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Research Paper

Demographic, behavioral, and psychosocial factors associated with insulin adherence among Filipino adults with diabetes mellitus

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ABSTRACT

Insulin adherence supports glycemic control and is influenced by behavioral and psychosocial factors, yet evidence among Filipino adults remains limited. This study examined associations between demographic characteristics, self-management constructs, and insulin adherence among Filipino adults on insulin therapy. A cross-sectional survey involved outpatients at a Level 2 private hospital. A ten-item, insulin-adapted, MyMAAT-derived instrument assessed medication-taking behavior, perceived utility, perceived barriers, and self-efficacy/social support. Scores were reverse-coded, with higher values indicating better adherence responses. Associations were analyzed using Spearman's rank correlation and exploratory multivariable linear regression. Among 110 participants, 52 had type 1 diabetes mellitus and 58 had type 2 diabetes mellitus. The mean insulin adherence score was 3.75 ± 0.66. Construct scores correlated positively with the composite: self-efficacy/social support (r = 0.8336), medication-taking behavior (r = 0.7709), perceived barriers (r = 0.7321), and perceived utility (r = 0.3526). These findings support patient-centered adherence assessment and counseling in pharmacy practice.

Key words: diabetes mellitus, insulin, medication adherence, self-management, Philippines

1. Introduction

Diabetes mellitus is a major chronic disease requiring long-term pharmacologic treatment, self-management, and continuous patient education. Globally, approximately 589 million adults aged 20 to 79 years were living with diabetes in 2024, and this is projected to increase further by 2050 (International Diabetes Federation, 2025a). In the Philippines, the International Diabetes Federation reported approximately 4.7 million adults aged 20 to 79 years living with diabetes in 2024, corresponding to an adult prevalence of about 7.5% (International Diabetes Federation, 2025b). This burden highlights the need for locally relevant strategies to support diabetes treatment and self-management.

Insulin therapy remains an important treatment option for patients who require glycemic control beyond lifestyle modification and non-insulin pharmacotherapy. However, adherence to insulin therapy may be more complex than adherence to oral medications because insulin use involves injection technique, timing of administration, dose adjustment, storage requirements, glucose monitoring, concerns about hypoglycemia, and possible fear or discomfort related to injections (Ku & Kegels, 2014; Roystonn et al., 2022; Sorli & Heile, 2014). These factors make insulin adherence a distinct and clinically important area of diabetes care.

Medication adherence is influenced not only by access to medicines but also by behavioral and psychosocial factors. Previous studies on diabetes self-management have emphasized the relevance of medication-taking behavior, perceived benefits and barriers, self-efficacy, social support, health literacy, and patient education (Ghisi et al., 2022; Hatah et al., 2020; Nguyen et al., 2014). Health literacy is also relevant in the Philippine setting because patient education and diabetes-related information needs remain important components of diabetes care (Arcellana & Jimeno, 2020; Ghisi et al., 2022; Tolabing et al., 2022).

Pharmacists may contribute to diabetes care through patient counseling, medication education, insulin-administration counseling, adherence monitoring, and reinforcement of glucose-monitoring practices (Nabulsi et al., 2020; Paz-Pacheco & Jimeno, 2015). In the Philippine setting, clearer local evidence on insulin adherence can support the development of pharmacist- and clinician-led interventions that respond to patient-specific adherence barriers, particularly in outpatient settings where long-term self-management is required (Ghisi et al., 2022; Seiglie et al., 2020).

Despite the importance of insulin adherence, local evidence remains limited regarding how specific behavioral and psychosocial constructs are associated with insulin adherence among Filipino adults receiving insulin therapy. Existing Philippine studies have described diabetes care, education needs, and glycemic control, but fewer studies have examined insulin-specific adherence using structured adherence constructs (Ang et al., 2022; Ghisi et al., 2022; Manteuffel et al., 2014). This study therefore focused on insulin therapy because insulin requires distinct self-management behaviors and presents unique adherence challenges.

The conceptual framework of this study was guided by diabetes self-management and behavioral adherence perspectives, which suggest that adherence is associated with medication-taking behavior, perceived usefulness of therapy, perceived barriers, and self-efficacy/social support. In this study, medication-taking behavior (MTB) referred to the patient's reported consistency in following the prescribed insulin regimen; perceived utility (PU) referred to the patient's perceived benefit or usefulness of insulin therapy; perceived barriers (PB) referred to the patient's reported difficulties related to insulin use; and self-efficacy/social support (SESS) referred to confidence in managing insulin therapy and perceived support from others. These constructs were assessed using the adapted instrument and examined in relation to overall insulin adherence.

This study aimed to examine the associations between demographic characteristics, diabetes self-management constructs, and insulin adherence among Filipino adults receiving insulin therapy in a Level 2 private hospital in Quezon City, Philippines.

2. Materials and Methods

2.1. Study Design

This study used a quantitative descriptive cross-sectional design to examine associations between demographic characteristics, diabetes self-management constructs, and insulin adherence among adult Filipino outpatients receiving insulin therapy. A cross-sectional design was appropriate because the study measured adherence-related variables and participant characteristics at a single point in time and aimed to identify exploratory associations rather than establish causal relationships. The manuscript was prepared with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidance for observational studies (Cuschieri, 2019).

2.2. Study Site

The study was conducted at the Internal Medicine outpatient clinic of a Level 2 private hospital in Quezon City, Philippines. Level 2 hospitals provide departmentalized clinical services and are expected to serve patients requiring specialist care, including patients with chronic diseases such as diabetes mellitus (Department of Health, 2012). The study site was selected because it served adult outpatients receiving insulin therapy and provided access to the target population during the approved data collection period.

2.3. Participants and Inclusion Criteria

The study population consisted of adult Filipino outpatients with diabetes mellitus seeking consultation at the Internal Medicine outpatient clinic during the approved 2023 data collection period. Participants were eligible if they were: (1) Filipino adults aged 18 years and above; (2) diagnosed with diabetes mellitus; (3) prescribed insulin therapy; (4) using the current insulin regimen for at least three months before recruitment; and (5) able to understand Filipino or English, provide written informed consent and complete the questionnaire. Participants who required assistance due to functional limitations could be assisted by a legally authorized representative, provided that informed consent was properly documented.

2.4. Sampling and Recruitment

A non-probability controlled quota sampling approach was used. Eligible participants were recruited consecutively from the Internal Medicine outpatient clinic until the final analytical sample was obtained. The phrase "first available eligible individuals" refers to eligible patients who were approached during clinic days and invited to participate after eligibility screening. This approach was used because the study was conducted in a clinical outpatient setting with a defined data collection period. However, because the method was non-probability-based, the possibility of selection bias was considered in interpreting the findings.

The final dataset contained 110 complete participant records. The total number of patients approached and the number who declined participation were not recorded in the analysis dataset; therefore, the response rate could not be verified from the available data. This limitation was considered in assessing potential non-response bias.

2.5. Sample Size Calculation

The minimum sample size was determined using an a priori power analysis for correlation analysis. The calculation used an assumed effect size of 0.15, alpha level of 0.01, and statistical power of 85%, based on sample size guidance for correlation analysis (Bujang & Baharum, 2016; Zar, 2014). The stricter alpha level was selected to reduce the likelihood of type I error because multiple adherence constructs were examined. To account for possible incomplete responses or attrition, the target sample size was increased to 135 participants. A total of 110 complete responses were included in the final analysis.

2.6. Research Instrument and Constructs

Data were collected using a self-report survey composed

of two sections. The first section obtained demographic and medication-use characteristics, including type of diabetes, duration of current insulin therapy, concomitant oral antidiabetic medication use, residence, age group, sex, educational attainment, and monthly income category. The second section assessed insulin adherence and diabetes self-management patterns using a ten-item insulin-specific instrument adapted from the Malaysian Medication Adherence Assessment Tool (MyMAAT) developed by Hatah et al. (2020). Although the original MyMAAT contains 12 items, the administered insulin-adapted version used in this study contained ten items focused on insulin-use behaviors. The English version of the administered items is provided in Supplementary Material 1.

The adapted instrument assessed four constructs: medication-taking behavior (MTB), perceived utility (PU), perceived barriers (PB), and self-efficacy/social support (SESS). MTB refers to the participant's reported consistency in using insulin according to the prescribed regimen. PU refers to the perceived usefulness or benefit of insulin therapy. PB refers to perceived barriers or difficulties related to insulin use. SESS refers to the participant's confidence in managing insulin therapy and perceived support from family members, caregivers, or healthcare providers.

2.7. Scoring and Operational Definition of Insulin Adherence

The administered questionnaire used a five-point Likert response format. In the raw dataset, responses were encoded as 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, and 5 = Always. Because the adherence items were worded as non-adherent insulin-use behaviors, lower raw scores indicated less frequent non-adherent behavior and therefore better adherence.

For interpretability, item scores were reverse-coded before computing adherence-related construct scores, such that higher scores reflected better adherence-related responses. Reverse-coded scores were computed as 6 minus the raw item score. Thus, after reverse coding, 1 indicated Always, 2 indicated Often, 3 indicated Sometimes, 4 indicated Rarely, and 5 indicated Never engaging in the non-adherent behavior.

Overall insulin adherence was operationally defined as the mean composite score derived from the ten reverse-coded adapted adherence items. The reverse-coded scores of all answered adherence items were summed and divided by the number of completed items, producing an overall mean score ranging from 1.00 to 5.00. Higher composite mean scores indicated better insulin adherence. Construct scores for MTB, PU, PB, and SESS were also computed as mean scores from their corresponding reverse-coded items. Because PB items were reverse-coded, higher PB scores indicated fewer reported barriers or less frequent barrier-related non-adherent behavior.

For exploratory known-groups comparison, the published MyMAAT-12 cutoff score of 54 was converted to a mean item-score threshold of 4.5 by dividing the cutoff by the original 12 items (Hatah et al., 2020). Because the insulin-adapted instrument used in the present study contained ten items, retention of the same mean item-score threshold corresponded to a reverse-coded total score of 45. Participants with reverse-coded total scores of 45 to 50 were therefore placed in the exploratory adherent group, whereas participants with reverse-coded total scores of 10 to 44 were placed in the exploratory non-adherent group. Under the raw scoring used in the present dataset, these ranges corresponded to raw total scores of 10 to 15 and 16 to 50, respectively. This proportional conversion was developed for the present study and has not been validated for the ten-item insulin-adapted instrument. Accordingly, the classification was used only for exploratory known-groups comparison and was not interpreted as a validated or diagnostic adherence classification.

2.8. Translation, Adaptation, and Validation

Permission to use and adapt the MyMAAT was obtained from the original author. The questionnaire was translated into Filipino and reviewed by a linguistics professional to support clarity and conceptual equivalence. The adapted instrument underwent expert validation by a panel consisting of one licensed physician with clinical experience in diabetes care and two licensed community pharmacists with experience in patient counseling and medication adherence assessment. The validators assessed the clarity, relevance, and appropriateness of the adapted items for Filipino adults using insulin therapy.

Content validity was assessed using the Item-Content Validity Index (I-CVI) and Scale-Content Validity Index (S-CVI). These indices were computed by two independent licensed pharmacists who were not part of the initial expert validation panel. Items rated as quite relevant or very relevant were considered content-valid. Based on the validation ratings, retained items achieved an I-CVI of 1.00 and an S-CVI above the acceptable threshold of 0.80.

Presurvey testing was conducted among 15 eligible participants outside the final study sample to identify potential problems in survey administration, comprehension, and response burden. Participants were asked to comment on item clarity, ease of answering, and any difficulties encountered while completing the questionnaire. The presurvey internal consistency test yielded a Cronbach's alpha of 0.82, indicating acceptable reliability. In the final analytical sample, the overall Cronbach's alpha for the ten items was 0.77. Domain-specific reliability was 0.60 for MTB, 0.32 for PB, and 0.75 for SESS, while PU consisted of a single item and was not assessed using Cronbach's alpha. Because the instrument was adapted from the MyMAAT and modified for a Filipino insulin-using population, further

construct validation remains necessary. Future studies should conduct factor analysis and additional psychometric testing using a larger and more diverse Filipino sample to confirm the construct structure and cultural equivalence of the adapted instrument.

2.9. Data Collection Procedure

Eligible patients were approached during outpatient clinic visits. After eligibility screening, the study purpose, procedures, risks, benefits, voluntary nature of participation, and confidentiality safeguards were explained. Written informed consent was obtained before survey administration. The questionnaire was self-administered in printed format, with assistance available for participants who needed clarification. The instrument was available in English and Filipino. Completion time was approximately 10 to 15 minutes. All participant identifiers were de-identified using unique codes before analysis.

2.10. Statistical Analysis

Data were encoded, cleaned, and analyzed using Stata Statistical Software: Release 15 (StataCorp LLC, College Station, Texas, USA). Descriptive statistics were used to summarize demographic and medication-use characteristics. Frequencies and percentages were used for categorical variables, while means, standard deviations, medians, and ranges were computed for adherence-related constructs. Construct scores were calculated as mean scores by summing the reverse-coded item responses within each construct and dividing the total by the number of answered items in that construct. The overall insulin adherence score was likewise computed as a mean composite score across all ten reverse-coded adherence items.

Spearman's rank correlation was used to examine associations between adherence-related construct scores and overall insulin adherence because the variables were derived from ordinal Likert-scale responses and were not assumed to satisfy normality requirements. Correlation strength was interpreted as follows: 0.00 to 0.19 = very weak, 0.20 to 0.39 = weak, 0.40 to 0.59 = moderate, 0.60 to 0.79 = strong, and 0.80 to 1.00 = very strong. The direction of association was interpreted as positive or negative based on the sign of the correlation coefficient.

Potential multicollinearity among the medication-taking behavior, perceived utility, perceived barriers, and self-efficacy/social support construct scores was assessed using variance inflation factors (VIFs) and tolerance values calculated from the construct-score predictor matrix. This analysis was conducted solely as a collinearity diagnostic. The construct scores were not interpreted as independent predictors of overall insulin adherence because each construct was derived from items included in the overall adherence composite.

The Wilcoxon rank-sum test was used to compare adherence scores between two independent groups, while the Kruskal-Wallis test was used for comparisons across three or more independent groups. Dunn-type pairwise post hoc comparisons with multiplicity adjustment were used when Kruskal-Wallis results were significant. Fisher's exact test and chi-square or proportion comparison tests were used, where appropriate, for demographic comparisons based on the exploratory adherent and non-adherent grouping defined in Section 2.7.

Missing data were handled using complete-case analysis. All 110 participants included in the final analysis had sufficient completed responses for the computation of adherence-related scores; therefore, no questionnaire was excluded from the final analysis due to substantial missing adherence data. No correction for multiple comparisons was applied to the primary exploratory correlations; therefore, the results were interpreted cautiously as preliminary associations.

To address potential confounding while avoiding circularity between the adherence domains and the overall adherence composite, an exploratory multivariable linear regression analysis was conducted in response to peer-review recommendations. The overall reverse-coded mean insulin adherence score was entered as the dependent variable, while demographic and medication-use variables were entered as independent variables. Adherence-domain scores were excluded from the model because they contributed to the overall adherence composite and could therefore introduce conceptual and mathematical overlap.

2.11. Ethical Considerations

Ethical approval was obtained from the University of the Philippines Manila Research Ethics Board (UPMREB 2023-0142-UND). Permission to conduct data collection was also secured from the study site. Written informed consent was obtained from all participants before survey administration. Participation was voluntary, and participants were informed that they could withdraw at any time without affecting their medical care. All collected data were de-identified and stored securely. The study was self-funded, and the authors declared no conflict of interest.

3. Results

3.1. Participant Profile

A total of 110 complete participant records were included in the final analysis. The total number of patients approached during recruitment and the number who declined participation were not recorded in the analysis dataset; therefore, the response rate could not be verified. The participant profile is summarized in Table 1. More than half of the participants were aged 65 years and above, indicating a predominantly older adult sample. Sex distribution was nearly equal. Most participants had at least secondary education, while approximately one-fifth had primary

Table 1. Demographic and Medication-Use Characteristics of Participants.

Characteristic	Category	n	%
Type of diabetes	Type 1 diabetes mellitus	52	47.27
	Type 2 diabetes mellitus	58	52.73
Duration of current insulin therapy	3 months	0	0.00
	>3 to ≤6 months	1	0.91
	>6 to ≤12 months	23	20.91
	More than 12 months	86	78.18
Concomitant oral antidiabetic medication	Yes	49	44.55
	No	61	55.45
Residence	Within NCR	94	85.45
	Outside NCR	16	14.55
Age group	18–34 years	8	7.27
	35–49 years	13	11.82
	50–64 years	28	25.45
	65 years and above	61	55.45
Sex	Male	56	50.91
	Female	54	49.09
Educational attainment	No formal schooling	0	0.00
	Primary school	24	21.82
	Secondary school and above	86	78.18
Monthly income	Less than PHP 12,082	56	50.91
	PHP 12,082 to <24,164	27	24.55
	PHP 24,164 to <48,328	18	16.36
	PHP 48,328 to <84,574	5	4.55
	PHP 84,574 to <144,984	1	0.91
	PHP 144,984 to <241,640	1	0.91
	PHP 241,640 and above	2	1.82

Note: NCR = National Capital Region. Percentages are based on n = 110 and may not total exactly 100.00% because of rounding.

education. The sample was predominantly from lower monthly income categories. The study included adults with insulin-treated diabetes mellitus, with 52 participants reporting type 1 diabetes mellitus and 58 reporting type 2 diabetes mellitus. Most participants had been using insulin for more than one year.

3.2. Insulin Adherence-Related Construct Scores

The adherence-related construct scores are presented in Table 2. Scores were reverse-coded so that higher values indicated better adherence-related responses. The highest mean score was observed for perceived utility, followed by medication-taking behavior, perceived barriers, and self-efficacy/social support. The mean overall insulin adherence score was 3.75 (SD = 0.66) on the reverse-coded 1 to 5 scale. Using the proportional threshold described in Section 2.7, 17 participants (15.45%) had reverse-coded total scores of 45 to 50, corresponding to raw total scores of 10 to 15, and were placed in the exploratory adherent group. The remaining 93 participants (84.55%) had reverse-coded total scores of 10 to 44, corresponding to raw total scores of 16 to 50, and were placed in the exploratory non-adherent group. These group labels were used only for exploratory comparison and do not represent a validated or diagnostic classification.

Table 2. Reverse-Coded Insulin Adherence-Related Construct Scores.

Construct	Mean ± SD	Median (range)
Medication-taking behavior (MTB)	3.87 ± 0.73	4.00 (1.75–5.00)
Perceived utility (PU)	4.60 ± 0.73	5.00 (2.00–5.00)
Perceived barriers (PB)	3.52 ± 0.97	3.50 (1.00–5.00)
Self-efficacy/social support (SESS)	3.47 ± 1.06	3.67 (1.00–5.00)
Overall insulin adherence	3.75 ± 0.66	3.80 (1.90–5.00)

Note: Higher scores indicate better adherence-related responses. MTB = medication-taking behavior; PU = perceived utility; PB = perceived barriers; SESS = self-efficacy/social support.

3.3. Associations Between Adherence Constructs and Overall Insulin Adherence

Table 3 presents the Spearman correlations between the adherence-related construct scores and the overall insulin-adherence composite. Overall insulin adherence showed positive correlations with all four constructs. The strongest positive correlation was observed for self-efficacy/social support, followed by medication-taking behavior and perceived barriers, while perceived utility showed a weak positive correlation. Because each construct score was derived from a subset of the same ten items used to calculate the overall insulin-adherence composite, these correlations

Table 3. Correlation Between Adherence Constructs and Overall Insulin Adherence.

Construct	Spearman r	p-value	Interpretation
MTB	0.7709	<0.001	Strong positive domain-level association
PU	0.3526	0.0002	Weak positive association
PB	0.7321	<0.001	Strong positive association
SESS	0.8336	<0.001	Very strong positive association

Note: Each construct score was calculated from items included in the overall insulin-adherence composite; therefore, the reported correlations are part-whole, domain-to-composite correlations and do not represent independent predictive effects. MTB = medication-taking behavior; PU = perceived utility; PB = perceived barriers; SESS = self-efficacy/social support.

Table 4. Bivariate Spearman Correlation Matrix of Adherence Constructs and Overall Insulin Adherence.

Variable	MTB	PU	PB	SESS	Overall adherence
MTB	1.0000	0.2785	0.4173	0.4034	0.7709
PU	0.2785	1.0000	0.2019	0.1771	0.3526
PB	0.4173	0.2019	1.0000	0.5422	0.7321
SESS	0.4034	0.1771	0.5422	1.0000	0.8336
Overall adherence	0.7709	0.3526	0.7321	0.8336	1.0000

Note: All values are Spearman correlation coefficients. MTB = medication-taking behavior; PU = perceived utility; PB = perceived barriers; SESS = self-efficacy/social support.

represent part-whole, domain-to-composite associations and should not be interpreted as independent predictive relationships. The very small p-values for medication-taking behavior, perceived barriers, and self-efficacy/social support reflect the magnitude of the observed correlations, the sample size, and the mathematical overlap between the construct scores and the overall composite.

To improve transparency, Table 4 presents the bivariate correlation matrix among adherence-related constructs and overall insulin adherence. Several constructs were correlated with each other, supporting the need to interpret the constructs as related domains of a broader adherence framework rather than fully independent predictors.

Because the overall insulin-adherence score was calculated as the item-weighted composite of the four construct scores, the correlations in Table 3 represent part-whole, domain-to-composite relationships. The mathematical overlap contributed to the magnitude of the observed correlations, which, together with the sample size of 110, produced the very small p-values. Collinearity diagnostics did not indicate problematic collinearity among the four construct scores: VIF values ranged from 1.14 to 1.51, tolerance values ranged from 0.66 to 0.88, and the largest interconstruct correlation was 0.5422. Accordingly, interconstruct collinearity did not account for the very small p-values.

3.4. Demographic and Medication-Use Group Comparisons

Age group showed a statistically significant difference in MTB scores (Kruskal-Wallis H = 10.17, p = 0.017). Pairwise post hoc comparisons indicated significant differences between the 35–49 and 50–64 age groups (adjusted p = 0.028) and between the 35–49 and 65 years and above age groups (adjusted p = 0.046). No statistically significant age-group differences were observed for PU, PB, SESS, or overall insulin adherence. Sex, educational attainment, socioeconomic classification, diabetes type, duration of insulin therapy, concomitant oral antidiabetic medication use, and residence were not consistently associated with adherence-related construct scores in bivariate analyses. Categorical adherent/non-adherent comparisons across demographic groups were also not statistically significant.

3.5. Exploratory Multivariable Regression

An exploratory multivariable linear regression model was conducted to examine demographic and medication-use variables in relation to overall insulin adherence. The overall model was not statistically significant ($F[16, 93] = 1.21$, $p = 0.273$), with an R-squared value of 0.173 and an adjusted R-squared value of 0.030. This suggests that the included demographic and medication-use covariates explained only a limited proportion of the variation in the overall adherence score. Although not taking concomitant oral antidiabetic medication showed a positive coefficient in the model ($B = 0.283$, $p = 0.041$), this result was interpreted cautiously because the overall model was not statistically significant and several categories had small cell counts (Table 5).

Figure 1 provides a graphical summary of the adherence-related construct scores, their associations with overall insulin adherence, the distribution of medication-taking behavior scores across age groups, and the exploratory adherent and non-adherent group comparisons.

4. Discussion

This study examined associations between demographic characteristics, diabetes self-management constructs, and insulin adherence among Filipino adults receiving insulin

Table 5. Exploratory Regression Summary for Overall Insulin Adherence.

Model/Variable	Statistic or coefficient	p-value	Interpretation
Overall adjusted model	F(16, 93) = 1.21	0.273	R-squared = 0.173; adjusted R-squared = 0.030
Concomitant oral antidiabetic medication: No vs Yes	B = 0.283	0.041	Interpreted cautiously because the overall model was not statistically significant

Note: Overall insulin adherence was entered as the dependent variable. Independent variables included type of diabetes, duration of current insulin therapy, concomitant oral antidiabetic medication use, residence, age group, sex, educational attainment, and monthly income category. Construct scores were not entered as predictors to avoid circularity with the adherence composite.

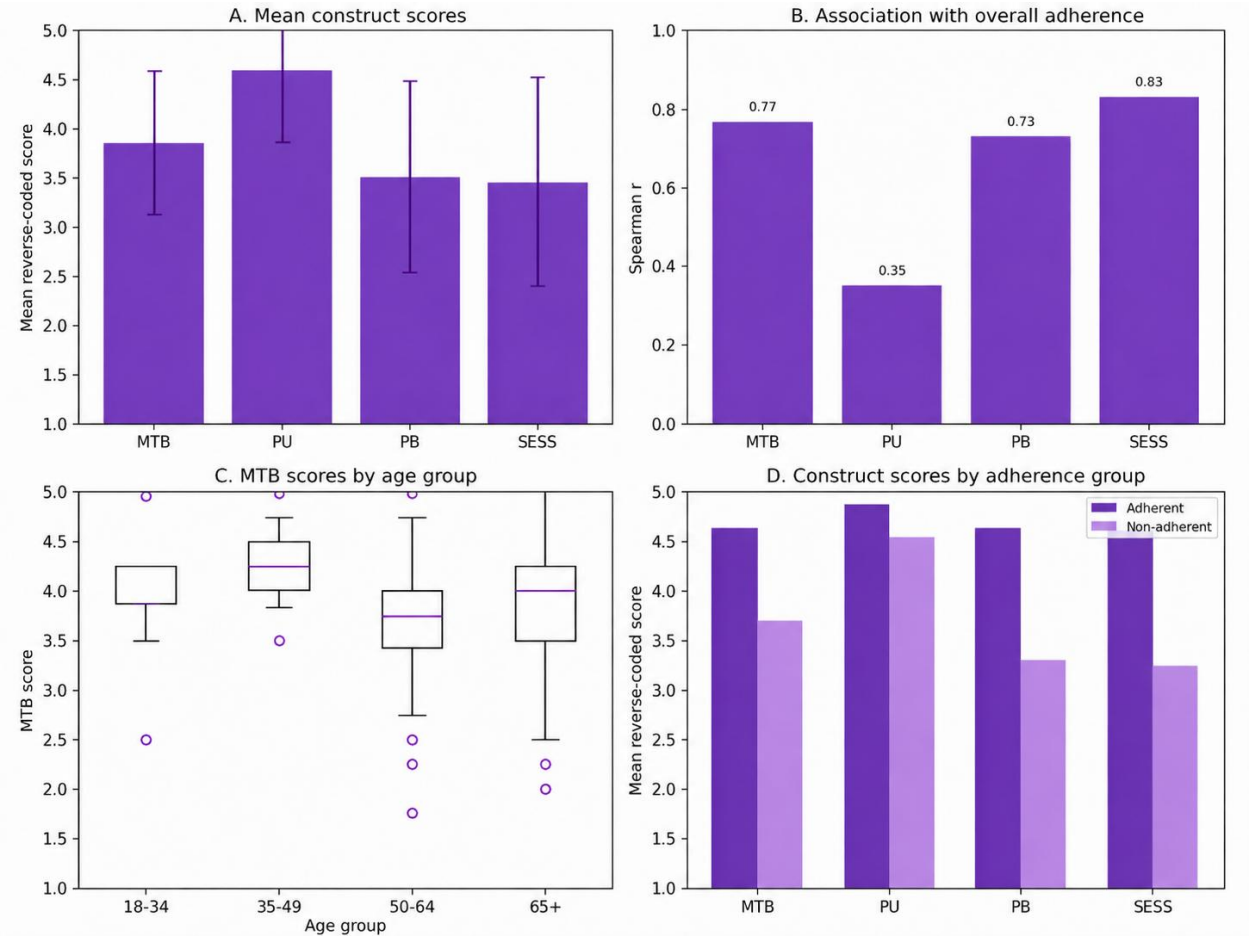

Figure 1. Summary of insulin adherence-related construct scores and associations. Figure 1A shows the reverse-coded mean scores of adherence-related constructs. Figure 1B shows the Spearman correlation coefficients between each adherence-related construct and overall insulin adherence. Figure 1C shows the distribution of MTB scores across age groups. Figure 1D compares adherence-related construct scores between participants placed in the exploratory adherent and non-adherent groups using the study-derived proportional threshold described in Section 2.7. MTB = medication-taking behavior; PU = perceived utility; PB = perceived barriers; SESS = self-efficacy/social support. Higher scores indicate better adherence-related responses, fewer reported barriers, or less frequent non-adherent insulin-use behavior, depending on the construct. The adherent and non-adherent groupings were used only for exploratory known-groups comparison and were not based on a cutoff validated for the ten-item insulin-adapted instrument.

therapy. Overall insulin adherence was positively associated with the assessed self-management constructs, particularly self-efficacy/social support, medication-taking behavior, and perceived barriers. Because the study used a cross-sectional design, these findings should be interpreted as associations and not as evidence of causal relationships.

The strongest association was observed between self-efficacy/social support and overall insulin adherence. This finding is consistent with diabetes self-management perspectives suggesting that patients who feel more capable of managing their treatment and who receive support from others may report better adherence-related behaviors (Ku & Kegels, 2014). In insulin therapy, social support may be especially relevant because patients may need assistance with reminders, injection preparation, glucose monitoring, clinic follow-up, or management of hypoglycemia concerns.

The construct scores showed varying degrees of correspondence with the overall insulin-adherence composite. However, all four constructs were calculated from subsets of the same ten items used to calculate the overall adherence score. Their correlations with overall adherence therefore represent part-whole relationships and should not be interpreted as evidence that the constructs independently predict adherence. Collinearity diagnostics did not indicate problematic multicollinearity among the construct scores; nevertheless, the absence of multicollinearity does not eliminate the mathematical overlap between each construct and the overall composite. The findings are more appropriately interpreted as showing the relative contribution and correspondence of each adherence domain within the composite measure.

Perceived barriers were positively associated with overall insulin adherence. This finding is consistent with the scoring procedure because PB items were reverse-coded; thus, higher PB scores indicated fewer reported barriers or less frequent barrier-related non-adherent behavior. This clarification is important because, without reverse coding, a positive relationship between barriers and adherence would be counterintuitive.

Perceived utility showed only a weak positive association with overall insulin adherence. This may indicate that perceiving insulin as useful is relevant but insufficient by itself to support adherence. Patients may recognize the value of insulin but still experience practical, financial, emotional, technique-related, or support-related barriers that affect actual insulin use (Seiglie et al., 2020; Widayanti et al., 2021). This finding supports the need for adherence assessment that goes beyond knowledge or perceived benefit alone.

Age group was associated with medication-taking behavior, and more than half of the participants were aged 65 years and above. The predominance of older adults may have influenced the findings because insulin adherence in older populations can be affected by comorbidities, polypharmacy, visual or motor limitations, cognitive changes, caregiver involvement, and duration of diabetes or insulin use. These factors were not fully measured in the present study and should be considered in future research.

The inclusion of both type 1 and type 2 diabetes mellitus reflects the insulin-treated outpatient population available in the study setting. This broad inclusion may improve clinical relevance for insulin-use behaviors but also introduces heterogeneity because insulin treatment expectations, disease duration, and self-management demands may differ between type 1 and type 2 diabetes mellitus. This was considered in the interpretation of the findings and should be explored further in future studies.

The findings have practical implications for clinicians and pharmacists. Adherence interventions may include structured insulin counseling, review of injection technique, assessment of hypoglycemia concerns, simplified reminder systems, caregiver-inclusive education for older adults, and routine screening for patient-specific barriers. Pharmacists may support these interventions through medication counseling, adherence monitoring, reinforcement of insulin storage and administration instructions, and patient education tailored to health literacy level.

This study has several limitations. First, its cross-sectional design prevents causal inference. Second, the study was conducted in a single Level 2 private hospital using non-probability sampling, which may limit generalizability and introduce selection bias. Third, the total number of eligible patients approached was not recorded in the analysis dataset; therefore, the response rate could not be verified, limiting assessment of potential non-response bias. Fourth, insulin adherence was measured using a self-report instrument, which may be affected by recall bias and social desirability bias. Fifth, the instrument was adapted from the MyMAAT and modified into a ten-item insulin-specific version; although reliability was acceptable overall, further psychometric validation among Filipino patients receiving insulin therapy is needed, including assessment of construct validity and cultural equivalence. The proportional threshold used for the exploratory adherent and non-adherent grouping has likewise not been validated for this ten-item insulin-adapted instrument; therefore, findings based on this grouping should be interpreted cautiously. Sixth, some adherence domains may overlap conceptually with the overall adherence score, particularly medication-taking behavior. Seventh, potential confounders such as duration of diabetes, duration of insulin use, insulin regimen complexity, number of medications, previous diabetes counseling, glycemic control, cognitive function, comorbidities, and caregiver involvement were not fully controlled. These limitations should be considered when interpreting the findings.

Future studies should use multicenter designs, probability-based or more systematic sampling approaches, larger sample sizes, and objective adherence or clinical measures such as pharmacy refill records, insulin-use monitoring, injection logs, glucose monitoring records, or HbA1c values. Further validation of the Filipino insulin-adapted MyMAAT-derived instrument is also recommended before broader use in clinical or research settings.

5. Conclusion

This study found positive associations between overall insulin adherence and the adherence-related constructs of self-efficacy/social support, medication-taking behavior, perceived barriers, and perceived utility among Filipino adults receiving insulin therapy. The strongest positive association was observed for self-efficacy/social support, while perceived utility showed a weaker positive association. Age group was associated with medication-taking behavior,

whereas sex, educational attainment, socioeconomic classification, diabetes type, duration of current insulin therapy, and concomitant oral antidiabetic medication use were not consistently associated with adherence-related construct scores. These findings suggest that insulin adherence assessment should consider behavioral and psychosocial dimensions, particularly patient confidence, support systems, and perceived barriers. Clinician- and pharmacist-led insulin counseling, adherence monitoring, and patient-centered education may be useful strategies in outpatient diabetes care. Future research should use longitudinal or multicenter designs, include objective adherence and glycemic control measures, control for confounders, and further validate the adapted instrument among Filipino patients receiving insulin therapy.

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SUPPLEMENTARY MATERIAL

Supplementary Material 1. English Version of the Administered Insulin-Adherence Items

The administered insulin-adapted questionnaire used the following response format in the survey: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, and 5 = Always. Because the items describe non-adherent insulin-use behaviors, scores were reverse-coded for analysis so that higher scores indicated better adherence-related responses.

Item number	English item
1	I fail to take my insulin in accordance with the instruction of my physician.
2	I take less of my insulin when I feel better.
3	I take my insulin and other antidiabetic medications alternately.
4	I am late/would miss getting my next insulin refill from the pharmacy.
5	I do not comply with my prescription because I feel it is unnecessary or insignificant.
6	I take less of my insulin for fear of side effects to my body.
7	I have difficulty remembering to take my insulin.
8	I have difficulty complying with my insulin regimen.
9	I miss my insulin dose if no one reminds me to do so.
10	I need support or help from a loved one to be motivated in complying with my insulin regimen.

Supplementary Material 2. Sample Size Calculation Parameters

The minimum sample size was based on a priori power analysis for correlation analysis using an assumed effect size of 0.15, alpha level of 0.01, and statistical power of 85%. This yielded a minimum required sample size of 107 participants. The target sample size was increased to 135 to account for possible incomplete responses or attrition. The final analytical sample included 110 complete participant records.