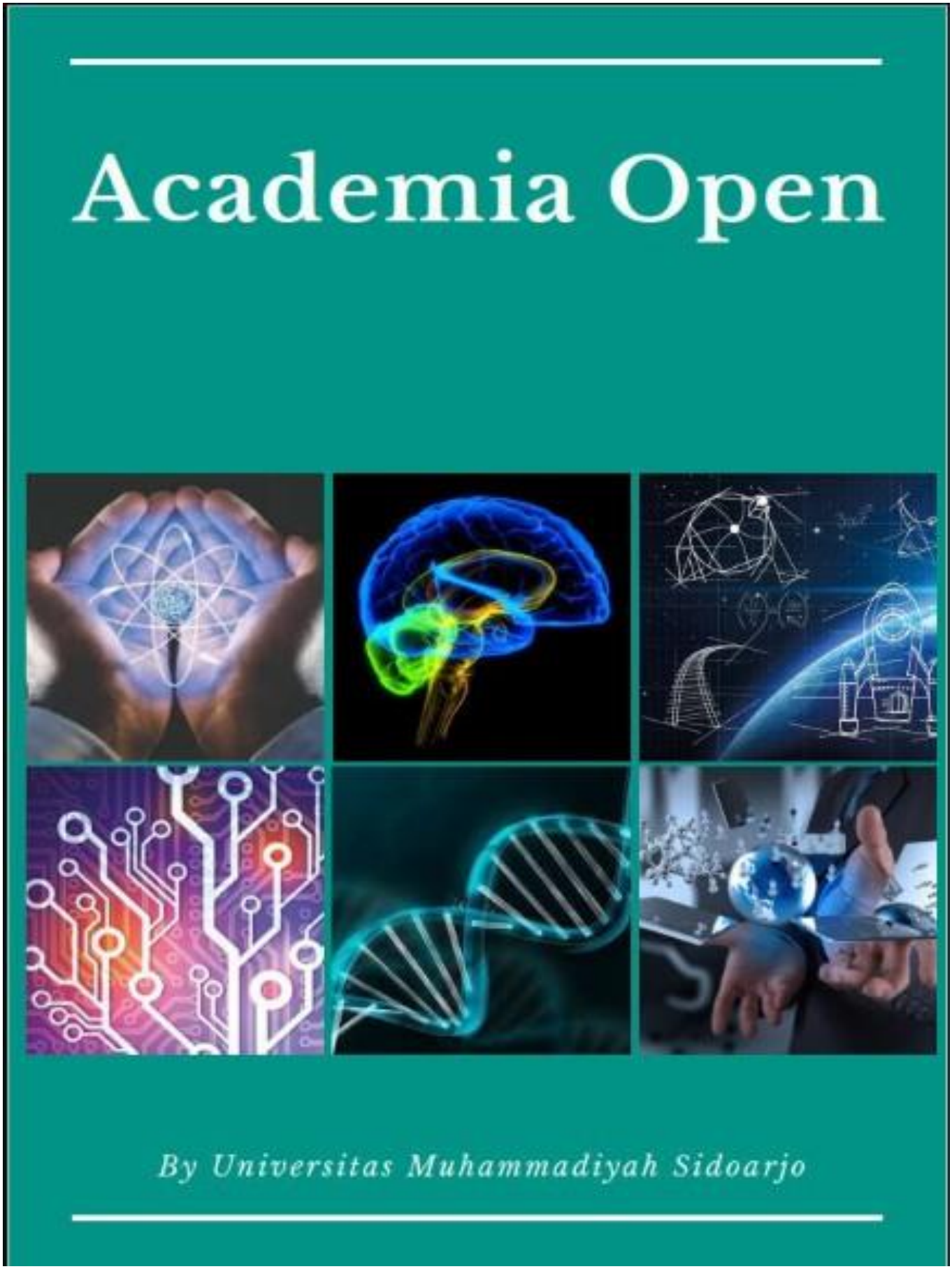
Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656



ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

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DOI: 10.21070/acopen.11.2026.14656

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Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

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Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

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Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

Adherence To Lifestyle Modifications Among Patients Attending Diabetes Management Clinics: A Comprehensive Evaluation

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Abstract

General Background: Type 2 diabetes mellitus remains a major global public health challenge, and lifestyle modification is considered a fundamental component of diabetes management. **Specific Background:** Despite strong clinical recommendations regarding dietary regulation and physical activity, adherence to lifestyle modification among patients with type 2 diabetes remains inconsistent, particularly in resource-limited settings. **Knowledge Gap:** Limited evidence is available regarding the determinants of dietary and exercise adherence among Iraqi patients with type 2 diabetes, particularly when examined through the PRECEDE model framework. **Aims:** This study aimed to evaluateadherence to dietary and exercise recommendations and identifysociodemographic, clinical, and behavioral factors associated with adherence among patients attending a tertiary diabetes management clinic in Al-Najaf, Iraq. **Results:** A descriptive cross-sectional study involving 412 patients revealed substantial differences between dietary and exercise adherence. Good dietary adherence was reported by 60.9% of participants, whereas only 3.2% achieved good exercise adherence and 81.8% demonstrated poor exerciseadherence. The aggregate PRECEDE score showed a weak positive correlation with exercise adherence. Older age, absence of formal education, lower body mass index, longer diabetes duration, and rural residence were identified as independent predictors of optimal dietaryadherence. **Novelty:** Thestudyseparately examined dietary and exercise adherence using the PRECEDE model within an Iraqi tertiary diabetes care setting, highlighting distinct determinants of each behavior. **Implications:** The findings emphasize the urgent need for barrier-specific physical activity interventions, stronger social reinforcement mechanisms, and integrated lifestyle support strategies to improve diabetes self-management outcomes.

Keywords: Type 2 Diabetes Mellitus, Lifestyle Modification, Dietary Adherence, Exercise Adherence, sPRECEDE Model

Key Findings Highlights

Dietary compliance was considerably higher than participation in recommended physical activity.
Social reinforcement emerged as the weakest behavioral determinant among participants.
Rural residence, older age, longer disease duration, lower body mass index, and lack of formal schooling were associated with better nutritional compliance.

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

Published date: 2026-05-31

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

1. Introduction

type 2 diabetes mellitus (t2dm) has become one of the most pressing non-communicable disease challenges of the present era, and its burden is rising most steeply in low- and middle-income countries, where health systems are least equipped to absorb the long-term costs of chronic care. global estimates indicate that the number of adults living with diabetes has more than tripled over the past three decades, and the middle east and north africa (mena) region is projected to record one of the steepest proportional increases of any world region in the coming decades [1,2]. within this regional picture, iraq carries a disproportionate share of the absolute burden, with reported prevalence estimates for type 2 diabetes among iraqi adults ranging between approximately 8.5% and 13.9%, translating into well over two million individuals who require sustained pharmacological treatment, regular clinical monitoring, and lifelong self-management [3]. the implications extend well beyond the individual patient, encompassing households that face catastrophic out-of-pocket expenditure and a health system already strained by competing infectious and non-communicable priorities.

although pharmacological agents are indispensable for achieving and maintaining glycemic targets, contemporary international guidelines are unequivocal that lifestyle modification — encompassing dietary adjustment, weight management, and structured physical activity — constitutes the foundation upon which all other therapeutic measures are built [4]. the evidence base supporting this position has strengthened considerably in recent years. landmark intervention trials have demonstrated that intensive, structured lifestyle programmers can not only improve glycemic control but, in a meaningful proportion of patients, induce clinical remission of type2 dm in its earlier stages [5]. physical activity in particular exerts pleiotropic benefits, improving insulin sensitivity, lipid profiles, blood pressure, and cardiovascular risk independently of weight loss [6]. these findings reinforce the principle that lifestyle modification is not an adjunct to be encouraged in passing but a core clinical intervention deserving the same rigor of assessment and follow-up as drug therapy.

despite this strong evidence and the prominence of lifestyle advice in clinical guidelines, adherence to dietary and physical activity recommendations among people with t2dm remains persistently and disappointingly low, especially in resource-limited settings. systematic reviews drawing on data from across low- and middle-income countries consistently report that fewer than half of patients maintain adequate dietary adherence over time, and that adherence to physical activity recommendations is typically far lower still [7,8]. the downstream consequences of this adherence gap are well documented and clinically serious: uncontrolled hyperglycemia, accelerated progression to microvascular and macrovascular complications, increased frequency of hospitalization, diminished health-related quality of life, and avoidable premature mortality [2,9]. closing this gap therefore represents one of the highest-value, lowest-cost opportunities available to diabetes care programmers, but doing so requires a precise understanding of why adherence fails in the first place.

the precede model — an acronym for predisposing, reinforcing, and enabling constructs in educational/ecological diagnosis and evaluation — offers a theoretically grounded and widely validated framework for dissecting the multidimensional determinants of health behaviour, including adherence to chronic disease self-management [10]. within this framework, predisposing factors encompass the knowledge, attitudes, beliefs, and perceptions that an individual brings to a behaviour; enabling factors capture the skills, resources, accessibility, and structural supports that make a behaviour practically achievable; and reinforcing factors reflect the feedback an individual receives from family members, peers, and healthcare providers that either sustains or undermines behaviour over time [11]. by disaggregating behaviour into these distinct but interacting domains, the model allows researchers and programme planners to identify precisely where an intervention should be targeted, rather than relying on generic and largely ineffective appeals to patient motivation.

although a growing international literature has applied precede-based frameworks to diabetes self-management, the evidence generated within the iraqi context — and particularly from tertiary diabetes clinics, where patients are most likely to receive structured, guideline-concordant management — remains comparatively sparse [11,12,13]. equally important, the existing body of work has not adequately characterised the differential way in which sociodemographic and clinical characteristics shape adherence to dietary versus exercise recommendations, despite mounting evidence that these two behaviours are governed by distinct sets of barriers and facilitators. this distinction carries direct programmatic relevance, because an intervention that successfully improves dietary adherence may have no effect whatsoever on physical activity. against this background, the present study was designed to provide a comprehensive evaluation of adherence to lifestyle modifications, and of the factors associated with that adherence, among type 2 diabetes patients attending a tertiary diabetes management clinic in al-najaf, iraq, using the precede model as its organising analytical framework.

2. Materials and Methods

2.1 study design and setting

a descriptive cross-sectional study was carried out at the diabetes management clinic of a tertiary health institution in al-najaf, iraq over a six-month period from june to november 2025. the clinic functions as a referral centre for the surrounding state and several neighbouring states and serves a demographically diverse population spanning urban, peri-urban, and rural catchment areas. at the time of the study, the clinic maintained an active register of patients with type 2 diabetes mellitus and recorded an average monthly attendance of approximately 210 such patients, providing an adequate sampling frame. routine clinic services included physician consultation, nurse-led education, pharmacy dispensing and intermittent access to dietetic counselling although dedicated physiotherapy input was not a standard component of the clinic workflow at the time of data collection.

2.2 study population and sampling

the study population consisted of adult patients aged 18 years and above with an established physician diagnosis of type 2 diabetes mellitus who had been attending the clinic for a minimum of three months prior to recruitment, this duration being chosen to ensure that participants had received

sufficient exposure to lifestyle counselling to allow a meaningful assessment of adherence. patients with type 1 diabetes mellitus, gestational diabetes, cognitive impairment precluding informed consent, or acute critical illness at the time of the clinic visit were excluded. recruitment employed a systematic random sampling technique: using the daily clinic attendance register as the sampling frame, a random start was selected and every second eligible patient was approached for participation until the predetermined sample size was attained. this approach was adopted to minimise selection bias while remaining feasible within the constraints of a busy outpatient clinic.

the minimum sample size was calculated using the cochran formula for cross-sectional studies, taking a prevalence estimate of 63.3% for good dietary adherence reported in a comparable regional study, a desired absolute precision of 5%, and a 95% confidence level. after applying a 10% upward adjustment to compensate for incomplete questionnaires and non-response, the minimum required sample was 412 participants, all of whom were successfully recruited and provided analysable data [14].

2.3 data collection instrument

data were collected using a structured, interviewer-administered questionnaire that was adapted from previously validated instruments employed in precede-based studies of chronic disease self-management and subsequently refined to reflect the local clinical and cultural context. prior to deployment, the instrument was reviewed for content validity by a panel comprising an endocrinologist a public health physician and a clinical dietitian, and was then pilot-tested among 20 patients at a comparable facility who were not included in the final analysis; minor ambiguities in wording identified during piloting were corrected before the main study commenced. the questionnaire comprised seven sections covering, respectively, sociodemographic and clinical characteristics; diabetes knowledge (a 6-item scale) perception towards lifestyle modification (a 24-item scale); reinforcing factors, principally social and family support together with healthcare provider reinforcement (a 15-item scale); enabling factors, including access to nutritional counselling, physical activity infrastructure, and financial resources (a 15-item scale); dietary adherence (a 9-item scale); and exercise adherence (a 9-item scale). each domain score was converted to a percentage of its maximum attainable value to permit direct comparison across domains. interviews were conducted in english or, where necessary, in the participant's preferred local language by trained research assistants fluent in those languages.

2.4 outcome measures

the principal outcomes of interest were adherence to dietary recommendations and adherence to exercise recommendations, each assessed independently. for each domain, participants who attained at least 67% of the maximum domain score were classified as having good adherence; those scoring between 33% and 66% were classified as having fair adherence; and those scoring below 33% were classified as having poor adherence. for the purpose of bivariate and multivariate analysis of predictors, the good category was treated as optimal adherence and the combined fair and poor categories as suboptimal adherence. the aggregate total precede score served as a composite measure of the behavioural determinants of adherence and was analysed both as a continuous variable and where appropriat after dichotomisation at the sample median.

2.5 ethical considerations

ethical approval for the study was obtained from the health research ethics committee of the host institution (reference hrec/2026/04/117) prior to commencement. written informed consent was obtained from every participant after a full explanation of the study's purpose, procedures, and voluntary nature, and participants were assured that declining to take part would in no way affect the care they received at the clinic confidentiality was maintained throughout by the use of anonymised participant codes during data collection,entry and analysis, and completed questionnaires were stored securely with access restricted to members of the research team.

2.6 data analysis

data were cleaned, coded, and analysed using ibm spss statistics version 26.0 (ibm corp., armonk, ny, usa). continuous variables were summarised as means with standard deviations and accompanying 95% confidence intervals, while categorical variables were expressed as frequencies and percentages. the strength and direction of monotonic associations between precede construct scores and adherence scores were examined using the spearman rank correlation coefficient . associations between categorical sociodemographic or clinical variables and adherence categories were tested with the pearson chi-square test , with fisher’s exact test substituted where expected cell counts were small . variables associated with optimal dietary adherence at a threshold of $p < 0.20$ on bivariate analysis were entered into a modified poisson regression model with robust error variance to identify independent predictors, with results reported as adjusted prevalence ratios and 95% confidence intervals. throughout, a two-sided p-value below 0.05 was regarded as statistically significant .

3. Results

3.1 sociodemographic and clinical characteristics

a total of 412 participants were enrolled and provided complete data. the cohort was predominantly older, with nearly half (44.7 %) falling within the 61–75 year age band and a further 9.0% aged 76 years or above, giving a mean age of 60.2 ± 11.3 years; younger patients aged 30 years or below were rare, accounting for only 1.7% of the sample. women outnumbered men, comprising 60.9 % of participants. educational attainment varied widely: 16.0 % had received no formal schooling, while at the other end of the spectrum 22.3% had completed the highest level of education recorded. salaried or formal employment was the most common occupational category (47.8%), and the great majority of participants were married (67.7%), with widowed individuals forming the next largest group (22.8 %). with respect to anthropometric status, more than half the cohort was above the healthy weight range, with 37.1 % overweight and a combined 24.8 % falling into the obese categories. with respect to residence, 60.2 % lived in urban catchments and 39.8 % in rural ones; comorbid hypertension was present in 57.3 % of the cohort and a family history of diabetes in 52.9 %. regarding treatment, oral hypoglycaemic agents alone were the most common modality (62.9%), followed by combined oral and insulin therapy

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DOI: 10.21070/acopen.11.2026.14656

(18.9 %). the full distribution of sociodemographic and clinical characteristics is presented in table 1.

table 1. *socio and demographic and clinical characteristics of study participant (n = 412)*

characteristics	frequency (n)	percentage (%)
sex of respondent		
women	251	60.9
men	161	39.1
age group (years)		
30 years or younger	7	1.7
31 to 45 years	34	8.3
46 to 60 years	150	36.4
61 to 75 years	184	44.7
76 years or older	37	9.0
residential setting		
urban dweller	248	60.2
rural dweller	164	39.8
highest educational level		
illiterate	66	16.0
primary school	121	29.4
secondary school	133	32.3
high school	92	22.3
principal occupation		
employed	197	47.8
professional	63	15.3
trader	55	13.3
retired	43	10.4
not employed	33	8.0
farming	21	5.1
marital status		
married	279	67.7
widowed	94	22.8
single	21	5.1
divorced	18	4.4
tobacco use		
non-smoker	301	73.1
ex-smoker	71	17.2
smoker	40	9.7
body mass index, bmi (kg/m²)		
underweight (< 18.5)	10	2.4
normal weight (18.5–24.9)	147	35.7
overweight (25.0–29.9)	153	37.1
obese class i/ii (30.0–39.9)	89	21.6
morbid obesity (≥ 40)	13	3.2
coexisting hypertension		
present	236	57.3
absent	176	42.7

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

characteristics	frequency (n)	percentage (%)
family history of diabetes		
positive history	218	52.9
no history	194	47.1
years since diagnosis		
under 6 months	52	12.6
6 months to 1 year	47	11.4
1 to 2 years	49	11.9
2 to 5 years	95	23.1
5 to 10 years	87	21.1
more than 10 years	82	19.9
treatment regimen		
oral agents only	259	62.9
oral agents plus insulin	78	18.9
insulin only	51	12.4
lifestyle measures only	24	5.8

3.2 precede factor scores and adherence levels

across the predisposing domain, the mean knowledge score was 4.5 ± 0.9 out of a possible 6 (75.0%), and the mean perception score was 20.1 ± 3.1 out of 24 (83.8%) ,indicating that participants generally held favourable attitudes towards lifestyle modification and possessed a reasonable, though imperfect, baseline of factual knowledge. the reinforcing-factor domain returned the lowest mean score of any construct at 8.7 ± 3.5 out of 15 (58.0%), pointing to relatively weak social, familial, and provider reinforcement, whereas the enabling-factor domain scored somewhat higher at 11.2 ± 2.6 (74.7%) . taken together the aggregate total precede score was 44.5 ± 6.7 out of 60, equivalent to 74.2% of the maximum and suggesting a broadly supportive behavioural environment.

the two adherence outcomes diverged sharply. the mean dietary adherence score was 7.3 ± 1.5 out of 9 (81.1 %),reflecting a comparatively strong commitment to dietary recommendations,while the mean exercise adherence score was only 4.2 ± 1.9 out of 9 (46.7 %) ,less than half the dietary figure. the combined total adherence score was 11.5 ± 2.1 out of 18 (63.9 %). these domain-level summary statistics are detailed in table 2.

table 2. *study respondents scores for precede factors and adherence to lifestyle modification (n = 412)*

factor	rating scale	mean	sd	95% ci (lower)	95% ci (upper)	score (%)
predisposing domain						
lifestyle perception	24	20.1	3.1	19.80	20.40	83.8
diabetes knowledge	6	4.5	0.9	4.41	4.59	75.0
enabling-factor domain	15	11.2	2.6	10.95	11.45	74.7
reinforcing-factor domain	15	8.7	3.5	8.36	9.04	58.0
aggregate precede score	60	44.5	6.7	43.85	45.15	74.2
adherence outcomes						
dietary adherence	9	7.3	1.5	7.16	7.44	81.1
exercise adherence	9	4.2	1.9	4.02	4.38	46.7
combined adherence score	18	11.5	2.1	11.30	11.70	63.9

sd = standard deviation; 95% ci = 95% confidence interval for the mean.

3.3 classification of precede and adherence scores

when the continuous scores were categorised into good, fair, and poor bands, the resulting picture reinforced the domain-level findings. within the predisposing domain, 36.9% of participants achieved good knowledge scores and 58.7% achieved good perception scores. the reinforcing domain again emerged as the weakest, with only 24.0% scoring well and a substantial 43.9% scoring poorly, while 43.2% achieved good enabling-factor scores. the contrast between the two adherence behaviours was stark: 251 participants (60.9%) demonstrated good dietary adherence, whereas only 13 participants (3.2%) reached the good adherence threshold for exercise, and the overwhelming majority of 337 participants (81.8%) fell into the poor exercise adherence category presented in table 3.

table 3. *respondents scores for factors associated with lifestyle modification adherences*

factor	good n(%)	fair n(%)	poor n(%)

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
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factor	good n(%)	fair n(%)	poor n(%)
lifestyle perception	242 (58.7)	121 (29.4)	49 (11.9)
diabetes knowledge	152 (36.9)	192 (46.6)	68 (16.5)
enabling factors	178 (43.2)	163 (39.6)	71 (17.2)
reinforcing factors	99 (24.0)	132 (32.0)	181 (43.9)
dietary adherence	251 (60.9)	107 (26.0)	54 (13.1)
exercise adherence	13 (3.2)	62 (15.0)	337 (81.8)

3.4 correlation between precede factors and adherence scores

spearman rank correlation analysis revealed no statistically significant monotonic relationship between any individual precede construct score and dietary adherence scores, with the single exception of perception, which showed a weak positive association with diet (ρ = 0.103 ,p = 0.037). by contrast several constructs were weakly but significantly associated with exercise adherence, namely reinforcing factors (ρ = 0.118 ,p = 0.017) and enabling factors (ρ = 0.097 ,p = 0.049). the strongest relationship to emerge was at the aggregate level, where the total precede score demonstrated a statistically significant, albeit weak, positive correlation with exercise adherence (ρ = 0.151 ,p = 0.002), suggesting that the cumulative effect of the behavior environment may exert a modest influence on physical activity that no single construct captures in isolation. the full correlation matrix is presented in table 4.

table 4. *correlation of precede factor scores with adherence scores (n = 412)*

precede construct	diet ρ	diet p	exercise ρ	exercise p
aggregate precede score	0.045	0.362	0.151	0.002*
predisposing (overall)	0.072	0.145	0.101	0.041*
lifestyle perception	0.103	0.037*	0.089	0.071
diabetes knowledge	-0.018	0.715	0.066	0.181
enabling factors	0.058	0.241	0.097	0.049*
reinforcing factors	-0.052	0.293	0.118	0.017*

p < 0.05 statistically significant; ρ = spearman rank correlation coefficient.

3.5 association between predictor variables and dietary adherence

bivariate analysis identified several sociodemographic and clinical variables significantly associated with dietary adherence. age showed a significant association (χ^2 = 5.29; p = 0.021): participants aged 60 years and above achieved optimal dietary adherence more frequently (66.1%) than their younger counterparts (55.0%). educational level was also significant (p < 0.001), with the highest optimal-adherence proportion observed, somewhat counterintuitively, among those with no formal education (80.3%). body mass index category (p = 0.032) and duration of diabetes diagnosis (p = 0.013) were likewise significantly associated with dietary adherence, the latter showing that patients with longer-standing disease adhered better. of the newly examined variables, place of residence was significantly associated with dietary adherence (p = 0.007), rural patients adhering better than urban ones, whereas comorbid hypertension and family history of diabetes were not. in contrast, neither gender nor treatment modality bore a statistically significant relationship to dietary adherence. these associations are summarised in table 5.

table 5. *association between predictor variables and adherence to dietary modification (n = 412)*

variable	optimal n(%)	suboptimal n(%)	χ^2	p-value
highest educational level				
no schooling	53 (80.3)	13 (19.7)	17.77	< 0.001*
primary level	78 (64.5)	43 (35.5)		
secondary level	75 (56.4)	58 (43.6)		
tertiary level	45 (48.9)	47 (51.1)		
residential setting				
urban dweller	138 (55.6)	110 (44.4)	7.29	0.007*
rural dweller	113 (68.9)	51 (31.1)		
age band (years)				
under 60 years	105 (55.0)	86 (45.0)	5.29	0.021*
60 years and above	146 (66.1)	75 (33.9)		
years since diagnosis				
under 5 years	136 (56.0)	107 (44.0)	6.11	0.013*
5 years and above	115 (68.0)	54 (32.0)		

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DOI: 10.21070/acopen.11.2026.14656

variable	optimal n(%)	suboptimal n(%)	χ^2	p-value
body mass index				
below 30 kg/m²	198 (63.9)	112 (36.1)	4.57	0.032*
30 kg/m² and above	53 (52.0)	49 (48.0)		
coexisting hypertension				
present	151 (64.0)	85 (36.0)	2.17	0.140
absent	100 (56.8)	76 (43.2)		
family history of diabetes				
positive history	139 (63.8)	79 (36.2)	1.57	0.211
no known history	112 (57.7)	82 (42.3)		
sex of respondent				
women	149 (59.4)	102 (40.6)	0.66	0.418
men	102 (63.4)	59 (36.6)		
treatment regimen				
oral agents only	159 (61.4)	100 (38.6)	1.15	0.766
oral agents plus insulin	48 (61.5)	30 (38.5)		
insulin only	28 (54.9)	23 (45.1)		
lifestyle measures only	16 (66.7)	8 (33.3)		

$p < 0.05$ statistically significant; χ^2 = pearson chi-square.

3.6 association between predictor variables and exercise adherence

in marked contrast to the dietary findings none of the sociodemographic or clinical predictor variables examined showed a statistically significant association with exercise adherence . this uniform absence of significant predictors is most plausibly attributable to the floor effect created by the extremely low overall prevalence of good exercise adherence across the entire cohort ,which left too little variation between subgroups for meaningful statistical contrasts and consequently constrained statistical power . the detailed bivariate results for exercise adherence are presented in table 6 .

table 6. *association between predictor variables and adherence to exercise instructions (n = 412)*

variable	optimal n(%)	suboptimal n(%)	χ^2	p-value
highest educational level				
no schooling	0 (0.0)	66 (100.0)	5.19	0.159
primary level	7 (5.8)	114 (94.2)		
secondary level	4 (3.0)	129 (97.0)		
tertiary level	2 (2.2)	90 (97.8)		
residential setting				
urban dweller	9 (3.6)	239 (96.4)	0.46	0.499
rural dweller	4 (2.4)	160 (97.6)		
age band (years)				
under 60 years	9 (4.7)	182 (95.3)	2.82	0.093
60 years and above	4 (1.8)	217 (98.2)		
years since diagnosis				
under 5 years	8 (3.3)	235 (96.7)	0.04	0.849
5 years and above	5 (3.0)	164 (97.0)		
body mass index				
below 30 kg/m²	9 (2.9)	301 (97.1)	0.26	0.610
30 kg/m² and above	4 (3.9)	98 (96.1)		
coexisting hypertension				
present	6 (2.5)	230 (97.5)	0.68	0.410
absent	7 (4.0)	169 (96.0)		

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
Vol. 11 No. 1 (2026): June
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variable	optimal n(%)	suboptimal n(%)	χ^2	p-value
family history of diabetes				
positive history	8 (3.7)	210 (96.3)	0.40	0.527
no known history	5 (2.6)	189 (97.4)		
sex of respondent				
women	7 (2.8)	244 (97.2)	0.28	0.595
men	6 (3.7)	155 (96.3)		
treatment regimen				
oral agents only	8 (3.1)	251 (96.9)	0.27	0.965
oral agents plus insulin	2 (2.6)	76 (97.4)		
insulin only	2 (3.9)	49 (96.1)		
lifestyle measures only	1 (4.2)	23 (95.8)		

$p < 0.05$ statistically significant; χ^2 = pearson chi-square.

3.7 perceived barriers to lifestyle modification

participants were asked to indicate their level of agreement with a series of statements describing potential barriers to lifestyle modification, and the responses provided important context for the adherence findings. the most frequently endorsed barriers were physical discomfort during exercise, particularly joint pain, with which 74.5 % of participants agreed or strongly agreed; financial constraints limiting healthy food choices (72.6 %); and time pressure arising from busy daily schedules (72.3 %). cultural and dietary belief conflicts were acknowledged by 60.4 % of respondents, while insufficient counselling from healthcare providers was reported as a contributing barrier by 46.4 %. a clear lack of knowledge about the recommended diet was endorsed by only a minority (37.9 %), indicating that the principal obstacles to adherence in this population were structural and physical rather than purely informational. the distribution of perceived barriers is presented in table 7.

table 7. *perceived barriers to lifestyle modification adherence among study participants (n = 412)*

barrier statement	strongly agree n(%)	agree n(%)	disagree n(%)
exercising tends to bring on joint pain or bodily discomfort	149 (36.2)	158 (38.3)	105 (25.5)
affording nutritious food is hard on my budget	121 (29.4)	178 (43.2)	113 (27.4)
my daily routine leaves no spare time for physical activity	103 (25.0)	195 (47.3)	114 (27.7)
the advised diet clashes with local food traditions	83 (20.1)	166 (40.3)	163 (39.6)
i get little encouragement from family or those around me	71 (17.2)	148 (35.9)	193 (46.8)
health workers seldom counsel me on diet or activity	58 (14.1)	133 (32.3)	221 (53.6)
i am unsure what the recommended diet actually involves	44 (10.7)	112 (27.2)	256 (62.1)

3.8 regression analysis for predictors of optimal dietary adherence

after entering the variables that were significant on bivariate analysis into a modified poisson regression model with robust error variance, five factors remained independent predictors of optimal dietary adherence. absence of formal education was the strongest independent predictor (adjusted pr = 1.41; 95% ci: 1.18–1.69; p < 0.001). age of 60 years or above also conferred a clear effect, raising the likelihood of optimal dietary adherence by about a third (adjusted pr = 1.34; 95% ci: 1.12–1.61; p = 0.002), as were rural residence (adjusted pr = 1.26; 95% ci: 1.07–1.49; p = 0.006), a diabetes duration of five years or more (adjusted pr = 1.22; 95% ci: 1.04–1.43; p = 0.014), and a body mass index below 30 kg/m² (adjusted pr = 1.19; 95% ci: 1.01–1.41; p = 0.041). comorbid hypertension and a good aggregate precede score showed positive but non-significant associations with dietary adherence after adjustment. the regression results are presented in table 8.

table 8. *modified poisson regression analysis of predictors of optimal dietary adherence*

predictor	adjusted pr	95% ci (lower)	95% ci (upper)	p-value
no schooling	1.41	1.18	1.69	< 0.001*
aged 60 years and above	1.34	1.12	1.61	0.002*
rural dweller	1.26	1.07	1.49	0.006*
diagnosed 5 years or more	1.22	1.04	1.43	0.014*
bmi below 30 kg/m²	1.19	1.01	1.41	0.041*
coexisting hypertension	1.08	0.92	1.27	0.352
good aggregate precede score	1.07	0.90	1.27	0.448
female sex	0.95	0.81	1.12	0.541

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

*pr = prevalence ratio; ci = confidence interval. * p < 0.05 statistically significant.*

4. Discussion

this study set out to provide a comprehensive evaluation of adherence to lifestyle modifications, and of the determinants of that adherence, among type 2 diabetes patients attending a tertiary diabetes management clinic in al-najaf, iraq. its central and most clinically arresting finding is the profound disparity between the two pillars of lifestyle modification: dietary adherence was relatively robust, with 60.9 % of participants achieving good adherence, whereas adherence to exercise recommendations had all but collapsed, with only 3.2 % of participants reaching the good threshold and more than four-fifths classified as poor adherers. this divergence is not a statistical artefact but a substantive behavioural reality with direct implications for how diabetes care is delivered in this setting, and it argues strongly against treating diet and exercise as a single, undifferentiated behavioural target.

the very low rate of exercise adherence observed here is broadly consistent with, though at the lower extreme of, the range reported elsewhere in the middle east and other low- and middle-income regions. studies from the gulf states and the wider region have similarly documented single-digit to low proportions of patients meeting physical activity recommendations, and qualitative work has attributed this pattern to a confluence of physical, economic, and cultural barriers [15,16,17]. the barrier data generated in the present study lend empirical weight to these explanations. the fact that joint pain and physical discomfort during exercise was the single most frequently endorsed barrier is highly congruent with the demographic profile of the cohort in which older adults among whom osteoarthritis and other musculoskeletal conditions are common predominated. in such a population, generic exhortations to exercise are likely to founder unless they are accompanied by concrete ,low-impact joint-friendly activity options and unless physical limitations are formally assessed and addressed [18]. the prominence of financial constraint and time pressure as additional barriers further underscores that physical inactivity in this context is rooted in the material circumstances of patients' lives rather than in ignorance or indifference.

the aggregate precede score of 74.2 % suggests that the overall predisposing and enabling environment for lifestyle modification in this clinic is reasonably supportive, yet this comparatively favourable behavioural backdrop has plainly failed to translate into adequate exercise adherence. this discordance between a supportive environment and poor behavioural outcomes echoes findings from other precede-based studies and reinforces a recurring lesson in behavioural medicine: knowledge and favourable attitudes, while necessary, are not sufficient to produce sustained behaviour change in the presence of strong structural barriers and weak reinforcement [11,19]. in this regard, the finding that reinforcing factors constituted the weakest of all precede domains, with a mean score of only 58.0 % and just 24.0 % of participants scoring well, is particularly instructive. it indicates that the social familial, and provider feedback loops that ordinarily sustain difficult behaviours over time are underdeveloped in this population, and it points to reinforcement as the most promising leverage point for intervention.

the pattern of correlations between the individual precede constructs and adherence scores merits careful interpretation rather than dismissal. the weak associations of perception with diet and of the reinforcing and enabling domains with exercise, while modest in magnitude, are consistent with the view that distinct behavioural levers operate on the two outcomes; this pattern has been reported in several previous precede-based adherence studies and may reflect a combination of measurement limitations inherent in self-reported scales, the genuinely multidirectional and interacting nature of behavioural influences, and the possibility that adherence in this resource-constrained setting is driven more powerfully by external structural determinants than by internal cognitive-motivational ones [13,20] . the strongest relationship that emerged — the weak positive correlation between the aggregate precede score and exercise adherence supports the view that it is the accumulation of multiple enabling and reinforcing conditions, rather than any single construct, that nudges patients towards physical activity and that interventions are therefore likely to be most effective when they act on several domains simultaneously.

several of the predictor relationships identified in the regression analysis warrant comment because they run contrary to intuitive expectation. the strong, independent association between older age and better dietary adherence is, however, a recurrent finding in the diabetes literature, and is plausibly explained by the heightened illness perception, greater fear of complications, reduced time pressure following retirement, and more frequent engagement with health services that often characterise older patients [21,22]. the equally robust finding that an absence of formal education predicted better dietary adherence is more surprising, but it too has precedent: patients without formal schooling may depend more heavily on direct, verbally delivered guidance from healthcare providers, which they may translate into consistent practice with fewer of the competing information sources and rationalisations available to more educated patients [14,23]. the newly observed advantage of rural over urban residence is consistent with this interpretation, in that rural patients may retain more traditional, less energy-dense dietary patterns and may be more responsive to clinician instruction. the associations between longer diabetes duration and better dietary adherence, and between lower body mass index and better dietary adherence, are likewise interpretable in terms of the progressive internalisation of dietary discipline over years of disease experience and the reinforcing effect of tangible metabolic benefit, respectively [9,24].

clear and actionable implications for diabetes care in this and comparable settings. the relative success in promoting dietary adherence suggests that existing dietetic counselling, where it occurs, is reaching at least a majority of patients, and that the priority is to consolidate and extend this through routine, structured involvement of trained dietitians or diabetes educators at every clinic visit [25,26]. the catastrophic shortfall in exercise adherence, by contrast, demands a fundamentally different and more proactive response. low-cost, joint-friendly modalities such as supervised walking programmes, chair-based and resistance exercises, and graded activity prescriptions tailored to older adults remain markedly underutilised in iraqi tertiary diabetes clinics and represent a concrete avenue for improvement [6,27]. the integration of even intermittent physiotherapy assessment into the diabetes clinic workflow, the establishment of peer-led activity and support groups to strengthen the weak reinforcing domain, and the explicit involvement of family members in self-management planning all merit serious consideration as practical and scalable interventions [27,28,29].

4.1 strengths and limitations

this study has several strengths. it employed a theoretically grounded analytical framework, drew on a relatively large sample selected by systematic random sampling, assessed dietary and exercise adherence separately rather than as a single composite, and complemented the analysis of determinants with a structured assessment of perceived barriers, thereby generating findings of direct programmatic relevance. nevertheless, a number of limitations must be acknowledged when interpreting the results. first, the cross-sectional design captures associations at a single point in time and cannot establish the temporal sequence or causal direction of the relationships observed; longitudinal designs would be required to confirm whether the identified predictors genuinely drive adherence. second, both adherence and the precede constructs were measured by self-report, raising the possibility of social desirability bias that may have inflated the relatively favourable dietary adherence figures in particular; the

incorporation of objective measures such as 24-hour dietary recall, food frequency questionnaires, or accelerometer-based activity monitoring in future work would substantially strengthen the validity of the findings. third, the study was conducted at a single tertiary institution, and its results may not generalise to primary care facilities, rural settings, or populations with poorer access to structured diabetes services. finally, the extremely low prevalence of good exercise adherence produced a floor effect that limited the statistical power available to detect predictors of exercise behaviour, an issue that future studies might address through targeted oversampling or alternative outcome definitions.

5. Conclusion

among type 2 diabetes patients attending this tertiary diabetes management clinic in al-najaf, iraq, adherence to dietary recommendations was reasonably acceptable, whereas adherence to exercise recommendations was remarkably and uniformly poor across every sociodemographic and clinical subgroup examined. reinforcing factors — encompassing social support, family encouragement, and active reinforcement by healthcare providers — emerged as the weakest of all the behavioural determinants assessed. older age, absence of formal education, a non-obese body mass index, longer diabetes duration, and rural residence were independent predictors of better dietary adherence, while no measured factor predicted exercise adherence. these findings make a compelling case for the development of clinic-integrated, barrier-specific physical activity promotion programmes, the strengthening of family and peer reinforcement mechanisms, and the routine institutionalisation of dietetic counselling within the diabetes management infrastructure of this and comparable settings. addressing the exercise adherence gap in particular should be regarded as an urgent priority for both clinical practice and future intervention research.

Declarations

conflict of interest: the authors declare that they have no competing interests relevant to this work.

funding: this research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. author contributions: asa conceptualised and designed the study and supervised data collection. fob and aje conducted data collection and entry. mkt performed the statistical analysis and contributed to interpretation. bno drafted the manuscript. all authors critically reviewed the manuscript and approved the final version for submission.

acknowledgements: the authors gratefully acknowledge the staff of the diabetes management clinic for their cooperation, and they thank all participants for their time and willingness to contribute to this study.

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Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.14656

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo