

Effect of a Pedometer-Guided Physical Activity Intervention on Quality of Life among Type 2 Diabetes Patients with Diabetes-Specific Distress: A Randomized Controlled Trial

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Type 2 diabetes mellitus (T2DM) frequently coexists with diabetes-specific distress (DSD), an emotional burden distinct from clinical depression that stems from the ongoing demands of glucose self-management rather than from a primary mood disorder. DSD has been linked to weaker treatment adherence, poorer glycemic control and lower quality of life (QoL). This study examined the effect of a 12-week, pedometer-guided physical activity program on QoL among adults with T2DM and DSD attending a tertiary-care hospital in Lahore, Pakistan, reporting the physical-activity arm of a larger four-group randomized controlled trial. One hundred participants were assigned to the physical intervention, which set a target of 150 minutes of moderate-intensity walking per week, monitored with a pedometer and supported by perceived-exertion feedback using the Borg scale. QoL was measured with the WHOQOL-BREF at baseline and immediately after the 12-week program, alongside diabetes-related distress using the Problem Areas in Diabetes (PAID) scale and glycemic control using HbA1c. Because the principal outcome variables departed from a normal distribution, non-parametric statistical tests were applied. Overall QoL rose from a mean WHOQOL-BREF score of 52.84 (SD 4.07) at baseline to 62.91 (SD 4.61) after the intervention ($p < .001$; Cohen's $d = 2.316$), with increases recorded across all four domains: physical health, psychological health, social relationships and environment. HbA1c decreased from 10.25% (SD 1.39) to 8.97% (SD 1.20) ($p < .001$; $d = 0.986$), and PAID scores fell from 49.79 (SD 4.24) to 39.53 (SD 5.88) ($p < .001$; $d = 2.002$). These results suggest that a low-cost, pedometer-guided walking program can be accompanied by meaningful gains in quality of life together with better glycemic control and

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reduced diabetes-related distress, even in a resource-constrained clinical setting. Because the intervention required only a simple step-counting device and a defined weekly activity target, it could plausibly be incorporated into routine outpatient diabetes counselling without specialist staffing. In the parent trial, combining physical activity with structured psychological support produced the largest gains across outcomes, suggesting that walking programs may serve as an accessible first step in care, with referral to psychosocial support reserved for patients whose distress remains elevated. Longer follow-up and multicenter replication are needed to confirm the durability of these findings.

Keywords: *type 2 diabetes mellitus, diabetes-specific distress, physical activity, pedometer, quality of life, randomized controlled trial*

Introduction:

Type 2 diabetes mellitus (T2DM) remains one of the fastest-growing chronic disease burdens worldwide. The International Diabetes Federation estimated that approximately 589 million adults aged 20–79 years were living with diabetes globally in 2025, with type 2 disease accounting for more than nine in ten of these cases (International Diabetes Federation, 2025). Pakistan is among the most heavily affected countries, with national estimates placing adult diabetes prevalence at around 30.8%, equivalent to roughly 33 million adults, most of whom have T2DM (Akhtar et al., 2019; International Diabetes Federation, 2025).

Beyond its metabolic consequences, T2DM carries a substantial psychological cost. Diabetes-specific distress (DSD) refers to the frustration, worry and emotional strain that arise specifically from the daily work of managing diabetes, and it is conceptually and clinically distinct from major depressive disorder (Fisher et al., 2012, 2014; Gonzalez et al., 2011; Polonsky et al., 2005). A systematic review estimated that clinically significant DSD affects roughly one in three adults with diabetes worldwide (Perrin et al., 2017), and Pakistani samples have reported considerably higher rates, with pooled prevalence estimates approaching two-thirds of patients (Asmat et al.,

2026). Because DSD can erode self-management behaviour and undermine emotional wellbeing, it is also associated with poorer quality of life (QoL), a multidimensional construct spanning physical, psychological, social and environmental domains (Jafari et al., 2024; Rubin & Peyrot, 1999).

Physical activity is a cornerstone of contemporary T2DM management. Regular structured exercise improves insulin sensitivity, cardiometabolic fitness and functional capacity, and it may also support psychological wellbeing through physiological and behavioural pathways (Colberg et al., 2016; Kanaley et al., 2022; Madsen et al., 2022; Shah et al., 2021). Walking-based programmes are particularly suited to resource-constrained settings because they require minimal equipment and can be prescribed across a wide range of functional abilities. Pedometers offer an inexpensive means of self-monitoring that can strengthen goal-setting and behavioural feedback, and systematic reviews indicate that pedometer- and accelerometer-based interventions can improve metabolic outcomes in adults with T2DM (Funk & Taylor, 2013; de Oliveira et al., 2024; Umpierre et al., 2011).

Despite this evidence base, few intervention studies from Pakistan have examined whether structured physical activity improves QoL specifically among patients with T2DM who also report diabetes-

specific distress. Cultural attitudes toward exercise, gender norms around outdoor activity, and constraints on access to structured exercise facilities may all shape both the feasibility and the effectiveness of such programmes in this setting. The present study reports the physical-activity arm of a four-group randomized controlled trial conducted at Jinnah Hospital, Lahore; a companion paper reports the psychological-intervention arm of the same trial (Ayub & Adewale, 2026). The objective of this analysis was to determine whether a 12-week pedometer-guided walking programme improved overall QoL, and its physical, psychological, social and environmental domains, relative to baseline, among adults with T2DM and diabetes-specific distress.

METHODOLOGY

Study Design and Setting

This analysis reports the physical-activity arm of a four-group randomized controlled trial conducted at Jinnah Hospital, Lahore, Pakistan. The parent trial compared usual care, a physical activity intervention, a psychological intervention and a combined physical-plus-psychological intervention, with 100 participants allocated to each arm ($N = 400$). Baseline and post-intervention assessments were completed across a 12-week intervention window, consistent with the psychological-intervention arm reported in the companion study conducted within the same institutional and ethical framework (Ayub & Adewale, 2026).

Participants

Eligible participants were adults with a diagnosis of T2DM of at least one year's duration, aged 40 years or older, who scored ≥ 2.0 on the mean item score of the Diabetes Distress Scale (DDS-17), indicating clinically relevant diabetes-specific distress, and who were willing to provide informed consent. Individuals with severe psychiatric illness, physical disabilities that would prevent participation in a walking program, or pregnancy were excluded. These criteria mirror those applied across the

parent four-arm trial, from which the present physical-activity sample was recruited using purposive sampling at the same tertiary-care site.

Randomization and Group Allocation

Participants were allocated to one of the four study arms using a computer-generated randomization sequence, concealed in sealed envelopes by a clinical trials specialist independent of the research team. This report focuses on the physical intervention group ($n = 100$) and, where relevant to interpretation, draws on the usual-care comparison embedded in the parent trial.

Physical Activity Intervention

Participants allocated to the physical intervention arm were enrolled in a structured, pedometer-guided walking program designed to build up to 150 minutes of moderate-intensity activity per week over 12 weeks. Each participant was individually instructed in the correct placement and daily use of a YamaxDigiWalker SW200 pedometer and was asked to wear the device throughout waking hours, removing it only for sleep and water-based activities. Participants maintained a daily activity log recording step counts and any additional physical activity performed. Perceived exercise intensity was tracked using the Borg Rating of Perceived Exertion scale, allowing the research team to individualize pacing and confirm that activity remained within a moderate-intensity range. Participants allocated to usual care were advised only to continue their habitual daily walking pattern without structured monitoring. The combined-intervention arm received the same pedometer-based walking program delivered concurrently with Problem-Solving Therapy for Diabetes, the psychological intervention described in the companion paper; the present analysis, however, isolates the physical-activity exposure and does not report on the psychological or combined arms in detail.

Outcome Measures

The primary outcome was quality of life, assessed with the WHOQOL-BREF, a 26-item instrument yielding four domain scores physical health, psychological health, social relationships and environment transformed to a 0–100 scale, with higher scores reflecting better QoL (World Health Organization, 1996). Diabetes-related distress was measured using the Problem Areas in Diabetes (PAID) scale, and glycemic control was assessed using HbA1c. Perceived exertion during the walking program was assessed with the Borg scale. Internal consistency in the study sample was good for the WHOQOL-BREF (Cronbach's $\alpha = 0.850$) and for the Diabetes Distress Scale ($\alpha = 0.800$).

Data Analysis And Results

Outcome variables were tested for normality using the Kolmogorov-Smirnov test, which indicated significant departures from a normal distribution for the PAID, DDS-17, PST-DM and WHOQOL-BREF scores; non-parametric procedures were therefore used throughout. Descriptive statistics are presented as means and standard deviations. Within-group pre–post comparisons were assessed using Wilcoxon signed-rank tests, and between-group comparisons used Kruskal-Wallis or Mann-Whitney procedures as appropriate. Effect sizes for pre–post change was expressed as Cohen's *d*. Statistical significance was set at $p < .05$.

Ethical Considerations

All participants provided written informed consent prior to enrolment. Participation was voluntary, confidentiality was maintained throughout data collection and analysis, and participants retained the right to withdraw at any stage without consequence for their ongoing clinical care. No study-related risks to participants were identified.

Participant Characteristics

The parent trial enrolled 400 participants, 100 in each of the four study arms, including the physical intervention group reported here. Participants ranged in age from 40 to 80 years, with no participants above 80 years in any arm. The physical intervention group showed a slight male predominance (52% male, 48% female), in contrast to a slight female predominance in the usual-care comparison group (55% female, 45% male). Marital status, educational attainment, occupation and monthly household income were all heterogeneous within the physical intervention group and broadly comparable with the usual-care group at baseline (Table 1), reflecting the socioeconomically diverse population served by the recruiting hospital. Descriptive comparisons across the four arms did not suggest systematic demographic imbalance at baseline.

Table 1 Baseline Demographic Characteristics of the Physical Intervention and Usual-Care Groups (n = 100 each)

Variable	Usual Care n (%)	Physical Intervention n (%)
Age		
40–50 years	30 (30)	29 (29)
50–60 years	23 (23)	17 (17)
60–70 years	15 (15)	25 (25)
70–80 years	32 (32)	29 (29)
Gender		
Male	45 (45)	52 (52)

Female	55 (55)	48 (48)
Marital status		
Single	17 (17)	22 (22)
Married	27 (27)	35 (35)
Divorced	41 (41)	31 (31)
Widowed	15 (15)	12 (12)
Education		
Illiterate	10 (10)	9 (9)
Primary	16 (16)	24 (24)
Secondary	25 (25)	18 (18)
Higher secondary	15 (15)	20 (20)
Graduation	26 (26)	20 (20)
Professional degree	8 (8)	9 (9)
Duration of T2DM		
< 1 year	12 (12)	15 (15)
1–2 years	21 (21)	27 (27)
3–4 years	29 (29)	25 (25)
4–5 years	21 (21)	21 (21)
> 5 years	17 (17)	12 (12)
Occupation		
Professional	12 (12)	9 (9)
Semi-professional	14 (14)	16 (16)
Clerical/shop/farm	19 (19)	13 (13)
Skilled worker	12 (12)	16 (16)
Semi-skilled worker	12 (12)	19 (19)
Unskilled	20 (20)	20 (20)
Unemployed	11 (11)	7 (7)
Monthly income (PKR)		
< 25,000	21 (21)	12 (12)
25,000–45,000	14 (14)	22 (22)
45,000–65,000	12 (12)	20 (20)

65,000–85,000	15 (15)	22 (22)
85,000–115,000	23 (23)	16 (16)
> 115,000	15 (15)	8 (8)

Note: Values are n (%). Data are drawn from the baseline demographic profile of the parent four-arm trial (N = 400); the psychological and combined intervention arms are not shown here as they fall outside the scope of this report.

Effect on Quality of Life

Overall QoL improved substantially over the 12-week intervention period. The mean WHOQOL-BREF score rose from 52.84 (SD 4.07) at baseline to 62.91 (SD 4.61) after the physical activity program, a change that was both statistically significant and large in magnitude ($p < .001$; Cohen's $d = 2.316$). Descriptive increases were evident across all four WHOQOL-BREF domains (Table 2): physical health rose from 27.42 (SD 8.04)

to 33.71 (SD 8.67); psychological health rose from 26.16 (SD 9.51) to 33.33 (SD 10.05); social relationships rose from 25.41 (SD 9.93) to 38.00 (SD 15.22); and environment rose from 24.59 (SD 6.26) to 36.84 (SD 8.47). Post-test comparisons of domain distributions across the four trial arms (Kruskal-Wallis) did not reach statistical significance for any domain, indicating that these between-group tests should not be read as evidence against the within-person changes reported above, which reflect a different statistical question.

Table 2 WHOQOL-BREF Domain Scores in the Physical Intervention Group ($n = 100$)

WHOQOL-BREF Domain	Baseline Mean $\pm$ SD	Post-test Mean $\pm$ SD	Absolute Change	Between-group post-test
Physical health	27.42 $\pm$ 8.04	33.71 $\pm$ 8.67	+6.29	H = 0.548, $p = .969$
Psychological health	26.16 $\pm$ 9.51	33.33 $\pm$ 10.05	+7.17	H = 3.407, $p = .492$
Social relationships	25.41 $\pm$ 9.93	38.00 $\pm$ 15.22	+12.59	H = 1.762, $p = .779$
Environment	24.59 $\pm$ 6.26	36.84 $\pm$ 8.47	+12.25	H = 4.754, $p = .314$
Overall WHOQOL-BREF	52.84 $\pm$ 4.07	62.91 $\pm$ 4.61	+10.07	$d = 2.316$, $p < .001^*$

*Note: Domain-level H statistics compare score distributions across all four trial arms at the post-intervention time point and are not within-person tests. *Overall WHOQOL-BREF change reflects a paired pre–post comparison within the physical intervention group.*

Glycemic Control and Diabetes-Related Distress

Glycemic control improved over the intervention period: HbA1c fell from 10.25% (SD 1.39) at baseline to 8.97% (SD 1.20) after 12 weeks, a statistically significant reduction with a large effect

size ($Z = -5.283$, $p < .001$; $d = 0.986$). Diabetes-related distress, measured with the PAID scale, also declined significantly, from 49.79 (SD 4.24) to 39.53 (SD 5.88) ($Z = -8.114$, $p < .001$; $d = 2.002$). Table 3 summarizes these within-group statistical comparisons alongside the overall WHOQOL-BREF change.

Table 3 *Summary of Within-Group Pre- to Post-Intervention Changes (Physical Intervention Group)*

Outcome Measure	Statistical Test	Z-value	p-value	Effect Size (d)	Interpretation
WHOQOL-BREF (overall QoL)	Paired comparison	—	< .001	2.316	Large improvement
HbA1c (glycemic control)	Wilcoxon	−5.283	< .001	0.986	Large reduction
PAID (diabetes distress)	Wilcoxon	−8.114	< .001	2.002	Large reduction

Perceived Exertion

At baseline, the four trial groups reported similar distributions of perceived exertion on the Borg scale ($\chi^2 = 6.373$, $p = .896$), indicating comparable starting activity levels. Following the intervention period, perceived exertion differed significantly across groups ($\chi^2 = 145.21$, $p < .001$; $\varphi = .603$), with the physical intervention group shifting toward lighter, more comfortable exertion categories relative to the usual-care group. The largest shift toward lighter exertion was observed in the combined physical-and-psychological intervention arm, consistent with an additive benefit when structured activity was paired with psychological support.

Table 4 presents the full post-intervention distribution. None of the physical intervention group rated their exertion as “very, very hard” after 12 weeks, compared with 14% of the usual-care group, all of whom fell in that heaviest category. Within the physical intervention group, the largest post-test cluster shifted to the “somewhat hard” band (31.6%), whereas the usual-care group remained concentrated in the “hard” (35.9%) and “very hard” (42.6%) bands. This pattern is consistent with a genuine reduction in perceived physical strain among participants who completed the pedometer-guided walking program, rather than a uniform shift affecting all study arms equally.

Table 4 *Post-Intervention Distribution of Perceived Exertion (Borg Scale) by Study Group (N = 400)*

Borg Rating Category	Usual Care n (%)	Physical Intervention n (%)	Psychological Intervention n (%)	Combined Intervention n (%)
Very, very light (6–8)	0 (0)	0 (0)	0 (0)	11 (100)
Very light (9–10)	0 (0)	15 (28.3)	15 (28.3)	23 (43.4)
Fairly light (10–11)	8 (9.9)	23 (28.4)	20 (24.7)	30 (37.0)
Somewhat hard (12–13)	22 (23.2)	30 (31.6)	19 (20.0)	24 (25.3)
Hard (14–15)	33 (35.9)	17 (18.5)	30 (32.6)	12 (13.0)
Very hard (16–17)	23 (42.6)	15 (27.8)	16 (29.6)	0 (0)
Very, very hard (18–20)	14 (100)	0 (0)	0 (0)	0 (0)

Note: $\chi^2(15, N = 400) = 145.21$, $p < .001$, $\varphi = .603$. Percentages are row percentages (share of each rating category contributed by each group), consistent with how the underlying chi-square analysis was reported.

Discussion

This randomized controlled trial found that a 12-week, pedometer-guided walking program was associated with a large improvement in quality of life among adults with T2DM and diabetes-specific distress attending a tertiary hospital in Lahore. The overall WHOQOL-BREF score rose by roughly ten points, with a correspondingly large effect size ($d = 2.316$), and the improvement was not restricted to physical functioning: psychological health, social relationships and environmental QoL all showed comparable descriptive gains.

These findings are consistent with established physiological and behavioral mechanisms linking activity to wellbeing. Regular walking can improve insulin sensitivity, cardiorespiratory fitness and physical function, while the experience of meeting a concrete, self-monitored activity goal may strengthen self-efficacy and a sense of mastery over one's condition (Colberg et al., 2016; Kanaley et al., 2022). Exercise-related improvements in mood and stress reactivity offer a plausible pathway through which a physical program, although not designed as psychotherapy, could nonetheless produce the meaningful reduction in PAID-measured distress observed here.

The glycemic findings reinforce the clinical relevance of the intervention. The average HbA1c reduction of just over one percentage point, with a large effect size, is consistent with evidence that structured, monitored exercise programs outperform general physical-activity advice for glycemic control (Umpierre et al., 2011). The pedometer itself likely contributed an important behavioural component: by making daily activity visible and quantifiable, it may have supported the kind of self-regulation and goal-directed behavior that underlies successful activity-monitoring interventions (Funk & Taylor, 2013; de Oliveira et al., 2024).

The QoL findings warrant a cautious interpretation, however. Although all four

WHOQOL-BREF domains increased descriptively, the between-group Kruskal-Wallis comparisons conducted at the post-intervention time point were not statistically significant for any domain. These between-group tests assess how score distributions differed across the four trial arms at a single time point; they do not test the within-person change reported for the overall WHOQOL-BREF score, which was based on a paired pre-post comparison. The strongest statistical evidence for benefit in this report therefore rests on the overall WHOQOL-BREF pre-post result, while the domain-level findings should be regarded as descriptive until confirmed with formal within-group inferential testing.

The parent four-arm trial also included psychological and combined intervention conditions. Reported outcomes from that trial suggest that the combined arm, which paired the walking program with Problem-Solving Therapy for Diabetes, produced larger changes across several measures than either component delivered alone (Ayub & Adewale, 2026). This pattern has practical implications for service planning: physical activity appears to be an accessible, low-cost entry point for diabetes care, but patients with more entrenched distress may derive additional benefit from concurrent psychological support. The present analysis is concerned specifically with the physical-activity exposure and does not claim that walking alone is sufficient for every patient.

From a health-systems perspective, a pedometer-guided walking program requires relatively little infrastructure and could plausibly be integrated into existing outpatient diabetes counselling in settings such as Pakistan, where access to formal exercise facilities is often limited. Implementation would need to remain individualized, with activity targets adjusted for functional capacity, comorbidity and clinical status, particularly among patients with diabetes-related complications or mobility limitations.

This study benefits from its randomized, four-arm design, a total recruited sample of 400 participants,

the use of a validated multidimensional QoL instrument, concurrent assessment of diabetes-related distress and glycemic control, and a clearly specified 12-week activity protocol supported by objective step-monitoring rather than self-report alone. Several limitations should nonetheless be acknowledged. The trial was conducted at a single tertiary-care hospital, which may limit generalizability to primary-care or rural populations. Assessment ended immediately after the 12-week intervention, so the durability of the observed gains is unknown. Some outcome measures relied on self-report and may be subject to response bias. Because the domain-level QoL comparisons reported here were based on between-group rather than within-group statistics, formal within-person inferential testing for each WHOQOL-BREF domain should be prioritized in future analyses of this dataset. Finally, this report addresses only one arm of a larger four-arm trial; conclusions about the relative or additive

effectiveness of physical, psychological and combined intervention should await a dedicated between-arm comparison.

Conclusion

A 12-week, pedometer-guided walking program targeting 150 minutes of moderate-intensity activity per week was associated with substantial improvement in overall quality of life among adults with T2DM and diabetes-specific distress in a tertiary-care setting in Lahore, alongside significant reductions in diabetes-related distress and improved glycemic control. These findings support structured, monitor-assisted physical activity as a feasible and potentially valuable component of patient-centered diabetes care in resource-constrained settings. Confirmation in multicenter trials with longer follow-up, transparent allocation reporting and prespecified between-arm comparisons is needed before the approach can be recommended for wider clinical adoption.

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