Path Analysis of Blood Glucose Determinant on Diabetes Mellitus Patients through Intervening Variables of Medication Adherence

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Abstract
The prevalence of Diabetes Mellitus (DM) patients in Indonesia in 2013 has increased compared to 2007. The non-adherence of patients in undergoing treatment therapy is one of the drug therapy problems (DTP) that needs special attention. The purpose of the study was to obtain the results of an analysis of direct and indirect relationships related to knowledge, attitudes, family support, and adherence to taking medication for blood glucose levels in patients with DM of type II. Research with correlation analytic research design, with a population of all DM patients of type II with outpatient care in the Sleman region, DIY, were 530 people. The sample was determined by the proportionate stratified random sampling technique of 119 people. The independent variables include knowledge, attitude, family support, while the dependent variable is blood glucose levels in patients with DM of type II and the intervening variable is adherence with taking medication. This study used path analysis techniques. The results of this study draw conclusions, knowledge, attitudes, family support and medication adherence to DM patients with directly influence blood glucose levels. Apart from knowledge, attitudes and family support through adherence to taking drugs indirectly affect blood glucose levels.

INTRODUCTION
The World Health Organization (WHO) predicts that there will be an increase in the number of diabetics from 135 million in 1995 to 300 million in 2025. The highest increase is predicted to occur in the Continent of Asia (Zahra et al., 2016). Diabetes mellitus (DM) is rapidly becoming one of the most common non-infectious diseases globally. Population growth, population aging, and urbanization with associated lifestyle changes are likely to cause a 55% increase worldwide, with diabetes by 2035. China has become the country with the largest number of diabetics in the world (Shugang et al, 2015). Based on WHO data in 2013, the prevalence of DM patients in Indonesia in 2013 (2.1%) experienced an increase compared to 2007 (1.1%). The most common type of DM and the increasing prevalence is type II diabetes mellitus with the most cases being 90% of all cases of DM in the world.

DM is a disease associated with lifestyle, so the success or failure of the management of DM is very dependent on the patient himself in changing his behavior. Rosyida et al. (2015), stated that patient non-adherence to undergoing treatment thera-
RESULTS AND DISCUSSION

The results showed that respondents’ characteristics as illustrated in Table 1, as many as 56-65 years old (45.4%), senior high school graduation (53.8%), good knowledge (84%), good attitude (82.4 %), Good family support (69.7%), medication compliance (76.5%) and controlled blood sugar (57.1%).

Based on the results of the normality and linearity test, it was concluded that the research data were normally distributed and there was a linear relationship between the independent variables consisting of knowledge, attitudes, family support, and adherence to taking drugs with the dependent variable namely blood sugar levels, so path analysis which is measured by multiple linear regression analysis. Then after testing the model validation with total determinant coefficients and theory trimming, the diagram is as follows:

Interpretation of Figure 1 is as follows:

Direct influence X1 to Y = P4, the influence of knowledge variables (X1) the variable of blood glucose levels (Y) are 0.193.

Direct influence X2 to Y = P5, the influence of attitude variable (X2) on the variable of blood glucose level (Y) is 0.203.

Direct influence X3 to Y = P6, the effect of family support variable (X3) on the variable of blood glucose level (Y) is 0.217.

Direct influence X4 to Y = P7, the effect variable of the adherence to taking medication (X4) on the variable of blood glucose level (Y) is 0.223.

Indirect influence X1 to Y through X4 = P1 x P7, The effect of the knowledge variable (X1) on the variable of blood glucose level (Y) through medication adherence (X4) is 0.290 x 0.223 = 0.065.

Indirect influence X2 to Y through X4 = P2 x P7, The effect of attitude variable (X2) on the variable of blood glucose level (Y) through medication adherence (X4) is 0.274 x 0.223 = 0.0611.

Indirect influence X3 to Y through X4 = P3 x P7, Effect of family support variables (X3) the variable of blood glucose level (Y) through medication compliance (X4) is 0.275 x 0.223 = 0.0613.

Total Influence X1 to Y through X4, Y = P4 + (P1 x P7) = 0.193 + 0.065 = 0.258

Total Influence X2 to Y through X4, Y = P5 + (P2 x P7) = 0.203 + 0.061 = 0.264

Total Influence X3 to Y through X4, Y = P6 + (P3 x P7) = 0.217 + 0.061 = 0.278

Direct Effects and Indirect Effects of Knowledge on Blood Glucose Levels

Based on the results of path analysis, it was shown that knowledge proved to have a direct effect on blood glucose levels with a path coefficient
Table 1. Overview of the Distribution of Respondents Characteristics

| Respondents Characteristics | Total | Percentage |
|-----------------------------|-------|------------|
| **Ages**                    |       |            |
| 36 - 45 years old           | 8     | 6.7%       |
| 46 - 55 years old           | 28    | 23.5%      |
| 56 - 65 years old           | 54    | 45.4%      |
| > 65 years old              | 29    | 24.4%      |
| **Education**               |       |            |
| Graduate of Master Degree   | 2     | 1.7%       |
| Graduate of Bachelor Degree | 17    | 14.3%      |
| Graduate of Diploma 3       | 9     | 7.6%       |
| Graduate of Senior High Graduate | 64 | 53.8%      |
| Graduate of Junior High School | 16  | 13.4%      |
| Graduate of Elementary School | 11  | 9.2%       |
| **Knowledge**               |       |            |
| Good                        | 100   | 84%        |
| Enough                      | 19    | 16%        |
| Less                        | 0     | 0.0%       |
| **Attitude**                |       |            |
| Good                        | 98    | 82.4%      |
| Enough                      | 17    | 14.3%      |
| Less                        | 4     | 3.4%       |
| **Family support**          |       |            |
| Good                        | 83    | 69.7%      |
| Enough                      | 34    | 28.6%      |
| Less                        | 2     | 1.7%       |
| **Adherence to taking drugs** |     |            |
| Obey                        | 91    | 76.5%      |
| Disobey                     | 28    | 23.5%      |
| **Blood Sugar Levels**      |       |            |
| Controlled                  | 68    | 57.1%      |
| Uncontrolled                | 51    | 42.9%      |

of 0.193 and knowledge was proven to influence blood glucose levels through medication adherence to a path coefficient of 0.065 with a total effect of 0.253. Good knowledge related to health problems will affect the way of view which then influences a person's behavior on the health problems they face. The better level of knowledge of a patient has about DM and its control, the more controlled his blood glucose levels are.

In this study the patient's knowledge is good and directly influences the blood sugar level of 19.3%, besides that knowledge through medication adherence will have a greater influence on blood glucose levels which is equal to 25.8%, where adherence to taking medication from patients at this research is 76.5% is good. Knowledge can directly affect the patient's blood sugar levels, because of other factors, such as diet, activity or sports factors, and stress factors, so the value of the influence obtained is smaller (19.3%). Knowledge can also influence adherence to taking medication which is a variable intervening, then it will affect blood sugar levels, so the total effect value is greater (25.8%), although there are several other factors that can influence such as family support or other support in the environment.

Knowledge is the basis for health behavior, especially the lack of knowledge about the rules of treatment, the benefits and complications caused by not adhering to the treatment recommendations. This is in line with studies that state that good knowledge related to knowledge about diabetes mellitus, both signs and symptoms and its handling will affect the control of blood glucose levels (Kassahun & Alemayehu, 2017; Qurratuaueni, 2010). The results...
of other studies say that ignorance of the treatment of diabetes will cause a lack of control of blood sugar levels and can trigger distress conditions that have an impact on rising blood sugar levels (Fisher et al., 2010).

New behavior, especially in adults, begins in the cognitive domain in the sense that the subject knows first about the stimulus in the form of material objects outside, giving rise to an inner response in the form of attitude. Finally, the stimulus that is the object that has been known and fully realized will cause a further response, namely in the form of an action against a stimulus or object. Knowledge is the first step for someone to determine their attitudes and behavior. So the level of knowledge will greatly influence the acceptance of a program (Notoatmodjo, 2007). Because of the importance of knowledge that must be known by DM patients, various ways are done to be able to transfer health education and patient behavior guidance that can reach large areas, including coastal areas (Quinn et al., 2011). According to Alsous et al. (2019), the need for more educational interventions to overcome negative attitudes and promote healthy lifestyle practices and routine health checks, especially in the subgroup of patients with certain characteristics, such as low education is very important.

**Direct Effects and Indirect Effects of Attitudes on Blood Glucose Levels**

Based on the results of path analysis, it was shown that attitudes proved to have a direct effect on blood glucose levels with a path coefficient of 0.203, besides that attitudes also influence blood glucose levels through medication compliance with a path coefficient of 0.061, with a total effect of 0.264. Attitude is a reaction or response that is still closed from someone to the stimulus. Attitudes will not necessarily be realized in the form of an action, supporting factors are needed or conditions are possible, such as facilities. A DM patient who has intended to go on a diet as recommended, sometimes gets out of the lane because the situation at home or office is not supportive.

The results of this study are in line with the results of previous studies, such as the results of a study by Al-Maskari et al. (2013), Roux et al. (2018), Ansari et al. (2019), who said that poor levels of knowledge and attitudes related to patient control of DM, which reflected in poor glycemic control and can contribute to morbidity and mortality. Although many research results say knowledge, and attitudes influence patients in controlling their blood sugar, but to improve the ability of DM patients to manage their own blood sugar, they need to think about demographics, education and age and economic conditions (Kheir et al., 2011).

**Direct and Indirect Effects of Family Support on Blood Glucose Levels**

Based on the path analysis results showed that family support proved to have a direct effect on blood glucose levels with a path coefficient of 0.217, besides that family support was proven to influence blood glucose levels through medication adherence to a path coefficient of 0.001 and a total influence of 0.217.
needs to be considered that has a clinically significant and sustained long-term impact on patient adherence. The goal of treatment for DM of type 2 is to prevent or delay complications and maintain quality of life, so it is very necessary to take a patient and environment-centered approach to increase patient involvement in self-care activities (Davies et al., 2018).

The availability of drugs in patients that includes daily, weekly, or even monthly doses must be available in the near future, in order to increase adherence to, resulting in increased glycemic control, reduced complications of diabetes, and health care with minimal costs that can be reduced. Aymen et al. (2017), explained that the longer duration of illness, old age, female sex, and self-perception and patient's belief about the severity of DM were factors associated with adherence to treatment. Increasing interaction and having partner relationships with patients is key to improving patient adherence to drugs.

The direct effect of medication adherence is an influence with the largest total value (22.3%), because for people with DM, drugs are a very influential external factor for controlling blood sugar levels, besides there are other factors that influence, such as diet done. The indirect effect on blood sugar levels with the greatest value is the effect of family support on blood sugar levels through adherence to medication (27.8%). Support from the environment of people with DM, especially the family environment is a factor that needs attention because the characteristics of the largest respondents in the age group are 56-65 years (45.4%), including the age group that begins to depend on the family environment.

**CONCLUSIONS**

Based on the research conducted, the conclusions are as follows: 1) Knowledge, attitudes, family support and medication adherence in with DM patients directly influence blood glucose levels. 2) Knowledge through adherence to taking drugs indirectly affects the blood glucose level by 25.8%. 3) There is an influence of attitude through adherence to taking medication indirectly to blood glucose levels of 26.4%. 4) Family support through adherence to taking medication has an effect on blood glucose levels of 27.8%.

**REFERENCES**

Al-Maskari, F., El-Sadig, M., Al-Kaabi, J.M., Afandi, B., Nagelkerke, N., Yeatts, K.B. 2013. Knowledge, Attitude and Practices of Diabetic Patients in the United Arab Emirates. *PLoS ONE*, 8(1): e52857.

Alsous, M., Jalil, M.A., Odeh, M., Al Kurdi, R., & Alnan, M. 2019. Public knowledge, attitudes and practices toward diabetes mellitus: A
cross-sectional study from Jordan. *PLoS ONE*, 14(3): e0214479.

Amalia, W.C., Sutikno, E., & Nugraheni, R. 2016. Hubungan antara Tingkat Pengetahuan tentang Diabetes Mellitus dan Gaya Hidup dengan Tipe Diabetes Mellitus di Puskesmas Wonodadi Kabupaten Blitar. *Jurnal Preven-
tia*, 1(1): 14-20.

Anggina, L.L., Hamzah, A., & Pandhit. 2010. Hubungan antara Dukungan Sosial Keluarga dengan Kepatuhan Pasien Diabetes Mellitus dalam Melaksanakan Program Diet di Poli Penyakit Dalam RSUD Cibabat Cimahi. *Journal Penelitian Kesehatan Suara Forikes*, 2(1): 1-9.

Anju, G., Bhatta, D.N., & Aryal, U.R. 2015. Diabetes related health knowledge, attitude and practice among diabetic patients in Nepal. *BMC Endocrine Disorders*, 15(25): 1-8.

Ansari, T, Sami, W., Althaqib, A.A., Almutairi, A.N., Alshamrani, M.A., Alanazi, M.A., Almutairi, M.A. 2019. Assessment of knowledge, attitude, and practice of diet pattern in patients with type 2 diabetes mellitus: a locality-based perspec-
tive study. *International Journal of Medicine in Developing Countries*, 3(7): 581–585.

Awodele, O., & Osuolale, J.A. 2015. Medication Ad-
herence in Type 2 Diabetes Patients: Study of Patients in Alimosho General Hospital, Igan-
do, Lagos, Nigeria. *Journal African Health Sciences*, 15(2): 513-522.

Aymen, E., Radwan, M., Al-Sharif, H., & Mustafa, A.A. 2017. Medications Adherence and Associated Factors among Patients with Type 2 Diabetes Mellitus in the Gaza Strip, Palestine. *Frontiers in Endocrinology*, 8(100): 1-9.

Davies, M., D'Alessio, D., Fradkin, J., Kernan, W., Mathieu, C., et. al. (2018). Management of hyperglycaemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European As-
soociation for the Study of Diabetes (EASD). *Diabetologia*, 61(12).

Fisher, L., Glasgow, R. E., & Strycker, L.A. 2010. The Relationship between Diabetes Distress and Clinical Depression with Glycemic Control Among Patients with Type 2 Diabetes. *BMC Public Health*, 33(5).

Hensarling. 2009. *Development and Psychometric Testing of Hensarling's Diabetes Family Support Scale*. Doctoral Thesis. Denton: Graduate School of the Texas Woman's University.

Herath, H.M.M., Weerasinghe, N.P., Dias., H., & Weeraratnha, T.P. 2017. Knowledge, Attitude and Practice Related to Diabetes Mellitus among the General Public in Galle District in Southern Sri Lanka: A Pilot Study. *BMC Public Health*, 17(353): 1-7.

Kaniz, E., Hossain, S., Natasha, K., Chowdhury, H.A., Akter, J., Khan, T., & Ali, L. 2017. Knowledge Attitude and Practice Regarding Diabetes Mellitus among Nondiabetic and Diabetic Study Participants in Bangladesh. *BMC Public Health*, 17(364): 1-10.

Kassahun, C., & Alemayehu, G. 2017. Knowledge, Attitude, Practices and Their Associated Fac-
tors towards Diabetes Mellitus among Non Diabetes Community Members of Bale Zone Administrative Towns, South East Ethiopia: A Cross-sectional Study. *Journal Pone*, 12(2): 1-18.

Kheir, N., Greer, W., Yousif, A., Al Geed, H., & Al Okkah, R. 2011. Knowledge, attitude and practices of Qatari patients with type 2 dia-
betes mellitus. *International Journal of Pharmacy Practice*, 19(3).

Meidikayanti & Chatarina. 2017. Hubungan Dukun-
gan Keluarga dengan Kualitas Hidup Diabetes Mellitus Tipe 2 di Puskesmas Pademawu. *Jurnal Berkala Epidemiologi*, 5(2): 240-252.

Notoatmodjo, S. 2007. *Promosi Kesehatan dan Ilmu Perilaku*. Jakarta: Rineka Cipta

Nuruali. 2016. Dukungan Keluarga dengan Kepatu-
han Pasien Diabetes Mellitus dalam Menj-
jalani Pengobatan di BULD RSU ZA Banda Aceh. *Idea Nursing Journal*, 7(2).

Nursalam. 2013. *Konsep Penerapan Metode Pene-
litian Ilmu Keperawatan*. Jakarta: Salemba Medika.

Okatiranti & Nur'aeni. 2016. Gambaran Pengeta-
han, Sikap dan Kepercayaan terhadap Diet Penderita DM di RSUD Kota Bandung. *Jurnal Ilmu Keperawatan*, 4(1).

Perdana, Burhanudin, & Devi. 2013. Hubungan Tingkat Pengetahuan Tentang Penyakit DM dengan Pengendalian Kadar Glukosa Darah pada Pasien DM Tipe II di RSU PKU Mu-
hammadiyah Surakarta. *Jurnal Biomedika*, 5(2): 17-21.

Quinn, C.C., Shadell, M.D., Terrin, M.L., Barr, E.A., Ballew, S.H., & Gruber-Baldini, A.L. 2011. Cluster-Randomized Trial of a Mobile Phone Personalized Behavioral Intervention for Blood Glucose Control. *Diabetes Care*, 34(9): 1934-1942.

Qurratauani. 2010. *Faktor-faktor yang berhubungan
dengan terkendalinya kadar gula darah pada pasien diabetes mellitus di RSUP Fatmawati
Jakarta tahun 2009*. Jakarta: UIN Syarif Hidayatullah.

Rochana, R.N. 2009. *Evaluasi kepatuhan pasien pen-
gobatan obat hipoglikemik oral bagi penderita diabetes mellitus tipe 2 pada pasien rawat jalan di RSUD dr. Moewardi Surakarta. Master Thesis. Surakarta: Universitas Muhammadiyah Surakarta.

Rosland, M.H., & Piette, J.D. 2012. The Impact of Family Behaviors and Communication Patterns on Chronic Illness Outcomes: A Systematic Review. *J Behav Med*, 35(2): 221–239.

Rosyida, L., Priyandani, Y., Sulistyarini, A., & Yunita. 2015. Kepatuhan Pasien pada Penggunaan Obat Anti Diabetes dengan Metode Pill-Count dan MMAS-8 di Puskesmas Kedurus Surabaya. *Jurnal Farmasi Komunitas*, 2(2): 36-41

Roux, M., Walsh, C., Reid, M., & Raubenheimer, J. 2018. Diabetes-Related Knowledge, Attitude and Practices (KAP) of Adult Patients with Type 2 Diabetes Mellitus in the Free State Province, South Africa. *South African Journal of Clinical Nutrition*, 2(8).

Shugang, L., Guo., S, He, F, Zhang, M., He, J., Yan, Y., Ding, Y., Zhang, J., Liu, J., Guo, H., Xu, S., & Ma, R. 2015. Prevalence of Diabetes Mellitus and Impaired Fasting Glucose, Associated with Risk Factors in Rural Kazakh Adults in Xinjiang, China. *International Journal of Environmental Research and Public Health*, 12: 554-565.

Zahra, Dewi, & Miftakhurrahman. 2016. Gambaran Pelayanan Konseling Gizi pada Pasien Diabetes Melitus Tipe 2 di Puskesmas Jatinangor Tahun 2015. *JSK*, 1(4) : 186-192.