ORIGINAL ARTICLE

The Role of Diabetes Knowledge and Mediating Effects of Self-Efficacy on Diabetes Knowledge Toward Diabetes Self-Care Activities among Indonesian Diabetes.

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ABSTRACT

Introduction: *Self-care activities is one of the critical element of controlling diabetes. Diabetes knowledge and self-efficacy were two main predictors suggested by evidence to be important in supporting diabetes self-care activities; both factors were also found to have a strong relationship. However, the minimal study explored the mediating effect of self-efficacy on diabetes knowledge toward diabetes self-care activities among Indonesian.* ***Objectives:*** *This study wants to explore the role of diabetes knowledge and examine the mediating effect of self-efficacy on diabetes knowledge toward diabetes self-care activities among Indonesian.* ***Methods:*** *This study was a cross-sectional-correlative study among 211 Indonesian adults with diabetes who utilized OPD Hospital in Malang, Indonesia. The primary valid and reliable instruments that measure diabetes knowledge, diabetes self-care activities, and self-efficacy were used in this study. Data were analysed using SPSS 23 Software, and the mediating effect analysis examines using Hayes PROCESS software for SPSS.* ***Results:*** *Most subjects demonstrated low diabetes knowledge and self-efficacy and reported less than optimal self-care activities. Self-efficacy shows a 'complete mediating effect' in diabetes knowledge toward diabetes self-care activities.* ***Conclusions:*** *This study highlights the importance of diabetes knowledge and self-efficacy and both factors' existence in supporting diabetes self-care activities.*

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1. Introduction

Diabetes is a metabolic condition caused by abnormalities in insulin secretion, insulin action, or both. It is characterized by persistent hyperglycemia and disruptions in carbohydrate, lipid, and protein metabolism (Amod et al., 2012). When the pancreas fails to generate enough of the hormone insulin, which controls blood sugar, or when the body struggles to utilize the insulin, diabetes develops (Davies et al., 2013). The body's inefficient use of insulin causes type 2 diabetes, also known as non-insulin-dependent or adult-onset diabetes. The vast majority of patients with diabetes globally have type 2 diabetes (World Health Organization, 2016). The interaction of genetic and metabolic factors influences the risk of type 2 diabetes, which is further influenced by older age, unhealthy lifestyles such as being overweight or obese and being inactive, as well as ethnicity, family history of diabetes, and prior gestational diabetes (World Health Organization, 2016).

Additionally, several dietary habits, such as a high intake of saturated fatty acids, a high intake of total fat, and a deficiency in dietary fiber, are associated with type 2 diabetes (Nishida et al., 2004). More proof points to a link between a heavy intake of sugar-sweetened beverages and a higher risk of type 2 diabetes. More proof points to a link between frequent sugar-sweetened

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beverages and a higher risk of developing type 2 diabetes (Consortium, 2013; Imamura et al., 2015; Malik et al., 2010; Palmer et al., 2008).

About 425 million individuals worldwide have diabetes were reported in 2017, and by 2045, that figure will rise to 629 million, or around 48 percent of the population (International Diabetes Federation, 2017). Moreover, over the past ten years, diabetes prevalence in low- and middle-income nations has increased faster than in high-income countries, rising from 4.7 percent in 1980 to 8.5 percent in 2014 (World Health Organization, 2016). Diabetes is one of the most prevalent health issues in persons aged 56 and older (pre-elderly to old elderly), with 10.3 million cases reported in Indonesia in 2017 and an expected 16.7 million cases by 2045 (International Diabetes Federation, 2017; Kementerian Kesehatan Indonesia, 2018). In addition, Indonesia is now rated sixth among the top 10 nations for the anticipated prevalence of diabetes in 2017 and is predicted to reach seventh globally in 2045 (International Diabetes Federation, 2017). Despite a higher ranking than in 2012, when Indonesia was listed as having the fourth-highest number of diabetics, the prevalence rate was anticipated to rise from 4.81 percent to 14.6 percent.

Diabetes can cause impairment and early mortality by causing damage to the heart, blood vessels, eyes, kidneys, and nerves. Uncontrolled diabetes can result in serious issues such as lower limb amputation, renal failure, blindness, and other long-term effects that substantially negatively impact the quality of life (World Health Organization, 2016). A longer duration of diabetes increases the likelihood of developing diabetic retinopathy, which in 2010 resulted in 2.6 percent of blindness worldwide and 1.9 percent of moderate to severe visual impairment (Bourne et al., 2013; Yau et al., 2012). According to Collins et al. (2015), who compiled data from 54 countries, diabetes is the primary cause of renal illness and accounts for at least 80% of end-stage renal disease (ESRD). Those all-complications cause escalating costs of diabetes treatment; thus, preventing the complications is essential.

Preventing diabetes complications is by controlling diabetes, which is a patient's self-care and is one of the critical points of controlling diabetes and its complications. Self-care activities

2. Methods

This study utilized an explorative cross-sectional descriptive correlation design. The accidental sampling was used to select samples of Indonesian adults with type 2 diabetes from the outpatient department (OPD) of a hospital in Malang City, East Java, Indonesia.

Sampling

The sample was chosen based on three inclusion criteria: persons 18 years of age and older, a confirmed diagnosis of type 2 diabetes, and a willingness to participate. They were prohibited from participating in the trial if they could not read or write Indonesian Bahasa and if they had severe diabetic consequences like blindness or dominant arm amputation.

The G-Power Analysis was used to determine the sample size. The preliminary results of the sample sizes calculation for multiple linear regression were 139 subjects by setting the medium effect size (f2=0.15), power of study .80, and α error probability of 0.05. Furthermore, 20% of additional sample sizes should be added to the estimated sample size to obtain 204 subjects for this study, considering the response rate.

Instruments

This study utilized three main questionnaires measuring patients' self-care activities, diabetes knowledge, and self-efficacy. The 17 items of The Expanded Summary of Diabetes Self-Care Activities- Indonesian version (SDSCA-I) were used to evaluate patients' self-care activities. It was calculated by the number of days a week (0 to 7); the scores ranged from 0 to 119. Then, the 24 items of the Diabetes Knowledge Questionnaire (DKQ) were adapted from Garcia et al.

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(2001). The DKQ measured the patient's knowledge of diabetes. The responses would be scored as zero or one (0=false or do not know; and 1= correct). The total diabetes knowledge score ranged from 0 to 24. Lastly, the 20 Diabetes Management Self-Efficacy Scales (DMSES) items measured patients' self-efficacy. The responses are rated on a 10-point scale ranging from "no confidence" to "high confidence" (1, 5). The Cronbach Alpha of all instruments was good (over 0.7, respectively).

Data analyzes

Data analysis consisted of descriptive statistics and inferential statistics. Descriptive statistics applied distribution frequency, mean, standard deviation, and percentages to determine the total subjects' proportions. While the bivariate analysis was used to examine the relationship between all variables, and the multivariate analysis was used to evaluate the predictors of diabetes self-care activities. All tests applied the α level of 0.05 and p-value < 0.05. Statistical analyses for quantitative data were performed using the Statistical Package for Social Sciences (SPSS) version 23. Then, the predictors and analysis of mediating effects were performed using Hayes PROCESS software for SPSS.

3. Results and Discussion

3.1 Subjects' characteristics

Table 1 demonstrates the subjects' demographic characteristics. Out of 211 subjects, the mean age was 54.6 years (SD=11.7). There were not many differences in gender, and females (58.3 %) represented a slightly higher proportion than males. The majority of subjects were married (84.4%, n=178). The subjects' education levels spread from all categories, which were not much different; the highest proportion of education levels was an elementary school (33.2%). The subjects' occupations also spread in all categories; the highest proportion was unemployment (28.4%). The mean duration of diabetes among respondents was 3.73 years (SD=3.35), ranging from 0.1 to 20 years; however, there were eight missing data. Most subjects received oral drug treatment (73.0%, n=154), and few received an insulin injection (4.2%, n=8). Unfortunately, most of them said they have diabetes complications or comorbidity (84.4%, n= 178), of which the mean of total comorbidity was 1.35 (SD= .94), ranging from 0–5. In addition, most subjects reported having a 'close personality' (56.4%).

Diabetes knowledge. The total score of diabetes knowledge was 0 to 24; the results found that the diabetes knowledge score in this study ranged from 5 to 23. The mean total score of diabetes knowledge was 11.9 (SD= 4.19), indicating that the correctness proportion was 49.8%. The items that most subjects answered correctly were item 1 (overeating sugar and sweet foods are the cause of diabetes) and item 15 (wounds in diabetes were long healing), which reached 81-80%, respectively. In contrast, the item with a higher proportion of subjects did not know was item 4 (kidney produce the insulin) and item 9 (the best way to check diabetes is through urine test) (26% for each).

Self-care activities. Patients reported performing self-care activities three to five days weekly (M=3.61, SD=1.75). The expected scores for self-care activities were 0 to 112; however, the finding ranged from 21 to 103, and the mean of the total score was 57.47 (SD=18.24), indicating that most patients also perform self-care activities less than optimal (Table 2). Table 2 shows the details of seven days of self-care activities. The highest regular self-care activities (in which subjects performed more than four days per week) were in domain medication, including taking recommended diabetes medications, including insulin injection (mean 4.58, SD=1.90), taking the recommended number of diabetes pills (mean 4.58, SD=1.77)—then followed by participating in at least 30 minutes of physical activity (walking) (mean 4.06, SD=2.12) and eating

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five or more servings of fruits and vegetables (mean 4.03, SD=1.93). The rest activities were only performed three to four days each week (mean above 3.0).

Self-efficacy. Twenty items were used to measure self-efficacy, which was the patients' capabilities to organize and execute courses of action required to meet given situational demands in diabetes management. Ten-point 1 to 10 scores were used, with the total self-efficacy scores expected to be 20 to 200; however, the results found that the total self-efficacy scores range from 32 to 173. The mean total self-efficacy score was 95.36 (SD=35.97), indicating that the subjects have relatively low self-efficacy. The mean item score ranged from 3.35 (SD=1.91) to 6.35 (SD=2.74) (Table 3), which indicated that most patients did not have appropriate confidence or self-efficacies in performing chronic disease management. In addition, most patients feel least confident about being able to check blood sugar/urine tests if needed (item 1) (M=3.35, SD=1.91) and able to follow a healthy eating pattern when eating out or at a party (item 16) (M=4.00, SD=2.37). In contrast, they were most confident in taking medication as prescribed (item 19) (M=6.35, SD=2.74) and followed by being able to adjust medication when sick (item 20) (M=6.08, SD=2.61).

Table 1 Respondents characteristics and the correlation toward diabetes self-care activities

Variables	**n**	**(%)**	**Self-care activities**		
			Mean (SD)	***analysis***	***P-value***
Age (mean ±SD)	54.6 (11.7)		*57.47 (18.2)*	*r* = -.114	*ns*
Gender					
Male	88	41.7	*56.2 (17.2)*	*t* =.854	*ns*
Female	123	58.3	*58.4 (18.8)*		
Marital status					
Married	178	84.4	*57.8 (18.1)*	*t* =.577	*ns*
Single/ Divorce	29	13.6	*55.8 (19.2)*		
Level of education					
Elementary school	70	33.2	*53.9 (16.1)*	*F*= 4.425 (4>1) (4>2) (4>3)	**.005***
Junior high school	50	23.7	*55.4 (15.7)*		
Senior high school	43	20.4	*58.2 (19.6)*		
University	42	19.9	*65.9 (19.4)*		
Missing	6				
Occupation					
Unemployment	60	28.4	*55.3 (18.5)*	*t* =1.12	*ns*
Employment	149	70.6	*58.4 (18.1)*		
Missing	2				
Duration of diabetes (year) (mean ±SD)	3.73 (3.35)		*57.47 (18.2)*	*r* = -.018	*ns*
Range	0.1 – 20				
Missing	8				
Medication					
Oral agents	154	73.0	*56.1 (17.6)*	*t* =-1.874	*ns*
Insulin/combination	52	26.6	*61.5 (19.5)*		
Missing	5				
Diabetes complications / Comorbidities					
Yes	178	84.4	*56.9 (17.9)*	*t* =-1.001	*ns*
No	33	15.6	*60.4 (19.8)*		
Comorbid	0 – 5	1.35 (.94)			
None	33	15.6	*60.4 (19.8)*	*F*= 2.517	*ns*
1-3	172	81.5	*56.4 (18.0)*		
3+	6	2.8	*71.5 (5.9)*		

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Personality					
Open mind	82	38.9	*61.2 (18.3)*	*t* =3.104	***.002****
Tend to close	119	56.4	*53.4 (16.1)*		
Missing	10				
Diabetes Knowledge (mean ±SD)	5-23	11.9 (4.19)	*57.47 (18.2)*	*r* = .202	***.000****

*Significant at p-value <0.05

Table 2 Subjects self-care activities

	Seven days of diabetes self-care activities	Item Mean (SD)	Rank
	Diet		
1.	Followed a healthful eating plan	3.94 (1.91)	5
2.	On average, over the past month, following the eating plan	3.66 (1.94)	6
3.	Eat five or more servings of fruits and vegetables	4.03 (1.93)	4
4.	Eat high-fat foods such as red meat or full-fat dairy products	3.36 (1.61)	10
5.	Space carbohydrates evenly throughout the day	3.52 (1.67)	7
	Exercise		
6.	Participate in at least 30 minutes of physical activity (Total minutes of continuous activity, including walking).	4.06 (2.12)	3
7.	Participate in a specific exercise session (such as swimming, walking, biking) other than what you do around the house or as part of your work	3.49 (1.84)	8
	Blood sugar testing		
8.	Test blood sugar	3.18 (1.74)	15
9.	Test blood sugar the number of times recommended by your healthcare provider	3.34 (1.80)	11
	Foot care		
10.	Check feet	3.30 (1.66)	13
11.	Inspect the inside of the shoes	3.14 (1.52)	16
12.	Wash feet	3.20 (1.56)	14
13.	Soak feet	3.32 (1.55)	12
14.	Dry between toes after washing	3.37 (1.66)	9
	Medication		
15.	Take recommended diabetes medication OR	4.40 (1.77)	2
	Insulin injections	4.58 (1.90)	1
16.	Take the recommended number of diabetes pills	4.58 (1.77)	2
	Average of all self-care activities	**3. 61 (1.75)**	

Table 3 Subjects diabetes self-efficacy

	Items	Mean (SD)	Rank
1	I can check my blood/urine sugar if necessary	3.55 (1.91)	**20**
2	I can correct my blood sugar when the sugar level is too high	4.23 (2.10)	17
3	I can correct my blood sugar when my blood sugar level is too low.	4.09 (2.20)	18
4	I can choose the correct food	5.11 (2.59)	4
5	I can choose different foods and stick to a healthy eating pattern	4.99 (2.47)	6
6	I can keep my weight under control	4.88 (2.38)	11
7	I can examine my feet for cuts	4.83 (2.44)	12
8	I can take enough exercise, for example, walking the dog or riding a bicycle	5.39 (2.62)	3
9	I can adjust my eating plan when ill	4.94 (2.50)	8
10	I can follow a healthy eating pattern most of the time	4.91 (2.41)	10
11	I can take more exercise if the doctor advises me to	4.99 (2.38)	7

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12	When doing more exercise, I can adjust my eating plan	4.92 (2.43)	9
13	I can follow a healthy eating pattern when I am away from home	4.59 (2.44)	13
14	I can adjust my eating plan when I am away from home	4.25 (2.36)	16
15	I can follow a healthy eating pattern when I am on holiday	4.52 (2.25)	14
16	I can follow a healthy eating pattern when I am eating out or at a party	4.00 (2.37)	19
17	I can adjust my eating plan when I am feeling stressed or anxious	4.48 (2.13)	15
18	I can visit my doctor once a year to monitor my diabetes	5.04 (2.96)	5
19	I can take my medication as prescribed	6.35 (2.74)	**1**
20	I can adjust my meditation when I am ill	6.08 (2.61)	2

3.2 Mediating effects of self-efficacy on diabetes knowledge toward diabetes self-care activities

Table 4 illustrates the mediating effects of self-efficacy on diabetes self-care activities using Hayes PROCESS for SPSS 23 software. In this analysis, diabetes knowledge was treated as the main predictor (X), and 'personality' was one of the covariates.

Findings show that self-efficacy significantly affects diabetes knowledge. About 16.2% of the variance in self-efficacy is explained by manipulating diabetes knowledge (R2=0.162). About 25.5% of the variance in diabetes self-care activities is accounted for by self-efficacy as proposed mediators and diabetes knowledge (R2=0.255). Then, from the model, self-efficacy was the mediator that significantly affected the diabetes self-care activities (b=.183, SE= .037, t[11,185]= 5.024, p< .01). The findings shows the total indirect effect (b=.649, SE= .219, 95%CI [.235, 1.102]) and the indirect effect of self-efficacy (b=.607, SE= .185, 95%CI [.286, 1.00]) indicates a mediating effect of self-efficacy on the relationship between diabetes knowledge and diabetes self-care activities. Moreover, this analysis shows that the direct and total effect of diabetes knowledge on diabetes self-care activities was insignificant (p>.05); thus, it demonstrated a full mediating effect of self-efficacy in the relationship between diabetes knowledge and diabetes self-care activities.

The 'personality' was the only significant covariate in this analysis. It indicates that patients with an open mind were 6.939 points higher in self-care activities than those with a closed mind (b= 6.939, SE= 2.299, t[185]= 3.019, p<.05). Despite a small effect, self-efficacy also indicated that a high self-efficacy showed lower perceived health-related action (b= -.019, SE= .008, t[190]= -2.325, p< .05). These findings highlight the importance of self-efficacy in improving diabetes self-care activities.

Table 4 Regression coefficient, standard errors, and model summary information for diabetes knowledge influenced by self-efficacy (mediator) and covariates toward diabetes self-care activities

Antecedent	**Consequent (self-efficacy)**			**Y (SDSCA)**		
	Coeff.	*SE*	*p*	*Coeff.*	*SE*	*p*
X (DKQ)	**a 3.310**	**.639**	**<.001**	**c'** -.046	.347	.894
M(self-efficacy)				**b .183**	**.037**	**<.001***
Edu1 (University)	-3.405	7.272	.640	6.596	3.554	.065
Edu2 (senior high school)	.509	6.391	.937	4.249	3.1362	.177
Edu3 (Junior high school)	-8.042	6.110	.190	2.761	2.986	.356
Personality	3.090	4.721	.514	**6.939**	**2.299**	**.003***
Constant	57.001	7.987	<.001	22.89	18.99	.230
	R^2 =.162			R^2 =.255		
	$F_{(5,191)}$= 7.357, p=<.001			$F_{(11,185)}$= 5.751, p=<.001		
Total effect: b=.602, SE .332, p=.072						
Direct effect: b=-.046, SE=.347, $t_{(10,194)}$= -.189, p=.894						

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Indirect effect total: b=.649, SE= .219, 95%CI [.235, 1.102]
The indirect effect of self-efficacy: b=.607, SE= .185, 95%CI [.286, 1.00]

Note: M=mediator

4. Conclusion

The consideration of treating diabetes knowledge (as a predictor) in diabetes self-care activities was based on the firm and consistent correlation between diabetes knowledge and self-care activities in this study's findings and the previous studies (Rahayu & Chen, 2020). Besides, the significant relationship between diabetes knowledge and self-efficacy also highlights the probability of self-efficacy as a mediator variable in the prediction analysis between diabetes knowledge and self-care activities. This consideration was based on the literature related to mediating analysis mentioned by Bennett (2000), in which a mediator is a variable that specifies how the association occurs between an independent (diabetes knowledge) and an outcome variable (self-care activities). Then, a mediator effect is only tested when a significant direct effect exists between the independent variable and the outcome variable (Baron & Kenny, 1986; Bennett, 2000; Fiedler et al., 2011). In this study's findings, self-efficacy was a significant mediator in diabetes knowledge and self-care activities. The findings show a 'complete mediating effect' on the relationship between diabetes knowledge and self-care activities. It highlights the essential role of self-efficacy in supporting chronic disease management among diabetes; higher self-efficacy was associated with more careful self-care behaviors (King et al., 2010; Messina et al., 2018; Sharoni et al., 2018). Self-efficacy also shows a mediating effect on social support and diet self-management among patients with type 2 diabetes. Gonzalez et al. (2014) also suggest that self-efficacy was highly correlated to self-management behaviors among Chinese patients with diabetes. Thus, it highlights that diabetes knowledge is essential in self-management behaviors or self-care activities. The findings showed that diabetes knowledge was not significant in self-care activities. In self-care activities, the diabetes knowledge effect was entirely mediated by self-efficacy. Therefore, it suggests that by manipulating self-efficacy, the effect of diabetes knowledge in self-care activities will be increased; likewise, by manipulating diabetes knowledge, self-efficacy also will be improved.

These study findings provide information for healthcare providers that diabetes knowledge and self-efficacy are still the most crucial factor of chronic disease management among diabetes patients in Indonesia. Thus, it could be a fundamental consideration to improve the treatment of diabetes patients. Therefore, improving health education, especially chronic disease management, is vital to enhance patients' chronic disease management competency among Indonesian diabetes in hospital and community settings. Besides, improving diabetes knowledge could also improve self-efficacy, significantly enhancing patients' self-management and self-care abilities. Moreover, among the findings, the variable that was possible to be intervened was diabetes knowledge. Hence, nursing education must develop a better chronic disease management education program in hospital-based and community-based settings.

Furthermore, based on this study's findings, Indonesian nurses must consider what strategic approaches can be affordable and suitable for diabetes patients in urban and rural Indonesia. For instance, public health centers can provide weekly free exercise and monthly health education groups for diabetes to overcome physical activity barriers. These are simple, straightforward, and easily understandable for low-level literacy people. In this issue, the healthcare providers could adopt education tools such as the diabetes conversation map (Healthy Interaction, 2016), which applies game methods to help patients enjoy and quickly understand the messages and learn about chronic disease management in diabetes. Besides, they could adopt established healthy diabetes plates or called the Idaho plate methods (Amod et al., 2012; Brown et al., 2001) that were used widely to help patients calculate the number and proportionate the

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kinds of foods as recommended to control calories intake, of course with some adjustments for fitting Indonesian.

In terms of nursing education, based on this study's results, nursing students have clinical practice by giving health education-related diabetes in the community in their fourth years. The nurses working in public health centers must also fulfill their roles as educators for their communities, such as designing health educator programs related to diabetes since public health centers are the primary health care services that most patients visit monthly. Also, they can work together with the nursing school to provide better educational programs for patients with diabetes.

Ethics approval and consent to participate

This study was approved for ethical clearance by the Institutional Review Board (IRB) at dr. Saiful Anwar Hospital of Malang, East Java, Indonesia (No. 400/032/K.3/302/2020). Informed consent from each respondent was obtained at previously to data collection.

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