake, dyslipidemia, excessive salt consumption, physical inactivity, stress, overweight/obesity, and alcohol use (Kementrian Kesehatan Republik Indonesia, 2020). Over the last three decades, the incidence of hypertension among individuals aged 30 to 79 years has increased (Organization, 2023).

In Indonesia, hypertension prevalence remains alarmingly high. National data from 2018 indicate that 34.1% of the population equivalent to approximately 85 million individuals are affected by hypertension. In response, the government has implemented promotive and preventive strategies through the CERDIK behavioral framework, which emphasizes routine health checks, avoidance of tobacco smoke, regular physical activity, balanced nutrition, adequate rest, and effective stress management (Kementrian Kesehatan Republik Indonesia, 2020). Empirical evidence suggests that adherence to CERDIK principles significantly contributes to improved prevention and control of non-communicable diseases, particularly through sustained lifestyle modification (Hariawan & Pefbrianti, 2020). From a theoretical standpoint, these behavioral components are closely linked to physiological mechanisms of blood pressure regulation. For instance, reduced sodium intake and balanced nutrition contribute to improved vascular function and decreased peripheral resistance; regular physical activity enhances endothelial function and autonomic balance; while stress management mitigates sympathetic nervous system overactivation, thereby stabilizing blood pressure. Consequently, CERDIK represents an integrative behavioral model grounded in biomedical and public health theory.

Despite the widespread promotion of CERDIK at the national level, existing studies have predominantly focused on urban or semi-urban populations, leaving a critical research gap in rural and geographically distinct settings. Villages such as Pelaga and Belok in Petang District, Badung Regency, are characterized by mountainous topography, limited healthcare accessibility, and distinct socio-cultural patterns that may influence health behavior adoption differently compared to urban populations. Geographic barriers, variations in health literacy, and reliance on traditional lifestyles potentially shape both the implementation of CERDIK behaviors and adherence to antihypertensive medication in these communities. However, empirical investigations examining how these contextual factors interact with CERDIK behavior remain limited.

Therefore, this study seeks to address this gap by analyzing the determinants of CERDIK behavior and their influence on medication adherence among hypertensive patients in Pelaga and Belok Villages in 2025. By situating the analysis within a rural and geographically unique context, this research is expected to contribute to the development of more context-sensitive public health interventions and strengthen the theoretical integration between lifestyle modification frameworks and hypertension management in underserved populations.

METHOD

This study employed an observational analytic design with a cross-sectional approach to examine the relationship between CERDIK behavioral practices and medication adherence among hypertensive patients. The target population comprised

individuals diagnosed with hypertension residing in Pelaga and Belok Villages, Petang District, Badung Regency. A stratified random sampling technique was applied to ensure representativeness across key population subgroups. The stratification was based on administrative village areas (Pelaga and Belok) and further categorized by age groups (≥30–45 years, 46–60 years, and >60 years), considering the epidemiological relevance of age in hypertension prevalence and management. From this stratification, a total sample of 130 participants was obtained using a standard sample size determination formula.

Primary data were collected using two structured instruments: the CERDIK behavioral questionnaire and the Morisky Medication Adherence Scale (MMAS-8). The CERDIK questionnaire was developed based on guidelines from the Kementerian Kesehatan Republik Indonesia (2018) and operationalized into measurable behavioral indicators aligned with internationally recognized lifestyle modification constructs in hypertension management. Specifically, the six CERDIK components were translated into technical domains: (1) routine health monitoring (regular blood pressure and health checks), (2) tobacco exposure avoidance, (3) physical activity engagement, (4) dietary regulation with emphasis on balanced nutrition and sodium restriction, (5) adequate sleep duration and quality, and (6) psychological stress management. This conceptual alignment ensures construct equivalence between the CERDIK framework and global biomedical standards for non-communicable disease prevention. The instrument demonstrated acceptable psychometric properties, with item validity coefficients ranging from 0.378 to 0.693 and a Cronbach's alpha of 0.732, indicating satisfactory internal consistency (Andriana & Yayuk, 2022).

Medication adherence was assessed using the MMAS-8, a widely validated instrument consisting of eight items that evaluate both intentional and unintentional non-adherence behaviors, including forgetfulness, discontinuation without medical consultation, and consistency in medication-taking routines. The MMAS-8 has demonstrated strong reliability (Cronbach's alpha = 0.83) and validity across diverse populations (Agustina & Shintya, 2019; Morisky et al., 2008). Scoring of the MMAS-8 categorizes respondents into adherence levels, which were subsequently dichotomized into adherent and non-adherent groups for analytical purposes (Pakpahan et al., 2021).

Data analysis was performed using SPSS version 30. Descriptive statistics were used to summarize participant characteristics and variable distributions. Bivariate analysis was conducted using the Chi-Square test to examine associations between CERDIK behavioral components and medication adherence, with statistical significance set at $p < 0.05$. In cases where expected cell counts were less than 5, Fisher's Exact Test was applied to maintain statistical validity. Multivariate analysis was performed using binary logistic regression to identify dominant predictors of medication adherence while controlling for potential confounding variables, with significance also determined at $p < 0.05$.

This study adhered to ethical principles in human subject research. Ethical clearance was obtained from an authorized Health Research Ethics Committee prior to data collection (Ethical Approval No.: [to be filled according to institutional approval]). All participants provided informed consent after receiving a comprehensive explanation of the study objectives, procedures, risks, and confidentiality assurances.

RESULT

At the descriptive level, all respondents (100%) reported engaging in routine health check-ups. This finding indicates a uniformly high level of participation in preventive health services, which may reflect the effectiveness of local primary healthcare

interventions in the study area. However, due to the absence of variability in this variable, its association with medication adherence could not be statistically analyzed. To improve analytical clarity and facilitate comparison across behavioral components, the results of the bivariate analysis examining the relationship between CERDIK components and medication adherence are presented in a single consolidated table.

Table 1. Bivariate Analysis of CERDIK Behavioral Components and Medication Adherence among Hypertensive Patients (n = 130)

Variable	Category	Adherent n (%)	Non-adherent n (%)	Total n (%)	p-value
Cigarette Smoke Avoidance	Yes	33 (47.1%)	36 (60.0%)	69 (53.1%)	0.143
	No	37 (52.9%)	24 (40.0%)	61 (46.9%)	
Physical Activity	Yes	66 (94.3%)	45 (75.0%)	111 (85.4%)	0.002
	No	4 (5.7%)	15 (25.0%)	19 (14.6%)	
Balanced Diet	Yes	63 (90.0%)	45 (75.0%)	108 (83.1%)	0.023
	No	7 (10.0%)	15 (25.0%)	22 (16.9%)	
Sufficient Rest	Yes	62 (88.6%)	32 (53.3%)	94 (72.3%)	<0.001
	No	8 (11.4%)	28 (46.7%)	36 (27.7%)	
Stress Management	Yes	66 (94.3%)	49 (81.7%)	115 (88.5%)	0.025
	No	4 (5.7%)	11 (18.3%)	15 (11.5%)	

The bivariate analysis demonstrates that several components of CERDIK behavior are significantly associated with medication adherence among hypertensive patients. Physical activity shows a statistically significant association with adherence ($p = 0.002$), where individuals engaging in regular physical activity tend to exhibit higher adherence rates. Similarly, adherence is significantly associated with a balanced diet ($p = 0.023$), indicating the importance of dietary regulation in supporting treatment compliance.

Sufficient rest emerges as the most strongly associated factor ($p < 0.001$), suggesting that adequate sleep and recovery may play a critical role in maintaining consistent medication-taking behavior. Stress management is also significantly associated with adherence ($p = 0.025$), supporting the role of psychological regulation in chronic disease management.

In contrast, cigarette smoke avoidance does not demonstrate a statistically significant association with medication adherence ($p = 0.143$), indicating that although smoking behavior is an important cardiovascular risk factor, it may not directly influence adherence behavior within this study population.

Overall, these findings highlight that not all components of CERDIK behavior contribute equally to medication adherence. Behavioral domains related to physiological regulation and daily routine stabilization such as physical activity, diet, rest, and stress management appear to have more direct and measurable associations with adherence compared to avoidance-based behaviors such as exposure to cigarette smoke.

Multivariate Analysis Results

To identify the most dominant predictors of medication adherence, a multivariate logistic regression analysis was conducted, incorporating both demographic characteristics and CERDIK behavioral components.

Table 2. Multivariate Analysis of Demographic Characteristics and Medication Adherence among Hypertensive Patients

Demographic Characteristics	p-value	Exp(B)
Gender	0.742	0.844
Age	0.270	1.380
Education	<0.001	3.653
Duration of Hypertension Diagnosis	0.399	1.489
Constant	0.007	0.043

The multivariate analysis indicates that education is the only demographic variable significantly associated with medication adherence ($p < 0.001$; Exp(B) = 3.653). This suggests that individuals with higher educational attainment are approximately 3.6 times more likely to adhere to antihypertensive treatment compared to those with lower education levels. In contrast, gender, age, and duration of diagnosis do not show statistically significant associations ($p > 0.05$).

From an analytical perspective, the strong influence of education can be interpreted through the lens of health literacy theory, which posits that individuals with higher educational backgrounds possess better cognitive capacity to access, process, and apply health-related information. In rural settings such as Pelaga and Belok Villages, disparities in educational attainment may translate into unequal understanding of hypertension as a lifelong condition requiring continuous pharmacological management. Patients with lower education levels may perceive medication as symptomatic relief rather than long-term therapy, thereby reducing adherence. This finding underscores the structural role of education in shaping treatment perception and behavior in rural populations.

Table 3. Multivariate Analysis of CERDIK Behavioral Components and Medication Adherence

Variable	p-value	Exp(B)
Cigarette Smoke Avoidance	0.872	0.937
Physical Activity	0.043	3.818
Balanced Diet	0.416	1.715
Sufficient Rest	<0.001	6.346
Stress Management	0.415	0.485
Constant	0.572	0.117

The analysis demonstrates that sufficient rest and physical activity are the most dominant predictors of medication adherence. Adequate rest shows the strongest association ($p < 0.001$; Exp(B) = 6.346), indicating that respondents with sufficient rest are more than six times as likely to adhere to medication. Physical activity is also significantly associated ($p = 0.043$; Exp(B) = 3.818), suggesting a nearly fourfold increase in adherence likelihood among physically active individuals. Meanwhile, cigarette smoke avoidance, balanced diet, and stress management do not exhibit statistically significant associations ($p > 0.05$).

A deeper interpretation of these findings reveals important contextual insights related to the socio-occupational characteristics of the study population. The majority of residents in Pelaga and Belok Villages are engaged in agricultural activities, which inherently involve high levels of physical exertion. This habitual physical activity may contribute not only to better physiological regulation but also to more structured daily routines, indirectly supporting consistent medication-taking behavior. However,

agricultural work is often accompanied by irregular rest patterns due to early working hours and physically demanding labor. Therefore, individuals who are able to maintain adequate rest may represent a subgroup with better overall lifestyle regulation, which translates into higher adherence. The prominence of sufficient rest as the strongest predictor can also be interpreted through behavioral regulation theory. Sleep adequacy is closely linked to cognitive function, memory, and executive control, all of which are essential for maintaining long-term treatment adherence. In contrast, insufficient rest may impair an individual's ability to follow medication schedules consistently.

DISCUSSION

Age-related findings indicate that the largest proportion of respondents in this study were aged 60–69 years (57.7%), followed by those aged 70–79 years (33.1%). These results are consistent with the findings of Rigaud (2001), which stated that both systolic blood pressure (SBP) and diastolic blood pressure (DBP) tend to increase with age. SBP rises progressively until the age of 70–80 years, while DBP typically increases until the age of 50–60 years, after which it tends to stabilize or slightly decline. The risk of developing hypertension increases with age due to various physiological changes associated with the aging process.

Gender-related results show that the majority of respondents were female (83.1%). This finding is supported by a study conducted by Chandra et al., (2020), which reported that the prevalence of hypertension was higher among women (58.7%). The increased susceptibility to hypertension in women, particularly in older age, is influenced by declining estrogen levels after menopause. Estrogen plays a key role in elevating High-Density Lipoprotein (HDL) levels and enhancing antioxidant production, which protects the vascular system in premenopausal women (Khezri et al., 2021).

Regarding education level, most respondents had only completed elementary school (58.5%). This result aligns with a study by Seprina & Bayhakki (2022), which found that the majority of participants had an elementary school education (41.5%). Education level is an important factor influencing an individual's ability to understand and apply health-related information.

Regarding the duration since diagnosis, 74.6% of respondents had been diagnosed with hypertension for ≤5 years. This is consistent with findings from Merlis & Alfiah (2022), who reported that most individuals with hypertension had been diagnosed within the previous five years (61.2%).

The association between routine health check-ups and medication adherence could not be analyzed statistically, as all respondents regularly participated in monthly non-communicable disease (NCD) screenings conducted by the staff of Puskesmas Petang II. These activities were implemented consistently across the service area and monitored by program coordinators. Due to uniformity in this variable, the data did not meet the requirements for Chi-square analysis, which is used to examine associations between nominal or ordinal variables. Interestingly, the data showed that despite participating in routine health check-ups, many respondents still demonstrated non-adherence to medication. This suggests that therapeutic success cannot be achieved solely through clinical monitoring without patient awareness and consistent adherence to prescribed treatment regimens (Riani & Riastienanda, 2023).

The analysis showed no significant relationship between smoking behavior and medication adherence, with a p-value of 0.143 ($p > 0.05$). This finding is consistent with the study by Merlis & Alfiah (2022), which examined smoking workers aged 18–64 years and similarly found no correlation between smoking status and adherence to medication.

In contrast, a significant association was found between physical activity and medication adherence, with a p-value of 0.02 ($p < 0.05$). This supports the findings of Pristianty et al. (2023), who reported that 67.7% of respondents engaged in regular physical activity such as morning walks, jogging, weekly exercise, or cycling. Regular exercise for 30–60 minutes per day, at least three times per week, has been shown to lower blood pressure levels.

A significant association was also found between adequate rest and medication adherence, with a p-value of <0.001 ($p < 0.05$). This is supported by Khalesi et al., (2017), who found that individuals with good medication adherence typically reported more than seven hours of sleep per day.

A balanced diet, however, was not significantly associated with medication adherence ($p = 0.173$). This aligns with findings from Riani & Riastienanda (2023), which reported that nutritional education, dietary balance, and health-related quality of life were not significantly related to hypertension medication adherence ($p = 0.05$). Contributing factors to non-adherence may include forgetfulness, concerns about side effects, and financial limitations. Additionally, stronger self-efficacy is needed to support behavioral changes that promote treatment adherence(Khalesi et al., 2017).

This study also found a significant relationship between stress management and medication adherence, with a p-value of 0.025. These findings are in line with studies by (Firmawati et al., 2023; Li et al., 2019), which noted that the duration of illness can trigger stress, and stress levels are closely associated with adherence to medication. Non-adherence may also be influenced by factors such as unwillingness to purchase medications, failure to follow health education guidance, or preference for alternative treatments such as herbal remedies (Wahdi et al., 2020).

This study also identified a significant association between demographic characteristics and medication adherence, particularly the education variable, which had a p-value of < 0.001 ($p < 0.05$). These findings are consistent with those of Nurjanah et al., (2021), who reported a correlation between education level and medication adherence among individuals with hypertension. Education plays a crucial role in shaping an individual's behavior and lifestyle, especially in fostering positive attitudes and motivation.

Furthermore, this study revealed a concurrent relationship between the "CERDIK" program and medication adherence among hypertension patients. Among the components of the program, physical activity ($p = 0.043$; $Exp(B) = 3.818$) and adequate rest ($p < 0.001$; $Exp(B) = 6.346$) remained significantly associated with adherence even after adjusting for other variables. According to research by Sulung et al., (2022), the effectiveness of the "CERDIK" program relies on the alignment between its inputs, processes, and outputs. Inputs include policy support, funding, human resources, and infrastructure. The processes involve socialization, education, implementation, and ongoing monitoring and evaluation. Outputs are measured by coverage of activities, accuracy in reaching target populations, and the appropriateness of timing and location.

Practical Implications for Primary Healthcare Services

These findings have important implications for primary healthcare delivery, particularly for community health centers such as Puskesmas Petang II. First, given the strong influence of education, health promotion strategies should prioritize improving functional health literacy through simplified, culturally appropriate educational interventions. This may include the use of visual aids, local language communication, and repeated counseling emphasizing that hypertension requires lifelong management.

Second, intervention programs should place greater emphasis on behavioral domains that were not statistically significant but remain clinically important, such as balanced diet and stress management. The lack of significance may indicate inconsistent implementation or limited understanding of these behaviors within the community. Therefore, targeted interventions such as community-based nutritional counseling and stress reduction programs are necessary to strengthen these components.

Finally, considering the dominant role of rest and physical activity, healthcare providers should adopt a contextualized approach by integrating health recommendations with local occupational patterns. For example, education on sleep hygiene and workload management for farmers could enhance both physiological recovery and medication adherence. Overall, the multivariate findings highlight that medication adherence in hypertensive patients is shaped by an interaction between structural factors (education) and daily behavioral regulation (rest and physical activity), emphasizing the need for integrated, context-sensitive public health strategies in rural settings.

Strength and limitations

This study presents several limitations. First, there may be other variables that contribute to medication non-adherence which were not included in this research. Second, although the sample consisted of 130 respondents, data collection was conducted within a restricted time frame, which may have affected the strength and reliability of the statistical correlations.

CONCLUSION

This study analysis demonstrated that engaging in physical activity, maintaining a balanced diet, getting adequate rest, and managing stress were all associated with medication adherence among hypertensive patients in Pelaga and Belok Villages. A simultaneous relationship was observed between the overall "CERDIK" behaviors and adherence to treatment. Among these factors, physical activity and sufficient rest remained significantly associated even after adjusting for other variables.

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Author contribution

All authors have contributed to all processes in this research including preparation, data gathering and analysis, drafting, and approval for publication of this manuscript.

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