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The Modeling Changes of Blood Glucose in Patients with Diabetes Mellitus Using Partial Least Square (PLS)

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ABSTRACT

Genesis Diabetes Mellitus in Indonesia occupies the fourth sequence of the highest in the world and is expected to increase from year to year. Blood sugar in patients with Diabtes Mellitus can be monitored by checking blood glucose with the aim to know the development of diabetes therapy target and perform drug dosage adjustment. The purpose of this research examines the factors that affect the alteration of blood glucose in patients with diabetes mellitus in *Lakesla Drs. Med. R. Rijadi S., Phys* Surabaya using Partial Least Square (PLS). The results of the study showed with the approach of SHEM PLS that changes the level of sugar in the blood is the model fit with accuracy of 93.8 percent. Drugs factor gives the greatest effects in the decrease in the level of sugar in the blood and eat time factor and factor activity and HBO therapy. So it is important to note to adjust the insulin dose during the treatment.

KEYWORDS: *Diabetes Mellitus , blood glucose, Therapy, PLS*

INTRODUCTION

The number of patients with Diabtes Mellitus in the world from year to year have increased. Based on data from the World Health Organization (WHO) in 2003, the number of patients with Diabtes Mellitus reached 194 million and is expected to increase to 333 million in 2025 future, half of the figure occurred in developed countries including Indonesia [1]. Genesis Diabetes Mellitus in Indonesia occupies the fourth sequence of the highest in the world namely 8.4 million [2]

Research cohort studies show that blood glucose decline in diabetic patients who undergo HBO therapy [3]. Changes in the level of sugar in the blood has become) that is consistent in almost all the study cohort studies, usually in the order of the 50 mg/dl. However, it is not yet clear whether this decline is associated with kausal Hyperbaric Therapy itself, or only the effects of time of treatment with food and medicines [4].

Changes in the level of sugar in the blood is too low is a clinical condition that occurs as a result of the blood glucose levels drop below the amount of the normal limit. Decrease the level of sugar in the blood can be caused by a variety of congenital anomalies and the seriousness is determined by the ever decrease blood glucose levels and light weight the symptoms [5]. In patients with Diabetes Mellitus, a drop of blood glucose mainly occurs as a result of giving drugs the sulfonilurea and usage of insulin [4].

Bad influence changes to extreme blood sugar level will cause disorders nerve function of the brain when long will increase the morbidity and mortality. In Genesis decrease blood sugar, plasma glucose patients with less than 50 mg/dl, although there are certain people who have been showing symptoms of blood sugar level drop on plasma glucose levels above 50 mg/dl. Blood glucose levels are too low cause the cells of the brain does not receive the supply of energy that is not able to function can even damaged [6]. Blood sugar level drop attacks on patients with diabetes commonly occurs when patients have forgotten or deliberately left (breakfast, day or night), eat too little (less than recommended by the doctor or nutrition expert), exercising too heavy, consume drugs anti diabetes in multiple doses greater than should drink alcohol, stress, and consume drugs that can cause degradation risk of blood glucose [7][8]. High pressure oxygen 2.4 ATA on HBO therapy during 3x30 minutes and interspersed rest 2x5 minutes in patients with diabetes mellitus, then occur *Oxphos process* (*Akt Oxidative*) in the mitochondria cell β pancreas increased. In this process results in insulin secretion increase the level of insulin in the blood to increase the level of blood glucose falls, happened the formation of serum aldimine also joined the decline and decrease the formation of ketoamine and serum HbA1c also declined [9]. Blood sugar in patients with Diabetes Mellitus can be monitored by checking blood glucose periodically with the aim to know the development of diabetes therapy target and perform drug dosage adjustment if targets have not been reached [4].

Based on explanation above, this research examines the factors that affect the alteration of blood glucose in patients with diabetes mellitus in *LakeslaDrs Med. R. Rijadi S., Phys* Surabaya Partial this approach Square (PLS). PLS is a method multivariat analysis based on the data does not have a distribution assumption, the scale of the measurement of the use of all types of the scale and the size of the small samples [10][11].

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LITERATURE STUDY

Partial Least square (PLS) is a method of analysis that continuing activity and often also called soft modeling. The estimation of parameters that includes the loading factor, path coefficient is calculated by iteration, iterations will stop if has reached the condition of convergence [1[0][11].

In the path analysis Model PLS consists of three sets of connection are [12][13]:

- Structural Model (*Inner Model*)

Structural Model or *inner model* is a model that shows the relationship or the strength of the estimation between the latent variable or change based on substantive theory.

Structural model equation is as follows.

$$\eta = \beta_0 + \beta\eta + \Gamma\xi + \zeta \quad (1)$$

With η is the vectors of change of endogen, ξ Is the vectors of change relatively exogenous and ζ Is the vectors of residual variable.

- The Measurement Model (*Outer Model*)

The measurement model is a model that shows how each indicator variables related with latennya variable. Equation model for *outer reflective model* (A) model is:

$$\mathbf{x} = \Lambda_x \xi + \delta_x \quad (2)$$

$$y = \Lambda_y \eta + \varepsilon_y \quad (3)$$

- Bridge weight (*Weight Relations*)

The weight of the link is the weight that connects the model o*outer* and *inner model* to form the estimation of exogenous latent variables and endogenous latent.

METHODOLOGY

The type of the instrument was done in this research is the questionnaire and GDA nickel coatings . In identifying some of the factors that affect the changes of blood glucose in patients with diabetes mellitus who follow HBO therapy in the form of questions about breakfast before the therapy, often sports, drug consumption, therapy period [14]. The sample in this research is some patients with diabetes mellitus in LakeslaDrs Med. R. Rijadi S., Phys Surabaya which amounted to people with the method simple random sampling [15][16].

Analysis of the steps that will be done to achieve the goal in this research is to do the estimation coefficient weight, path, and loading, hypothesis test with the bootstrap approach and get the best model. Outer Model, covers the validity test is seen from the results of loading factor, and reliability tests seen from the value of Composite reliability. The indicator is called valid if has a value of loading factor > 0.5, and said reliable if the value of composite reliability > 0.6. Inner Model, test this can be seen as a result of the value of the inner weight to test the research hypothesis through t test on the bootstrap samples and goodness of fit model. The model can be stated to have the goodness of fit if has a value R-Square > 0 and the value of $Q^2 = 1 - (1 - R_1^2)(1 - R_2^2)(1 - R_3^2) > 0.35$ provides high accuracy [16][17][18].The framework of the concept of the change of blood glucose in patients with diabetes mellitus finances on the following image.

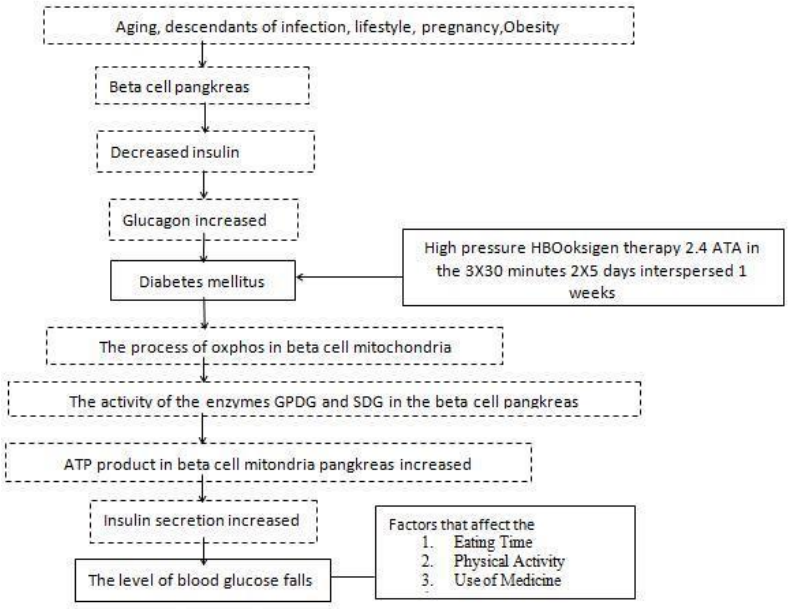

Figure 1. The framework of the concept of the change in the level of sugar in the blood of patients with Diabetes Mellitus

RESULTS AND DISCUSSION

Model evaluation consist 2 steps are an evaluation of the measurement model and structural model evaluation. The evaluation of the measurement Model to determine the validity and reliability of the model. The validity of convergence is used to know the validity of each indicator in the model. The validity of convergence can be seen from the values of loading factor ε .5 [10]. The validity of the discriminant related with the measuring line (indicator variable) from the change is

different from each other not correlates. The validity of discriminant reflective model can be evaluated with the cross loading from each indicator. This method considers the correlation between indicator (loading factor) with construct, and change other. Composite reliability is used to evaluate the steps in building internal reliability consistency. The formula that can be used are as follows [12].

$$\rho_c = \frac{\left(\sum_i^k \lambda_i\right)^2}{\left(\sum_i^k \lambda_i\right)^2 + \sum_i^k \left(1 - \lambda_i^2\right)} \quad (4)$$

The measurement of the model consists of a validity test and reliability test. The results are presented in detail in the following table.

Table 1. Validity test and the reliability of the indicators on the latent Variable

The variables	The indicator	Loading Factor at rotation 1	The validity of the		*Composite Reliability (C-R)*
			Loading Factor	T-Statistics	
Time Eat factor (FM)	Eat before doing the therapy (FM1)	0.787	0.718	15.156	0.841
	Often too late to eat (FM2)	-0.018 (nv)			
	Hours how you eat before doing the therapy (FM3)	0.891	0.972	104.143	
	Food before you perform the therapy (FM4)	-0.040 (nv)			
	Drink before performing the therapy (FM5)	-0.121 (nv)			
Medicine Factor (FO)	Using the insulin therapy (FO1)	0.685	0.753	24.080	0.893
	The appropriate dose in recommend by doctors (FO2)	0.278 (nv)			
	Often too late to inject insulin (FO3)	0.750	0.822	52.527	
	Using oral drugs (FO4)	0.383 (nv)			
	Oral drugs that in the consumption (FO5)	0.817	0.831	50.975	
	Injected insulin and consume oral drugs before attending the therapy (FO6)	0.901	0.855	139.177	
	The insulin dose unit (FO7)	0.702	0.682	29.367	
Activity factor (FA)	Type of Work (FA1)	-0.097 (nv)			0.940
	During the work whether you often sit (FA2)	0.436 (nv)			
	During the work whether you often stand (FA3)	0.924	0.945	60.988	
	During the work whether you lift heavy load (FA4)	0.859	0.908	41.566	
	After work you feel tired (FA5)	0.638	0.729	9.408	
	After work you sweating (FA6)	0.556	0.675	11.552	
	Can berolaraga (FA7)	0.619	0.622	6.497	
	How often you berolaraga (FA8)	0.773	0.782	9.516	
	During spare time, whether you often sweating (FA9)	0.727	0.767	22.249	
	During spare time whether you watch TV (FA10)	0.397 (nv)			
	During spare time if you often walk (FA11)	0.536	0.707	15.187	
	During spare time you biking (FA12)	0.776	0.795	10.001	
	How many minutes you walk/bicycle per day and to the workplace/market (FA13)	0.812	0.846	29.103	

Note: (nv = non valid)

Table 1. shows that the value of loading factor of the first round there are several indicators that are not valid, namely FM2, FM4, FM5, FO2, FO4, FA1, FA2 and FA10, so that the indicator is removed from the model. The value of loading factor and T-statistics after the indicator is not valid remove each latent variable is greater than 0.5 and greater than T-table

= 1.96, then all said indicator is valid and significant in forming the latent variable. While for the reliability of the Table 1 also shows that the latent variable time eat factor, medicine factors, activity factor gives the value of composite reliability (C-R) above the value of the cut-off his 0.7 it can be said all the latent variable reliable.

Structural models are evaluated in view of the significance of the relationship between the construct (latent variable). The value of the significance of the change can be seen from the value of the T-test (critical ratio) bootstrapping process. Then continues to see the value of R^2 for each endogenous latent variable. Structural Model (Inner Weight) partial least square with the bootstrap partition to test the research hypothesis test through t and bootstrap stop if between the estimates of the original

and the bootstrap estimates have values that approach. The results of the original estimates and estimates of the bootstrap, B=500 served on the following image.

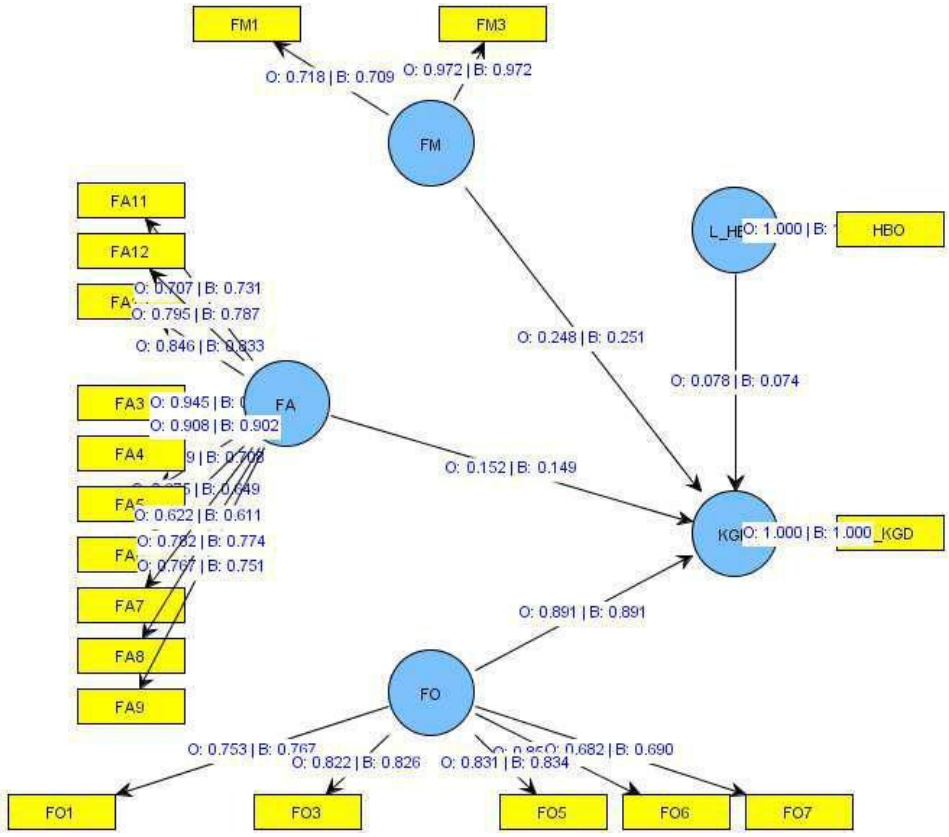

Figure 2.The relationship of time eat factors, medicine factors, activity factors with changes in the blood glucose

The test results of the full model can be seen from the values R-Square that illustrates *the goodness of the fit* of a model. The value of R-Square that is recommended is greater than zero. The value of R-square presented in table 2 below:

Table 2. *Goodness of Fit* Changes the blood sugar

Exogenous variable	**Endogenous Variable**	***R-Square***
Time Eat Factor (FM), Aactivity Factor (FA), Medicine Factor (FO), Hyperbaric Therapy Oxygen (L_HBO)	Changes the level of blood glucose (KGD)	0.938

Table 2 explains that the donation or the proportion of time eat Factor (FM), the activity Factor (FA), Medicine Factor (FO), Hyperbaric Therapy Oxygen (L_HBO) in explaining the variations around the variable changes the level of blood glucose (KGD) of 0.938. The result of the value of the R-square greater than zero means that the model of this research is already meet the goodness of Fit is required. The value of Q^2 = 0.938, it means that the model of changes in the level of blood glucose (KGD) have high accuracy.

From the appropriate model in Figure 2 can be interpreted each path coefficient. The path coefficient is the hypothesis in this research that can be performed in the following structural equation:

KGD = FM + 0.152 0.248 FA + 0.891 FO + 0.078 L_HBO

With

KGD = Changes of blood glucose
FM = Time Eat Factor
FA = Activity Factors
FO = Medicine Factors
L_HBO = Hyperbaric Therapy Oxygen

The results of the structural path coefficient (Inner Weight) along with the value of the full significance is shown in Table 3.

Table 3: Test inner weight on the model of the changes in the level of blood glucose with the bootstrap samples (B=500)

Exogenous variable Endogenous Variable	Coeficient Orginal	BOOTSTRAP samples (B=500)		
		Subsample coefficient	T - Statistics	Description
Time Eat factor (FM) Changes of blood glucose (KGD)	0.248	0.251	8.218	Significant
Medicine factor (FO) Changes of blood glucose (KGD)	0.891	0.891	59.959	Significant
HBO therapy (L_HBO) Changes of blood glucose (KGD)	0.078	0.074	5.889	Significant
Activity factor (FA) Changes of blood glucose (KGD)	0.152	0.149	5.638	Significant

Based on the Table 3, interpretation of each path coefficient is as follows:

Time eat factor (FM) have positive and significant impact on the change of the changes of blood glucose (KGD). This can be seen from the path marked by the positive coefficient of 0.248 with T statistics of 8.218 value greater than t table = 1.96 from equal significance (α) determined by 0.05. Thus time eat factor (FM) directly impact on the change of blood glucose (KGD) of 0.248, which means there is increasing every time eat factor (FM) then the decrease in the level of sugar in the blood (KGD) of 0.248.

Medicine factor (FO) have positive and significant impact on the change of the changes of blood glucose (KGD). This can be seen from the path marked by the positive coefficient of 0.1285 with T statistics of 59.959 value greater than t table = 1.96 from equal significance (α) determined by 0.05. Thus medicine factor (FO) directly impact on the change of blood glucose (KGD) equal 0.1285, which means that every increase in the medicine factor (FO) then will increase the changes of blood glucose (KGD) equal 0.1285.

HBO therapy (L_HBO) have positive and significant impact on the change of the changes of blood glucose (KGD). This can be seen from the path marked by the positive coefficient of 0.078 with T statistics of 5.889 value greater than t table = 1.96 from equal significance (α) determined by 0.05. Thus the HBO Therapy (L_HBO) directly impact on the change of blood glucose (KGD) of 0.078, which means that every increase in HBO Therapy (L_HBO) then will increase the changes of blood glucose (KGD) of 0.078.

Activity factor (FA) have positive and significant impact on the change of the changes of blood glucose (KGD). This can be seen from the path marked by the positive coefficient of 0.152 with T statistics of 5.638 value greater than t table = 1.96 from equal significance (α) determined by 0.05. Thus the activity factor (FA) directly impact on the change of blood glucose (KGD) of 0.152, which means that every increase in the activity Factor (FA) then will increase the changes of blood glucose (KGD) of 0.152.

CONCLUSION

The results of the study showed with of SEM PLS approach that changes the level of sugar in the blood is the model fit with accuracy of 93.8 percent. Indicators on the time eat factor (FM), activity factor (FA), medicine factors (FO), Hyperbaric Therapy Oxygen (L_HBO) and changes in the level of sugar in the blood (KGD) is valid and reliable. Time factor Eat (FM) affect the changes in the changes of blood glucose (KGD) of 0.248, medicine factors (FO) affect the changes in the level of sugar in the blood (KGD) of 0.891, HBO therapy (L_HBO) affect the changes in the level of sugar in the blood (KGD) of 0.078, and activity Factor (FA) affect the changes in the level of sugar in the blood (KGD) of 0.152. Factors drugs give the greatest effects in the decrease in the level of sugar in the blood that it needs to be noted the dose related insulin and blood sugar levels. When the blood sugar becomes too low, must be taken into consideration to adjust the insulin dose during treatment. Nurses and the involvement of other parties have a special role in strengthening the advice given to the client. In fact client education is the key to success in controlling diabetes can in the measuring cup from good blood sugar level namely with discipline in the injecting insulin that has been recommended by doctors regularly.

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