

Behavioral Patterns and Barriers to Medication Adherence in Older Adults with Diabetes

Ngamdee, N.,¹ Chumfang, N.,^{1*} Chiangkhong, A.,¹ Satsuwan, A.¹ and Sukdee, S.²

¹Kuakarun Faculty of Nursing, Navaminradhiraj University, Bangkok, Thailand

E-mail: nittaya@nmu.ac.th, natshiwat@nmu.ac.th,* araya@nmu.ac.th, amornrat@nmu.ac.th

²Rajamangala University of Technology Suvarnabhumi, Nontaburi, Thailand, E-mail: sukdee.nate@gmail.com

*Corresponding Author

DOI: <https://doi.org/10.52939/ijg.v20i3.3135>

Abstract

Diabetes is a prevalent chronic condition that significantly impacts older adults worldwide. Effective management of diabetes relies on consistent adherence to prescribed antihyperglycemic medications. However, medication non-adherence remains a challenging issue, resulting in suboptimal glycemic control and increased complications. This study aims to explore behavioral patterns and barriers related to medication use among older adults with diabetes. In-depth interviews were conducted with 18 older adults diagnosed with type 2 diabetes, who had been actively taking glycemic control medication for at least ten years. The data collection took place in four communities in Bangkok, selected for their accessibility and the presence of individuals using diabetes medications. Through thorough content analysis, various themes related to medication adherence patterns and barriers emerged. The findings of the study revealed poor behavioral patterns, including dosage adjustment, drug discontinuation, and improper medication storage. Key factors hindering medication adherence were physical limitations, such as forgetfulness resulting from Cognitive Decline, visual impairments, and mobility limitations. Additionally, the study identified the physician-patient interaction and a lack of purpose in life as major obstacles to medication adherence. To address these challenges, the study emphasized the importance of providing accessible medication information to aid individuals with visual impairments. Furthermore, practical support, like medication organizers and reminders, effectively improved adherence, helping individuals overcome physical limitations.

Keywords: Diabetes Management, Diabetes Medications, Glycemic Control, Medication Adherence, Older Adults

1. Introduction

Diabetes mellitus is a significant and escalating global health challenge, with an estimated 463 million individuals diagnosed worldwide [1]. This figure is expected to increase, marking diabetes as one of the most critical public health crises of the 21st century. Characterized by persistent hyperglycemia, diabetes management requires comprehensive strategies to reduce the risk of serious complications such as cardiovascular disease, kidney failure, vision loss, and neuropathy [2]. Central to managing diabetes is monitoring blood glucose levels, for which the Hemoglobin A1c (HbA1c) test is crucial. This test provides a two- to three-month average of blood glucose levels, making it an essential component of treatment decisions and adjustments for reducing the risk of diabetes-related complications [3] and [4]. Effective diabetes management involves a holistic approach that

includes dietary modifications, regular physical activity, continuous blood glucose monitoring, and adherence to medication regimens. Glucose control medications are particularly vital for those unable to achieve blood sugar targets through lifestyle changes alone [5] and [6]. However, elderly patients face unique challenges in managing diabetes, attributed to the aging population and a rising prevalence of diabetes among older adults [1] and [7]. Issues such as age-related physiological changes, comorbidities, polypharmacy, cognitive impairment, and social factors add complexity to diabetes care in this group [8] and [9]. Understanding the self-care experiences and challenges of older individuals with diabetes, particularly regarding glucose control drug utilization, is essential for optimizing their care and improving treatment outcomes.

This research aims to investigate the behavioral self-care patterns and identify barriers to medication use among older adults with diabetes. By examining glucose control drug utilization and the factors influencing medication adherence, the study seeks to inform interventions tailored to the specific needs of older adults. Enhancing self-care practices among this demographic is crucial for improving health outcomes and addressing the global public health challenge of diabetes [2][10][11] and [12]. Through exploring the experiences and challenges associated with glucose control drug utilization among the elderly, this research will provide valuable insights into diabetes management. The findings will aid healthcare professionals in developing tailored interventions that cater to the unique needs of older individuals with diabetes, promoting better self-care practices and leading to enhanced treatment outcomes for this vulnerable population.

2. Methodology

This study employed a descriptive qualitative research approach to comprehensively understand the experiences associated with the utilization of blood sugar-lowering drugs among elderly patients with diabetes. The research focused on Bangkok, the region with the highest prevalence of diabetes compared to other provinces, as illustrated in Figure 1. The scope of this study was narrowed to patients who have been prescribed glucose-lowering medication for a minimum duration of ten years. Data collection was executed through in-depth interviews, facilitating a detailed exploration of patient experiences.

2.1 Participants

This study collected data from diabetic patients aged 60 years and above, categorized as the elderly according to the World Health Organization's definition. These individuals, having resided in Bangkok for more than 10 years, were selected through purposive sampling based on stringent criteria. They were required to have managed their diabetes with medication for a minimum of ten years and to have recorded an HbA1c level above 7 in the previous year (2019-2020). The HbA1c test, assessing average blood sugar levels over the past three months, is acknowledged as an essential instrument for evaluating the blood sugar control of diabetes patients. Furthermore, participants were required to be proficient in Thai, without intellectual or hearing impairments, and willing to engage in in-depth interviews. Data collection proceeded until reaching data saturation, resulting in the participation of 18 individuals in the study.

2.2 Instruments

The data collection method employed in this study was in-depth interviews conducted using a structured questionnaire. The questionnaire consisted of three key questions designed to explore specific aspects of the participants' experiences. To ensure the quality and validity of the interview tool, it underwent a rigorous evaluation process. Three experts, including an elderly nursing consultant, a qualitative education consultant, and a medical consultant, conducted a thorough content and language validity check. Their expertise and insights were instrumental in refining the interview questionnaire, ensuring its appropriateness and effectiveness in capturing the desired information. The interview protocol was also adjusted and tailored based on the individual needs and characteristics of the participants, ensuring the relevance and appropriateness of the questions asked during the interviews.

2.3 Ethical Considerations

The study was approved by the Kuakarun Faculty of Nursing's Ethics Review Board, Navamindradhiraj University (trial number: KFN-IRB201-0). Informed consent was obtained from all participants, assuring them of anonymity and confidentiality. Additionally, participants had the right to withdraw at any time.

2.4 Data Collection

After receiving approval from the ethics committee, the researcher initiated data collection by conducting in-depth interviews in the field. The interviews were scheduled at times and locations convenient for the eighteen elderly patients diagnosed with type 2 diabetes, who were undergoing glycemic control medication and participated in this study. Most interviews took place at the participants' homes, while others were conducted at the Community Health Service Center, based on individual preferences and logistical considerations. Before each interview, the researcher obtained participants' consent to record the audio for accurate transcription and analysis. Each session lasted between 40 to 60 minutes, providing ample opportunity for participants to share their experiences, perspectives, and challenges related to medication self-management. The researcher meticulously transcribed every word spoken during the interviews to ensure a comprehensive and accurate representation of the data. In instances where information was incomplete or needed clarification, the researcher reached out to the respective individuals for additional details or clarification on specific points.

This iterative process of data collection, transcription, and verification proceeded until data saturation was achieved, indicating that no new or substantial information was being discovered through the interviews. Throughout the data collection and analysis process, the researcher strictly adhered to ethical principles and guidelines, ensuring confidentiality, privacy, and respect for the participants' rights.

2.5 Data Analysis

This study employed a qualitative research design, utilizing content analysis as the chosen analytical approach, guided by the framework proposed by [9]. The data analysis process followed a systematic and rigorous procedure consisting of data organizing, code generation, data display, conclusion drawing, interpretation, and verification. Initially, the collected data were organized to facilitate a systematic examination and understanding of the content. This process involved carefully arranging and structuring the data to identify patterns, themes, and relevant units of analysis. Subsequently, codes were generated to capture meaningful segments and concepts within the data. These codes served as labels or descriptors that summarized and categorized specific elements or ideas present in the collected information. The prevalence rates of diabetes in Thailand illustrate in Figure 1.

3. Results and Discussion

The data collection period spanned from March 2021 to June 2021, allowing for a comprehensive exploration of the experiences and perspectives of elderly individuals with diabetes in managing their condition through glucose control drug therapy. The findings of the study were presented in alignment with the study objectives, ensuring a systematic and organized representation of the research outcomes. The results were categorized and presented in a manner that corresponded to the specific aims and objectives of the study, offering detailed insights and analysis relevant to each research objective. The characteristics of the participants presents in Table 1.

3.1 Behavioral Patterns in the Utilization of Diabetes Medications

Elderly individuals with diabetes face the challenge of adhering consistently to their prescribed medications. The study highlights problematic drug use behaviors in this demographic, characterized by deviations from medical prescriptions. These behaviors encompass persistent misuse of drugs, such as "Dosage adjustment" and "Discontinuation," as well as "Improper drug storage." These issues have become prevalent challenges among this population.

Detailed findings regarding these aspects are provided below.

3.1.1 Theme 1: Dosage adjustment and drug discontinuation

Dosage adjustment and self-discontinuation of medication are common drug use behaviors observed among elderly individuals, often attributed to various conditions. One primary reason for these behaviors is the lack of understanding regarding the rationale behind medication usage or adjustments made by healthcare professionals. Moreover, beliefs and misconceptions, such as concerns about potential liver or kidney damage, or fears of experiencing excessive side effects, contribute to the decision to self-administer or discontinue medications among the elderly population with diabetes.

Table 1: Characteristics of participants

Code	Age (years)	Gender	duration of diabetes (years)	HbA1C
P1	68	Female	14	8.0
p2	71	Male	15	8.6
P3	77	Female	13	10
P4	82	Female	11	9.0
P5	68	Male	15	7.4
P6	69	Female	13	8.1
P7	73	Male	12	11.0
P8	79	Female	22	12.0
P9	81	Female	13	9.0
P10	80	Male	20	9.3
P11	65	Female	11	7.5
P12	64	Male	13	7.8
P13	65	Male	14	8.0
P14	69	Female	14	8.6
P15	71	Female	12	8.1
P16	74	Female	13	12.0
P17	87	Female	17	11.2
P18	73	Male	11	13.0
Md	71.00	-	13.00	8.8
IQR	10.25	-	3.00	3.1

Difficulties with pill splitting, such as the inability to accurately divide a pill as instructed by the doctor due to the absence of a medication break device or impaired vision, pose further challenges. Consequently, some individuals resort to taking a whole tablet, reducing their medication intake during subsequent meals. Additionally, travel limitations may hinder regular check-ups, leading to medication shortages or self-discontinuation. To address these multifaceted issues, patient education, improved communication, and the provision of appropriate aids are imperative to ensure medication adherence and mitigate potential risks associated with self-adjustment or discontinuation of medications among the elderly with diabetes

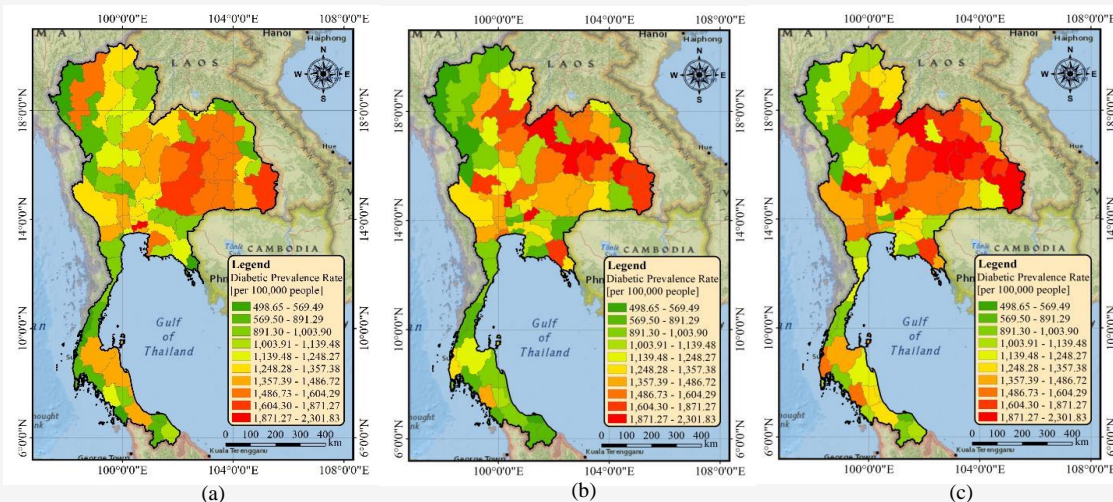


Figure 1: Diabetic prevalence rate situations in Thailand (a) 2016 (b) 2017 (c) 2018

3.1.2 Theme 2: Improper medication storage

Improper drug storage among the elderly poses significant problems, leading to drug deterioration and potential risks. The results of the study have highlighted various instances of improper storage practices, particularly among elderly individuals using injectable diabetes medications. For example, medications were stored in refrigerators alongside food items and other objects, resulting in unsuitable temperature conditions for drug preservation. Moreover, the packaging of tablets exhibited concerning issues, such as multiple drugs being stored together in the same package. Compromised labels due to wetness or tearing made it difficult to identify the drug and understand proper usage instructions. Additionally, instances were observed where the medication was stored in incorrect packaging, with the name on the front of the envelope not matching the actual medication contained within. Unclean containers were also used to store cut or broken pills, potentially leading to moisture-induced degradation.

3.2 Barriers to Medication Adherence

Ensuring continuous adherence to prescribed antihyperglycemic medications is crucial for individuals with diabetes to effectively manage their condition. However, several challenges can hinder adherence, including medication complexity, forgetfulness, side effects, cost concerns, and lifestyle factors. The complexity of antihyperglycemic medications, involving multiple drugs or insulin injections, can pose difficulties for adherence. Coordinating different medications, understanding dosing instructions, and managing timing requirements can be overwhelming,

especially when dealing with other health conditions or taking additional medications for other reasons.

3.2.1 Theme 1: Physical limitation

The physiological changes that occur with aging can hinder the continuous intake of medications among older adults. Vision impairments and limited mobility are key factors contributing to challenges in adhering to medication schedules, resulting in both correct and irregular medication intake. The following section provides further details on these aspects.

Subtheme 1: Forgetfulness from cognitive decline

Forgetfulness is a common barrier to adherence. People with diabetes may struggle to remember to take their medications at the prescribed times, leading to missed doses. Cognitive decline, including memory loss and impaired executive functioning, can significantly affect medication adherence in aging adults. Remembering to take medications at the correct times and following complex dosing instructions becomes challenging. Additionally, understanding the importance of adherence and the consequences of non-adherence may be compromised, further impacting medication-taking behavior.

"I have instances where I cannot recall if I have taken the medication, leading me to take it again. On certain days, I tend to forget to have dinner."
(P9)

"When I have to take pills for multiple meals, I often forget and only take one during breakfast."
(P8)

"When there are numerous pills to be taken multiple times a day, it becomes easy to forget." (P17)

"When I leave the house for errands, I frequently forget to bring my medication along, resulting in delayed intake." (P5)

"I experienced a situation where I forgot about a scheduled appointment with my doctor. This led to a shortage of my diabetes medication as I did not have enough supply." (P3)

Subtheme 2: Visual impairments

Visual impairments can make it difficult for individuals to read and understand medication labels, which often contain important information such as drug names, dosage instructions, and precautions. Illegible or small print, complex packaging, or inadequate lighting can further exacerbate these

difficulties, leading to errors in medication administration or confusion about the correct dosing regimen. Identifying potential medication-related issues, such as expired medications or medication interactions, can be challenging without visual cues. Visual inspection of medication containers, checking expiration dates, or recognizing changes in medication appearance may not be feasible for individuals with vision deterioration. Consequently, they may unknowingly continue using expired or potentially harmful medications.

"The medication package will contain a label displaying the name of the medication, although it may be difficult to read the small letters." (P12)

"My vision is limited, making it challenging to accurately identify the types and quantities of food I should consume. Additionally, there are numerous medications that sometimes get mixed up or replaced with each other." (P4)

"I struggled to select the correct injection site due to poor visibility. Consequently, I injected into the same spot I had used before, fearing that injecting in the wrong area might have adverse effects." (P14)

"I am no longer able to visually discern the appropriate medication. Therefore, I have no opportunity to view the expiration date or read the cautionary information provided by the doctor." (P16)

Subtheme 3: Mobility limitations

The decline in mobility that occurs in old age poses significant challenges to adherence to a prescribed antihyperglycemic medication regimen. As individuals age, they may experience reduced physical mobility, which can affect their ability to manage their medication effectively. Several factors associated with mobility decline contribute to difficulties in medication adherence. One of the main challenges is the physical limitations that result from mobility decline. Older adults may experience difficulties in reaching and accessing their medication, especially if it is stored in high or hard-to-reach places. Limited mobility can also make it challenging to open medication containers, handle small pills, leading to errors or missed doses.

"I am unable to go by myself, and sometimes I have to wait for someone to accompany me, which can be inconvenient. I often have a busy schedule and get caught up in errands, causing me to miss taking some of my medication." (P2)

"I rarely arrive at appointments on time. My aunt goes alone, but it's challenging for her due to her knee problems. She waits for her knees to improve a little before attempting to go. She relies on someone to accompany her." (P 6)

"It's difficult for me to get up and fetch water to take my medication by myself. I observe my aunt, who struggles to walk due to her size. I have to keep the medicine within reach. Occasionally, when the medication supply runs out, I forget to inform my grandchildren, and no one picks it up, so I consume it all in one meal." (P13)

"I am unable to break the medicine on my own. The large pill is challenging to swallow, especially when I need to split it in half. On certain days, if I can't break it, I choose not to take it because I fear it might get stuck in my throat." (P 15)

"The small size of the pill makes it challenging for me to grasp or pick up." (P 17)

3.2.2 Theme 2: Dissatisfaction with the physician-patient interaction

In relation to the perspective of patients regarding physicians' demeanor, a majority of patients expressed dissatisfaction with the way physicians interacted with them. They conveyed that they felt constrained in discussing their health condition openly with the doctor, indicating a lack of free and open communication. The patients' experiences

provided clear evidence of strained relationships with their physicians.

"I encountered some difficulties after starting my medication. I attempted to contact the doctor, but he was unresponsive. Eventually, I managed to reach him during the evening, and he informed me that he does not provide medical consultations at his residence. The following day, he changed my medications once again and charged me a fee, but the issue persisted. I believe he is using me as a test subject for different medications, and I am displeased with this approach." (P5)

"I visited a doctor and endured a waiting period of approximately 2 hours for my check-up. However, the doctor only spent around 3-4 minutes with me and charged me an exorbitant fee, in addition to the cost of the prescribed medication. Furthermore, he did not fully listen to my concerns. I am convinced that he is primarily focused on maximizing profits, which is why I chose not to use the prescribed medications." (P14)

"After undergoing the health check, the doctor instructed me to take the prescribed medications and advised me to avoid sugary foods and stress. While I was already aware of these general guidelines, what I truly sought was specific guidance on portion sizes, dietary options, and lifestyle modifications. Unfortunately, the doctor did not provide any detailed advice in these regards, leaving me to rely on my own understanding and implementation." (P6)

3.2.3 Theme 3: lack of purpose in life

The indifference towards glycemic control and medication intake among individuals with diabetes can be attributed to multiple factors. One significant factor is the lack of purpose in life, which can diminish motivation and engagement in self-care practices. When individuals do not have a clear sense of purpose or goals, they may prioritize other aspects of their lives over managing their diabetes and adhering to their prescribed antihyperglycemic medication. Additionally, non-adherence to medication can further contribute to indifference, as individuals may not see the immediate benefits or perceive the importance of strict glycemic control.

"Chronic conditions like diabetes require long-term treatment, which can sometimes lead to weariness and boredom. As a result, there are days when individuals choose to stop taking their medication on their own." (P17)

"For older adults, health may not be as important as happiness. Sometimes, it becomes troublesome to take medication. They have to keep it cool, and some uncles even suggest taking a break from medication for a couple of days, believing that high blood sugar is less worrisome than low blood sugar." (P10)

"If I don't go and get my medication for a few days, it shouldn't be a big deal. I'm getting older, and eventually, I have to go. It's not burdensome for my children. Sometimes they are busy and postpone it. Later, my children scold me and say that they need to inform in advance to schedule a visit to the doctor so that I don't miss any important medications." (P9)

"At this age, elderly individuals actually desire good health, but managing diabetes requires continuous care and long-term medication use. Consequently, it leads to a sense of weariness towards various aspects, including medication intake. It becomes challenging to choose between different priorities, such as taking medication, controlling diet, and engaging in physical activities. Thus, medication intake is often placed on the back burner." (P4)

3.3 Discussion

3.3.1 Behavioral patterns in the utilization of diabetes medications

3.3.1.1 Dosage adjustment and drug discontinuation
Among older individuals with diabetes, dosage adjustment is a prevalent behavioral pattern, where they independently modify their medication dosages without consulting healthcare professionals. This behavior can be attributed to various factors, including cognitive decline, misconceptions, and the challenges associated with complex medication regimens [13] and [14]. Cognitive decline can adversely affect memory and executive functioning, leading to difficulties in adhering to prescribed dosages. Another concerning behavioral pattern among older adults with diabetes is drug discontinuation, involving the deliberate cessation of medication use without medical guidance or approval. Older individuals may discontinue their diabetes medications due to diverse reasons, such as adverse effects, forgetfulness, financial constraints, or a lack of perceived benefits [15].

3.3.1.2 Improper medication storage

Impaired medication management practices pose challenges for older adults with diabetes, as visual impairments, physical limitations, and cognitive decline can hinder their ability to effectively handle

medications [16]. To address these challenges, it becomes imperative to provide accessible medication information and suitable storage solutions [17] and [18]. Previous studies have highlighted the importance of large print labels or Braille instructions to aid individuals with visual impairments in proper medication use. Tailored interventions are necessary to address these issues effectively. Patient education plays a pivotal role in promoting medication adherence among older adults, involving clear instructions, simplified regimens, and addressing concerns or misconceptions [19]. Moreover, healthcare providers must prioritize communication strategies that are sensitive to the needs of older adults, fostering a positive physician-patient relationship and impacting medication adherence [20].

Additionally, providing practical support in the form of aids and resources can assist older adults in proper medication storage. Medication organizers, reminders, and assistance with organizing medications help overcome physical limitations and enhance adherence [21]. Research has underscored the effectiveness of verbal instructions from healthcare providers and medication organization assistance in improving adherence among older adults with visual impairments.

3.3.2 Barriers to medication adherence

3.2.2.1 Physical limitation

Forgetfulness from Cognitive Decline: Cognitive decline presents significant hurdles to medication adherence due to its detrimental impact on memory and executive functioning. A comprehensive investigation demonstrated a noteworthy association between cognitive impairment and suboptimal medication adherence [10]. Cognitive impairment is a common, underdiagnosed complication of diabetes that can interfere with the ability to adequately perform required daily self-management behaviors. It is more frequently observed in older adults, but declines in cognitive function have also been described in younger people with diabetes. Deficiencies in memory capacity, attention to detail, planning, ability to reason, decision-making, and information processing speed are associated with deficits in diabetes self-care behaviors, including poor compliance with medication, diet, and exercise recommendations, failure to receive appropriate care, and worse glycemic control, leading to more hypoglycemia [22]. Streamlining medication regimens and providing explicit instructions can effectively improve adherence levels among individuals afflicted with cognitive impairment [15].

Visual Impairments: Visual impairments can significantly challenge medication adherence by

hindering the ability to read labels or distinguish between different medications. For individuals with visual impairments, accessible medication information is crucial. Providing large print labels or Braille instructions has been shown to facilitate proper medication use effectively. Moreover, receiving verbal instructions from healthcare providers and assistance in organizing medications can enhance adherence among individuals with visual impairments [16] and [17].

Mobility Limitations: Mobility limitations can present formidable obstacles to medication adherence as they restrict access to medications and healthcare facilities. Studies have revealed that individuals grappling with mobility limitations exhibited lower rates of medication adherence. To surmount this challenge, the implementation of medication storage solutions that are conveniently accessible becomes imperative. Strategies such as keeping medications within reach or employing assistive devices have demonstrated efficacy in promoting adherence. Additionally, the utilization of delivery services or mobile clinics can serve as viable solutions to circumvent the barriers imposed by mobility limitations [22][23] and [24].

3.2.2.2 Dissatisfaction with the physician-patient interaction

A negative or unsatisfactory physician-patient interaction can significantly impact medication adherence as it hampers effective communication and patient-centered care, potentially resulting in frustration or confusion. The pivotal role of patient-provider communication in diabetes management has been widely acknowledged. To enhance adherence within this context, strategies should focus on fostering an improved physician-patient relationship through active listening, clear communication, and shared decision-making. Furthermore, the provision of comprehensive education regarding the benefits of antihyperglycemic medications, coupled with the proactive addressing of concerns or misconceptions, has been demonstrated to positively influence adherence rates [25][26] and [27].

3.2.2.3 Lack of purpose in life

A lack of purpose in life can contribute to an apathetic attitude towards glycemic control and medication intake. When individuals lack clear goals or a sense of purpose, the management of diabetes may be relegated to a lower priority. Studies have consistently shown that a sense of purpose in life is associated with better health behaviors, including medication adherence [28]. Effectively addressing this barrier necessitates the implementation of strategies that center on fostering motivation, such as

engaging individuals in activities that give meaning and purpose to their lives [29]. Furthermore, emphasizing the long-term advantages of strict glycemic control can help individuals recognize the importance of medication adherence [30].

4. Conclusion

Understanding and addressing behavioral patterns related to diabetes medication use, including dosage adjustment, drug discontinuation, and proper storage, are crucial for optimizing diabetes management in older adults. Tailored interventions, such as patient education, improved communication, and practical support, play pivotal roles in enhancing medication adherence and ultimately improving outcomes in this specific population. Several barriers, such as cognitive decline, visual impairments, mobility limitations, dissatisfaction with the physician-patient interaction, and a lack of purpose in life, hinder medication adherence among individuals managing diabetes. However, healthcare providers can help individuals

5. Recommendations

In addressing the management of elderly diabetic patients in urban areas and the monitoring of their medication intake with a Geoinformatic system, a comprehensive study is recommended to investigate innovative methods that improve medication management for those with physical limitations. This research should prioritize the creation and evaluation of specialized packaging, devices, and assistive technologies designed to ease the handling, opening, and administration of medications, catering specifically to the unique needs of this group. Furthermore, the exploration of novel drug delivery systems intended for older adults with physical limitations is essential. Assessing the usability and effectiveness of user-friendly insulin pens, auto-injectors, and wearable technologies is crucial to making the administration of blood sugar-lowering medications more efficient. The overarching aim is to devise sophisticated solutions that streamline medication management, thereby enabling elderly adults to more effectively control their health conditions.

Acknowledgements

The research received funding from the Navamindradhiraj University Research Fund and was conducted as a component of a research project entitled "The Development of Healthcare Media in Drug Adherence of Diabetes Mellitus among Older Adults.

References

- [1] International Diabetes Federation., (2021). *IDF Diabetes Atlas*, 10th Ed., Brussels, Belgium. [Online]. Available: <https://www.diabetesatlas.org>. [Accessed Nov. 19, 2023].
- [2] American Diabetes Association., (2020). Standards of Medical Care in Diabetes-2020 Abridged for Primary Care Providers. *Clin Diabetes*. Vol. 38(1), 10–38. <https://doi.org/10.2337/cd20-as01>.
- [3] Sherwani, S. I., Khan, H. A., Ekhzaimy, A., Masood, A. and Sakharkar, M. K., (2016). Significance of HbA1c Test in Diagnosis and Prognosis of Diabetic Patients. *Biomarker Insights*, Vol.11, 95–104. <https://doi.org/10.4137/BMI.S38440>.
- [4] Eyth, E. and Naik, R., (2023), *Hemoglobin A1C*. [Updated 2023 Mar 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; Jan. Available: <https://www.ncbi.nlm.nih.gov/books/NBK549816/>.
- [5] Adu, M. D., Malabu, U. H., Malau-Aduli, A. E. O. and Malau-Aduli, B. S., (2019). Enablers and Barriers to Effective Diabetes Self-Management: A Multi-National Investigation. *PloS one*, Vol. 14(6). <https://doi.org/10.1371/journal.pone.0217771>.
- [6] Sugandh, F., Chandio, M., Raveena, F., Kumar, L., Karishma, F., Khuwaja, S., Memon, U. A., Bai, K., Kashif, M., Varrassi, G., Khatri, M. and Kumar, S., (2023). Advances in the Management of Diabetes Mellitus: A Focus on Personalized Medicine. *Cureus*, Vol.15(8). <https://doi.org/10.7759/cureus.43697>.
- [7] Bajwa, S. J., Sehgal, V., Kalra, S. and Baruah, M. P., (2014). Management of Diabetes Mellitus Type-2 in the Geriatric Population: Current Perspectives. *Journal of Pharmacy and Bioallied Sciences*, Vol. 6(3), 151-157. <https://doi.org/10.4103/0975-7406.130956>.
- [8] Powers, M. A., Bardsley, J., Cypress, M., Duker, P., Funnell, M. M., Fischl, A. H., Maryniul, M., Siminerio, L. and Vivian, E. M., (2017). Diabetes Self-Management Education and Support in Type 2 Diabetes: A Joint Position Statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *The Diabetes Educator*, Vol. 43(1), 40-53. <https://doi.org/10.1177/0145721716689694>.

- [9] Chippa, V. and Roy, K., (2023). *Geriatric Cognitive Decline and Polypharmacy*. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK574575/>. [Accessed Nov. 19, 2023].
- [10] Gellad, W. F., Grenard, J. L. and Marcum, Z. A., (2011). A Systematic Review of Barriers to Medication Adherence in the Elderly: Looking Beyond Cost and Regimen Complexity. *American Journal of Geriatric Pharmacotherapy*, Vol. 9(1), 11-23. <https://doi.org/10.1016/j.amjopharm.2011.02.004>.
- [11] Afaya, R. A., Bam, V., Azongo, T. B., Afaya, A., Kusi-Amponsah, A., Ajusiyine, J. M. and Hamid, T.A., (2020). Medication Adherence and Self-Care Behaviours among Patients with Type 2 Diabetes Mellitus in Ghana. *PLoS ONE*, Vol. 15(8). <https://doi.org/10.1371/journal.pone.0237710>.
- [12] Christopher, C., Kc, B., Shrestha, S., Blebil, A. Q., Alex, D., Mohamed Ibrahim, M. I. M. and Ismail, N., (2022). Medication Use Problems among Older Adults at Primary Care: A Narrative of Literature Review. *Aging Medicine*, Vol. 5(2), 126-137. <https://doi.org/10.1002/agm.2.12203>.
- [13] Miles, M. B., Huberman, A. M. and Saldaña, J., (2014). *Qualitative Data Analysis: A Methods Sourcebook* (3rd Ed.). Arizona: SAGE.
- [14] Campbell, N. L., Boustani, M. A., Skopelja, E. N., Gao, S., Unverzagt, F. W. and Murray, M. D., (2012). Medication Adherence in Older Adults with Cognitive Impairment: A Systematic Evidence-Based Review. *American Journal of Geriatric Pharmacotherapy*, Vol. 10(3), 165-177. <https://doi.org/10.1016/j.amjopharm.2012.04.004>.
- [15] Sarkar, U., López, A., Maselli, J. H. and Gonzales, R., (2011). Adverse Drug Events in U.S. Adult Ambulatory Medical Care. *Health Services Research*, Vol. 46(5), 1517-1533. <https://doi.org/10.1111/j.1475-6773.2011.01269.x>.
- [16] Wakui, N., Ozawa, M., Yanagiya, T., Endo, S., Togawa, C., Matsuoka, R., Shiroso, S., Machida, Y. and Kikuchi, M., (2021). Factors Associated with Medication Compliance in Elderly Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study. *Frontiers in Public Health*, Vol. 9. <https://doi.org/10.3389/fpubh.2021.771593>.
- [17] Lee, S. and Schommer, J. C., (2022). Medication Use and Storage, and their Potential Risks in US Households. *Pharmacy*, Vol. 10(1). <https://doi.org/10.3390/pharmacy10010027>.
- [18] Leat, S. J., Krishnamoorthy, A., Carbonara, A., Gold, D. and Rojas-Fernandez, C., (2016). Improving the Legibility of Prescription Medication Labels for Older Adults and Adults with Visual Impairment. *Canadian Pharmacists Journal*, Vol. 149(3), 174-184. <https://doi.org/10.1177/1715163516641432>.
- [19] Gellad, W. F., Grenard, J. L. and Marcum, Z. A., (2011). A Systematic Review of Barriers to Medication Adherence in the Elderly: Looking Beyond Cost and Regimen Complexity. *American Journal of Geriatric Pharmacotherapy*, Vol. 9(1), 11-23. <https://doi.org/10.1016/j.amjopharm.2011.02.004>.
- [20] Chan, A. H. Y., Cooper, V., Lycett, H. and Horne, R., (2020). Practical Barriers to Medication Adherence: what Do Current Self- or Observer-Reported Instruments Assess?. *Frontiers in Pharmacology*, Vol. 11. <https://doi.org/10.3389/fphar.2020.00572>.
- [21] Pratiwi, H., Kristina, S. A., Widayanti, A. W., Prabandari, Y. S. and Kusuma, I. Y., (2023). A Systematic Review of Compensation and Technology-Mediated Strategies to Maintain Older Adults' Medication Adherence. *International Journal of Environmental Research and Public Health*, Vol. 20(1). <https://doi.org/10.3390/ijerph20010803>.
- [22] Emadi, F., Ghanbarzadegan, A., Ghahramani, S., Bastani, P. and Baysari, M. T., (2022). Factors Affecting Medication Adherence among Older Adults Using Tele-Pharmacy Services: A Scoping Review. *Archives of Public Health*, Vol. 80(1). <https://doi.org/10.1186/s13690-022-00960-w>.
- [23] Piragine, E., Petri, D., Martelli, A., Calderone, V. and Lucenteforte, E., (2023). Adherence to Oral Antidiabetic Drugs in Patients with Type 2 Diabetes: Systematic Review and Meta-Analysis. *Journal of Clinical Medicine*, Vol. 12(5). <https://doi.org/10.3390/jcm12051981>.
- [24] Yu, S. W. Y., Hill, C., Ricks, M. L., Bennet, J. and Oriol, N. E., (2017). The Scope and Impact of Mobile Health Clinics in the United States: A Literature Review. *International Journal of Equity in Health*, Vol. 16(1). <https://doi.org/10.1186/s12939-017-0671-2>.
- [25] Kennedy, B. M., Rehman, M., Johnson, W. D., Magee, M. B., Leonard, R. and Katzmarzyk, P. T., (2017). Healthcare Providers Versus Patients' Understanding of Health Beliefs and Values. *Patient Experience Journal*, Vol. 4(3), 29-37. <https://doi.org/10.35680/2372-0247.1237>.

- [26] Marrero, D. G., Ard, J., Delamater, A. M., Peragallo-Dittko, V., Mayer-Davis, E. J., Nwankwo, R. and Fisher, E. B., (2013). Twenty-First Century Behavioral Medicine: A Context for Empowering Clinicians and Patients with Diabetes: A Consensus Report. *Diabetes Care*, Vol. 36(2), 463-470. <https://doi.org/10.2337/dc12-2305>.
- [27] Fisher, L., Polonsky, W. H., Hessler, D. M., Masharani, U., Blumer, I., Peters, A. L., Strycker, L.A. and Bowyer, V., (2015). Understanding the Sources of Diabetes Distress in Adults with Type 1 Diabetes. *Journal of Diabetes Complications*, Vol. 29(4), 572-577. <https://doi.org/10.1016/j.jdiacomp.2015.01.012>.
- [28] Kim, E. S., Strecher, V. J. and Ryff, C. D., (2014). Purpose in Life and Use of Preventive Health Care Services. *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 111(46), 16331-16336. <https://doi.org/10.1073/pnas.1414826111>.
- [29] Adu, M. D., Malabu, U. H., Malau-Aduli, A. E. O. and Malau-Aduli, B. S., (2019). Enablers and Barriers to Effective Diabetes Self-Management: A Multi-National Investigation. *PLoS One*, Vol. 14(6). <https://doi.org/10.1371/journal.pone.0217771>.
- [30] Williams, J. L., Walker, R. J., Smalls, B. L., Campbell, J. A. and Egede, L. E., (2014). Effective Interventions to Improve Medication Adherence in Type 2 Diabetes: A Systematic Review. *Diabetes Management*, Vol. 4(1), 29-48. <https://doi.org/10.2217/dmt.13.62>.