Multidimensional quality of life of hypertension patients analysis using structural equation modelling-partial least square

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Abstract. Hypertension is one of the non-communicable diseases that continues to experience an increasing prevalence rate. Hypertension in Indonesia has the highest prevalence compared to other non-communicable diseases. The province of Aceh ranks tenth in the highest prevalence of hypertension in Indonesia. The third highest prevalence cases in Aceh Province is in Pidie Regency. This study was conducted to analyze the factors influencing the quality of life of hypertensive patients using the Structural Equation Modeling-Partial Least Square (SEM-PLS) method. The research utilized data from a non-communicable disease survey conducted in Pidie Regency in 2023. The results of this study revealed 4 indicators representing demographic factors, 3 indicators representing activity factors, and 4 indicators representing quality of life. The factors significantly are demographics, physical activity, and medication adherence, with a Q^2 value of 0.98, meaning that 98% of the variability can be explained by demographic, physical activity, and medication adherence factors.

1 Introduction

Non-Communicable Diseases (NCDs) stand as the leading global cause of death, with almost 36 million annual fatalities, according to 2020 World Health Organization (WHO) data. The prevalence of NCDs is on the rise, notably hypertension, affecting approximately 1.28 billion individuals aged 30-79 worldwide [1]. Hypertension is particularly prevalent in low to middle-income countries, including Indonesia [2]. The substantial number of cases is closely linked to high prevalence rates, making hypertension the NCD with the highest prevalence in Indonesia.

National Basic Health Research (Riskesdas) in 2018 reveals a 34.11% prevalence of hypertension among individuals aged >18 years in Indonesia, marking a 5% increase over the previous five years [3]. In Aceh Province, the prevalence is 26.45%, and certain demographic factors such as age, education level, and employment status contribute

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significantly (Riskesdas Aceh, 2018) [4]. Pidie Regency in Aceh is among the areas with a high incidence of hypertension. Data from the Aceh Provincial Health Office (2023) indicates 464,839 hypertension cases in 2022, with nearly 20% occurring in Pidie Regency. While not having the highest prevalence, Pidie Regency ranks as the third highest among 23 regencies/cities in Aceh [5].

Individuals with hypertension undergo lifestyle, physical, psychological, and social interaction changes, impacting their quality of life. WHO (2008) identifies four indicators physical, psychological, social relationships, and environmental aspects as crucial benchmarks for assessing one's quality of life [6]. The interplay of these factors is key to achieving optimal quality of life. Factors influencing the quality of life for individuals with diseases include demographic factors, medication adherence, and physical activity. Previous studies have explored the relationships between these factors [7, 8, 9, 10]. Health research often used statistical analysis, and Structural Equation Modeling (SEM) is a method used for this purpose.

SEM, a multivariate statistical analysis, examines correlations and significances comprehensively, combining regression, factor analysis, path analysis, and simultaneous indirect analysis. It is employed to analyze relationships among latent variables, necessitating direct measurable variables as indicators for latent variables [11]. SEM comes in two types: Covariance-Based SEM (SEM-CB) and Partial Least Square SEM (SEM-PLS). While SEM-CB is used for confirming strong theoretical bases, SEM-PLS is more flexible, allowing for predictive relationship testing. Pidie Regency is selected for this study, given its significant hypertension cases.

2 Theory of Factors

Hypertension is a medical condition characterized by a persistent increase in blood pressure, typically ranging from 90/60 mmHg to 120/80 mmHg. Diagnosis occurs when systolic blood pressure reaches 140 mmHg or higher, or diastolic blood pressure reaches 90 mmHg or higher [3]. Although symptoms may not be immediately apparent, hypertension can lead to severe complications such as heart disease, stroke, or organ damage. Causes vary, including genetic factors, unhealthy lifestyle choices, and certain medical conditions. Management involves lifestyle modifications, like a healthy diet and exercise, and may require medications as per medical guidelines.

Medication adherence is crucial, especially for conditions like hypertension. Adherence rates vary, influenced by factors like age, gender, education, and occupation. Patients must consistently take medication to stabilize blood pressure and prevent complications. Socioeconomic factors play a role, with adherence rates in hypertensive patients estimated between 50-60%. Especially in the elderly, adherence to antihypertensive medication is pivotal for optimal therapeutic outcomes.

Physical activity is vital in managing hypertension, as it correlates with blood pressure reduction. Regular exercise helps lower blood pressure, particularly in elderly individuals. Benefits include improved heart and vascular health, weight loss, and stress management, positively contributing to hypertension management.

Quality of life is an individual's perception of their life situation. Measurement involves physical health, mental health, social relationships, and overall life satisfaction. Factors like illness symptoms, habits, medical conditions, and financial conditions impact quality of life. Decline in well-being affects activities, work capacity, hearing, and life satisfaction [12].

Demography studies the structure and characteristics of a population in a given area, analyzing data such as age, gender, race, and other demographic compositions. The goal is to understand population dynamics and changes, including births, deaths, migration, and factors influencing population structure. Demographic analysis provides crucial insights for policy-making, especially in health-related fields [13].

Table 1. Research variables.

No.	Latent Variabel	Indicator Variabel	
1	Demography (η_1)	Y_1	Age
		Y_2	Education
		Y_3	Habit of consuming salty foods
		Y_4	Habit of consuming fatty foods
2	Physical Activity (η_2)	Y_5	Light
		Y_6	Normal
		Y_7	Heavy
3	Medication Adherence (ξ)	X	Medication Adherence
4	Quality of Life (η_3)	Y_8	Physical health
		Y_9	Psychological health
		Y_{10}	Social relations
		Y_{11}	Environment

3 Method

3.1 About Data

The data used in this research is secondary data sourced from a non-communicable disease survey group in Pidie District in 2023, conducted through interviews and questionnaire distribution. The data collection for this research involved healthcare professionals working in health centers in the Pidie District, with a total of 5 health centers. The analyzed data consists of respondents with hypertension, totaling 267 respondents.

3.2 Data analysis

This study uses Structural Equation Modeling (SEM) method, specifically Partial Least Square-SEM (PLS-SEM). Software: Smartpls3, was used to estimate and test the proposed model, and determine causal relationships. The inferential analysis was conducted using the Structural Equation Modeling-Partial Least Square (SEM-PLS) method, with the following stages:

1. Designing measurement and structural models based on theoretical studies.
2. Constructing a path diagram.
3. Estimating SEM-PLS model parameters with three iterations.
4. Conducting an evaluation of the measurement model (outer model).

The measurement model is evaluated for validity and reliability. Validity is measured through convergent validity and discriminant validity, while reliability is measured by the composite reliability value. A measurement model that has been validated will proceed to the next stage, which is the evaluation of the structural model. If not, the path diagram construction is repeated so that all indicators meet the measurement model evaluation criteria. Evaluation criteria for the measurement model are as follows:

1. Eliminating indicators with loading factor values equal to or less than 0.5.

2. Conducting discriminant validity tests by eliminating indicators with loading factor values less than the cross-loading factor value.
3. Calculating the composite reliability value.

The evaluation of the structural model (inner model) is then conducted with the following criteria:

1. Testing hypotheses to determine factors that influence and mutually influence the quality of life, both directly and indirectly. The significance criterion is met when the t-value > t-table or p-value < 0.05.
2. Evaluating the coefficient of determination (R^2) values.
3. Calculating the predictive relevance value (Q^2).

4 Results

4.1 Characteristics of respondents

The study involved 267 respondents who owned households in Pidie Distric.

Table 2. Demographics of respondents.

No.	Characteristic	Category	Frequency (n)	Persentage (%)
1	Age	17-25	3	1.12
		26-35	7	2.62
		36-45	61	22.85
		46-55	75	28.09
		56-65	78	29.21
		>65	43	16.10
2	Gender	Male	97	36.33
		Female	170	63.67
3	Work	Yes	123	46.07
		No	144	53.93
4	Education	College	43	16.10
		Senior high school	79	29.59
		Junior high school	63	23.60
		Elementary school	81	30.34
		No	1	0.37
5	IBM	<18,5	12	4.49
		18,5–22,9	94	35.21
		23–24,9	51	19.10
		25–29,9	85	31.84
		≥ 30	25	9.36

Table 2 shows the number of respondents and their percentages in each predefined category of respondent identity. The category with the highest age group is the elderly category, comprising 78 respondents (29.21%). The categories of gender, employment status, and highest education level have the highest representation with 170 female respondents (63.67%), 144 respondents not/not yet working (53.93%), and 81 respondents with an elementary school education (30.34%). Additionally, for the body mass index category, the majority falls into the normal category, with 94 respondents (35.21%).

4.1 Model Structure

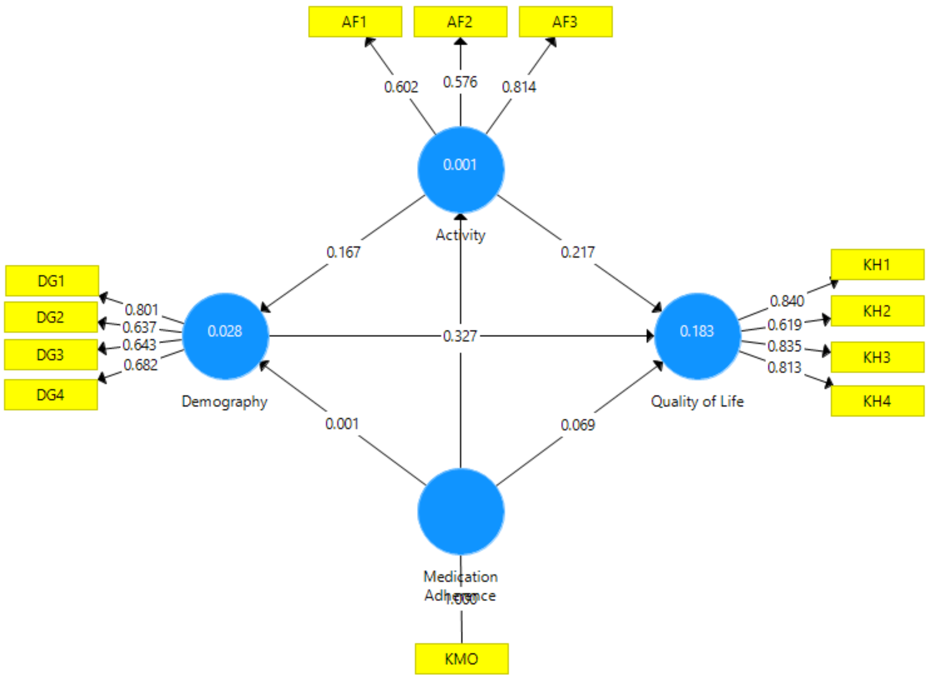

Fig. 1. Model structure.

A path diagram includes the directional relationships between latent variables and their indicators, the relationships among the latent variables, and notations for the coefficients in the model. This facilitates the researcher in visualizing the model.

4.2 Outer model

The evaluation of the measurement model is assessed based on the loading factor values.

Table 3. Loading factor values.

No.	Latent Variable	Indicator Variable	Loading Factor
1	Demography	DG_1	0.80
		DG_3	0.64
		DG_8	0.64
		DG_9	0.68
2	Physical Activity	AF_1	0.60
		AF_2	0.58
		AF_3	0.81
3	Quality of Life	KH_1	0.84
		KH_2	0.62
		KH_3	0.84
		KH_4	0.81

The loading factor values for all indicators, after the path diagram reconstruction, are now equal to or greater than 0.5. All indicator variables in the validated table will be utilized in the subsequent testing.

4.3 Inner model

Table 4. Hypothesis testing results in direct effect.

Direction			Coefficient	t_{values}	Sig.
$\boldsymbol{\eta_1}$	→	η_3	-0.49	2.24	0.03
$\boldsymbol{\eta_2}$	→	η_3	0.90	23.79	0.00
$\boldsymbol{\xi}$	→	η_3	0.48	2.46	0.01

All direct influences between the formed variables have t-values and p-values within the criteria for rejecting H_0. Based on these results, it can be concluded that demographic, activity, and medication adherence variables in all models significantly affect the quality of life directly.

The structural model equation based on the parameter estimation results is as follows:

$$\eta_3 = -0.49\eta_1 + 0.90\eta_2 + 0.48\xi.$$

The parameter estimation results in the structural model equation all show negative values for demography, and positive values for physical activity and medication adherence.

Table 5. Hypothesis testing results in indirect effect.

Direction							Coefficient	t_{values}	Sig.
$\boldsymbol{\xi}$	→	η_2	→	η_1	→	η_3	-0.01	0.79	0.43
$\boldsymbol{\xi}$	→	η_2	→	η_3			0.20	3.73	0.00*
$\boldsymbol{\xi}$	→	η_1	→	η_3			-0.45	2.27	0.02*
$\boldsymbol{\eta_2}$	→	η_1	→	η_3			-0.05	0.99	0.32

The involvement of physical activity and demographic factors in the model does not have a significant impact on the quality of life in a single path.

The structural model equation based on the parameter estimation results is as follows:

$$\eta_3 = -0.05\eta_2 - 0.26\xi.$$

The activity variable influences the quality of life by lowering its path coefficient through a mediating variable. Similarly, the medication adherence variable, through a mediating variable, reduces its path coefficient.

Table 6. R^2 values.

Latent Variable	R^2	Q^2
Demografi (η_1)	0.92	0.98
Aktivitas Fisik (η_2)	0.05	
Kualitas hidup (η_3)	0.75	

The R^2 value for the activity variable in the model is 0.05, indicating that 5% of the variability in the activity variable can be explained by medication adherence, while the remaining 95% is explained by other factors not considered in this study. The R^2 value for the demographic variable is 0.92, meaning that 92% of the variability in the demographic variable can be explained by physical activity and medication adherence, while the remaining 8% can be explained by other factors not considered in this study. The R^2 value for the quality of life variable is 0.75, indicating that 75% of the variability in the quality of life variable can be explained by demographic, physical activity, and medication adherence variables, while the remaining 25% can be explained by other factors not considered in this study.

The Q^2 value for the quality of life variable in model is 0.98, indicating that 98% of the variability in the quality of life variable can be explained by demographic, physical activity, and medication adherence variables.

5 Conclusion

The SEM-PLS method was applied to identify indicators influencing the quality of life for hypertensive patients in Pidie District. These indicators include age, education, habits related to the consumption of salty and fatty foods, levels of physical activity (light, moderate, and heavy), medication adherence, and factors related to physical health, psychological health, social relationships, and the environment. The latent variables of demographics, activities, and medication adherence directly impact the latent variable of quality of life for hypertensive patients in Pidie District. Specifically, the latent demographic variable exhibits a negative and significant impact on the quality of life, while the latent variables of activities and medication adherence have negative and significant impacts as well. The Path Diagram demonstrates a Predictive Relevance (Q^2) value of 0.98, indicating that 98% of the variability in the quality of life variable can be explained by the demographic, physical activity, and medication adherence variables.

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