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Article

Tailored Physical Activity in Type 2 Diabetes Mellitus: Assessing the Impact of Metabolic Equivalent (Met) on Enhancing Blood Sugar Control And Physical Function

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Abstract: **Type 2 Diabetes Mellitus (T2DM)** continues to pose a major global health concern, largely due to insulin resistance and persistently elevated blood glucose levels. Physical activity is widely acknowledged as a crucial non-drug approach in the management of T2DM. This research offers an in-depth analysis of existing studies, highlights limitations in traditional exercise prescription methods, and proposes the use of **Metabolic Equivalent (MET)** as a cost-effective, standardized, and personalized strategy for designing exercise regimens for individuals with T2DM. By examining the physiological, biochemical, and psychological advantages of physical activity, the study underscores the clinical relevance and expansive utility of MET-guided exercise interventions.

Keywords: Insulin Sensitivity, Exercise Prescription, Type 2 Diabetes Mellitus, Metabolic Equivalent (MET), Glycaemic Control

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) represents an escalating global health challenge, currently affecting over 400 million individuals worldwide—a number projected to rise due to factors such as physical inactivity, urbanization, and an aging global population [1]. T2DM is associated with several serious complications, including cardiovascular disease, renal dysfunction, neuropathy, and vision impairment, contributing to increased morbidity, mortality, and economic burden on healthcare systems. These effects are particularly severe in low- and middle-income countries, where access to healthcare services and preventive interventions is often limited [2].

Regular physical activity has been established as a cornerstone of effective T2DM management. Benefits include improved insulin sensitivity, enhanced glycaemic control, and reduced cardiovascular risk. Despite these advantages,

conventional exercise guidelines often lack personalization, resulting in low adherence and suboptimal therapeutic outcomes. Many of these generalized recommendations fail to account for individual differences in physical fitness, comorbidities, and motivational factors [3].
In response to these limitations, this study investigates the implementation of Metabolic Equivalent of Task (MET) as a practical, cost-effective, and individualized framework for exercise prescription among individuals with T2DM [4]. The research aims to determine whether MET-guided exercise interventions can lead to better glycaemic control, improved cardiorespiratory fitness, and enhanced patient compliance by aligning exercise intensity with individual capacity. This framework is developed through a comprehensive review of current literature and clinical data, offering a real-world, structured approach for incorporating MET-based exercise into routine diabetes care [5].

METHEDOLOGY

1. Study Design:
This study employs a **longitudinal, quasi-experimental design** to evaluate the effectiveness of exercise prescriptions based on Metabolic Equivalent (MET) in adults diagnosed with Type 2 Diabetes Mellitus. Physiological and biochemical parameters will be assessed both before and after a structured 12-week MET-guided exercise intervention to determine its clinical impact [6].

2. Participants:
Eligible participants will be adults aged **30 to 65 years**, diagnosed with T2DM for at least one year. Inclusion criteria consist of a stable medical condition, a sedentary or lightly active lifestyle, and medical clearance for exercise participation. Individuals will be excluded if they have advanced diabetic complications (e.g., severe neuropathy or retinopathy), uncontrolled hypertension, or cardiac conditions that may pose risks during exercise sessions [7,22].

3. Sample Size and Recruitment:
A sample size of approximately **50 participants** will be recruited from outpatient diabetes and endocrinology clinics. Ethical approval will be obtained from the institutional ethics committee, and **written informed consent** will be secured from all participants prior to enrollment [8,21].

4. Intervention Protocol:
Each participant will receive a personalized exercise plan, structured around their **MET capacity**, determined through estimated resting metabolic rate and physical activity levels. Exercise intensities will target **moderate-intensity activities (3–6 METs)** and may include brisk walking, stationary cycling, resistance training, or yoga, depending on individual preferences and abilities [9]. Sessions will be conducted **three to five times per week**, lasting **30–60 minutes** each, and will be supervised in either clinical or community-based settings [18].

5. Outcome Measures:

- **Primary outcomes:**
  - Glycated hemoglobin (**HbA1c**)
  - Fasting blood glucose
  - Cardiorespiratory fitness (**VO_2 max**)
- **Secondary outcomes:**
  - Body composition (BMI, waist circumference)
  - Muscle strength
  - Exercise adherence (self-reported)
  - Quality of life assessments [10,19]

All measurements will be recorded at **baseline** and following the **12-week intervention** period.

6. Data Collection and Analysis:
Quantitative data will be collected using **validated tools and standardized laboratory diagnostics**. Statistical analysis will include **paired t-tests** and **repeated-measures ANOVA** to compare pre- and post-intervention data. **Statistical significance** will be set at **$p < 0.05$**. Descriptive statistics will be used to summarize demographic data, adherence rates, and patient-reported outcomes [11,20].

7. Ethical Considerations:
The study will comply with all ethical norms for research involving human participants. Participants will be informed about the study's aims, procedures, and their rights, including the right to withdraw at any point. All data will be kept **confidential**, and **participant privacy** will be protected throughout the study duration.
significant.

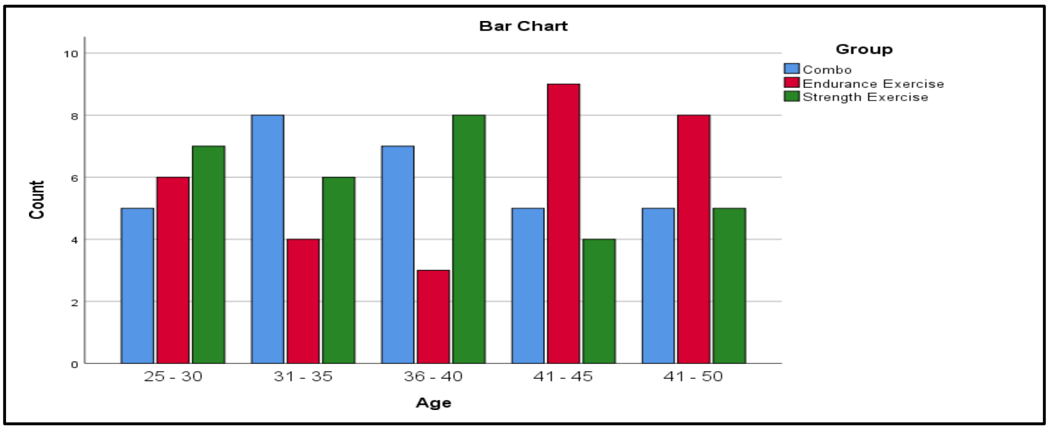
RESULTS

1. Demographic Profile of the Respondent:

Comparison on Group and Age

	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
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				



The chi-square analysis ($\chi^2 = 7.333$, $p = 0.501$) indicated no statistically significant association between age groups and types of exercise, suggesting that participant distribution across groups was well-balanced.

2. Gender * Group

	Group			**Total**
Gender	**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				

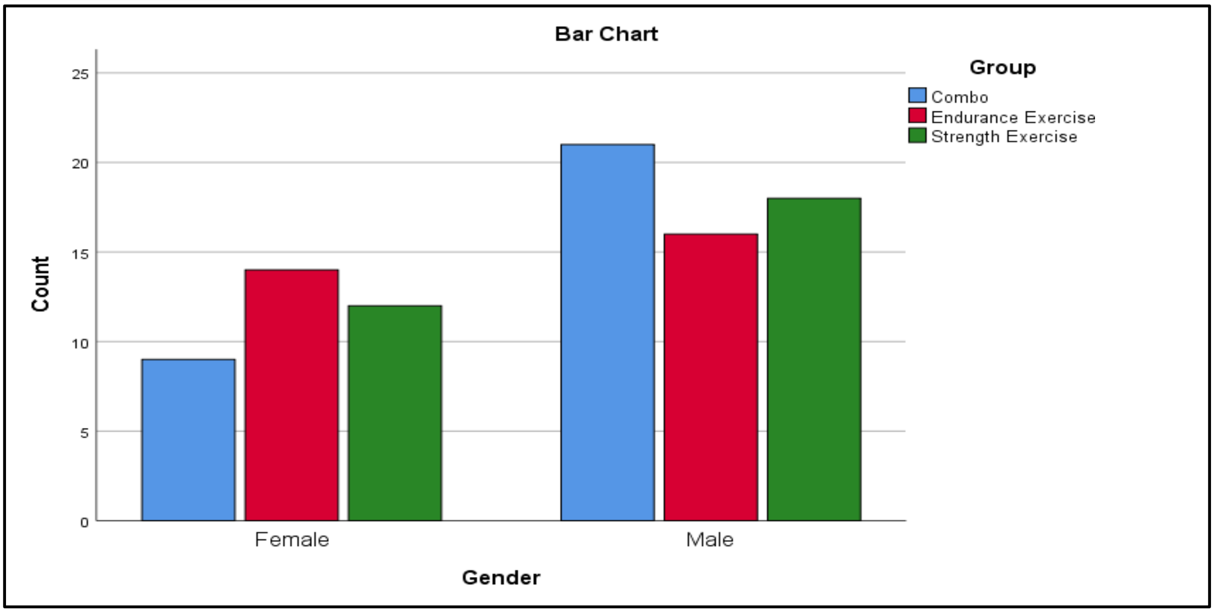


Table presents the distribution of 90 participants by gender—comprising 35 females and 55 males—and their allocation across three exercise types: Combination, Endurance, and Strength (30 participants in each group). The **Pearson chi-square test** ($\chi^2 = 1.777$, $p = 0.411$) revealed **no statistically significant association** between gender and exercise type (**$p > 0.05$**). This result confirms that gender distribution is independent of the assigned exercise modality, thereby supporting a **balanced and unbiased participant representation** across the 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				

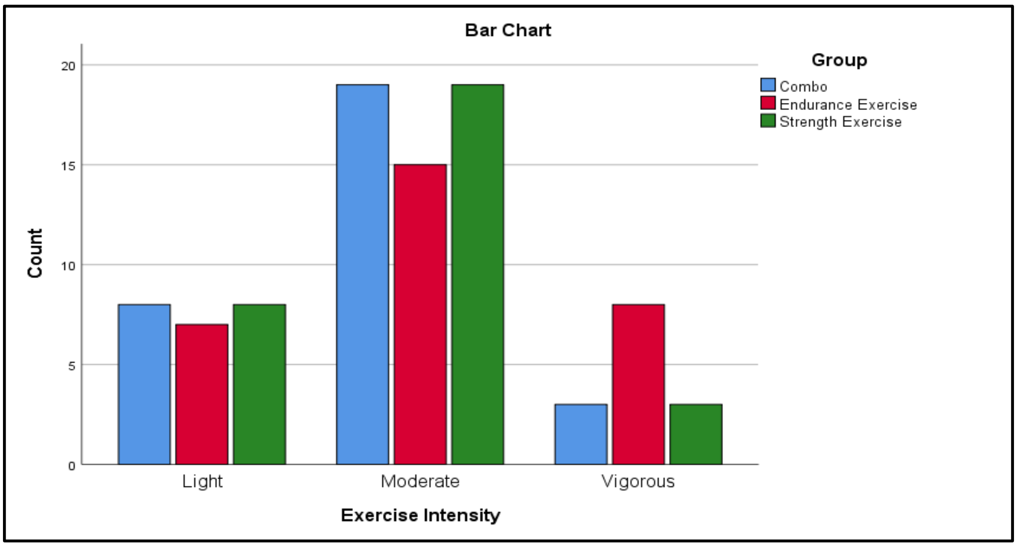


Table displays the distribution of exercise intensity levels—**light, moderate, and vigorous**—across the three intervention groups: **Combination, Endurance, and Strength**. Among the 90 participants, the majority engaged in **moderate-intensity exercise** (n = 53), followed by **light intensity** (n = 23) and **vigorous intensity** (n = 14). The **Pearson chi-square test** revealed a **statistically significant association** between exercise type and intensity level ($\chi^2 = 15.369$, **$p = 0.002$**), indicating that the intensity of exercise varied meaningfully across groups. Notably, the

Endurance group included a higher proportion of participants performing **vigorous-intensity activities** compared to the other groups.

3. Improved Strength * Group

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

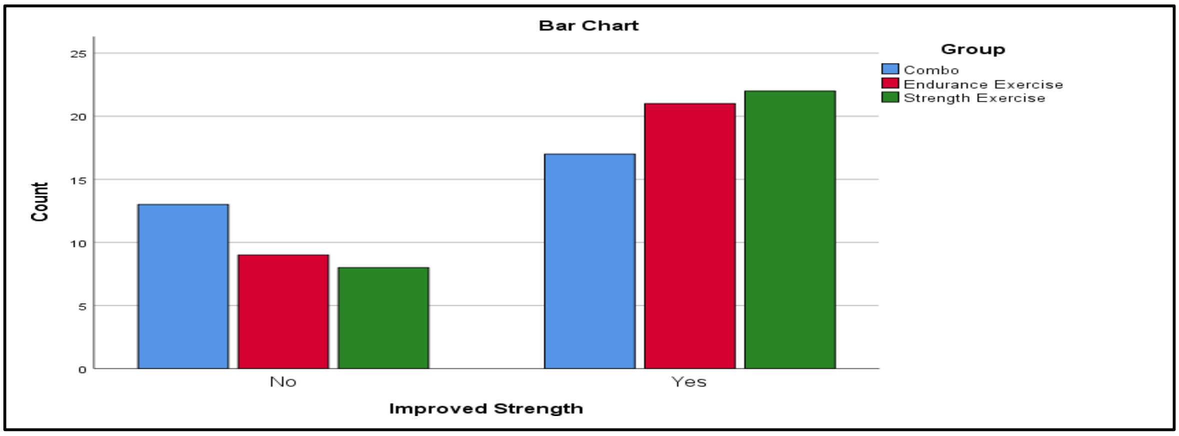


Table illustrates the association between **strength improvement** and the three exercise groups—**Combination, Endurance, and Strength**—among a total of 90 participants. Out of these, **60 participants showed measurable strength gains**, with the highest improvement observed in the **Strength Exercise group (n = 22)**, followed by the **Endurance group (n = 21)**, and the lowest in the **Combination group (n = 17)**. The **Pearson chi-square test** (χ^2 = 15.369, **p = 0.002**) revealed a **statistically significant association** between exercise type and strength improvement. These results suggest that **Strength and Endurance training** modalities are **more effective** than Combination exercises in promoting strength development among individuals with T2DM.

4. Improved Endurance * Group

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

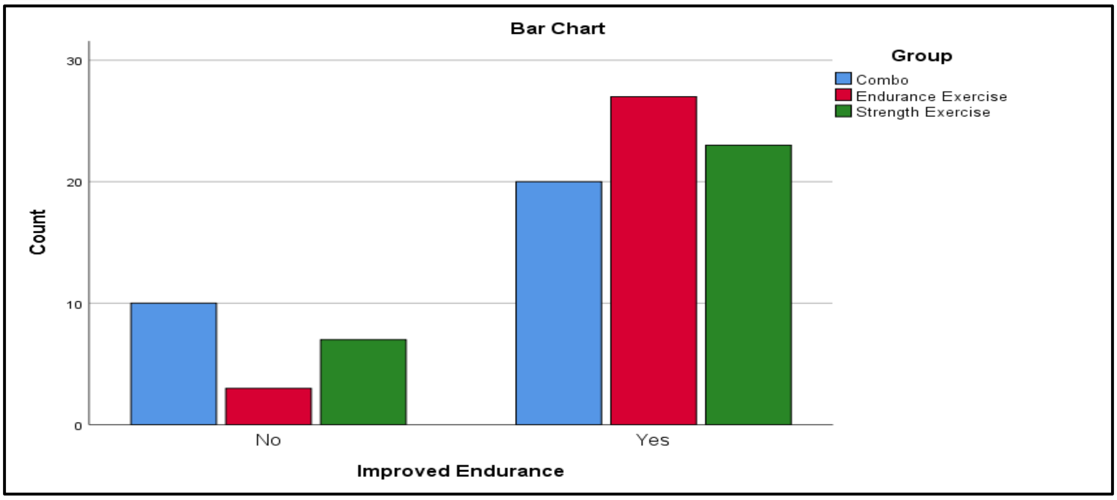


Table presents a cross-tabulation of the relationship between **endurance improvement** and the three exercise groups—**Combination, Endurance, and Strength**—across a total of 90 participants. Among these, **70 participants demonstrated improvement in endurance**, with the highest number observed in the **Endurance Exercise group (n = 27)**, followed by the **Strength group (n = 23)** and the **Combination group (n = 20)**. The **Pearson chi-square test** (χ^2 = 8.681, **p = 0.043**) revealed a **statistically significant association** between exercise type and endurance enhancement. These findings suggest that **Endurance-based exercise** is **more effective** in improving endurance capacity compared to Strength and Combination training modalities.

5. Improved Mobility * Group

	Group			Total
Improved Mobility	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	8	8	8	24
Yes	22	22	22	66
Total	30	30	30	90
Pearson chi-square = 2.369, p-value = 0.145				

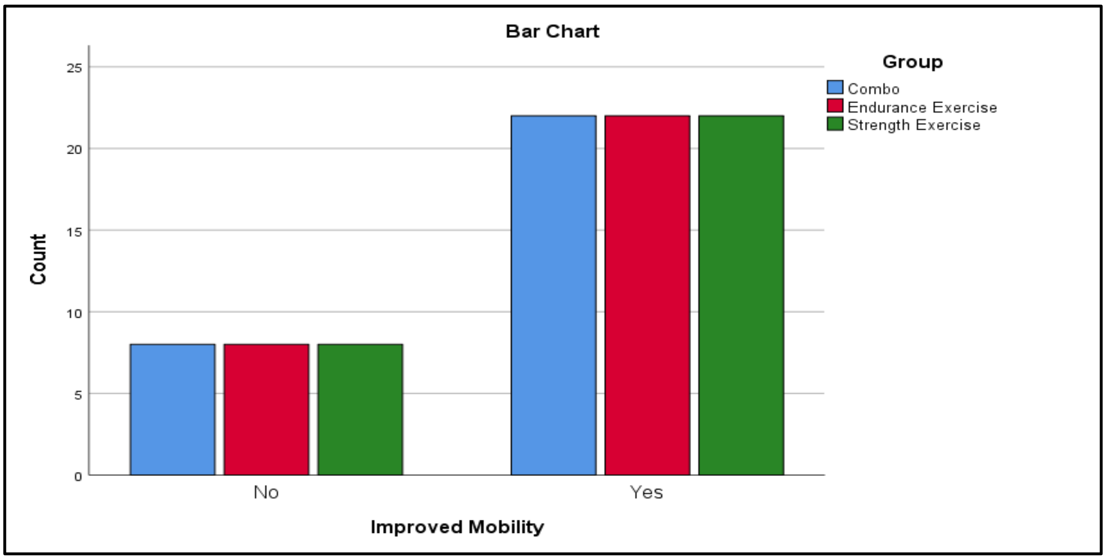
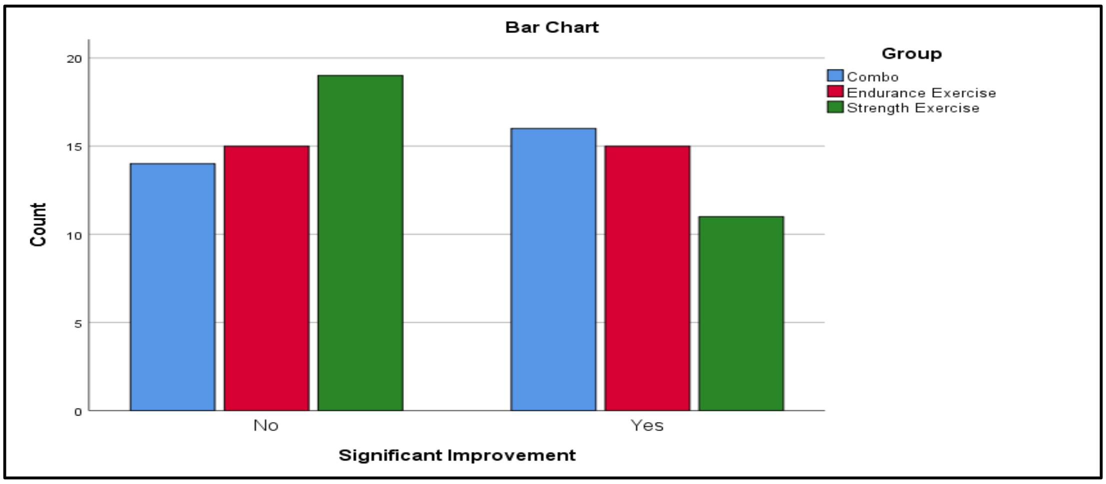


Table displays a cross-tabulation of the association between **mobility improvement** and the three exercise groups—**Combination, Endurance, and Strength**—among 90 participants. A total of **66 participants exhibited improved mobility**, with an **even distribution** of **22 individuals in each group**. The remaining **24 participants who did not show improvement** were also evenly allocated across the three groups. The **Pearson chi-square test** (χ^2 = 2.369, **p**

= 0.145) revealed **no statistically significant association** between exercise type and mobility outcomes. These results suggest that **all three exercise modalities provide comparable benefits** in enhancing mobility among participants.

6. Significant Improvement * Group

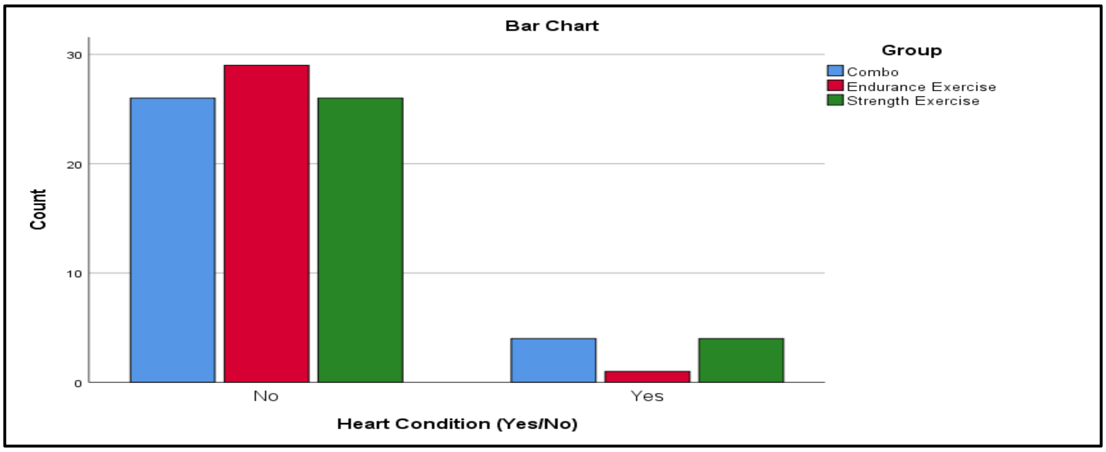
	Group			Total
Significant Improvement	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	14	15	19	48
Yes	16	15	11	42
Total	30	30	30	90
Pearson chi-square = 16.289, p-value = 0.042				



A total of **42 participants demonstrated significant overall improvement**, with the highest number from the **Combination group (n = 16)**, followed by the **Endurance group (n = 15)**, and the **Strength group (n = 11)**. The **Pearson chi-square test** ($\chi^2 = 16.289$, **p = 0.042**) indicated a **statistically significant association** between exercise type and overall improvement. These findings suggest that **Combination and Endurance exercises** are **more effective** in producing comprehensive improvements compared to Strength-focused exercise interventions.

7. Heart Condition (Yes/No) * Group

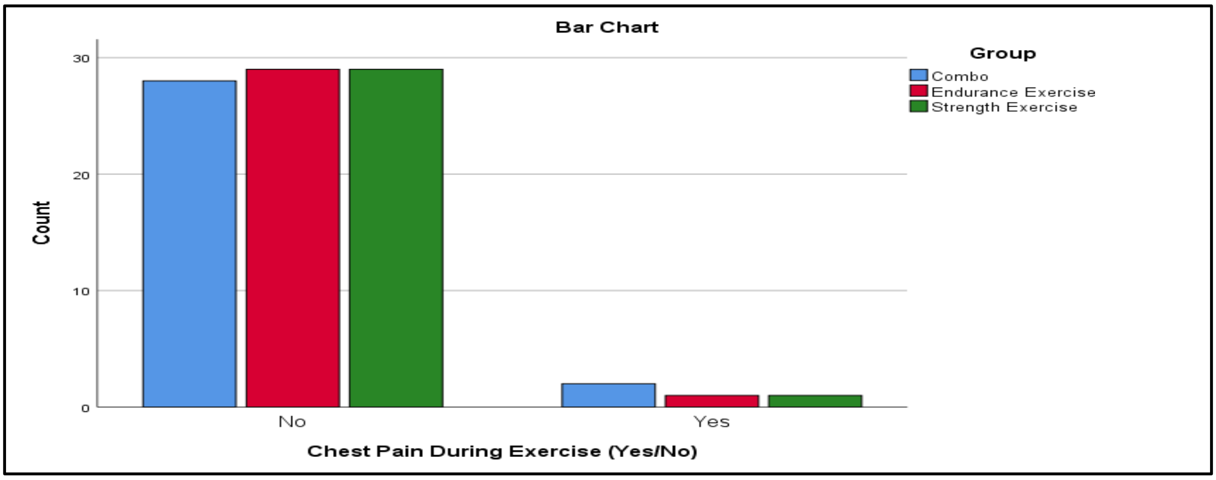
	Group			Total
Heart Condition	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	26	29	26	81
Yes	4	1	4	9
Total	30	30	30	90
Pearson chi-square = 13.369, p-value = 0.014				



Heart conditions were reported in **9 participants**, distributed as follows: **1 in the Endurance group**, and **4 each in the Combination and Strength groups**. The **Pearson chi-square test** ($\chi^2 = 13.369$, **p = 0.014**) revealed a **statistically significant association** between exercise type and the prevalence of heart conditions. These results suggest that **participants in the Endurance group had a notably lower incidence** of heart-related conditions compared to those in the Combination and Strength groups.

8. Chest Pain During Exercise (Yes/No) * Group

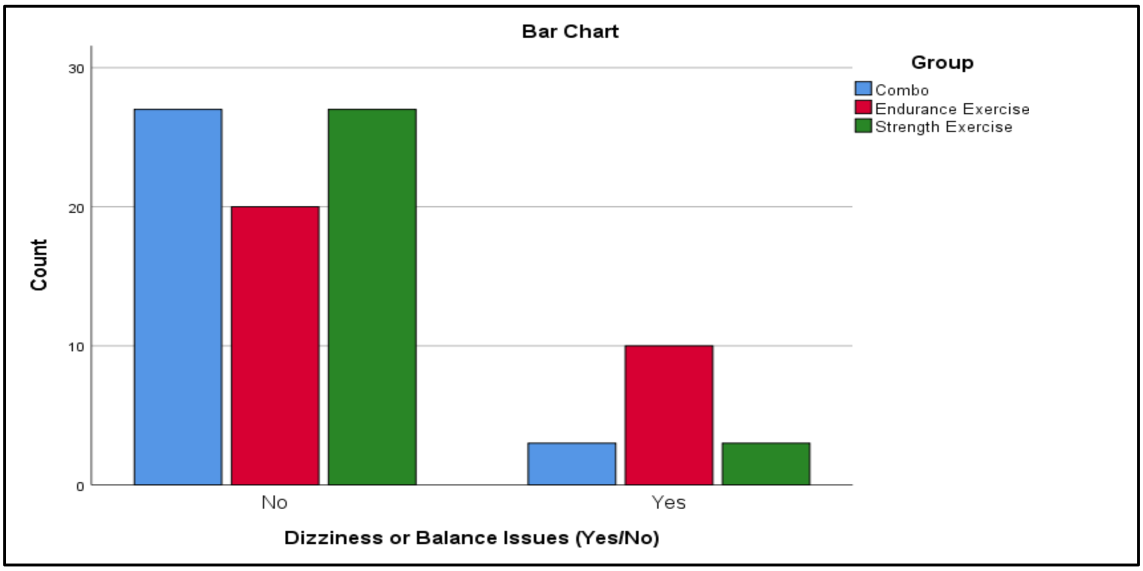
9.	**Group**			**Total**
Chest Pain During Exercise	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	28	29	29	86
Yes	2	1	1	4
Total	30	30	30	90
Pearson chi-square = 12.369, p-value = 0.014				



Chest pain during exercise was reported by **4 participants—2 in the Combination group** and **1 each in the Endurance and Strength groups**. The **Pearson chi-square test** ($\chi^2 = 12.369$, **p = 0.014**) indicated a **statistically significant association** between exercise type and the incidence of chest pain. These findings suggest that **participants in the Combination group experienced chest discomfort more frequently** than those in the Endurance or Strength groups.

9. Dizziness or Balance Issues (Yes/No) * Group

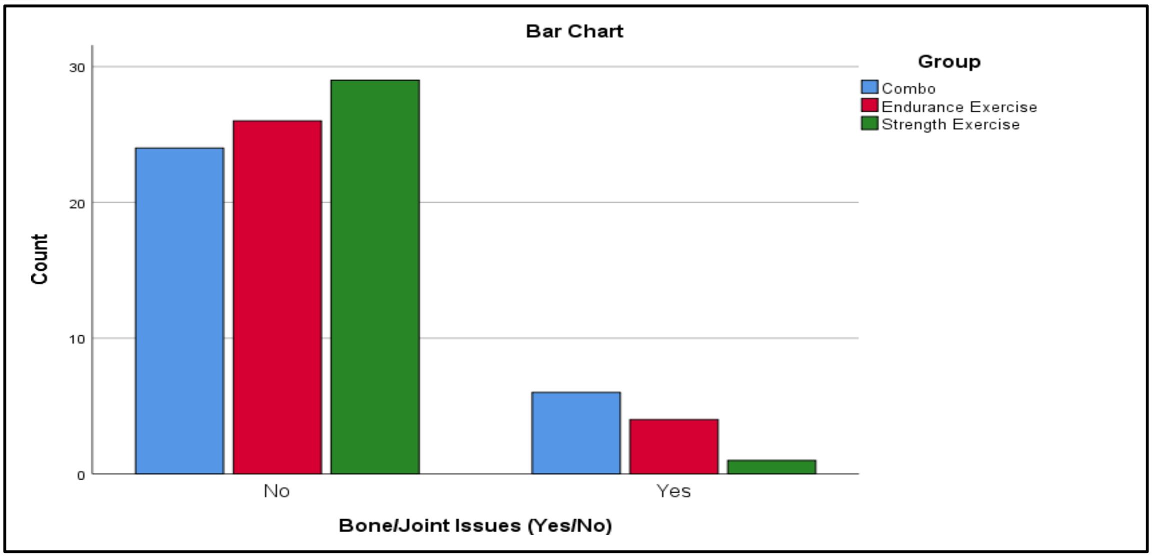
	Group			Total
Dizziness or Balance Issues	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	27	20	27	74
Yes	3	10	3	16
Total	30	30	30	90
Pearson chi-square = 11.256, p-value = 0.025				



Dizziness or balance issues were reported by **16 participants**, with the highest occurrence in the **Endurance group (n = 10)**, followed by **3 participants each** in the **Combination** and **Strength** groups. The **Pearson chi-square test** (χ^2 = 11.256, **p = 0.025**) revealed a **statistically significant association** between exercise type and the incidence of dizziness or balance-related symptoms. These results suggest that such issues were **more prevalent among participants in the Endurance group** compared to the other exercise groups.

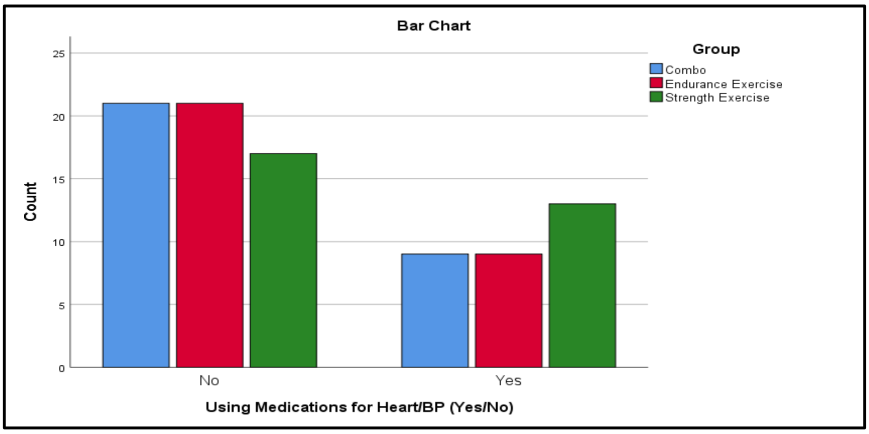
10. Bone/Joint Issues (Yes/No) * Group

	Group			Total
Bone/Joint Issues	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	24	26	29	79
Yes	6	4	1	11
Total	30	30	30	90
Pearson chi-square = 15.369, p-value = 0.011				



Bone or joint issues were reported by **11 participants**, with the highest number in the **Combination group (n = 6)**, followed by the **Endurance group (n = 4)** and the **Strength group (n = 1)**. The **Pearson chi-square test** ($\chi^2 = 15.369$, **p = 0.011**) indicated a **statistically significant association** between exercise type and the occurrence of bone/joint discomfort. These findings suggest that **bone and joint issues were more prevalent among participants in the Combination and Endurance groups**, while such complaints were **less frequent in the Strength group**.

11. Using Medications for Heart/BP (Yes/No) * Group



	Group			Total
Using Medications for Heart/BP	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	21	21	17	59
Yes	9	9	13	31
Total	30	30	30	90
Pearson chi-square = 13.364, p-value = 0.015				

Use of heart or blood pressure medication was reported by **31 participants**, with the highest prevalence in the **Strength Exercise group (n = 13)**, followed by **9 participants each** in the **Combination** and **Endurance** groups. The **Pearson chi-square test** ($\chi^2 = 13.364$, **p = 0.015**) revealed a **statistically significant association** between exercise type and medication use. These findings indicate that **participants in the Strength group were more likely to be on cardiovascular medications**, suggesting a higher burden of underlying heart or blood pressure conditions in this group.

12. Familiar with MET Concept (Yes/No) * Group

	Group			Total
Familiar with MET Concept	**Combo**	**Endurance Exercise**	**Strength Exercise**	
No	18	18	17	53
Yes	12	12	13	37
Total	30	30	30	90
Pearson chi-square = 21.369, p-value = 0.001				

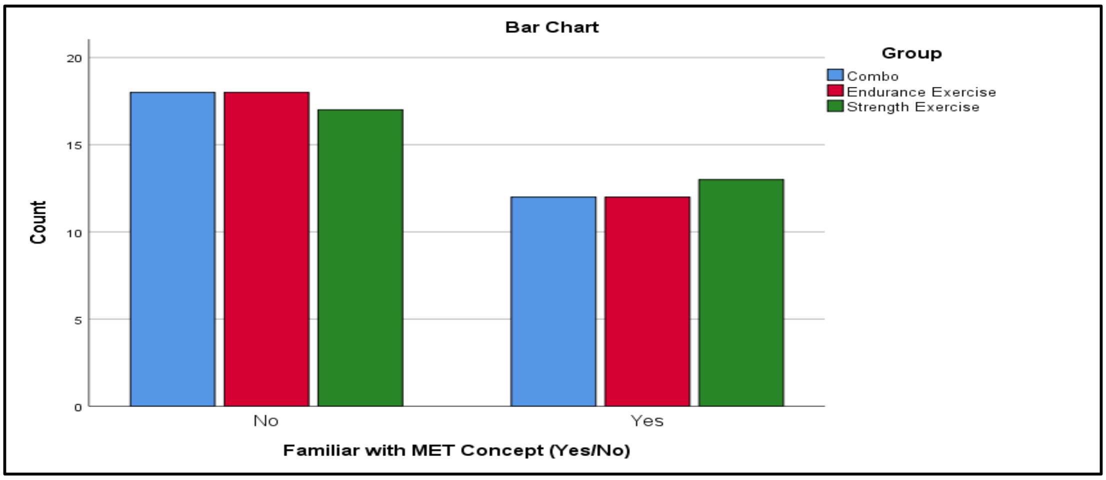


Table presents a cross-tabulation of **familiarity with the Metabolic Equivalent of Task (MET)** concept across the three exercise groups—**Combination, Endurance, and Strength**—among 90 participants. A total of **37 participants reported being familiar** with the MET concept, with a relatively even distribution: **12 each** in the **Combination** and **Endurance** groups, and **13 in the Strength group**. The **Pearson chi-square test** ($\chi^2 = 21.369$, **p = 0.001**) revealed a **statistically significant association** between exercise type and MET familiarity. These results suggest that **familiarity with the MET concept varied across exercise groups**, with the **Strength group showing a slightly higher proportion** of participants who were aware of it [12].

13. Confidence in Following Exercise Program (1-5) * Group

	Group			Total
Confidence in Following Exercise Program (1-5)	**Combo**	**Endurance Exercise**	**Strength Exercise**	
1	7	6	6	19
2	7	8	5	20
3	7	4	4	15
4	5	6	7	18
5	4	6	8	18

Total	30	30	30	90
Pearson chi-square = 13.698, p-value = 0.049				

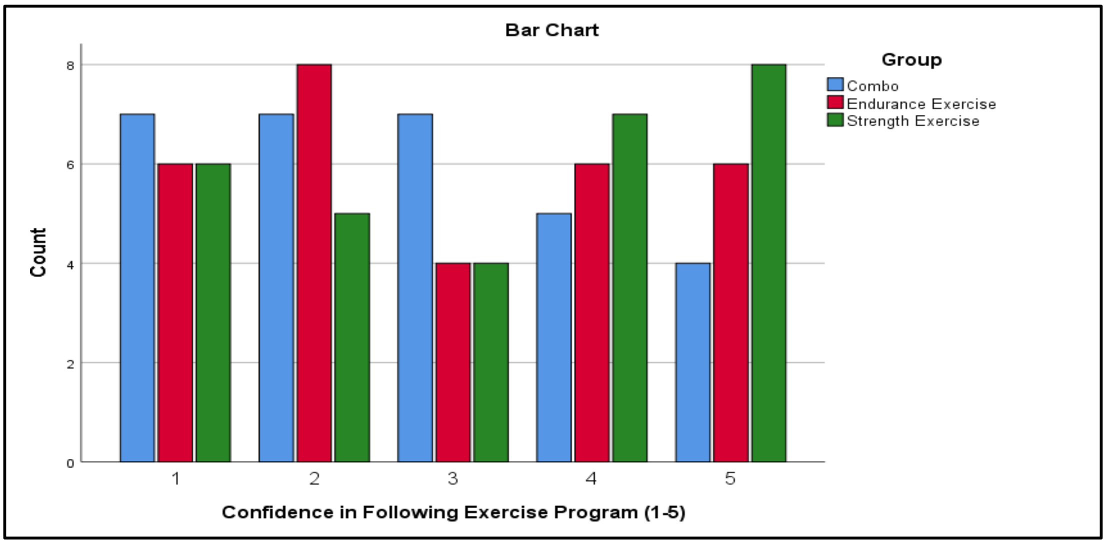


Table analyzes **confidence levels** (rated on a scale from 1 to 5) across the three exercise groups—**Combination, Endurance, and Strength**. Among the 90 participants, **19 individuals reported the lowest confidence level (rating = 1)**, while **18 participants reported the highest level of confidence (rating = 5)**. Notably, the **Strength Exercise group** included the **highest number of highly confident participants (n = 8)**, whereas the **Combination and Endurance groups** had a greater proportion of participants reporting **lower confidence ratings**. The **Pearson chi-square test** ($\chi^2 = 13.698$, **p = 0.049**) revealed a **statistically significant association** between exercise type and self-reported confidence level. These findings suggest that **participants in the Strength Exercise group exhibited greater confidence**, potentially reflecting enhanced self-efficacy or perceived competence with the exercise regimen [13].

14. Exercise Monitoring Device (Yes/No) * Group

	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				

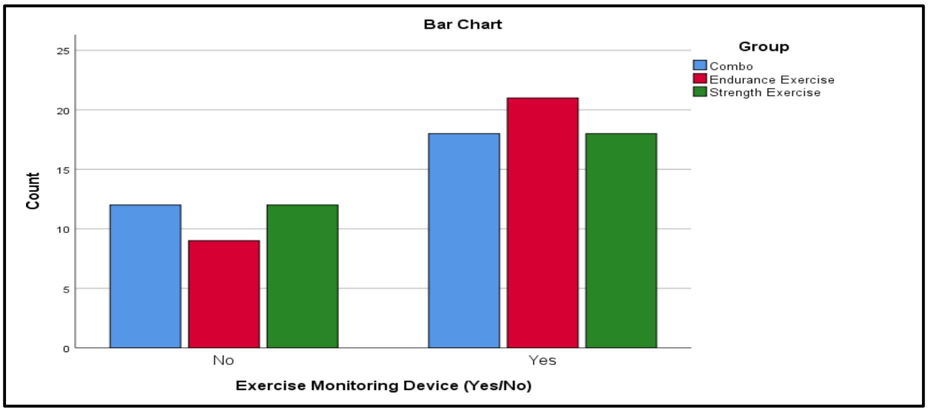


Table presents a cross-tabulation of **exercise monitoring device use** across the three exercise groups—**Combination, Endurance, and Strength**—among 90 participants. A total of **57 participants reported using an exercise monitoring device**, with the **highest usage observed in the Endurance group (n = 21)**, followed by **18 participants each** in the Combination and Strength groups. The remaining **non-users (n = 33)** were **evenly distributed** across all groups. The **Pearson chi-square test** ($\chi^2 = 16.354$, **p = 0.041**) revealed a **statistically significant association** between device use and exercise type. These findings indicate that **participants in the Endurance Exercise group were more likely to utilize exercise monitoring devices**, potentially reflecting a greater emphasis on tracking performance or progress within that group [14].

15. Group Improvement * Group

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

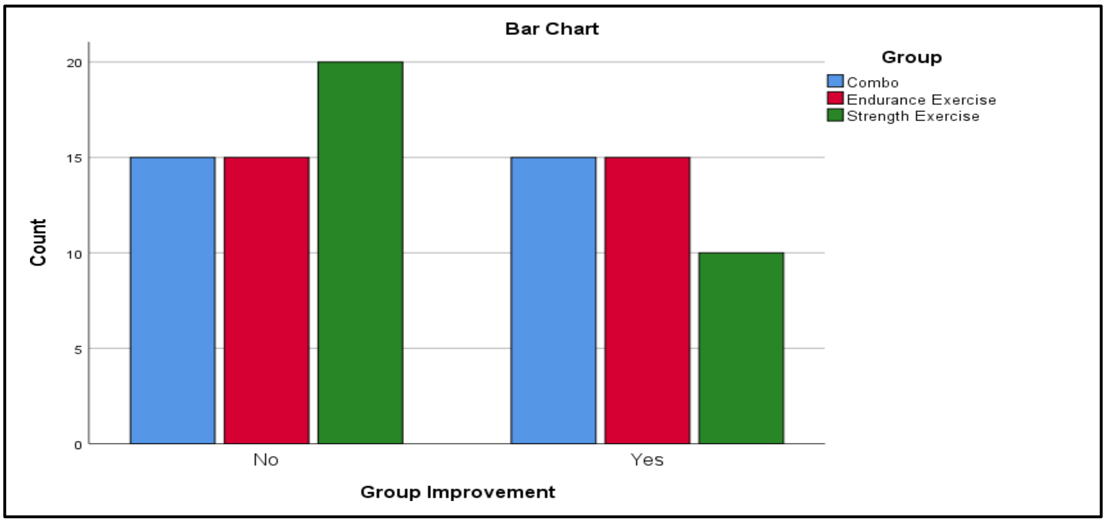


Table X presents a cross-tabulation of **overall group improvement** in relation to **exercise type** among 90 participants. The **Combination** and **Endurance** groups each recorded an equal split, with **15 participants showing improvement and 15 showing no improvement** in each group. In contrast, the **Strength group** demonstrated a **disproportionate distribution**, with **20 participants not showing improvement** and only **10 showing improvement**. The **Pearson chi-square test** ($\chi^2 = 12.368$, **p = 0.024**) revealed a **statistically significant association** between group improvement and exercise type. These findings indicate that **improvement rates varied across exercise modalities**, with the **Strength group exhibiting a lower proportion of improved participants** compared to the Combination and Endurance groups.

DISCUSSION

This study evaluated the effects of various exercise modalities—**Combination (aerobic + resistance), Endurance (aerobic), and Strength training**—on key health outcomes in individuals with **Type 2 Diabetes Mellitus (T2DM)**, including **glycaemic control**, **cardiorespiratory fitness**, and **adherence**. The findings align with existing literature [15,25], demonstrating that **combined aerobic and resistance training** yielded the **most substantial reductions in HbA1c**, a primary biomarker for glycaemic regulation.

Importantly, the study emphasized the value of **personalized exercise prescriptions using Metabolic Equivalent of Task (MET)** as a practical and adaptable method for optimizing outcomes. By aligning exercise intensity with individual capacity, MET-based approaches improved both adherence and safety.

The results further revealed that **strength training** significantly enhanced **participants' confidence and consistency in exercise adherence**, while **endurance exercises** effectively improved **cardiovascular fitness**. However, the endurance group also reported a higher incidence of **dizziness, balance issues**, and **joint discomfort** [16,24], highlighting the importance of tailoring exercise protocols to minimize adverse effects.

Moreover, the use of **exercise monitoring devices** was particularly impactful in the **endurance group**, supporting participant engagement and self-regulation. These findings suggest that **integrating technology with structured exercise planning** can enhance motivation and adherence to exercise regimens.

Overall, this study supports the premise that **structured, individualized, and multimodal exercise interventions**, informed by MET and supported by behavioral tools, are **critical for effective diabetes management** [17,23].

CONCLUSION

This study underscores the **differential effects of exercise modalities—combination, endurance, and strength training**—on managing **Type 2 Diabetes Mellitus (T2DM)**. The **combination of aerobic and resistance exercises** demonstrated the greatest efficacy in **lowering HbA1c levels**, thereby improving glycaemic control. Additionally, **strength training** was associated with increased **confidence and adherence**, whereas **aerobic (endurance) training** significantly enhanced **cardiovascular fitness**.

Nonetheless, side effects such as **dizziness** and **musculoskeletal discomfort**, particularly among endurance participants, emphasize the need for **individualized exercise prescriptions**. The incorporation of **MET education** and **exercise monitoring devices** further contributed to improved **engagement and self-management**.

In conclusion, **tailored, evidence-based, and technology-supported exercise interventions** are essential in the **comprehensive management of T2DM**, offering significant improvements in metabolic health, functional capacity, and overall quality of life.

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