

Telenursing versus Traditional Outpatient Care for Older Adults with Type 2 Diabetes: Patient Satisfaction, Medication Adherence, and Lifestyle Modification

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ABSTRACT

Background: Comparative evidence on routine telenursing versus traditional outpatient care for older adults with type 2 diabetes in Saudi Arabia remains limited. **Objectives:** To compare the two modalities on patient satisfaction, medication adherence and lifestyle modification. **Methods:** A cross-sectional comparative study, reported per STROBE, at Hafar Al-Batin Diabetes Center, Saudi Arabia. Stratified random sampling drew 743 older adults from the telenursing ($n = 362$) and traditional outpatient ($n = 381$) clinic populations; allocation followed routine service, not randomization. Outcomes were measured with the Telenursing Interaction and Satisfaction Scale (TISS), Adherence to Refills and Medications Scale (ARMS) and Perceived Adherence Lifestyle Modification Questionnaire (PALM-Q). Groups were compared with independent-samples t , Mann–Whitney U and chi-square tests, and care modality entered into multivariable linear regression adjusted for sociodemographic and clinical covariates. **Results:** Total satisfaction was marginally higher with telenursing (93.90 ± 3.50 vs. 93.28 ± 3.41 ; mean difference 0.61, 95% CI 0.12–1.11; $d = 0.18$), confined to the health information ($p < 0.001$) and decisional control ($p = 0.013$) domains. After adjustment it was attenuated and borderline ($\beta = 0.52$, 95% CI 0.01–1.04, $p = 0.048$), and not robust to specification. Medication adherence, lifestyle modification and HbA1c did not differ (HbA1c $8.22 \pm 1.03\%$ vs. $8.33 \pm 1.10\%$, $p = 0.189$). **Conclusion:** Routine telenursing delivered patient experience and self-management outcomes comparable to traditional care, with no evidence of a clinically meaningful advantage in either direction, supporting it as a non-inferior alternative where in-person attendance is difficult rather than a superior model. The cross-sectional design precludes causal inference.

Keywords: Lifestyle Modification; Medication Adherence; Older Adults; Patient Satisfaction; Telenursing; Type 2 Diabetes

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a major public health challenge, particularly among older adults, whose age-related changes complicate management (ADA, 2024). Approximately 589 million adults aged 20–79 years had diabetes worldwide in 2024, a number projected to reach 853 million by 2050 (IDF, 2025a), and Saudi adult prevalence reached 23.1% (IDF, 2025b). Among older Saudi adults, polypharmacy, limited mobility and unmet glycemic targets complicate self-management (Alghamdi *et al.*, 2025), while clinic-based care imposes access burdens (Mulyaningsih *et al.*, 2026).

Telenursing may overcome these barriers through remote monitoring, timely feedback and home-based education (Hou *et al.*, 2025), and has been associated with better adherence and glycemic control (Alsahli *et al.*, 2025). It aligns with Vision 2030 digital-health goals (Al-Kahtani *et al.*, 2022) and is framed in Saudi nursing as continuous remote follow-up (Alharbi *et al.*, 2024), though effects may differ where families share health decisions (Albougami & Alotaibi, 2020) and digital engagement varies (Knotnerus *et al.*, 2024). How nursing interaction dimensions compare across modalities remains under-examined (Esposito *et al.*, 2024); these are

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the client–professional components of Cox's Interaction Model of Client Health Behaviour, operationalized by the TISS (Mattisson *et al.*, 2023).

The closest Saudi comparisons are limited. Among 583 patients with T2DM in Riyadh primary care, 62.7% receiving telemedicine achieved satisfactory glycaemic control versus 32.1% receiving in-person care (adjusted odds ratio 5.12, 95% CI 3.11–8.45), a very large effect for an uncontrolled comparison (Almalki *et al.*, 2024). Meta-analytic evidence on nurse-led telephone interventions reports HbA1c reductions depending on follow-up protocol (Chen *et al.*, 2025), and Saudi hybrid programmes target uncontrolled diabetes (Tourkmani *et al.*, 2024). Each evaluates telemedicine as an organized intervention; such effects should not be expected from routine telenursing.

Study Aim

This study compared telenursing and traditional outpatient nursing care regarding patient satisfaction, medication adherence and lifestyle modification among older adults with type 2 diabetes in Saudi Arabia.

Research Questions

Do older adults receiving telenursing and those receiving traditional outpatient nursing care differ in patient satisfaction, medication adherence and lifestyle modification?

After adjustment for sociodemographic and clinical characteristics, is care modality independently associated with these outcomes?

METHODOLOGY

Research Design

A cross-sectional comparative design, reported by STROBE (Von Elm *et al.*, 2007), examined differences between telenursing and traditional outpatient care. Because exposure and outcomes were assessed concurrently and allocation was not randomized, the design supports association testing but not causal inference (Figueiredo *et al.*, 2025).

Setting

The study was conducted at Hafar Al-Batin Diabetes Center, Saudi Arabia, which provides diabetes management through two virtual (telenursing) and two in-person outpatient clinics, alongside endocrinology, foot care, nutrition and pharmacy services.

Description of the Care Modalities

Telenursing participants received structured remote follow-up by telephone or video every one to two weeks, covering medication routines, glucose monitoring, symptom review, diet, activity, foot care and self-management support, with referral for in-person assessment when indicated. The traditional group received the same content face-to-face at scheduled appointments.

Sample and Sampling

A stratified random sampling technique was used. The two strata were the pre-existing clinic populations, which improves subgroup comparability (Elfil & Negida, 2017). Random selection was applied within each stratum only, using computer-generated random numbers. Because the strata were defined by existing clinic assignment rather than sampled, the design is stratified random sampling, not two-stage. Recruitment yielded 743 participants (Figure 1).

Allocation to modality occurred before recruitment as part of routine service and was not controlled by the researchers; randomization applied only to selection within strata. Because telenursing required smartphone and internet access, the groups may differ in digital literacy and socioeconomic position and differed at baseline (Tables 1–2); these were addressed by covariate adjustment.

Sample Size

From 2024 Ministry of Health Mawid data the eligible population was 11,859 older adults (3,953 telenursing; 7,906 outpatient), and group sizes used Slovin's formula (Mukti, 2025). Although the eligible population was distributed about 1:2 between strata, near-equal groups were targeted deliberately, since power is maximized under balanced allocation; no weighting was applied, so results compare the two clinic populations.

Inclusion and Exclusion Criteria

Participants were eligible if aged ≥ 60 years, diagnosed with T2DM for at least six months, receiving their care modality for at least three months, able to consent and to communicate in Arabic or English; telenursing additionally required smartphone and internet access. Exclusions were type 1 or gestational diabetes, cognitive impairment, sensory deficits, acute instability or severe complications.

Data Collection Tools

Sociodemographic and Clinical Profile

A structured questionnaire assessed age, gender, nationality, marital status, education, employment, income, comorbidities and self-reported HbA1c, categorized as good ($< 7.0\%$), intermediate ($7.0\text{--}8.5\%$) or poor control ($> 8.5\%$).

Telenursing Interaction and Satisfaction Scale (TISS)

Adapted from Mattisson *et al.* (2023) via Arabic forward–backward translation, the TISS assesses satisfaction across four subscales — Health Information (8 items), Professional-Technical Competence (5), Affective Support (9) and Decisional Control (3) — reverse-scored so higher totals indicate greater satisfaction (25 items; range 25–125). The original items refer to “the call”; for the traditional group this was adapted to “the visit”, scoring unchanged. The adaptation was reasonable because the subscales are anchored in a general rather than telephone-specific model but was not itself validated.

Adherence to Refills and Medications Scale (ARMS)

Adopted from Alammari *et al.* (2021), the ARMS evaluates medication-taking and refill adherence across 12 items (range 12–48; lower scores indicate better adherence), classified as good (12–16), moderate (17–24) or poor (25–48) adherence.

Perceived Adherence Lifestyle Modification Questionnaire (PALM-Q)

Adopted from Nor *et al.* (2022), the PALM-Q assesses adherence to diet, physical activity and self-care across 18 items, classifying adherence as non-adherence (≤ 31), unpredictable (32–53) or presumed (≥ 54).

Validity and Reliability

Content validity was confirmed by three community health nursing professors. The TISS was translated and piloted with 30 participants ($\alpha = 0.80$); the ARMS (Alammari *et al.*, 2021) and PALM-Q (Nor *et al.*, 2022) were validated previously. Within the present sample, $\alpha = 0.72$ (TISS), 0.76 (ARMS) and 0.77 (PALM-Q). No confirmatory factor analysis or measurement-invariance test was carried out on the Arabic TISS, so its factor structure cannot be assumed equivalent across groups; subscale scores are descriptive and the total is used for the primary comparison.

Data Collection Procedure

Data collection ran from February to April 2025. Traditional-care participants were approached in clinic waiting areas, gave written consent and completed paper questionnaires; telenursing participants were contacted by telephone after virtual consultations, gave digital consent and completed the same instruments online, in the same order. The difference in administration mode is addressed in the limitations; participant flow is shown in Figure 1.

Statistical Analysis

Data were analyzed in Stata 17. Independent-samples *t*-tests were the primary test for the three outcome totals, since they estimate the mean difference and its confidence interval, with Welch's correction where variances were unequal. Shapiro–Wilk was significant throughout, but with skewness and kurtosis near zero and groups above 350 the *t*-test is robust here, so Mann–Whitney *U* is reported once as a sensitivity check (Table 5) and throughout for subscales (Table 3). Categorical variables used chi-square and Cramér's *V*; correlations used Spearman's (Table 6). Three multivariable linear regression models tested whether care modality remained associated with each outcome after adjustment. Covariates were categorical indicators with these references: age group (60–<65 years), gender (male), nationality (Saudi), education (no formal education), employment (employed), income (not enough), comorbid condition (cardiovascular disease), diabetes duration (< 1 year), treatment type (insulin) and HbA1c category (good control) — giving 24 covariate degrees of freedom which, with one for care modality, give the 25 model degrees of freedom in Table 9.

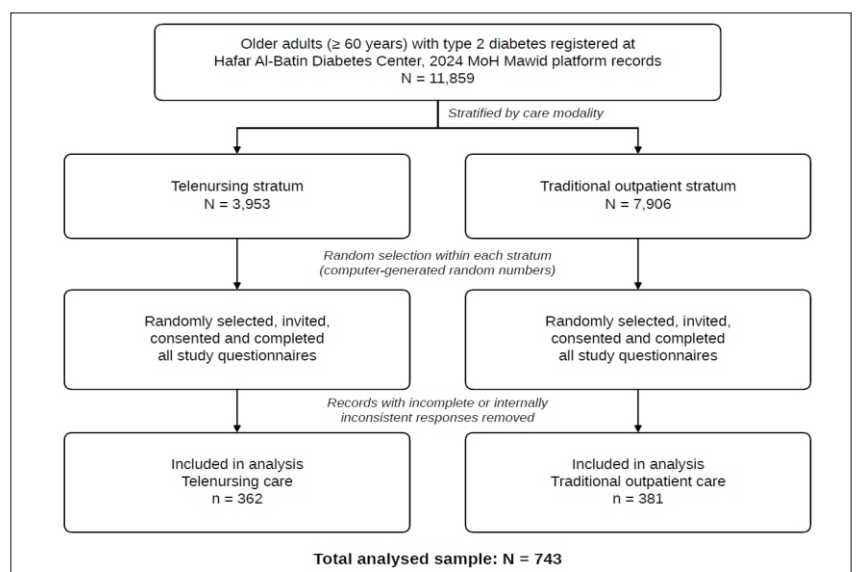
Ethical Considerations

The researchers obtained ethical clearance from the Scientific Research Ethics Committee, Faculty of Nursing, Cairo University, Egypt, with reference number IORG0006883 on 30th September 2024 along with preliminary approval with study number 2024-09-10 on 3rd November 2024.

The Approval for data collection in Saudi Arabia was granted by the Institutional Review Board of Riyadh Second Health Cluster with reference number IRB log 25-073E on 10th February 2025; exempt; KACST with reference number H-01-R-012, FWA00018774, and recruitment began only thereafter.

Administrative permission was obtained from Hafar Al-Batin Diabetes Center, Egypt, Saudi Arabia, before recruitment, and final approval was granted by the Cairo committee, Egypt, with reference number IRB0005857 on 23rd April 2025.

The study followed the Declaration of Helsinki; consent was written for in-person care and digital for telenursing, and all data were anonymized. Informed consent was obtained from all participants — written for in-person care and digital for the telenursing group. Participation was voluntary and all data were anonymized.



Note: Strata are the two pre-existing clinic populations; Random selection was applied within each stratum only. Stage-wise recruitment counts were not retained; see limitations

Figure 1: Participant Flow Through the Study, from Source Population to Analyzed Sample (n = 743)

RESULTS

Table 1: Sociodemographic Characteristics of Participants by Care Modality (n = 743)

Variable	Category	Traditional		Telenursing		Test Statistic
		n	%	n	%	
Age Group (years)	60–<65	74	19.4	82	22.6	$\chi^2(3) = 1.69; p = 0.639; V = 0.05$
	65–<70	105	27.6	103	28.5	
	70–<75	79	20.7	72	19.9	
	≥ 75	123	32.3	105	29.0	
Gender	Male	213	55.9	195	53.9	$\chi^2(1) = 0.31; p = 0.577; V = 0.02$
	Female	168	44.1	167	46.1	
Marital Status	Married	336	88.2	324	89.5	$\chi^2(3) = 0.56; p = 0.905; V = 0.03$
	Widowed	16	4.2	12	3.3	
	Divorced	19	5.0	16	4.4	
	Separated	10	2.6	10	2.8	
Education	No Formal Education	48	12.6	46	12.7	$\chi^2(3) = 1.27; p = 0.737; V = 0.04$
	Primary	60	15.7	61	16.8	
	Secondary	207	54.3	203	56.1	
	Higher Education	66	17.3	52	14.4	
Working Status	Employed	70	18.4	109	30.1	$\chi^2(2) = 23.04; p < 0.001^{**}; V = 0.18$
	Unemployed	299	78.5	227	62.7	
	Retired	12	3.1	26	7.2	
Nationality	Saudi	357	93.7	313	86.5	$\chi^2(1) = 10.97; p = 0.001^{**}; V = 0.12$
	Non-Saudi	24	6.3	49	13.5	
Monthly Family Income	Not Enough	52	13.6	57	15.7	$\chi^2(2) = 5.88; p = 0.053; V = 0.09$
	Enough	221	58.0	230	63.5	
	Enough and More	108	28.3	75	20.7	

Note: χ^2 = Pearson chi-square; V = Cramér's V. Trad. = traditional outpatient care (n = 381); Tele. = telenursing care (n = 362). *p < 0.05; **p < 0.01

The two groups were comparable in age, gender, marital status, education and income but differed in working status and nationality (Table 1), and these were carried forward as covariates.

Table 2: Clinical Characteristics of Participants by Care Modality (n= 743)

Variable	Category	Traditional		Telenursing		Test Statistic
		n	%	n	%	
Comorbid Chronic Condition	Cardiovascular Disease	52	13.6	35	9.7	$\chi^2(5) = 25.12; p < 0.001^{**}; V = 0.18$
	Hypertension	165	43.3	221	61.0	
	Kidney Disease	72	18.9	48	13.3	
	Neuropathy	31	8.1	25	6.9	
	Retinopathy	31	8.1	19	5.2	
	Other	30	7.9	14	3.9	
Family History of T2DM	Yes	87	22.8	80	22.1	$\chi^2(1) = 0.06; p = 0.810; V = 0.01$
	No	294	77.2	282	77.9	
Duration of T2DM	< 1 year	46	12.1	66	18.2	$\chi^2(3) = 6.50; p = 0.090; V = 0.09$
	1–2 years	115	30.2	103	28.5	
	3–5 years	127	33.3	102	28.2	
	> 5 years	93	24.4	91	25.1	

Current Treatment Type	Insulin Injections	138	36.2	145	40.1	$\chi^2(2) = 7.22; p = 0.027^*; V = 0.10$
	Oral Antidiabetic Tablets	189	49.6	188	51.9	
	Other	54	14.2	29	8.0	
Smoking Status	Smoker	85	22.3	67	18.5	$\chi^2(2) = 1.66; p = 0.437; V = 0.05$
	Former Smoker	48	12.6	47	13.0	
	Non-smoker	248	65.1	248	68.5	

Note: V = Cramér's V ; T2DM = type 2 diabetes mellitus. Trad. = traditional outpatient care; Tele. = telenursing care. * $p < 0.05$; ** $p < 0.01$

Groups were broadly comparable in family history, diabetes duration and smoking (Table 2) but differed in comorbid conditions and treatment type, with hypertension more prevalent under telenursing; these were also carried forward as covariates.

Table 3: Comparison of Telenursing Interaction and Satisfaction Scale Scores by Care Modality (n = 743)

TISS domain	Telenursing Median (95% CI)	Traditional Median (95% CI)	U	z	p-value	r
Health Information	27 (27–28)	26 (26–27)	79101.0	3.488	< 0.001**	0.128
Professional–technical Competence	19 (19–20)	19 (19–20)	65215.5	−1.327	0.185	−0.049
Affective Support	36 (36–37)	36 (36–37)	66155.0	−0.997	0.319	−0.037
Decisional Control	12 (12–13)	12 (12–13)	75784.5	2.488	0.013*	0.091
TISS Total Score	94 (94–95)	93 (93–94)	76744.5	2.672	0.008**	0.098

Note: Mann–Whitney U test; 95% CI = distribution-free limits for the median. z is tie-corrected, so positive values indicate higher telenursing scores; $r = z/\sqrt{N}$. * $p < 0.05$; ** $p < 0.01$

The telenursing group scored significantly higher on Health Information and total TISS score, and on Decisional Control despite identical medians. Professional -Technical Competence and Affective Support did not differ. All effect sizes were small ($|r| \leq 0.13$; Table 3).

Table 4: Distribution of Lifestyle Modification (PALM-Q) and Medication Adherence (ARMS) Categories by Care Modality (n = 743)

Instrument	Category	Telenursing n (%)	Traditional n (%)	Test statistic
PALM-Q	Non-adherence (≤ 31)	0 (0.0)	0 (0.0)	$\chi^2(1) = 2.52; p = 0.113; V = 0.06$
	Unpredictable Adherence (32–53)	102 (28.2)	88 (23.1)	
	Presumed Adherence (≥ 54)	260 (71.8)	293 (76.9)	
ARMS	Good Adherence (12–16)	31 (8.6)	31 (8.1)	$\chi^2(2) = 3.34; p = 0.188; V = 0.07$
	Moderate Adherence (17–24)	222 (61.3)	257 (67.5)	
	Poor Adherence (25–48)	109 (30.1)	93 (24.4)	

Note: Cut-offs as defined in Data Collection Tools; higher PALM-Q and lower ARMS scores indicate better adherence; The PALM-Q test compares the two occupied categories; no participant has met the non-adherence criterion

No participant met the PALM-Q criterion for non-adherence, and presumed adherence predominated in both groups. Medication adherence was concentrated in the moderate band, with poor adherence somewhat more frequent under telenursing. Neither distribution differed significantly between modalities (Table 4).

Table 5: Between-group Comparison of Outcome Measures by Care Modality (n= 743)

Outcome	Telenursing M $\pm$ SD	Traditional M $\pm$ SD	Mean diff. (95% CI)	t (df= 741)	p-value	Cohen's d	η^2
Patient Satisfaction (TISS total)	93.90 $\pm$ 3.50	93.28 $\pm$ 3.41	0.61 (0.12 to 1.11)	2.42	0.016*	0.18	0.008
Medication Adherence (ARMS total)	22.39 $\pm$ 4.25	21.97 $\pm$ 3.79	0.42 (−0.17 to 1.00)	1.40	0.161	0.10	0.003
Lifestyle Modification (PALM-Q total)	55.65 $\pm$ 4.18	55.88 $\pm$ 3.30	−0.23 (−0.78 to 0.31)	−0.84	0.402	−0.06	0.001

Note: Independent-samples t-test (df = 741), with Welch's correction for medication adherence (df = 721.4) and lifestyle modification (df = 686.5).

Care modalities differed significantly in patient satisfaction (mean difference 0.61, 95% CI 0.12–1.11; $p = 0.016$), though the effect was small ($d = 0.18$). Medication adherence and lifestyle modification did not differ, and confirmatory Mann–Whitney tests agreed (Table 5).

Table 6: Spearman Correlations Between TISS Domains and Adherence Outcomes by Care Modality ($n = 743$)

TISS domain	Care modality	Lifestyle modification r_s (95% CI)	p -value	Medication adherence r_s (95% CI)	p -value
Health Information	Telenursing	−0.051 (−0.153 to 0.052)	0.335	0.051 (−0.052 to 0.153)	0.331
	Traditional	0.018 (−0.083 to 0.119)	0.729	0.188 (0.088 to 0.284)	< 0.001**
Professional–technical Competence	Telenursing	0.177 (0.075 to 0.275)	0.001**	−0.068 (−0.170 to 0.035)	0.194
	Traditional	−0.049 (−0.148 to 0.052)	0.343	−0.043 (−0.143 to 0.058)	0.403
Affective Support	Telenursing	−0.001 (−0.104 to 0.102)	0.983	0.010 (−0.093 to 0.113)	0.846
	Traditional	0.092 (−0.009 to 0.191)	0.073	−0.186 (−0.282 to −0.086)	< 0.001**
Decisional Control	Telenursing	−0.138 (−0.238 to −0.035)	0.009**	−0.051 (−0.153 to 0.052)	0.332
	Traditional	−0.083 (−0.182 to 0.018)	0.106	−0.034 (−0.134 to 0.067)	0.504
TISS Total Score	Telenursing	−0.041 (−0.143 to 0.062)	0.434	0.011 (−0.092 to 0.114)	0.839
	Traditional	−0.012 (−0.113 to 0.089)	0.810	0.060 (−0.041 to 0.160)	0.239

Note: r_s = Spearman’s rank correlation; 95% CIs by Fisher z transformation with the Bonett–Wright standard error. For the ARMS a positive coefficient means higher satisfaction accompanies poorer adherence. * $p < 0.05$; ** $p < 0.01$

Four associations achieved significance (Table 6). In telenursing, professional-technical competence correlated positively with lifestyle adherence and decisional control negatively; in traditional care, higher health information scores were associated with poorer medication adherence and higher affective support scores with better medication adherence. All were small ($|r_s| \leq 0.19$).

Sociodemographic and Clinical Correlates of Lifestyle Adherence

Table 7: Sociodemographic and Clinical Correlates of Lifestyle Modification Adherence (PALM-Q Total) by Care Modality ($n = 743$)

Variable	Traditional outpatient care	Telenursing care
Age Group	$F(3, 377) = 1.96; p = 0.119; 0.015$	$F(3, 358) = 0.79; p = 0.502; 0.007$
Gender	$t(379) = 1.93; p = 0.054; 0.20$	$t(360) = 1.97; p = 0.050*; 0.21$
Marital Status	$F(3, 377) = 2.48; p = 0.061; 0.019$	$F(3, 358) = 0.46; p = 0.712; 0.004$
Education	$F(3, 377) = 1.75; p = 0.157; 0.014$	$F(3, 358) = 4.12; p = 0.007**; 0.033$
Working Status	$F(2, 378) = 3.70; p = 0.026*; 0.019$	$F(2, 359) = 11.41; p < 0.001**; 0.060$
Monthly Family Income	$F(2, 378) = 3.93; p = 0.020*; 0.020$	$F(2, 359) = 21.33; p < 0.001**; 0.106$
Comorbid Condition	$F(5, 375) = 0.44; p = 0.818; 0.006$	$F(5, 356) = 3.14; p = 0.009**; 0.042$
Family History of T2DM	$t(379) = 1.04; p = 0.301; 0.13$	$t(360) = 1.30; p = 0.195; 0.16$
Duration of T2DM	$F(3, 377) = 6.11; p < 0.001**; 0.046$	$F(3, 358) = 3.45; p = 0.017*; 0.028$
Current Treatment Type	$F(2, 378) = 0.28; p = 0.760; 0.001$	$F(2, 359) = 1.36; p = 0.258; 0.008$
Smoking Status	$F(2, 378) = 0.26; p = 0.770; 0.001$	$F(2, 359) = 3.00; p = 0.051; 0.016$

Note: One-way ANOVA or t -test of PALM-Q totals within each modality; cells give the test statistic, p and effect size (η^2 for F , d for t). * $p < 0.05$; ** $p < 0.01$

Exploratory analyses examined sociodemographic and clinical correlates of lifestyle adherence within each modality (Table 7). Socioeconomic position dominated, more strongly under telenursing: income showed the largest effect ($\eta^2 = 0.106$), followed by working status and education. Comorbid condition type mattered in telenursing only, and diabetes duration in both groups.

Table 8: HbA1c by Care Modality (n = 743)

Measure	Telenursing (n = 362)	Traditional (n = 381)	Statistic	p-value
Good Control (< 7.0%), n (%)	32 (8.8)	32 (8.4)	$\chi^2 (2) = 2.08; V = 0.05$	0.354
Intermediate Control (7.0–8.5%), n (%)	227 (62.7)	222 (58.3)		
Poor Control (> 8.5%), n (%)	103 (28.5)	127 (33.3)		
HbA1c (%), M ± SD	8.22 ± 1.03	8.33 ± 1.10	$t (741) = -1.31; d = -0.10$	0.189
HbA1c (%), Median [range]	8.0 [6.5–11.0]	8.0 [6.5–11.0]	$U = 65752; z = -1.13$	0.259

Note: Mean difference (telenursing – traditional) = -0.10 (95% CI -0.26 to 0.05). HbA1c was participant-reported at a single time point

HbA1c did not differ between groups, whether compared by category or continuously (8.22% vs. 8.33%; $p = 0.189$; Table 8), exceeding 8% in both and indicating suboptimal control. The identical observed range (6.5–11.0%) most plausibly reflects a floor and ceiling effect of self-report to the nearest 0.5% combined with the exclusion of participants with acute instability or severe complications.

Table 9: Multivariable Regression Models for the Association Between Care Modality and Study Outcomes, Adjusted for Sociodemographic and Clinical Covariates (n = 743)

Outcome	Care modality (telenursing vs. traditional): unadjusted $\beta \rightarrow$ adjusted β (95% CI)	p-value	Adj. R^2	Model F (df)
Patient Satisfaction (TISS Total)	0.61 $\rightarrow$ 0.52 (0.01 to 1.04)	0.048*	0.041	2.26 (25, 717)
Medication Adherence (ARMS Total)	0.42 $\rightarrow$ 0.30 (-0.31 to 0.91)	0.336	0.016	1.47 (25, 717)
Lifestyle Modification (PALM-Q Total)	$-0.23 \rightarrow 0.27$ (-0.26 to 0.80)	0.315	0.148	6.14 (25, 717)

Note: β = unstandardised coefficient; CI = confidence interval; traditional care is the reference. All models adjust for the covariates coded in the Statistical Analysis. * $p < 0.05$

After adjustment the satisfaction coefficient fell to 0.52 and sat on the boundary of significance (95% CI 0.01–1.04, $p = 0.048$) and was not robust to specification. Care modality was not independently associated with medication adherence or lifestyle modification (Table 9), where income, employment and education were the strongest predictors.

DISCUSSION

Telenursing was associated with higher satisfaction, particularly in health information and decisional control, while medication adherence and lifestyle modification were comparable — suggesting that in routine diabetes care telenursing may improve patient experience without compromising self-management (Sim & Lee, 2021; Aldakhil *et al.*, 2025).

The magnitude and robustness of this difference warrant caution. The 0.61-point difference ($d = 0.18$) is detectable at this sample size but below thresholds ordinarily considered clinically meaningful, and no minimal clinically important difference exists for the TISS. The data support an upper bound on the effect rather than a demonstrated one. Two alternative explanations deserve equal weight. The first is differential instrument fit: the TISS's items refer to “the call” and were adapted to “the visit” for the traditional group, an unvalidated substitution, so the groups answered textually different items. The second is administration mode, confounded with modality here. Either could produce a difference of this size without any underlying difference in care (Newhouse *et al.*, 2025).

The absence of between-group differences in adherence and lifestyle outcomes is also noteworthy: rather than indicating no benefit, it suggests telenursing achieves comparable outcomes under real-world conditions (Lo Monaco *et al.*, 2025), with larger gains more likely when remote care is delivered as a structured behavioural intervention (Chen *et al.*, 2025). within traditional care, higher health information scores were associated with poorer medication adherence and higher affective support scores with better adherence (AkbariRad *et al.*, 2023). All correlations were small and should be regarded as hypothesis-generating (Figueiredo *et al.*, 2025).

The associations of employment and income with adherence indicate that care delivery alone cannot overcome socioeconomic barriers (Al-Taani *et al.*, 2025). Because telenursing required smartphone and internet access, results may partly reflect a more digitally connected subgroup, and the higher prevalence of hypertension there is consistent with regional data (Ibrahim & Al-Nuaimy, 2024). Implementation should pair telenursing with age-friendly digital support (Tourkmani *et al.*, 2024).

This study contributes context-specific evidence on routine telenursing versus traditional outpatient care for older Saudi adults with T2DM, with practical relevance for digital diabetes service development (Toschi *et al.*, 2024).

Limitations

Several limitations applied in this study. The cross-sectional design precludes causal inference, and allocation followed routine service rather than randomization; the smartphone/internet requirement may have yielded a more digitally literate sample, groups differed at baseline (Tables 1–2), and residual confounding cannot be excluded. All outcomes were self-reported, HbA1c once to the nearest 0.5%. Recruitment counts were not retained, administration mode was confounded with modality, and the single-centre setting limits external validity. A further limitation concerns instrumentation. The TISS was designed for telephone nursing and its adaptation for the traditional group was not validated: neither factor structure nor measurement invariance was tested, and internal consistency ($\alpha = 0.72$) fell below the pilot value, so the satisfaction finding should be treated as provisional.

Future Scope

Future research should adopt longitudinal or experimental designs to assess long-term outcomes, cost-effectiveness and hybrid models, using laboratory-confirmed HbA1c and objective adherence measures. The most direct methodological priority is instrumentation: a measure demonstrably equivalent across remote and in-person care is needed, requiring either re-validation of the TISS with tests of measurement invariance, or a modality-neutral replacement.

CONCLUSION

Among older adults with type 2 diabetes, routine telenursing achieved medication adherence, lifestyle modification and glycaemic profiles comparable to traditional outpatient care, with a marginally higher satisfaction score confined to two interaction domains, supporting it as a non-inferior, patient-centred alternative to in-person follow-up rather than a superior model.

Practically, telenursing is a workable component of a structured hybrid diabetes service, particularly for older adults for whom attending in person is difficult, requiring staff preparation, standardized protocols and alternatives for patients without smartphone access. Because socioeconomic position predicted adherence more strongly than modality, service design should also address financial barriers.

CRedit Authorship Contribution Statement

O.A.A.: Conceptualization, Methodology, Formal analysis, Investigation, Writing — original draft. **B.M.O.:** Conceptualization, Methodology, Formal analysis, Investigation, Writing — original draft, Supervision. **N.A.:** Writing — review and editing, Supervision. All authors read and approved the final manuscript.

AI Assistance Declaration

Generative artificial intelligence tools were used for language editing only, not for data collection, analysis or interpretation.

Conflict of Interest

The authors declare that they have no competing interests.

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