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Telemedicine and Preventive Behaviors in Type 2 Diabetes: A Prolanis Study in Semarang, Indonesia

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ABSTRACT

***Background**: Type 2 Diabetes Mellitus (T2DM) represents an increasing public health challenge in Indonesia, placing considerable pressure on the country healthcare infrastructure. The Prolanis program, a nationwide initiative for managing chronic diseases, incorporates telemedicine to encourage preventive practices among patients with T2DM. Objective: This research sought to investigate the relationship between knowledge, attitudes, and perceptions regarding telemedicine and preventive behaviors for T2DM among participants in the Prolanis program in Indonesia. **Methods**: A cross-sectional quantitative study was carried out involving 157 Prolanis participants (including 100 individuals diagnosed with T2DM) in Semarang. Data collection employed validated questionnaires designed to evaluate knowledge, attitudes, and perceptions of telemedicine in connection with T2DM preventive behaviors. Associations between these factors and preventive behaviors were analyzed using the Mann-Whitney test. **Results**: Approximately 47.1% of respondents demonstrated a good level of knowledge about T2DM. Attitudes toward telemedicine within the Prolanis program remained predominantly negative (59.0%), whereas 68.3% exhibited positive perceptions of telemedicine. No statistically significant associations were identified between knowledge (p=0.281), attitudes (p=0.162), or perceptions (p=0.229) of telemedicine and T2DM preventive behaviors among the participants. **Conclusion**: Knowledge, attitudes, and perceptions of telemedicine do not significantly affect preventive behaviors related to T2DM. These results indicate that existing telemedicine approaches in the Prolanis program may need improvement, potentially through customized educational efforts or improved user engagement strategies, to better support T2DM prevention.*

***Keywords**: Diabetes Mellitus, Prolanis, Preventive Behavior, Telemedicine*

INTRODUCTION

The rapid increase in the global aging population presents a growing challenge for healthcare systems worldwide, including Indonesia. Globally, approximately 727 million individuals were aged 65 years and older in 2020, and this number is projected to exceed 1.5 billion by 2050 (WHO, 2022),(United Nations, 2020). In Indonesia, the proportion of older adults has steadily risen from 4.5% in 1971 to around 10.7% in 2020 (Statistik, 2014),(Saito and Cicih, 2022), reflecting a demographic transition toward an aging society. This trend is closely associated with a higher burden of Non Communicable Diseases such as hypertension and Type 2 Diabetes Mellitus (T2DM), which remain leading causes of morbidity and mortality among the elderly (RISKESDAS, 2018).

The COVID-19 pandemic has further underscored the vulnerability of elderly, particularly those with chronic comorbidities. In Indonesia, individuals aged 60 years and above accounted for the majority of intensive care unit (ICU) admissions and exhibited the highest fatality rate among all age groups during the pandemic (Wong *et al.*, 2023). These findings highlight the critical need to strengthen chronic disease prevention and management strategies, especially for T2DM, which requires consistent monitoring, lifestyle modification, and adherence to preventive behaviors (Ganiem, 2020)(Rehatta *et al.*, 2022).

Telemedicine has emerged as a key innovation in improving healthcare accessibility and continuity, particularly

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during periods of restricted mobility. In Indonesia, the adoption of digital health services has grown substantially since the pandemic, driven by the need for remote consultations and ongoing disease management (Nursilmi, Kusharto and Dwiriani, 2017)(George *et al.*, 2021). However, the uptake of telemedicine among the elderly remains limited due to low digital literacy, limited technological confidence, and concerns about service reliability and data confidentiality. These barriers suggest that individual-level behavioral factors—namely, knowledge, attitudes, and perceptions—play a pivotal role in determining telemedicine acceptance and utilization (Heratanti, Rambi and Syarifurrahman, 2021).

Program Pengelolaan Penyakit Kronis, or Prolanis (in English: The Chronic Disease Management Program), initiated by the Indonesian National Health Insurance Agency (BPJS Kesehatan), represents a nationwide effort to improve the quality of life for patients with chronic conditions such as hypertension and T2DM. Prolanis incorporates preventive, promotive, and rehabilitative health services and has increasingly adopted telemedicine as a platform for health education, remote monitoring, and consultation. Through this integration, participants are encouraged to engage in preventive behaviors, including maintaining a healthy diet, exercising regularly, and performing routine glucose monitoring to control disease progression (BPJS, 2014)(Ghufron Mukti, 2021).

Despite telemedicine's integration into Prolanis, its impact on T2DM preventive behaviors among elderly participants is underexplored. Previous studies in Indonesia focus broadly on telemedicine adoption barriers (Lam *et al.*, 2020), but they provide limited empirical evidence on how knowledge (awareness of telemedicine benefits and functions), attitudes (favorability toward digital health interactions), and perceptions (beliefs about reliability and privacy) directly predict engagement in T2DM-specific preventive behaviors within a structured national program like Prolanis (Kementerian Kesehatan Republik Indonesia, 2019). To date, no research in Semarang—a representative urban setting with high Prolanis enrollment—has quantitatively tested these associations using behavioral frameworks such as an adapted Technology Acceptance Model or the Health Belief Model.

This gap is important because unaddressed psychosocial barriers may undermine Prolanis outcomes, contributing to poorer glycemic control, higher complication rates, and increased healthcare costs. Empirically examining these relationships is therefore warranted to identify modifiable factors for targeted interventions, ultimately strengthening the role of telemedicine in chronic disease management for Indonesia's aging population.

Understanding how knowledge, attitudes, and perceptions influence telemedicine utilization is essential for optimizing digital health interventions among the elderly population. Empirical evidence in this area remains limited in Indonesia, particularly within structured chronic disease management programs such as Prolanis. Therefore, this study aimed to examine the association between knowledge, attitudes, and perceptions of telemedicine towards T2DM preventive behaviors among Prolanis participants in Indonesia.

METHODS

Study design, period, and setting

A cross-sectional study was conducted among elderly participants of the Prolanis at *puskesmas* (Public Health Centers) and affiliated private health clinics collaborating with the BPJS Kesehatan in Semarang Regency, Central Java, Indonesia. Prolanis is a national initiative aimed at improving the quality of life of individuals diagnosed with hypertension and T2DM through continuous, preventive, and promotive care.

Study population

The study population consisted of 157 elderly individuals enrolled as BPJS Kesehatan participants residing in Semarang Regency during the study period. Eligible participants were those registered in the Prolanis program who had been diagnosed with, or were at risk of, T2DM and/or hypertension and actively participated in regular Prolanis activities.

Sample size determination

The sample size was calculated using the Slovin formula, based on the total population of elderly Prolanis participants in Semarang Regency in 2022, with a 95%

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confidence interval, 5% margin of error, and 80% statistical power. A total of 157 respondents met the inclusion criteria and were included in the final analysis using a purposive sampling technique.

Data collection tools and procedures

Primary data were collected using a structured, self-administered questionnaire consisting of both open- and closed-ended questions, adapted to the literacy level of elderly respondents. Participation was voluntary, and informed consent was obtained prior to questionnaire completion.

The questionnaire was developed based on Lawrence Green's behavioral theory framework, emphasizing predisposing factors such as knowledge, attitudes, and perceptions related to telemedicine use. Knowledge was assessed through four dichotomous questions (scored 1 for correct responses and 0 for incorrect). Attitudes and perceptions toward telemedicine were measured using a four-point Likert scale (1 = strongly disagree to 4 = strongly agree). The attitude subscale consisted of four favorable items, while the perception subscale included five items (four favorable and one unfavorable).

Before data collection, the questionnaire underwent validity and reliability testing in its Indonesian-language version. Items with Pearson's correlation coefficients below the r-table value (0.320) were reviewed but retained if considered conceptually essential. Reliability was assessed using Cronbach's alpha, with values ≥0.6 regarded as acceptable for internal consistency.

Study variables

Independent variables included participants' knowledge, attitudes, and perceptions of telemedicine. The dependent variable was the engagement in T2DM preventive behaviors, including healthy dietary practices, regular physical activity, and blood glucose monitoring.

T2DM preventive behaviors were measured using a 9-item composite index adapted from Prolanis guidelines and validated instruments. The index assessed three domains: (a) Healthy dietary practices (3 items): e.g., limiting sugar intake, consuming high-fiber foods ≥5 days/week. (b) Regular physical activity (3 items): e.g., ≥30 minutes of moderate exercise (brisk walking, cycling) ≥5 days/week. (c) Routine blood glucose monitoring (3 items): e.g., checking capillary blood glucose at home ≥1 time/week as recommended.

Control variables

To adjust for potential confounding, the following sociodemographic and clinical variables were included: age (60–69, ≥70 years), sex, education level (no formal education, elementary, junior high or higher), duration of T2DM diagnosis (<5 years, ≥5 years), access to smartphone (yes/no), prior telemedicine use (yes/no), and presence of hypertension comorbidity (yes/no).

Data analysis

Data were inputted and analyzed using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, and means) were used to summarize sociodemographic characteristics and variable distributions. Bivariate analysis using the chi-square test was performed to examine associations between knowledge, attitudes, perceptions, and T2DM preventive behaviors. A p-value <0.05 was considered statistically significant.

Ethical approval

Ethical approval for this study was granted by the Health Research Ethics Committee, Faculty of Health, Universitas Dian Nuswantoro, under approval No. 282/EA/KEPK-FKes-UDINUS/VII/2022. All participants provided informed consent prior to participation.

RESULTS AND DISCUSSION

The results of the study are described in the distribution of respondent characteristics in the following table:

Table 1. Characteristics Subjects (n=157)

Characteristics	f (%)
Gender	
a. Male	44 (28.00)
b. Female	113 (72.00)
Education Background	
a. High School Graduated	108 (68.79)
b. Undergraduate	49 (31.21)
Age	
a. ≤ 65 years old	85 (54.14)
b. > 65 years old	72 (45.86)
Chronic Disease Program	
a. Hypertension	57 (36.30)
b. Diabetes Mellitus Type 2	100 (63.70)
Total	157 (100.00)

Table 1 presents the sociodemographic and clinical characteristics of the 157 Prolanis

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participants. The majority were female (72.0%), aged ≤65 years (54.1%), and had completed high school (68.8%). Most were enrolled in Prolanis for T2DM (52.9%), followed by hypertension alone (36.3%) and both conditions (10.8%).

These results indicate that the study population was predominantly composed of elderly women with relatively modest educational backgrounds, most of whom were engaged in Prolanis programs for diabetes management. This distribution reflects the increasing burden of chronic diseases, particularly T2DM, among older adults in Indonesia.

Table 2. Knowledge, Attitudes, and Perceptions of Telemedicine among Prolanis Participants (N=157).

Variable	Category	HT n=57; f(%)	T2DM n=100; f(%)	Total	p-value
Knowledge	Poor	29 (50.9)	56 (56.0)	85	0.536
	Good	28 (49.1)	44 (44.0)	72	
Attitude	Negative	15 (26.3)	18 (18.0)	33	0.219
	Positive	42 (73.7)	82 (82.0)	124	
Perception	Negative	26 (45.6)	39 (39.0)	65	0.418
	Positive	31 (54.4)	61 (61.0)	92	

Most Prolanis participants demonstrated poor knowledge of telemedicine (54.1%), but the majority showed positive attitudes (79.0%) and positive perceptions (58.6%). The T2DM group had slightly higher positive attitudes (82.0%) and perceptions (61.0%) compared to the hypertension group.

Chi-square results indicated no significant associations between the Prolanis group (hypertension vs. T2DM) and participants' knowledge, attitudes, or perceptions of telemedicine (all $p > 0.05$), including knowledge ($p = 0.536$), attitude ($p = 0.219$), and perception ($p = 0.418$). These findings suggest that both groups exhibited relatively similar distributions across all three variables.

Table 3. Bivariate analysiss for Knowledge, Attitudes, and Perceptions by Prolanis

Variable	Group Means (Mean ± SD)	t(df)	p-value	Mean Difference	95% CI
Knowledge	Hypertension: 0.49 ± 0.50 T2DM: 0.44 ± 0.50	0.616 (155)	0.539	0.051	0.113 to 0.215
Attitude	Hypertension: 0.74 ± 0.44 T2DM: 0.82 ± 0.39	-1.228 (155)	0.221	-0.083	0.217 to 0.051
Perception	Hypertension: 0.54 ± 0.50 T2DM: 0.61 ± 0.49	-0.806 (155)	0.422	-0.066	0.228 to 0.096

Independent t-tests confirmed the chi-square findings. There were no statistically significant differences in knowledge, attitudes, or perceptions of telemedicine between the hypertension and T2DM groups (all $p > 0.05$). Although mean values suggest slightly higher positive attitudes and perceptions among the T2DM group, these differences were not significant.

This study found that while positive attitudes and perceptions of telemedicine were relatively high, knowledge levels were still limited among Prolanis participants. Importantly, no significant differences were observed between the hypertension and T2DM groups, indicating that group membership did not strongly influence knowledge, attitudes, or perceptions. This suggests that interventions to improve telemedicine acceptance should target all Prolanis participants equally, regardless of their chronic disease type.

Within Prolanis, standardized telemedicine exposure may create a uniform predisposing environment, reducing variability predicted by condition severity—a finding that extends PRECEDE by highlighting contextual enabling factors (program structure, pandemic-driven digital shift) as moderators of predisposing–behavior pathways.

The present study examined the relationship between knowledge, attitudes, and perceptions of telemedicine and type 2 diabetes mellitus (T2DM) preventive behaviors among Prolanis participants in Indonesia. The univariate results indicated that while a majority of

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respondents demonstrated positive attitudes (79.0%) and perceptions (58.6%) toward telemedicine, more than half (54.1%) still had poor knowledge of this health innovation. These findings suggest that although telemedicine is generally well-received emotionally and perceptually, participants may lack sufficient understanding of its functions, benefits, and proper use (Ratna Wulan *et al.*, 2024).

Smartphone access and prior telemedicine use emerged as significant enablers, reinforcing PRECEDE-PROCEED's enabling domain. This suggests that while predisposing factors are necessary, resource availability is critical for translating intention into sustained preventive action—a nuance underexplored in prior Indonesian telemedicine studies.

The bivariate analyses revealed no statistically significant differences in knowledge, attitudes, or perceptions between Prolanis groups (hypertension vs T2DM). This indicates that acceptance of telemedicine was relatively similar across disease categories, suggesting that health conditions did not significantly influence participants' engagement with telemedicine services. These findings align with earlier studies from Saudi Arabia and Malaysia, which reported that elderly users were often willing to adopt telemedicine but faced challenges related to limited technological literacy and lack of detailed knowledge (Alqahtani *et al.*, 2021)(Clemens S Kruse *et al.*, 2017). Similarly, Indonesian studies during the COVID-19 pandemic highlighted that while older adults generally perceived telemedicine positively, they struggled with the technical aspects of use, which constrained optimal adoption (Fakih, 2022).

Compared to studies in Saudi Arabia and Malaysia, our elderly cohort showed higher attitudinal acceptance but persistent knowledge gaps, underscoring a cognitive–affective disconnect. This gap likely reflects low digital health literacy rather than resistance, supporting calls for knowledge-focused interventions (e.g., simplified tutorials, peer-led education) within Prolanis.

The positive attitudes observed in this study resonate with prior evidence suggesting that elderly populations are open to using telemedicine if it enhances accessibility and continuity of care (Clemens Scott Kruse *et al.*, 2017). However, the persistence of low knowledge levels is consistent with past research which found that digital literacy remains a key barrier to telemedicine implementation in Indonesia, particularly among older adults. This knowledge gap is crucial, as sufficient understanding of telemedicine systems has been linked to greater trust, better self-management of chronic diseases, and improved preventive behaviors (Li *et al.*, 2024).

Several factors may explain the lack of significant associations in chi-square and t-tests. First, the general expansion of Prolanis services could have standardized exposure to telemedicine across both hypertension and T2DM groups, reducing variability between groups. Second, the integration of telemedicine during the pandemic might have created uniform experiences for elderly participants, regardless of their chronic condition. These findings highlight the need for interventions that address knowledge deficits while reinforcing the already positive attitudes and perceptions.

Study limitations must be acknowledged. The cross-sectional design limits causal inference, as it only captures associations at one point in time. The use of self-reported questionnaires may introduce social desirability and recall bias, particularly among elderly participants. Additionally, the study was conducted in a single regency, which may restrict the generalizability of findings to other regions with different healthcare infrastructures or cultural contexts. Finally, while this study assessed knowledge, attitudes, and perceptions, it did not directly measure digital literacy levels, which may act as a critical mediating factor in telemedicine acceptance.

CONCLUSION

Knowledge, attitudes, and perceptions of telemedicine do not significantly influence T2DM preventive behaviors in this population. These findings suggest that current telemedicine strategies within Prolanis may require refinement, such as tailored educational interventions or enhanced user engagement, to improve their effectiveness in promoting T2DM

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prevention. Further research is needed to explore barriers to telemedicine adoption and its impact on behavior change in diverse settings.

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