



The Effect of Pharmacist Counseling on Adherence to Antidiabetic Medications and Glycemic Control

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ABSTRACT: Controlling blood glucose is paramount in diabetes management, yet medication non-adherence often hinders optimal outcomes. This study investigated the impact of pharmacist counseling on Fasting Blood Glucose (FBG) levels and medication adherence in Type 2 Diabetes Mellitus (T2DM) patients within a rural primary healthcare setting. A quasi-experimental pre- and post-test design was employed with 112 T2DM outpatients from Puskesmas Simpang Mamplam, Bireuen City, Aceh, Indonesia, from March to April 2024. Medication adherence was assessed using the MARS-10 Questionnaire, and FBG levels were measured via finger prick. The majority of participants were female (79.5%), aged 41-60 (45.5%, mean age 55.70 ± 10.07 years), with secondary education (43.8%), predominantly sedentary/inactive workers (60.7%), and reported low-income (38.4%). Data analysis was performed using the Wilcoxon Signed rank Test. Following counseling, which was provided every two weeks over the two-months period, the mean medication adherence score significantly increased ($p < 0.001$) from 3.150 ± 0.942 to 8.790 ± 1.297. FBG levels also significantly decreased ($p < 0.05$), from an initial mean of 308.98 ± 72.995 to 220.42 ± 68.547 at two weeks, 162.36 ± 50.191 at four weeks, and 130.00 ± 27.774 at six weeks. These findings suggest that pharmacist counseling significantly improves both medication adherence ($p < 0.001$) and glycemic control (FBG decrease, $p < 0,05$) in T2DM patients.

Keywords: T2DM; medication adherence; glycemic control; pharmacist counselling.

Introduction

Diabetes mellitus (DM), a prevalent condition affecting 8.5% of the global population [1], poses a significant health burden worldwide, including Indonesia. As a major Non-Communicable Disease (NCD), DM is rapidly increasing in prevalence and mortality rates. Type 2 Diabetes Mellitus (T2DM) constitutes the vast majority of these cases. Focus on this type is crucial because Indonesia is projected to experience a substantial rise in T2DM cases between 2020 and 2045. The national prevalence is expected to increase from 9.19% (18.69 million cases) in 2020 to 16.09% (40.7 million cases) in 2045, representing a 75.1% increase over 25 years. This translates to an average annual increase of 3% in prevalence [2].

The main goal of diabetes medication is to control blood sugar levels [3,4]. Achieving this treatment success, however, strongly depends on how well patients follow or adhere to their medication plan. [5,6]. Adherence means following a healthcare provider's advice, such as taking medication, eating a specific diet, or changing lifestyle habits [7]. Several factors can impact adherence, including

the complexity of the treatment plan, side effects, the quality of the patient-provider relationship, and personal factors like age, income, and the severity of the disease [8].

The scarcity of primary care physicians and endocrinologists, coupled with the substantial time commitment required for intricate diabetes management, poses significant challenges in delivering comprehensive care, particularly in rural regions [1]. Research findings suggest that rural diabetic patients may exhibit lower adherence to prescribed treatment regimens compared to their urban counterparts [9].

Additional hurdles to effective diabetes management include poor medication adherence, complex treatment plans, medication side effects, ineffective patient-provider communication, and financial [1,10]. If individuals with diabetes harbor negative perceptions of medication's impact on their bodies, their adherence to treatment regimens is likely to diminish. A preponderance of research on medication adherence has concluded that negative beliefs about medication constitute a significant barrier [11].

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Frequent monitoring, intensive follow-up, and extensive patient education are essential components of effective T2DM management. Consequently, pharmacists can play a crucial role in this process. [1,10]. Pharmacists have the potential to significantly contribute to improving T2DM care outcomes by supporting, educating, and collaborating with all involved parties, especially in resource-constrained settings [10]. Pharmacists are an essential part of healthcare access, particularly in rural areas with limited resources [12].

The Regulation of the Minister of Health of the Republic of Indonesia (Permenkes RI) of 2016 states that pharmacist counseling is an activity that provides advice or suggestions related to drug therapy from a pharmacist (counselor) to patients and/or their families [13]. Additionally, several studies, including those by the American Diabetes Association (ADA) and the Canadian Diabetes Association, recommend involving pharmacists in multidisciplinary diabetes care teams. Previous literature reviews have demonstrated that pharmacist-led interventions can contribute to achieving glycemic targets and enhancing medication adherence [8].

This study aims to assess the effect of pharmacist-led T2DM counseling interventions on glycemic control and medication adherence among patients in a rural Indonesian primary healthcare setting.

Methods

This is a quasi-experimental study with one group pre- and post- test procedure. Participants were T2DM patients who were outpatient in Puskesmas Simpang Mamplam, Bireuen City, Aceh, Indonesia from March to April 2024.

This study obtained ethical clearance from the Ethics Committee of the Faculty of Medicine, University of Sumatera Utara (No. 691/KEPK/USU/2024).

Sample Size and Sampling Technique

The sampling method used in this study was Total Sampling. This method involved including all patients who met the established eligibility criteria and were undergoing outpatient care for T2DM at Puskesmas Simpang Mamplam, Aceh, Indonesia, during the study period (March to April 2024). This technique was chosen to obtain comprehensive data from the entire target population (N=112) available at the study site, thereby ensuring the maximum sample size possible.

Eligibility Criteria

The inclusion criteria of this study were (1) Registering as an outpatient in Puskesmas Simpang mamplam, (2) Above the age of 18 years old, (3) FBG level above 126 mg/dL, (4) willingness to participate in research by signing an informed consent. The exclusion criteria of this study were (1) irregular control schedules, (2) incomplete medical record data, and (3) circumstances that did not allow filling out the questionnaires (e.g., inability to speak, see, or hear).

Data Integrity and Missing Data Handling

All data analyses were conducted based on the Intention-to-Treat (ITT) principle. This approach ensures that all participants, once included and randomized, remain in the analysis of the final outcome, regardless of adherence to the intervention protocol or subsequent dropout (lost to follow-up).

Should any participants be lost to follow-up or provide incomplete final test data, the missing values will be addressed using the Last Observation Carried Forward (LOCF) method. This conservative imputation method assumes that the last measured FBG or adherence score remains unchanged, thereby preventing the artificial inflation of the intervention effect due to selective participant dropout. The study team also actively monitored participant adherence and schedule regularity, consistent with the exclusion criteria, to minimize the incidence of lost to follow-up.

Instrument

The guide books used were Management and prevention guidelines for type 2 diabetes mellitus in Indonesian adults 2021 by PERKENI [14] to explained the T2DM causes and symptoms, the reasons for the importance of therapy, the non-pharmacological and pharmacological therapies available (drug names, strengths, indications, rules of use, side effects, interactions, and storage), the purpose of controlling blood sugar levels, medications that need to be avoided, and guidelines for missed doses. The pharmacists explained all the contents within the module in 15 min to each patient.

The education program covers five areas: 1) definition of diabetes mellitus, and blood glucose testing, 2) diet therapy, 3) controlling measures for diabetes, 4) symptoms and treatment approaches to hypoglycemia and uncontrolled hyperglycemia, and 5) information on medication and necessary adjustments during fasting. Detailed records of counseling sessions are kept in counseling form.

The instrument for adherence measurement was the MARS-10 questionnaire adopted from the previous study

[15], The MARS-10 questionnaire was tested for reliability using Cronbach's Alpha Coefficient (α) with a result of 0.747 (>0.6). A result of $\alpha > 0.6$ was considered an indicator that the questionnaire was valid. These results served as the basis for considering the MARS-10 questionnaire valid for measuring medication adherence in T2DM patients.

The total adherence score, ranging from 0 to 10, was then classified into three adherence categories based on the established methodology: a score of 7–10 was categorized as Adherent; 4–6 was classified as Moderately Adherent; and 0–3 was defined as Non-Adherent. This classification method was utilized to evaluate the effect of the intervention on patient adherence levels [15].

Data Collection

Sociodemographic and clinical data (including medication profile and FBG level) were obtained from medical records and questionnaire. All patients provided written informed consent before participating in the study.

A three-session counseling program was implemented, focusing on diabetes education and management strategies. The primary outcome measures included Fasting Blood Glucose (FBG) levels and Medication Adherence Rating Score (MARS).

The socioeconomic status of participants was categorized based on household per capita expenditure, consistent with the official classification used by Statistics Indonesia (Badan Pusat Statistik or BPS). The participants' monthly household income were divided into four tiers: Very High (income above Rp 3,500,000), High (income between Rp 2,500,000 and Rp 3,500,000), Medium (income between Rp 1,500,000 and Rp 2,500,000), and Low (income below Rp 1,500,000) [16].

The participants were administered the MARS-10 questionnaire in the first month of the study, as a pre-test procedure. The patients participated for 2 months and were asked to fill out the questionnaire again at the end time point, as a post-test procedure. The patients received a 10-15 min face-to-face counseling session including the standard medicine information service from a pharmacist after every FBG (every two weeks for 2 months) except for the last test.

Data Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0. IBM Corp. Prior to hypothesis testing, the normality of the data distribution was assessed using the Shapiro-Wilk test. As the pretest and posttest data were found to be abnormally distributed ($p < 0.05$), differences between pretest and posttest were

compared using the non-parametric Wilcoxon signed-rank test.

Result and Discussion

A total of 112 patients were enrolled in this study. The baseline characteristics of the respondents are shown in Table 1. The majority of respondents were geriatric, in the age range between 41 and 60 years old comprising 51 people (45.5%), with an average age of 55.70 ± 10.07 years (mean \pm SD). The majority of participants were female (89 people, 79.5%). Most participants had a secondary level of education (49 people, 43.8%), and the dominant occupational category was sedentary/inactive workers (68 people, 60.7%). Furthermore, a significant portion of participants reported low-income status (43 people, 38.4%).

This research reveals a gender disparity in the prevalence of T2DM. A total of 79.5% of the study sample were women, while only 20.5% were men. This finding is consistent with previous studies, which also showed a higher prevalence of diabetes in women [17–19]. These results highlight the importance of considering gender factors in the prevention and management of diabetes. Women are at a higher risk of developing T2DM because physically they are more susceptible to obesity [17,20]. Obesity causes excessive accumulation of body fat, forcing the pancreas to work harder to produce insulin to process blood sugar. However, over time, beta cells in the pancreas can become fatigued and unable to produce enough insulin, causing blood sugar levels to continue to rise and leading to diabetes [20].

Analysis based on age shows that the almost half of research participants (51 people or 45.5%) were between 45 - <60 years old. Followed by ≥ 60 years old (46 people or 41,8%) and under 45 years old (15 people or 13,3%). This finding can be explained by the decline in pancreatic function associated with aging. As we age, the ability of pancreatic beta cells to produce insulin decreases, increasing the risk of developing T2DM [21,22]. As for younger people, Physical inactivity is a key factor in the diabetes epidemic [23].

Education plays a crucial role in the management of T2DM. In this study, it was found that the majority of T2DM patients only had up to a high school education. very recent study from Korea examines education as a social determinant of T2DM risk implies that individuals with lower educational attainment (primary, and by extension, high school) are at significantly higher risk and thus would likely represent a larger proportion of T2DM

Table 1. Patient Characteristic.

Characteristic	N	%
Gender		
• Male	23	20.5
• Female	89	79.5
Age (y.o)		
• <45	15	13.3
• 45- <60	51	45.5
• ≥60	46	41.8
Educational Level		
• Primary School	8	7.1
• Middle School	43	38.4
• High School	49	43.8
• College	12	10.7
Working Status		
• sedentary/inactive	68	60.7
• Active	43	38.4
Monthly Household Income		
• > Rp 3.500.000 (Very High)	11	9.8
• Between Rp 2.500.000- 3.500.000 (High)	18	16.1
• Between Rp 1.500.000- Rp 2.500.000 (Medium)	40	35.7
• < Rp 1.500.000 (Low)	43	38.4

Notes: The age abbreviation "y.o" refers to "years old." Data is presented as number (N) and percentage (%).

cases compared to highly educated groups [24].

In US, adults with less than a high school education or only a high school education have a higher incidence of diagnosed diabetes than adults with more than a high school education [25]. However, the effect of education on diabetes may vary by race and ethnicity [24].

Income, along with education and occupation, is an indicator of socioeconomic status, which describes a person's position in the social structure. Socioeconomic status has previously been reported to be negatively associated with various health problems [26]. Based on Table 1, 68 (60.7%) of the DM2 respondents were actively working, and 43 (38.4%) were passive workers. In terms of income, 43 (38.4%) of the respondents had low income, 40 (35.7%) had medium income, 18 (16.1%) had high income, and 11 (9.8%) had very high income. A study by Bird et al [27], revealed that low-income men were 94% more likely to have T2DM, while low-income women were 175% more likely to have T2DM. It can be imagined that the difficult living conditions experienced by those living in poverty make it difficult for them to adhere to treatment and access the necessary healthcare resources to manage their condition. Income is also strongly and independently associated with diabetes-related conditions, such as high blood pressure and overweight or obesity, and the primary behavioral factor is a lack of physical activity.

Medication adherence was assessed using the MARS-10 questionnaire that has been validated in

Bahasa Indonesia [15]. Baseline and two month follow-up investigations were considered for pre- and post-intervention, respectively. A Wilcoxon signed rank test was used to compare medication adherence scores before and after the intervention. The number of patients with good, moderate, and poor adherence at baseline was 0 (0%), 29 (25,9%), and 83 (74,1%), respectively. Post-intervention, the patients with High adherence increased (0 (0%) to 100 (89,3%), while with poor adherence decreased (83 (74,1%) to 0 (0%)); the average score of medication adherence increased significantly ($p < 0.001$) from $3,150 \pm 0,942$ to 8.790 ± 1.297 (Table 2).

A majority of respondents, amounting to 74.1%, were categorized as non-adherent. This finding aligns with the National Basic Health Research (Risikedas 2018) which reported that 50.4% of individuals with T2DM in Indonesia did not regularly take anti-diabetic medications, either because they felt healthy or due to forgetfulness [28]. This situation may arise from a lack of patient knowledge about their disease, thus necessitating healthcare services to provide education to T2DM patients on the importance of medication adherence, particularly by pharmacists who provide direct medication-related services. Education and counseling by pharmacists can also strengthen their role in the management of T2DM [29].

After counselling, A significant majority of respondents, constituting 100 (89.03%), exhibited high adherence, while 12 (10.7%) demonstrated moderate

Table 2. Patient Adherence Before and After Pharmacist Counseling.

Time	Adherence			MARS	p value
	High	Moderate	Poor		
Pre	0 (0%)	29 (25,9%)	83 (74,1%)	3,150 ± 0,942	0,000
Post	100 (89,3%)	12 (10,7%)	0 (0%)	8.790 ± 1.297	

Noted: n (%) for proportions.

adherence, and none reported Poor adherence. This outcome represents a substantial improvement compared to the pre-counseling condition, where the majority of patients exhibited non-adherence.

The result showed a significant improvement on adherence. Statistical testing yielded a *p-value* of 0.000, indicating a significant difference in adherence scores before and after counseling. This suggests that pharmacist counseling has a positive impact on improving patient adherence.

Another study conducted in two community health centers in Palembang, Indonesia, revealed similar findings. Pharmacist counseling improved patient adherence, not only by maintaining medication adherence but also by reducing patients' unhealthy eating habits [30]. This positive impact is consistently reflected in other Indonesian studies. Research conducted in Puskesmas Ngembal Kulon Kudus, Jawa Tengah [31] confirmed that patient counseling provided by pharmacists significantly enhanced adherence scores among diabetic patients. Similarly, a randomized study in Semarang, Indonesia [32] found that structured pharmaceutical care interventions resulted in sustained improvements in adherence and reduced medication-related problems compared to standard care. These findings collectively reinforce the conclusion that pharmacist involvement is essential for optimizing T2DM outcomes within the Indonesian healthcare context.

A study in rural India also stated that pharmacist counseling has a significant impact on patient medication adherence [33]. This research emphasized the importance

of correct timing of medication intake as an indicator of treatment success. Patients are more likely to follow prescribed medical therapy if they understand the reasons for their treatment and if the treatment regimen is simple and clear [34]. Therefore, in counseling, pharmacists aim to ensure that patients understand and simplify the complexities of medication regimens. This is how pharmacist counseling can ultimately improve patient adherence to treatment.

The results of glycemic control measurements are summarized as proportions in Table 3.

Before the intervention, the mean FBG were 308,98 ± 72,995 and reduced to 220,42 ± 68,547 the next two weeks, 162,36 ± 50,191 in the fourth week and 130,00 ± 27,774 at the sixth week; The results showed statistically significant differences to that of post-intervention (*p* < 0.000). A *p value* < 0.05, indicating a significant difference in patients' FBG level before and after counseling.

A comparison of glycemic control (measured by FBG in T2DM patients) before and after counseling illustrated in Table 4. According to the defining criteria where FBG ≥ 126 mg/dL indicates hyperglycemia [35], and diabetes mellitus, the pre-counseling data, reflecting the baseline status of the 112 participating patients, showed that all individuals were in a hyperglycemic state, indicating the need for intervention. Following the counselling, a notable shift in glycemic control was observed: 42.0% (47 patients) achieved FBG levels below 126 mg/dL, thereby reaching the standard for improved glycemic control. Conversely, 58.0% (65 patients) continued to have FBG levels ≥ 126

Table 3. FBG Level Before and Following Pharmacist Counseling.

N	Time Point	FBG (mg/dL)	p value
112	Baseline (Week 0)	308,98 ± 72,995	0,000
	Week 2	220,42 ± 68,547	
	Week 4	162,36 ± 50,191	
	Week 6	130,00 ± 27,774	

Table 4. Comparison of the Glycemic Control of T2DM Patients Pre- and Post-Counseling.

Reach the Standard		Intervensiann (%)	
		Pre	Post
FBG	Yes	0 (0%)	65 (58.0%)
	No	112 (0%)	47 (42.0%)

Notes: n (%) for proportions; FBG: Fasting Blood Glucose (FBG equal to or more than 126 mg/dL defines hyperglycemia and diabetes mellitus).

mg/dL. Despite a portion of patients still experiencing hyperglycemia post-intervention, the analysis revealed a statistically significant difference in FBG levels before and after counseling (p -value <0.05). This finding strongly supports the effectiveness of the pharmacist counseling intervention in reducing FBG levels and improving clinical outcomes among T2DM patients.

This is consistent with previous studies that have shown that pharmacist counseling has a positive impact and a significant influence on reducing FBG level or improving clinical outcomes in T2DM patients [29,33,36]. Another research has also concluded that interventions conducted by pharmacists can have a positive impact on patient treatment outcomes, with a significant impact on patient treatment through therapy monitoring, prevention, and resolution of drug-related problems. Effective communication between patients and pharmacists contributes to better adherence and clinical outcomes [30].

Hening et al [3], in a study conducted in Depok Indonesia, discussed the relation between blood glucose levels, knowledge, and treatment adherence to T2DM patients. Lack of knowledge related to diabetes among patients results in poor adherence to treatment and ultimately causes poor glycemic control. The causes of poor knowledge or inaccurate understanding of the diseases suffered include the lack of time to interact with medical practitioners, lack of counseling about their illnesses, and various sources of alternative medicine referrals that provide wrong information about DM, whereas the causes of medication noncompliance include poor knowledge; lack of understanding and concern for the illness; and the inability to access health services, which leads to differences in services, facilities, and treatment received by patients. This study suggests that future studies shall be conducted to look at the main causative factors that can affect glycemic control.

The present study results showed that the implementation of pharmacist counseling for management of diabetes in a rural community pharmacy has resulted in better diabetes control.

This study has several limitations that should be considered when interpreting the results. The most significant limitation is the absence of a true control group due to the quasi-experimental design employed, which restricts the ability to definitively attribute the observed improvements in adherence and FBG levels solely to the pharmacist counseling intervention. Although improvements were observed, the lack of a control group means that potential confounding factors, such as the Hawthorne effect (participants changing behavior simply because they know they are being observed) or natural temporal changes in health status, cannot be entirely excluded.

Furthermore, the data collection was confined to a single primary healthcare setting, and the use of Total Sampling limits the generalizability of these findings to broader populations. Adherence was measured using the MARS-10 questionnaire, which relies on self-reporting, potentially introducing response bias (social desirability bias).

Future research should utilize a randomized controlled trial (RCT) design to more robustly establish the causality of pharmacist-led interventions. Additionally, incorporating objective adherence measures (e.g., pill counts or pharmacy refill data) alongside subjective reporting would provide a more complete assessment of adherence behavior.

Conclusion

The medication adherence and glycemic control of T2DM could be significantly improved by pharmacist counseling. The intervention should be encouraged in the management of T2DM.

This finding also supports a potential role of the pharmacist in diabetes care to help and support other healthcare professionals to achieve optimal treatment targets, especially in improving medication adherence among patients with diabetes. Further studies are needed to explore the feasibility, and barriers to implementing the

interventions in different population groups.

Conflict of Interest

The authors declare no conflict of interest.

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References

- Orabone AW, Do V, Cohen E. Pharmacist-Managed Diabetes Programs: Improving Treatment Adherence and Patient Outcomes. *Diabetes, Metab Syndr Obes.* 2022;15(June):1911–23.
- Wahidin M, Achadi A, Besral B, Kosen S, Nadjib M, Nurwahyuni A, et al. Projection of diabetes morbidity and mortality till 2045 in Indonesia based on risk factors and NCD prevention and control programs. *Sci Rep* [Internet]. 2024;14(1):1–17. Available from: <https://doi.org/10.1038/s41598-024-54563-2>
- Hening W, Sartika RD, Sauriasari R. Effect of hospital pharmacist counseling on clinical outcomes of type 2 diabetes mellitus outpatients. *J Res Pharm Pract.* 2019;8(3):155.
- Wexler DJ. Patient education: Type 2 diabetes: Treatment (Beyond the Basics). May 20, 2024. 2024.
- Kautzky-Willer A, Leutner M, Harreiter J. Sex differences in type 2 diabetes. *Diabetologia.* 2023;66(6):986–1002.
- Selvadurai S, Makmor-Bakry M, Ali AM. An explorative qualitative study on pharmacist active engagement approach in primary healthcare diabetic education. *Indones J Pharm.* 2020;31(3):193–204.
- WHO. Adherence to long-term therapies: evidence for action. World Health Organization; 2003.
- Presley B, Groot W, Pavlova M. Pharmacy-led interventions to improve medication adherence among adults with diabetes: A systematic review and meta-analysis. *Res Soc Adm Pharm* [Internet]. 2019;15(9):1057–67. Available from: <https://doi.org/10.1016/j.sapharm.2018.09.021>
- Pasadena Nursing Center. Differences In Health Services Between Urban And Rural Areas [Internet]. September 5. 2023. Available from: <https://pasadenanursingcenter.com/differences-in-health-services-between-urban-and-rural-areas/#:~:text=Urban areas generally offer better,a higher concentration of healthcare>
- Elnaem MH, Nuffer W. Diabetes care and prevention services provided by pharmacists: Progress made during the COVID-19 pandemic and the need for additional efforts in the post-pandemic era. *Explor Res Clin Soc Pharm* [Internet]. 2022;6(November 2021):100137. Available from: <https://doi.org/10.1016/j.rcsop.2022.100137>
- Nguyen TMH, Ngo TKC, Tran TTN, Le C. Evaluation of Factors Associated with Beliefs About Antidiabetic Medicine in Outpatients with Type 2 Diabetes in Vietnam. *Indones J Pharm.* 2023;34(4):675–85.
- Terry DR, Peck B, Phan H, Hills D, Bishop J, Kirschbaum M, et al. Understanding rural pharmacists perspectives: lived experiences and insights associated with rural recruitment and retention. *Rural Remote Health.* 2024;24(1).
- Indonesia Ministry of Health. Standard of Pharmaceutical Services in Community Health Centers (Minister of Health Regulation No. 74 of 2016) [Internet]. 74 2016. Available from: <https://farmalkes.kemkes.go.id/unduh/permenkes-74-2016/#:~:text=Peraturan Menteri Kesehatan Nomor 74,Jenderal Kefarmasian dan Alat Kesehatan>
- PERKENI. Management and Prevention Guidelines for Type 2 Diabetes Mellitus in Indonesian Adults 2021 [Internet]. Jakarta: PB. PERKENI; 2021. 1–119 p. Available from: <https://pbperkeni.or.id/wp-content/uploads/2021/11/22-10-21-Website-Pedoman-Pengelolaan-dan-Pencegahan-DMT2-Ebook.pdf>
- Wibowo MINA, Fitri FM, Yasin NM, Kristina SA, Prabandari YS. Medication Adherence in Patients with Type 2 Diabetes in Several Health Centers of Banyumas District. *J Kefarmasian Indones* [Internet]. 2021;11(2):98–108. Available from: doi.org/10.22%0A435/jki.v11i2.3635%0D
- Statistics Indonesia (BPS). Statistics of welfare 2018 [Internet]. Jakarta. 2019. Available from: <https://www.bps.go.id/publication/2019/11/18/8885b57d077d70390a775191/statistik-kesejahteraan-rakyat-2018.html>
- Riches-Suman K. Increasing the Representation of Women in Diabetes Research. *Diabetology.* 2023;4(2):128–33.
- Indrahadi D, Wardana A, Pierewan AC. The prevalence of diabetes mellitus and relationship with socioeconomic status in the Indonesian population. *J Gizi Klin Indones.* 2021;17(3):103.
- Yogal C, Shakya S, Karmacharya B, Koju R, Stunes AK, Mosti MP, et al. Diabetes Prevalence and Associated Risk Factors among Women in a Rural District of Nepal Using HbA1c as a Diagnostic Tool: A Population-Based Study. *Int J Environ Res Public Health.* 2022;19(12):1–15.
- Bashir M, Fagier Y, Ahmed B, C Konje J. An overview of diabetes mellitus in pregnant women with obesity. *Best Pract Res Clin Obstet Gynaecol* [Internet]. 2024;93(December 2023):102469. Available from: <https://doi.org/10.1016/j.bpobgyn.2024.102469>
- Tudurí E, Soriano S, Almagro L, Montanya E, Alonso-Magdalena P, Nadal Á, et al. The pancreatic β -cell in ageing: Implications in age-related diabetes. *Ageing Res Rev.* 2022;80(April).
- Zhu M, Liu X, Liu W, Lu Y, Cheng J, Chen Y. β cell aging and age-related diabetes. *Aging (Albany NY)* [Internet]. 2021;13:7691–706. Available from: <https://doi.org/10.18632/aging.202593>
- Kallio P, Pahkala K, Heinonen Oj, Tammelin T, Hirvensalo M, Telama R, et al. Physical Inactivity from Youth to Adulthood and Risk of Impaired Glucose Metabolism. *Med Sci Sport Exerc* [Internet]. 2018;50(6):1192–8. Available from: doi: 10.1249/MSS.0000000000001555
- Lee MJ, Seo BJ, Kim YS. Impact of Education as a Social Determinant on the Risk of Type 2 Diabetes Mellitus in Korean Adults. *Healthc.* 2024;12(14):1–14.
- CDC. National Diabetes Statistics Report [Internet]. may 15, 2024. 2024. Available from: <https://www.cdc.gov/diabetes/php/data-research/index.html#print>
- Zissimopoulou O, Leontidou E, Tsiptsios D, Manolisa A, Ioannides D, Trypsania I, et al. Association of Family Income with Health Indices and Healthcare Utilization in a Large Sample of Residents in Northern Greece. *MAEDICA – a J Clin Med.* 2020;15(4):490–502.
- Bird Y, Lemstra M, Rogers M, Moraros J. The relationship between socioeconomic status/income and prevalence of diabetes and associated conditions: A cross-sectional population-based study in Saskatchewan, Canada. *Int J Equity Health* [Internet]. 2015;14(1):1–8. Available from: <http://dx.doi.org/10.1186/s12939-015-0237-0>

- [28]. Ministry of Health of the Republic of Indonesia (Kemenkes RI). Basic Health Research (RISKESDAS) 2018. Jakarta: Ministry of Health of the Republic of Indonesia (Kemenkes RI); 2018.
- [29]. Masdin MR, Sartika RAD, Sauriasari R. Evaluation of pharmacist-led structured counselling on glycemic control and clinical outcomes of Type 2 diabetes mellitus patients at a health centre in East Jakarta, Indonesia. *Pharm Educ.* 2022;22(2):194–9.
- [30]. Besemah NA, Sartika RAD, Sauriasari R. Effect of Pharmacist Intervention on Medication Adherence and Clinical Outcomes of Type 2 Diabetes Mellitus Outpatients in Primary Healthcare in Indonesia. *J Res Pharm Pract* [Internet]. 2021;9(4):186–95. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/33912501%0A> <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC8067894>
- [31]. Rahmawaty A, Anggraeni NW. The Effect of Pharmacist Counseling on The Level Of Drug Compliance and Blood Sugar Levels in Diabetes Mellitus Patients. *J Ris Kefarmasian Indones.* 2023;5(1):181–93.
- [32]. Fatiha CN, Sabiti FB. Improvement of Taking Medicines Compliance through Pharmacist Counseling in Type 2 Diabetes Mellitus Patients at Halmahera Public Health Center, Semarang City. *J Pharm Sci Clin Res* [Internet]. 2021;01:41–8. Available from: doi: 10.20961/jpscr.v6i1.39297
- [33]. Goruntla N, Mallela V, Nayakanti D. Impact of Pharmacist-directed Counseling and Message Reminder Services on Medication Adherence and Clinical Outcomes in Type 2 Diabetes Mellitus. *J Pharm Bioallied Sci.* 2019;11(1):68–76.
- [34]. Religioni U, Barrios-Rodríguez R, Requena P, Borowska M, Ostrowski J. Enhancing Therapy Adherence: Impact on Clinical Outcomes, Healthcare Costs, and Patient Quality of Life. *Med.* 2025;61(1):1–12.
- [35]. Healthdirect. Diabetes testing and monitoring devices for blood sugar and ketone self-monitoring [Internet]. November 2022. 2022. Available from: <https://www.healthdirect.gov.au/diabetes-testing-and-monitoring#:~:text=Blood glucose meter— a finger,needing to prick a finger>
- [36]. Rina H, Nasution A, Khairunisa. Impact of pharmacist counseling on the clinical outcomes in the management of type 2 diabetes mellitus outpatients admitted to a hospital. *Int J Basic Clin Pharmacol.* 2024;13(1):42–6.



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