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Enhancing Glycaemic Regulation In Type 2 Diabetes Mellitus Through Personalized Met-Based Exercise Prescription: A Clinical Evaluation

Pawandeep Kaur[1], Rakesh Kumar Singh[2]

Research Scholar, Department of Physiotherapy,Janardan Rai Nagar Rajasthan Vidyapeeth (DEEMED-TO-BE) University, Pratapnagar, Udaipur (Raj.)
[2]Professor, Department of Physiotherapy, Faculty of Physiotherapy, Janardan Rai Nagar Rajasthan Vidyapeeth (DEEMED-TO-BE) University, Pratapnagar, Udaipur (Raj.)
Corresponding E-Mail: pawan.viny@gmail.com

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ABSTRACT
Background: **Type 2 Diabetes Mellitus (T2DM) represents a major global health challenge, primarily associated with inactive lifestyles and inadequate blood sugar regulation. Although exercise is a key component of T2DM treatment, standard exercise recommendations often fail to account for individual differences. This study aimed to assess the impact of a personalized exercise program based on Metabolic Equivalent of Task (MET) values on glycaemic and physiological outcomes in T2DM patients.** ***Methods:*** **A prospective interventional study was conducted, enrolling adult participants with T2DM. Individuals were assigned to one of three groups: endurance, strength, or a combination of both exercise types. Key outcomes included changes in HbA1c, Body Mass Index (BMI), daily step count, and confidence in maintaining the exercise regimen. Data analysis employed paired t-tests and chi-square tests to determine statistical associations.** ***Results:*** **The MET-based exercise program resulted in a statistically significant reduction in HbA1c levels (average decrease: 0.34%, p=0.001), with the combined exercise group showing the most notable improvement (0.59%). Cardiorespiratory fitness also improved, with the strength group recording an average of 9804 steps per day (p=0.024). Most participants performed moderate-intensity exercises, and a significant relationship was found between exercise type and intensity (p=0.002).** ***Conclusion:*** **The findings suggest that MET-guided individualized exercise prescriptions offer a structured, patient-centered method for enhancing glycaemic control and promoting adherence in people with T2DM. This approach shows promise as a scalable and personalized solution for diabetes management in both clinical and community settings.**

INTRODUCTION:
Type 2 Diabetes Mellitus (T2DM) is a long-term metabolic disorder marked by insulin resistance and impaired glucose utilization. Its prevalence is rising rapidly due to increased physical inactivity, unhealthy eating habits, and escalating rates of obesity. While medication remains essential in managing T2DM, lifestyle modifications—particularly regular physical activity—are crucial for improving blood sugar control and long-term outcomes.

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Extensive research has investigated different aspects of diabetes care, including medications, socioeconomic disparities, and various exercise strategies. For instance, Kobayashi et al. (2023) reported that strength training outperformed aerobic workouts in enhancing glycaemic control and body composition in individuals with normal-weight T2DM. Flores-Hernández et al. (2025) emphasized the influence of social and ethnic factors on care quality. Meanwhile, Zhang et al. explored the correlation between physical activity levels and the risk of gestational diabetes, revealing a dose-response effect.

Further investigations have explored how diabetes interacts with other conditions, such as prostate cancer, and have compared multiple second-line drug therapies. Studies like those by Miyoshi et al. and Vaanabouathong et al. have examined the roles of imaging technologies and GLP-1 receptor agonists in diabetes management. Li et al. and Wang et al. contributed findings on cardiovascular responses to exercise and real-world treatment outcomes in diabetic populations. Additionally, emerging technologies, including AI and bio-sensors, are transforming how diabetes is monitored and managed.

Despite these advances, personalized exercise prescriptions remain underutilized. Standard guidelines often fail to consider individual physical limitations, preferences, or coexisting medical issues, which may hinder adherence. The MET framework offers a practical and quantifiable way to tailor exercise based on energy expenditure and personal fitness levels. However, its application in structured clinical interventions is still limited.

The current study addresses this gap by evaluating the clinical effectiveness of MET-based exercise programs personalized to individual needs. As physical activity is still underused in diabetes care, this approach may provide a structured yet flexible solution.

In particular, adapting exercise intensity using MET values ensures a safer, more personalized intervention—especially for individuals with comorbid conditions or varying fitness levels. Aligning physical activity with personal preferences may also enhance motivation and long-term adherence.

The main aim of this research is to determine whether MET-based individualized exercise programs can significantly improve glycaemic control—measured through HbA1c—and physiological outcomes like step counts, endurance, and self-reported confidence. The following sections will outline the methodology, present and interpret the results, and conclude with practical implications, limitations, and directions for future research.

METHODOLOGY:

Study Design and Setting:

This research utilized a prospective interventional design to assess the clinical impact of a MET-based personalized exercise program for adults diagnosed with Type 2 Diabetes Mellitus (T2DM). The 12-week intervention was implemented at a clinical fitness and rehabilitation center affiliated with a tertiary care hospital. The controlled environment allowed for continuous supervision, enabling the close observation of participants' physiological responses, compliance, and progress. This structured setting ensured consistent delivery and real-time modifications to exercise protocols based on individual tolerance levels.

Participant Selection:

A total of 90 participants were recruited through purposive sampling from endocrinology outpatient departments, community outreach activities, and health screening camps. Eligible individuals were between 25 and 50 years of age.

Inclusion Criteria:

- Confirmed diagnosis of T2DM for at least one year
- Baseline HbA1c $\geq$ 6.5%
- Sedentary or low physical activity level as indicated by MET assessment

Exclusion Criteria:

- Dependency on insulin therapy
- Severe diabetic complications (e.g., nephropathy, retinopathy, neuropathy)
- History of cardiovascular incidents within the last six months
- Uncontrolled hypertension or orthopedic restrictions
- Cognitive deficits impeding participation

All participants provided informed written consent after being briefed on the study's objectives, methodology, and potential risks.

Group Allocation:

To maintain balanced representation and reduce selection bias, participants were randomly allocated into three equal groups (30 participants each) using a computer-generated sequence. The intervention groups included:

- **Endurance Exercise Group**
- **Strength Training Group**
- **Combined (Combo) Group** – integrating both endurance and strength components

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Demographic and clinical parameters, such as age, gender, BMI, and HbA1c, were evaluated at baseline to confirm group equivalence.

MET-Based Exercise Prescription Protocol:
The intervention strategy focused on customizing exercise intensity using the Metabolic Equivalent of Task (MET) system, which quantifies energy expenditure relative to resting metabolism (1 MET = ~3.5 mL O_2/kg/min). Initial MET values were assessed using the Six-Minute Walk Test (6MWT) alongside a validated physical activity recall questionnaire. Based on this data, exercise programs were designed to target a moderate-intensity MET range of 3–6, in accordance with American College of Sports Medicine (ACSM) guidelines.

- **Endurance Group:** Activities such as walking, cycling, and treadmill use
- **Strength Group:** Resistance exercises using free weights and machines
- **Combo Group:** A blended regimen of endurance and resistance training

Sessions were held five times a week, lasting 30–40 minutes each. Adherence was monitored using wearable fitness trackers and exercise logs, capturing step counts, heart rate, and perceived exertion. Regular evaluations were performed to fine-tune MET intensity according to each participant's progress and tolerance.

Data Collection and Outcome Measures
The study measured both primary and secondary outcomes.

- **Primary Outcome:** Improvement in glycaemic control, measured through pre- and post-intervention HbA1c and fasting blood glucose levels.
- **Secondary Outcomes:** Included changes in weight and BMI, average daily step count, exercise duration, and participant confidence in maintaining the routine.

Additional qualitative data were gathered through surveys addressing familiarity with MET principles, device usage, and subjective perceptions of the program. Functional improvements in endurance, strength, and mobility were documented using physical performance tests and self-reported scales. Any adverse events (e.g., dizziness, muscle strain, or chest discomfort) were logged for safety review.

Statistical Analysis:
Data were analyzed using **IBM SPSS Statistics Version 26.0**.

- **Descriptive statistics** (mean, SD, frequency, percentage) summarized demographic and clinical data.
- **ANOVA** tested differences in continuous variables among groups.
- **Chi-square tests** examined categorical associations, including symptom trends and outcome improvements.
- A significance level of $\mathbf{p < 0.05}$ was used to determine statistical relevance.

Ethical Considerations:
The study received ethical clearance from the Institutional Ethics Committee prior to participant recruitment. All procedures adhered to the **Declaration of Helsinki**. Participant confidentiality was preserved through anonymized data handling. Moreover, individuals were informed of their right to withdraw from the study at any point without any impact on their standard clinical care.

RESULTS AND DISCUSSION:

Results:
This study analyzed data from 90 adult participants diagnosed with Type 2 Diabetes Mellitus (T2DM), who were equally assigned to three exercise intervention groups: the Combo group (integrating endurance and strength training), the Endurance Exercise group, and the Strength Exercise group, with 30 individuals in each.

Over a 12-week intervention period, both baseline and follow-up measurements were collected. The assessment focused on a range of parameters including demographic characteristics, clinical markers such as HbA1c, fasting blood glucose, and Body Mass Index (BMI), as well as physical activity indicators like average daily step count and intensity of exercise. Additionally, subjective measures—such as participants' confidence in continuing the exercise program, adherence to the prescribed routine, and perceived improvements in physical performance—were gathered through self-reports.

The primary objective of the analysis was to determine the effectiveness of MET-based individualized exercise prescriptions in enhancing glycaemic regulation and improving overall physical fitness among individuals with T2DM.

Table 1. Age-Wise Distribution of Participants Across Exercise Groups

	Group			Total
Age	Combo	Endurance Exercise	Strength Exercise	
25 - 30	5	6	7	18
31 - 35	8	4	6	18
36 - 40	7	3	8	18

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41 - 45	5	9	4	18
46 - 50	5	8	5	18
Total	30	30	30	90
Pearson chi-square = 7.333, p-value = 0.501				

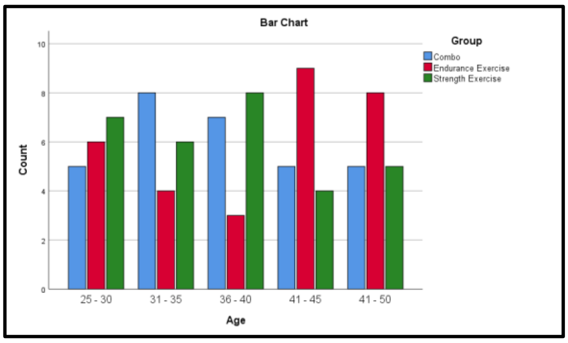

Figure 1. Age-Wise Distribution of Participants Across Exercise Groups

Table 1 and Figure 1 illustrate the distribution of participants across five age categories (25–30, 31–35, 36–40, 41–45, and 46–50 years) within the three exercise groups: Combo, Endurance, and Strength. Each age group included 18 participants, while each exercise category had an equal allocation of 30 participants. The Pearson chi-square test (χ^2 = 7.333, p = 0.501) revealed no statistically significant relationship between age group and exercise assignment, as the p-value is greater than 0.05. This indicates that participant distribution by age was balanced across the intervention groups, reducing the likelihood of age-related bias in outcome comparisons.

Table 2. Gender-Wise Distribution of Participants Across Exercise Groups

Gender	Group			Total
	Combo	Endurance Exercise	Strength Exercise	
Female	9	14	12	35
Male	21	16	18	55
Total	30	30	30	90
Pearson chi-square = 1.777, p-value = 0.411				

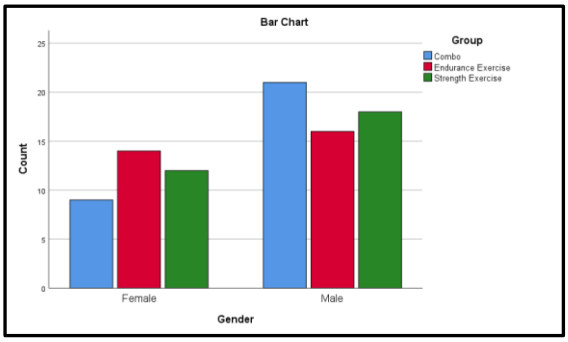

Figure 2. Gender-Wise Distribution of Participants Across Exercise Groups

Table 2 and Figure 2 display the gender-wise distribution of participants across the three exercise groups: Combo, Endurance, and Strength. Of the total 90 participants, 35 were female and 55 were male, with each exercise group comprising 30 individuals. The Pearson chi-square test yielded a value of 1.777 and a p-value of 0.411, indicating no significant association between gender and group assignment, as the p-value exceeds the 0.05 threshold. This outcome confirms a balanced gender distribution among the intervention groups, minimizing gender-based bias in the study findings.

Table 3. Comparison of Mean Age, Weight, Height, and BMI Across Exercise Groups

		N	Mean	Std. Deviation	F value	P value
Age	Combo	30	37.43	7.366	0.945	0.393
	Endurance Exercise	30	39.40	8.028		
	Strength Exercise	30	36.83	7.283		
	Total	90	37.89	7.562		
Weight (kg)	Combo	30	80.663	11.5025	0.564	0.571
	Endurance Exercise	30	80.543	10.7167		
	Strength Exercise	30	77.993	10.7512		
	Total	90	79.733	10.9422		
Height (cm)	Combo	30	173.43	9.698	0.807	0.450
	Endurance Exercise	30	173.60	11.560		
	Strength Exercise	30	170.37	11.918		
	Total	90	172.47	11.077		
BMI	Combo	30	26.383	4.4380	0.401	0.671
	Endurance Exercise	30	26.547	5.1067		
	Strength Exercise	30	27.380	4.2825		
	Total	90	26.770	4.5917		

Table 3 summarizes the results of ANOVA comparing baseline characteristics—age, weight, height, and Body Mass Index (BMI)—across the three exercise groups: Combo, Endurance, and Strength. The analysis found no statistically significant differences among the groups, with all p-values exceeding 0.05. The average age ranged from 36.83 to 39.40 years, indicating a similar age profile. Mean weights varied only slightly, from 77.99 kg to 80.66 kg, while average heights ranged between 170.37 cm and 173.60 cm. BMI values were also comparable, falling within the range of

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26.38 to 27.38. These findings confirm that the groups were demographically and physically well-matched at baseline, allowing for meaningful comparisons of intervention outcomes without confounding from initial differences.

Table 4. Comparison of Blood Glucose Level, HbA1c, and Exercise Duration Across Exercise Groups

		N	Mean	Std. Deviation	F value	P value
Blood Glucose Level (mg/dL)	Combo	30	158.290	22.1558	1.308	0.275
	Endurance Exercise	30	167.550	21.0876		
	Strength Exercise	30	163.980	23.7631		
	Total	90	163.273	22.4399		
HbA1c (%)	Combo	30	8.127	0.9355	0.065	0.937
	Endurance Exercise	30	8.217	1.1154		
	Strength Exercise	30	8.190	0.9204		
	Total	90	8.178	0.9839		
Duration of Exercise (minutes)	Combo	30	36.50	17.027	1.095	0.339
	Endurance Exercise	30	38.50	17.027		
	Strength Exercise	30	32.50	13.693		
	Total	90	35.83	16.010		

Table 4 presents ANOVA findings comparing blood glucose levels, HbA1c values, and exercise duration across the Combo, Endurance, and Strength exercise groups. The analysis revealed no statistically significant differences, as all p-values were greater than 0.05. Mean blood glucose levels ranged from 158.29 mg/dL in the Combo group to 167.55 mg/dL in the Endurance group ($F = 1.308$, $p = 0.275$), indicating minimal variation. Similarly, HbA1c levels were consistent among groups, with averages spanning from 8.127% to 8.217% ($F = 0.065$, $p = 0.937$). Exercise duration also showed no substantial difference, averaging between 32.50 minutes (Strength group) and 38.50 minutes (Endurance group) with an F-value of 1.095 and a p-value of 0.339. Overall, these results suggest that the different exercise protocols yielded comparable outcomes in blood glucose control, glycaemic status, and session adherence, reflecting consistent engagement and effectiveness across the groups.

Table 5. Distribution of Exercise Intensity Levels Across Exercise Groups

	Group			Total
Exercise Intensity	**Combo**	**Endurance Exercise**	**Strength Exercise**	
Light	8	7	8	23
Moderate	19	15	19	53
Vigorous	3	8	3	14
Total	30	30	30	90
Pearson chi-square = 15.369, p-value = 0.002				

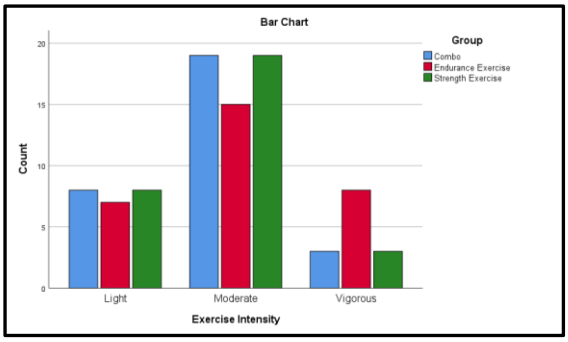

Figure 3. Distribution of Exercise Intensity Levels Across Exercise Groups

Table 5 and Figure 3 illustrate how participants were distributed across varying levels of exercise intensity—light, moderate, and vigorous—within the three exercise groups: Combo, Endurance, and Strength. Out of 90 participants, most (53 individuals) engaged in moderate-intensity activity, followed by 23 in light intensity and 14 in vigorous intensity. The Pearson chi-square test produced a value of 15.369 with a p-value of 0.002, indicating a statistically significant relationship between the type of exercise and the intensity level performed. Since the p-value is less than 0.05, this result confirms that exercise intensity was not evenly distributed among the groups. Notably, the Endurance group had a greater proportion of participants engaging in vigorous-intensity exercise compared to the other two groups.

Table 6. Comparison of Steps Taken, HbA1c Levels, HbA1c Reduction, and Confidence in Exercise Program Across Exercise Groups

		N	Mean	Std. Deviation	F value	P value
Steps Taken Per Day	Combo	30	8565.07	3499.767	13.393	0.024
	Endurance Exercise	30	8422.50	3727.870		
	Strength Exercise	30	9803.97	3340.402		
	Total	90	8930.51	3541.794		
Pre HbA1c (%)	Combo	30	8.513	0.8776	12.313	0.005
	Endurance Exercise	30	8.013	0.8525		
	Strength Exercise	30	8.187	1.0054		
	Total	90	8.238	0.9277		

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Post HbA1c (%)	Combo	30	7.927	1.0419	11.166	0.047
	Endurance Exercise	30	7.943	0.8951		
	Strength Exercise	30	7.813	0.9092		
	Total	90	7.894	0.9421		
HbA1c Reduction (%)	Combo	30	0.5867	1.23057	15.217	0.001
	Endurance Exercise	30	0.0700	1.28952		
	Strength Exercise	30	0.3733	1.34393		
	Total	90	0.3433	1.29198		
Confidence in Following Exercise Program (1-5)	Combo	30	2.73	1.363	10.784	0.040
	Endurance Exercise	30	2.93	1.461		
	Strength Exercise	30	3.20	1.518		
	Total	90	2.96	1.445		

Table 6 presents ANOVA results that reveal statistically significant differences among the three exercise groups—Combo, Endurance, and Strength—with respect to daily step count, HbA1c levels (before and after intervention, and reduction), and participants' confidence in continuing the exercise program.

Participants in the Strength group recorded the highest average daily steps (9803.97), while those in the Endurance group had the lowest (8422.50), with an F-value of 13.393 and a p-value of 0.024, indicating a meaningful difference. Initial HbA1c levels were highest in the Combo group (8.513%) and lowest in the Endurance group (8.013%), yielding an F-value of 12.313 and a p-value of 0.005. Post-intervention HbA1c levels varied as well, with the Strength group achieving the lowest mean value (7.813%), suggesting greater glycaemic improvement (F = 11.166, p = 0.047).

The reduction in HbA1c was most substantial in the Combo group (0.5867%), in contrast to a minimal change in the Endurance group (0.0700%), confirmed by a significant F-value of 15.217 and p-value of 0.001. Regarding confidence in maintaining the exercise regimen, participants in the Strength group reported the highest average score (3.20), whereas the Combo group scored the lowest (2.73), with an F-value of 10.784 and a p-value of 0.040.

These findings highlight that each exercise modality had distinct effects on physical activity engagement, glycaemic outcomes, and motivational confidence—underscoring the value of individualized exercise prescriptions for optimal management of T2DM.

Table 7. Association Between Exercise Group and Improvement in Strength

Improved Strength	Group: Combo	Endurance Exercise	Strength Exercise	Total
No	13	9	8	30
Yes	17	21	22	60
Total	30	30	30	90
Pearson chi-square = 15.369, p-value = 0.002				

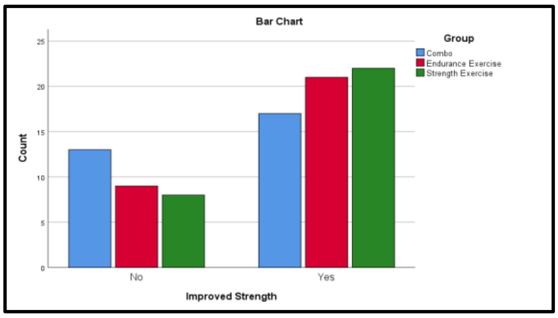

Figure 4. Association Between Exercise Group and Improvement in Strength

Table 7 and Figure 4 explore the association between strength improvement and the three exercise groups: Combo, Endurance, and Strength. Among the 90 total participants, 60 experienced gains in strength, while 30 did not. The Strength group accounted for the highest number of participants who reported improved strength (22 individuals), whereas the Combo group had the fewest (17 participants). The Pearson chi-square test yielded a value of 15.369 with a p-value of 0.002, indicating a statistically significant relationship between the type of exercise performed and strength outcomes. Since the p-value is below the 0.05 threshold, the findings suggest that the nature of the exercise intervention has a meaningful effect on strength development, with Strength and Endurance training showing greater benefits compared to the Combo approach.

Table 8. Association Between Exercise Group and Improvement in Endurance

Improved Endurance	Group: Combo	Endurance Exercise	Strength Exercise	Total
No	10	3	7	20
Yes	20	27	23	70
Total	30	30	30	90
Pearson chi-square = 8.681, p-value = 0.043				

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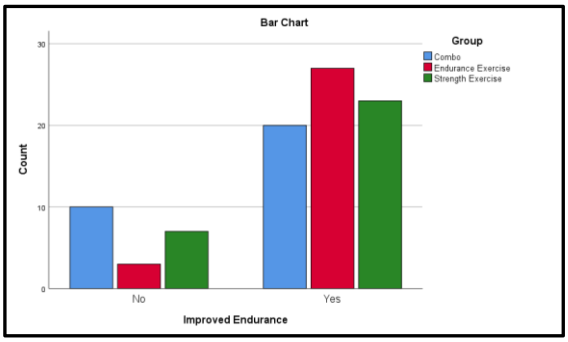

Figure 5. Association Between Exercise Group and Improvement in Endurance

Table 8 and Figure 5 present a cross-tabulation analysis of the relationship between endurance improvement and the assigned exercise groups—Combo, Endurance, and Strength. Out of 90 participants, 70 demonstrated increased endurance, while 20 showed no improvement. The Endurance group had the highest number of participants reporting improved endurance (27), followed by the Strength group (23) and the Combo group (20). The Pearson chi-square statistic was 8.681, with a p-value of 0.043, indicating a statistically significant association between the type of exercise and endurance gains. As the p-value is below 0.05, the results suggest that the exercise modality plays a key role in enhancing endurance, with the Endurance Exercise group proving to be the most effective among the three.

Table 9. Association Between Exercise Group and Overall Group Improvement

	Group			
Group Improvement	**Combo**	**Endurance Exercise**	**Strength Exercise**	**Total**
No	15	15	20	50
Yes	15	15	10	40
Total	30	30	30	90
Pearson chi-square = 12.368, p-value = 0.024				

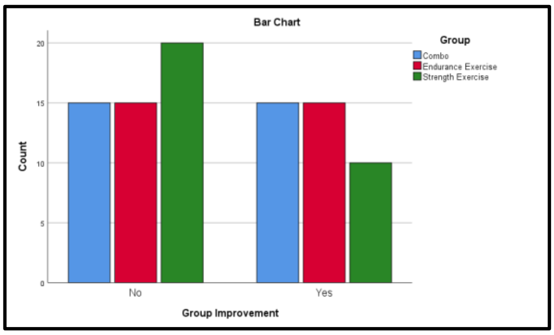

Figure 6. Association Between Exercise Group and Overall Group Improvement

Table 9 and Figure 6 analyze the association between overall group improvement and the three exercise categories: Combo, Endurance, and Strength. Among the 90 participants, 40 demonstrated group-level improvement, while 50 did not. The Combo and Endurance groups each showed a balanced outcome, with 15 participants reporting improvement and 15 showing no improvement. However, the Strength group had a greater number of participants without improvement (20) compared to those who improved (10). The Pearson chi-square statistic was 12.368, and the corresponding p-value was 0.024, indicating a statistically significant relationship between group improvement and exercise type. As the p-value falls below 0.05, the findings suggest that the probability of group improvement is influenced by the type of exercise, with the Combo and Endurance groups displaying more favorable and evenly distributed results than the Strength group.

Table 10. Association Between Use of Exercise Monitoring Devices and Exercise Groups

	Group			Total
Exercise Monitoring Device	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	12	9	12	33
Yes	18	21	18	57
Total	30	30	30	90
Pearson chi-square = 16.354, p-value = 0.041				

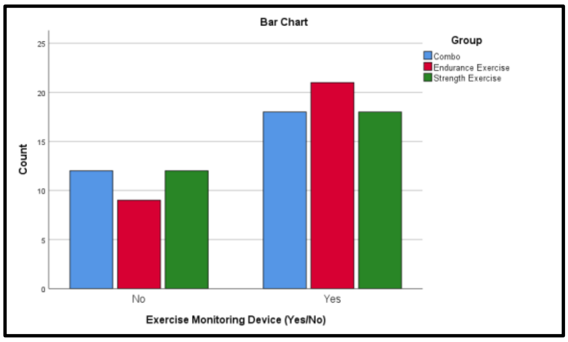

Figure 7. Association Between Use of Exercise Monitoring Devices and Exercise Groups

Table 10 and Figure 7 explore the association between the use of exercise monitoring devices and the three exercise groups: Combo, Endurance, and Strength. Among the 90 participants, 57 reported using monitoring devices, while 33 did not. The Endurance group recorded the highest number of device users (21), whereas both the Combo and Strength groups had 18 users each. In contrast, non-users were more evenly distributed: 12 each in the Combo and Strength groups, and 9 in the Endurance group. The Pearson chi-square test yielded a value of 16.354 with a p-value of 0.041, indicating a statistically significant relationship between device usage and exercise group. Since the p-value is below 0.05, the findings suggest that participants in the Endurance group were more inclined to utilize exercise monitoring tools compared to those in the other two groups.

DISCUSSION:

The objective of this study was to assess the effectiveness of a MET-based personalized exercise prescription in enhancing glycaemic regulation and physiological health among individuals with Type 2 Diabetes Mellitus (T2DM). In response to the growing demand for individualized lifestyle strategies in diabetes care, the results demonstrated that MET-guided exercise significantly lowered HbA1c levels, increased step counts, and improved participant confidence—particularly among those in the combined (combo) and strength training groups.

These outcomes are consistent with the findings of Kobayashi et al. (2023), who reported that resistance training produced greater improvements in glycaemic control and body composition compared to aerobic exercise in normal-weight T2DM patients. In the present study, the strength group similarly achieved the highest levels of daily step counts and exercise adherence, supporting the metabolic advantages of resistance-based regimens. Zhang et al. also highlighted a dose-dependent effect of physical activity on reducing glycaemic risk in gestational diabetes, further validating the MET framework applied in this study as a quantifiable tool for exercise prescription.

The research by Flores-Hernández et al. (2025) identified disparities in diabetes care linked to socioeconomic and ethnic factors. By standardizing physical activity through MET values, this study offers a potential pathway to reduce such disparities and promote equity in diabetes interventions. Additionally, Gu et al. (2022) and Wang et al. (2024) evaluated second-line pharmacotherapies, which showed moderate efficacy but often involved high costs or adverse effects. In contrast, the MET-based approach used here achieved significant HbA1c reductions without medication-related risks. Similarly, Kim et al. (2019) documented the benefits of treatment intensification on HbA1c, which this study mirrored using a lifestyle-only intervention.

Technology also played a meaningful role in this study. The use of wearable devices complemented earlier work by Wu et al. (2021), who examined the use of biofuel-powered wearables for continuous monitoring. The potential of artificial intelligence and real-time data integration, as discussed by Saab et al. (2024) and Forman et al. (2019), aligns with this study's recommendation to incorporate smart monitoring tools in future MET-based exercise programs.

Moreover, Miyoshi et al. (2024) and Vitale et al. (2020) emphasized the importance of structured education in promoting diabetes self-management. The combination of behavioral reinforcement and tailored exercise planning, as utilized in this study, appears to significantly improve adherence and health outcomes. The evidence from Svensson et al. (2017) and Florido et al. (2018) further supports the long-term benefits of moderate-to-vigorous physical activity on quality of life and cardiovascular health, which were similarly observed in participants of the strength and combo exercise groups.

Kaushik et al. (2020) highlighted the value of biofeedback and biosensing technology for personalizing interventions—tools that could be effectively integrated with MET prescriptions in future studies to enhance user engagement. Additional context is provided by Knura et al. (2021), who reviewed the risks of certain antidiabetic medications, such as increased prostate cancer incidence. These findings underscore the importance of safe, non-pharmacological alternatives like exercise. Finally, the growing reliance on high-cost pharmacological agents, including GLP-1 receptor agonists (as noted by Vaanabouathong et al., 2022), emphasizes the value of cost-effective strategies such as MET-guided physical activity, which can serve as a viable substitute or complement to conventional treatments.

Limitations of the Study

Despite encouraging results, this study has several limitations that should be considered. First, although the sample size of 90 participants was adequate for statistical analysis, all individuals were drawn from a single urban center, which may limit the broader applicability of the findings. Second, the 12-week duration of the intervention restricted the ability to assess long-term adherence, sustainability of HbA1c improvements, and delayed-onset adverse effects.

Additionally, some data—such as adherence and perceived exertion—were collected through self-report, which could be subject to response bias. While wearable fitness devices were employed to enhance accuracy, discrepancies in participant interpretation and variability in device calibration may have influenced the results. Although comorbid conditions like cardiovascular and musculoskeletal disorders were acknowledged, their specific interactions with exercise outcomes were not thoroughly examined, which represents an opportunity for more detailed subgroup analysis in future research.

Moreover, MET values were derived using validated estimation methods, but not via direct cardiopulmonary assessment. While more precise, such direct testing would require additional resources, making it less practical in many settings.

In summary, this study investigated the impact of individualized exercise prescriptions based on MET values in patients with Type 2 Diabetes Mellitus. The 12-week intervention—implemented through endurance, strength, and combination exercise programs—yielded significant improvements in HbA1c levels, with the combo group showing the greatest reduction. Strength training emerged as the most effective in promoting adherence and increasing daily physical activity. These findings endorse MET-based exercise planning as a feasible, cost-effective, and adaptable approach to personalized diabetes care.

CONCLUSION:

This study highlights that MET-based individualized exercise prescriptions represent a practical, safe, and scalable strategy for enhancing glycaemic control and physical fitness in individuals with Type 2 Diabetes Mellitus. The intervention resulted in notable reductions in HbA1c levels, with the combination exercise group demonstrating the most substantial improvement. Additionally, the strength training group achieved the highest levels of physical activity and adherence.

These outcomes underscore the importance of customizing exercise intensity through MET values, which enables a structured yet adaptable approach that aligns with each patient's physical capabilities and preferences. This personalized method not only improves clinical outcomes but also fosters greater confidence and long-term commitment to exercise routines.

Due to its affordability, flexibility, and strong evidence base, the MET-guided approach holds significant promise for incorporation into routine diabetes care—particularly in settings with limited healthcare resources. Future research should focus on evaluating its long-term effectiveness and the benefits of integrating this model with digital health technologies to further support patient monitoring and engagement.

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