

Beyond fitness: The impact of community-based exercise on body composition and metabolic health in Egyptian men

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Abstract

Visceral adiposity and insulin resistance are the determinants of sarcopenic obesity and metabolic syndrome and pose growing health problems in older Egyptian men. This study aims to assess the effectiveness of a structured exercise program in improving body composition, functional physical fitness, and cardiometabolic health in sedentary men aged 50–60 years who are overweight/obese in El Minya, Egypt. Twenty-four males (BMI ≥ 27.0 kg/m², mean age = 56.22 years) were randomly divided into two groups: an exercise group (n = 12) and a control group (n = 12). The intervention group participated in a 10-week, multi-component, supervised exercise program (aerobic, resistance, flexibility exercises; 3 sessions/week, 65–75 min/session) at a local sports facility. The control group continued with their normal lifestyles. The body composition parameters measured were BMI, body fat percentage, fat mass; the ten functional tests of physical fitness were assessed; and the cardiometabolic parameters measured were lipid profile, fasting glucose, HbA1c, blood pressure, blood lactate and VC. Independent and paired t-tests were used to analyze the data, and Cohen's d was used for effect sizes. There were no significant differences between groups at baseline ($p > 0.05$). The exercise group showed very significant changes in body weight (–4.30 kg), BMI (–1.47 kg/m²), body fat (–3.70%), and fat mass (–4.65 kg) after the intervention ($p < 0.001$). Every functional fitness parameter improved significantly ($p \leq 0.002$), notably plank endurance (+20.20 s, $d = 1.76$), leg strength (+15.50 kg, $d = 1.65$), and abdominal sit-ups (+6.30, $d = 1.58$). Moreover, there was a deep cardiometabolic recalibration as evident by the drop in: SBP (–10.10 mmHg); total cholesterol (–25.90 mg/dL); triglycerides (–30.20 mg/dL); LDL-C (–26.40 mg/dL); fasting glucose (–14.40 mg/dL); and HbA1c (–0.50%), and a rise in protective HDL-C (+7.30 mg/dL). There were no significant improvements in the control group. All delta comparisons between the groups were statistically significant ($p \leq 0.004$). A community-based exercise program is very effective in combating sarcopenic obesity, reversing prediabetic and atherogenic phenotypes, and restoring functional independence in older Egyptian men (50–60 years). The results strongly recommend that community sports facilities in Egypt, which are accessible to the public, should be part of the country's preventive healthcare system in order to prevent non-communicable lifestyle diseases.

Keywords Community-Based Exercise; metabolic syndrome; body composition; Insulin Resistance; Sarcopenic Obesity; Functional Fitness; Cardiometabolic Health.

Introduction

Metabolic syndrome (Mets) is one of the most important public health issues of the present day, defined as a cluster of cardiometabolic risk factors, such as central adiposity, atherogenic dyslipidemia, hypertension, and disrupted glucose homeostasis (Rybak et al., 2025). The prevalence of these metabolic disorders is rapidly increasing in the Arab region and especially in Egypt, mostly due to urbanization and sedentary lifestyle (Al-Daghri et al., 2014). There is impaired insulin sensitivity at the pathophysiological center of this crisis, which leads to a chain reaction of systemic dysfunctions, including endothelial damage and unregulated hepatic glucose output (Usui et al., 2010). This therefore suggests a more sustainable strategy of targeting the root cause to reduce downstream cardiometabolic complications.

Disproportionate deposition of visceral adipose tissue, a component of body composition, is a major a etiological factor of metabolic impairments. Visceral adiposity is an active endocrine organ that contributes to systemic inflammation and directly impairs insulin signaling pathways (Usui et al., 2010). At the same time, the constant lack of exercise makes this physiological decay even worse. Evidence clearly shows that reduced CRF is an independent factor in impairing lipid profile and hemodynamic responses, creating a physiological

environment that is very favorable for the development of Mets, especially in middle-aged men (Huot et al., 2011; Ugur-Altun et al., 2004).

Combined environmental and behavioral changes in Egypt, including hot temperatures making physical activity outdoors unattainable, as well as the high prevalence of hyper-caloric diets, have contributed to the emergence of an obesity epidemic among adult men (Hassan et al., 2024). Previous small-scale trials have shown that people with glucose intolerance can gain normal glucose tolerance with aggressive lifestyle changes, but these studies can be hard to implement in the real world. To fill this gap, it is necessary to adapt not only to a new clinical environment but also to use available community resources, including sports clubs and leisure facilities. Community-based approaches provide high accessibility, promote social integration, and provide a sustainable approach to providing multicomponent exercise interventions to vulnerable populations (García-Sánchez et al., 2020; Fien et al., 2022).

Hence, the present study was designed to examine the dramatic changes in body composition and metabolic health parameters of overweight sedentary Egyptian male subjects undergoing a 10-week community-based supervised exercise program. This research proposes to create evidence that can be translated into action to recognize that community sports facilities can be crucial components of the primary healthcare system and thus help to reshape the cardiometabolic path of vulnerable groups “beyond fitness”.

Research Hypotheses

H1: Participants who completed the community-based exercise intervention will have statistically significant improvement in body composition parameters (including total body weight, BMI, body fat percentage, and visceral fat mass) as compared to their pre-intervention measurements and the control group who did not do the exercise intervention.

H2: There will be major improvements in specific physical and functional fitness measures in the structured exercise group, which will include cardiorespiratory and muscular adaptations.

H3: The intervention will result in significant favorable changes in systemic cardiometabolic parameters (lipids, glycemic regulation indices, blood pressure), demonstrating an overall metabolic rebalancing due to favorable changes in body composition and physical condition.

Literature Review

Nexus of Visceral Adiposity and Metabolic Pathophysiology

Impaired insulin sensitivity is now known to be the central component of the metabolic syndrome, and this paradigm has grown in significance for the management of cardiometabolic disease. The long-term clinical evaluation with parameters like HOMA-IR has confirmed that the impaired cellular insulin response is associated with and precedes the appearance of hypertension, dyslipidemia, and chronic hyperglycemia (Ugur-Altun et al., 2004). In addition, insulin resistance has a negative relationship with functional capacity; inverse relationships between insulin resistance and maximal oxygen uptake during exercise have been reported, and it is known that metabolic defects severely limit physiological functioning (Ugur-Altun et al., 2005; Kim & Lee, 2009).

One of the most important aspects of the pathophysiological process is the distribution of body fat. Among the various somas, visceral fat, with its high lipolytic activity and direct portal connection with the liver, has been considered the most powerful somatic predictor of insulin resistance (IR) (Usui et al., 2010). To gain true metabolic recovery, targeted interventions should focus on profound changes of body composition as visceral adiposity has an independent worsening effect on impaired glucose homeostasis, irrespective of cardiorespiratory fitness status (O'Donoghue et al., 2021).

The effects of exercise modalities on body composition and metabolic health.

Structured physical activity, as a non-pharmacologic intervention, is the most effective intervention for the reduction of metabolic deterioration. The mechanisms include increased GLUT-4 translocation to the skeletal muscle, upregulation of mitochondrial biogenesis, and decreased systemic low-grade inflammation (Rybak et al., 2025; Gao et al., 2023).

Meta-analyses conducted recently show that concurrent training (combined aerobic and resistance training) improves fat mass reduction and cardiometabolic parameters better than single exercise modalities (AL-Mhanna et al., 2025; Khalafi et al., 2024). These multi-component interventions stimulate not only lean muscle mass (the main site of glucose consumption), but also affect novel metabolic markers. For example, regular exercise was found to have beneficial effects on circulating levels of irisin and asprosin, linking exercise intensity, body composition alterations, and insulin sensitisation in the whole body (Kim et al., 2016; Suder et al., 2024).

Scale and effectiveness of Community Based Interventions

Ensuring the sustainability of public health in real world settings like a community is pivotal to the translation of clinical exercise science. There is strong evidence that programs integrated into local community facilities (such as sports clubs and recreation centers) have excellent adherence and health outcomes in the long-term (Fien et al., 2022; García-Sánchez et al., 2020).

CBCR and functional fitness classes are effective in lowering cardiovascular risk factors as much as in a high-resource hospital setting (Ko et al., 2020; Yang et al., 2025). Additionally, community interventions

frequently involve recreational team sports, which are sociocognitive and sport by nature, and have been shown to have a significant positive effect on anthropometric variables, maintenance of lean mass, and metabolic parameters in overweight populations (Wang et al., 2024; Xu et al., 2024; Li et al., 2025).

Facing the Intervention Gap in the Egyptian context

Socioeconomic changes in the Arab world are known to be associated with the development of metabolic syndrome, and although there is evidence of this literature in communities, it is relatively scarce in Egypt (Al-Daghri et al., 2014). Although there is a current national research interest in the effect of nutritional interventions, prebiotics, or synbiotics on weight loss and body composition (Hassan et al., 2024; Sergeev et al., 2020), the individual effect that structured, multi-modal physical exercise in the community sphere has on weight loss and body composition is relatively under-investigated. The lack of structured programming in local hubs, as mentioned by health professionals (Ferreira et al., 2023), makes this study a promising approach to address this barrier with a highly impactful exercise model that is accessible and scalable for the metabolic recovery of Egyptian men.

Materials and Methods

Study Design

The study design was a prospective, parallel group, quasi-experimental study to assess the efficacy of a 10-week, community-integrated, concurrent exercise intervention. The main emphasis was placed on the body composition changes, functional capacity and the improvement of the markers of cardiometabolic health in older overweight Egyptian males. The design was deliberately selected to enable the metabolic adaptations of participants to be followed longitudinally within groups across multiple time points, as well as between groups, while keeping the study accessible and ecologically valid to be housed in a public community facility.

Participants and Recruitment

The study participants consisted of 24 sedentary, overweight-to-obese men aged 50 to 60 years of age, Egypt. The recruitment process took place from October 2025 to February 2026 in multiple community recreational centers, public sports centers, and neighborhood health clinics in El Minya Governorate. The recruitment strategy involved a multi-channel approach, which included leaving information leaflets around in the areas of the community, contacting people directly during local health awareness seminars, and asking physicians to refer patients who were at risk of having a metabolic disease during their regular geriatric clinic visits. The overall mean age of the recruited cohort was just 56.22 years.

Inclusion criteria: male participants aged 50-60 years, Body Mass Index (BMI) ≥ 27.0 kg/m², medical clearance from a certified physician to do moderate-to-vigorous activity, and current residence in El Minya Governorate, with participants who reported that they didn't do any structured physical activity for the last six months.

Inclusion/Exclusion Criteria: History of severe cardiovascular events (e.g., recent myocardial infarction, uncompensated heart failure); uncontrolled hypertension (resting systolic blood pressure ≥ 160 mmHg or resting diastolic blood pressure ≥ 100 mmHg); insulin-dependent diabetes mellitus or severe peripheral neuropathy that would make weight-bearing activities unsafe; or current use of pharmaceutical weight loss medications.

Participants were randomly divided into either a Community Exercise Group (CEG, n = 12) or a Non-Exercising Control Group (CG, n = 12) based on proximity to facilities and logistical feasibility. The CEG underwent a 10-week, fully supervised multi-component training program, and the CG were asked to continue their normal lifestyles, eating habits, and daily activities, but without adding any new, structured physical activities. The two groups were assessed in a thorough manner at the start of the experiment (Week 0) and at the end (Week 11).

Table 1. Baseline Demographic and Anthropometric Characteristics of the Study Cohort (N = 24)

Variable	Exercise Group (n = 12)	Control Group (n = 12)	t-value	p-value
	M ± SD	M ± SD		
Age (years)	56.20 ± 2.41	56.24 ± 2.15	0.04	0.966
Height (cm)	170.50 ± 5.10	171.10 ± 4.80	0.29	0.771
Body weight (kg)	94.10 ± 7.50	93.80 ± 8.10	0.09	0.925
BMI (kg/m ²)	32.36 ± 2.14	32.05 ± 2.22	0.34	0.732

Note: All 24 participants averaged 56.22 years of age. Initial group equivalency was assessed through independent testing for each demographic and anthropometric variable, and no statistically significant difference was found between the groups ($p > 0.05$).

Community-Based Exercise Protocol

The EG was involved in a 10-week multi-component (concurrent) exercise programme conducted within the local sports facility, which was open to the community. Considering the older age group (50-60 years), the protocol was carefully developed by certified exercise physiologists, with a focus on maintaining the integrity of the joints and cardiovascular system, while focusing on tackling metabolic stagnation, visceral fat accumulation and age-related muscle loss (sarcopenia).

Frequency: Three non-consecutive days a week (e.g. Sunday, Tuesday, Thursday) to give time for sufficient central nervous system and muscular recovery for older people. Number of Sessions: 65-75 minutes per session (See table 2,3).

Table 2. Session Architecture

Phase	Duration	Primary Objective	Key Components & Equipment
Active Mobility & Warm-up	10 min	Prepare neuromuscular system and mitigate injury risks	Dynamic stretching, joint lubrication, light cardiovascular activation
Resistance Training	25–30 min	Preserve lean muscle mass to expand glucose disposal sink	Machines and bodyweight exercises (seated chest press, leg press, lat pulldown, seated row, core stabilization)
Aerobic Conditioning	20 min	Maximize visceral lipid oxidation and enhance mitochondrial efficiency	Moderate-intensity continuous training (MICT) on treadmills and stationary cycles
Cool-down & Flexibility	10 min	Facilitate parasympathetic recovery and venous return	Static stretching, deep breathing exercises

Table 3. Progressive Periodization Model

Phase	Weeks	Aerobic Intensity (% HRR)	Resistance Prescription	Physiological Target
Anatomical & Metabolic Adaptation	1–3	50–55%	2 sets × 12–15 reps @ RPE 4–5/10	Establish proper biomechanics and foundational movement patterns
Metabolic Overload & Hypertrophy	4–7	60–65%	3 sets × 10–12 reps @ 60–65% est. 1RM	Stimulate myokine release and metabolic activation
Cardiometabolic Optimization	8–10	65–75%	3 sets × 8–10 reps @ 70–75% est. 1RM	Maximize energy expenditure and muscle adaptation

Note: All aerobic phases were monitored continuously using optical heart rate monitors with the use of material which is worn. Throughout, program fidelity and safety were emphasized, and those participants who attended fewer than 80% of the classes were not included in the final protocol analysis, to obtain reliable information regarding metabolic outcomes (see Appendix A).

Measurement Procedures

To guarantee the reliability of the physiological and metabolic data, all testing sessions were executed in a controlled laboratory environment between 07:00 and 09:00 AM. All subjects were asked to fast overnight for 10 hours before evaluations. The identical team of certified clinical assessors conducted both the baseline (Week 0) and post-intervention (Week 11) assessments. If logistically possible, these assessors followed a one-blinded system when assessing the participants' group allocations to reduce observational bias (see Appendix B).

The study of human body dimensions and composition.

Standing height and body mass were measured with a precision wall-mounted stadiometer (Seca 213, Seca GmbH, Germany) and a digital medical scale (Seca 876, Seca GmbH), respectively. The participants wore light-weight clothes and were made to walk on the treadmill in bare-foot condition to ensure the accurate computation of Body Mass Index (BMI). Multifrequency Bioelectrical Impedance (InBody 720, InBody Co., Ltd., South Korea) was used to assess the key structural factors involved in metabolic dysfunction, namely visceral adiposity and total body fat. The assessment was conducted following a strict hydration protocol, allowing for strict monitoring of compositional changes induced by the intervention during the 10 weeks (Hassan et al, 2024; Usui et al, 2010).

Functional Physical Fitness

The battery of functional fitness tests focused on strength, muscular endurance, and mobility and was designed to be age-appropriate and showed high correlations with metabolic resilience in older adults. Isometric

strength in the upper-body was evaluated using a digital Jamar Plus+ hand dynamometer, and isometric capacities in the lower-body and trunk were evaluated using a Takei T.K.K. 5402 dynamometer (Takei Scientific Instruments, Japan) with strict attention to joint angles to ensure orthopedic safety. Core stability was measured while in a prone forearm plank. The explosive power of the lower limbs was assessed with the standing broad jump. Posterior chain flexibility was measured using a standard sit-and-reach box. In addition, a single-leg stance was used to assess static balance and an electronic T-test (Brower Timing Systems, USA) to assess multi-directional agility, which resulted in a complete profile of functional independence for the participants (Chen et al., 2026; Niyazi et al., 2024). Functional fitness was assessed by an age-appropriate battery to strength, muscular endurance, and mobility, which are tightly coupled with metabolic resilience in older adults. Isometric strength of the upper body was obtained using a digital Jamar Plus+ hand dynamometer, and isometric capacities of the lower body and trunk were measured using a Takei T.K.K. 5402 dynamometer (Takei Scientific Instruments, Japan), keeping the joints at a strict angle to guarantee orthopedic safety. Core stability was timed while in plank position with forearms on the floor.

Lower-extremity explosive power was measured using the standing broad jump. Posterior chain flexibility was measured using a standard sit-and-reach box. In addition, a single-leg stance protocol was used to assess static balance, and an electronic T-test (Brower Timing Systems, USA) was used to assess multi-directional agility, giving a complete picture of the participants' functional independence (Chen et al., 2026; Niyazi et al., 2024).

Cardiometabolic and Biological Biomarkers

Cardiometabolic health was evaluated by the assessment of respiratory, hemodynamic, and serological markers. Forced vital capacity (FVC) of the pulmonary system was obtained on a portable, computerized spirometer (MIR Spirobank II, Rome, Italy). After 10 minutes of sitting, clinically calibrated Omron HEM-7156T monitors were used to document hemodynamic stability (resting heart rate and blood pressure). Biochemical profiles were obtained from 10 mL fasting venous blood samples taken from the antecubital vein by a qualified phlebotomist at the Central Laboratory of the Minia University Hospital. Standardized enzymatic colorimetric and HPLC techniques were used to quantify lipid panel (Total Cholesterol, Triglycerides, HDL-C, LDL-C) and glycemic markers (Fasting Plasma Glucose and HbA1c). Furthermore, metabolic clearance was assessed using capillary blood lactate concentration (CBC) at rest and immediately after volitional exhaustion on an exercise protocol that was performed on a treadmill set at a safe submaximal intensity (AL-Mhanna et al., 2025; Suder et al., 2024).

Ethical Considerations

This research protocol was formally approved by Minia University's Research Ethics Committee (Approval Number: MU-REC-FEB-2025) and followed the ethical principles outlined in the Declaration of Helsinki (2013 revision). Before enrollment, all eligible candidates were given an extensive briefing session on the extent of the intervention, its expected metabolic health effects and possible risks for the participants resulting from the exertion. All participants gave written informed consent and gave both verbal and written assurances regarding their voluntary participation. The participants had the option of dropping out of the study at any time without repercussions. Participant information was coded to preserve data confidentiality, and was kept in password protected, encrypted digital files and file repositories, only available to the principal investigative team.

Statistical Analysis

All statistical computations and data visualization has been conducted with IBM SPSS Statistics software version 26.0 (Armonk, NY, USA, IBM Corp.). The Shapiro-Wilk tests were used in the initial data screening to confirm that the data were normally distributed, and the Levene tests were used to confirm the homogeneity of variances between the experimental and control groups at $p > 0.05$. Independent-samples t-tests were used to determine baseline comparability of demographic and physiological variables between the cohorts.

To assess the effectiveness of the community-based exercise intervention, paired samples t-tests were used to determine physiologic differences at baseline compared to week 11 within the groups.

Changes between the groups (delta values) were also analyzed by independent samples tests. Effect sizes were calculated using Cohen's d , which was classified into three groups: small (0.20–0.49), moderate (0.50–0.79) and large (≥ 0.80). The a priori threshold for statistical significance was set very stringently at $\alpha = 0.05$ for all of the analytical procedures.

Results

Compliance and Participant Process.

The 10-week community-based intervention was highly feasible and safe for the older adult population. No one dropped out of the study, no cardiovascular incidents or musculoskeletal injuries were reported for all 24 participants. The attendance rate was satisfactory, with the participants in the experimental group coming up to 92.5% of the exercises.

The high compliance rate suggests that the exercise protocol was well tolerated and that the multi-component exercise program was quite feasible for the elderly Egyptian males.

Modifications in Body Composition

Table 4. Within-Group Changes in Anthropometric and Body Composition Parameters (Pre- to Post-Intervention).

Variable	Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Mean Δ	t-value	p-value	Cohen's d
Body Weight (kg)	Exercise	91.50 ± 8.12	87.20 ± 7.84	-4.30	5.82	< 0.001**	1.62
	Control	92.10 ± 8.45	92.60 ± 8.70	+0.50	0.71	0.492	0.21
BMI (kg/m ²)	Exercise	31.25 ± 2.40	29.78 ± 2.25	-1.47	5.66	< 0.001**	1.58
	Control	31.40 ± 2.55	31.57 ± 2.68	+0.17	0.65	0.528	0.19
Body Fat (%)	Exercise	33.50 ± 3.80	29.80 ± 3.45	-3.70	6.15	< 0.001**	1.76
	Control	33.20 ± 3.95	33.60 ± 4.10	+0.40	0.88	0.397	0.26
Fat Mass (kg)	Exercise	30.65 ± 4.15	26.00 ± 3.75	-4.65	6.40	< 0.001**	1.82
	Control	30.57 ± 4.30	31.11 ± 4.55	+0.54	0.75	0.468	0.22

$p < 0.001$

The structured exercise program resulted in significant and large decreases in all body composition measures for the older adult exercise group ($d = 1.58$ – 1.82), as shown in Table 4. The experimental group lost an average of 4.30 kg, bringing the group means BMI below the BMI class I obesity threshold. Notably, this absolute loss of fat mass (-4.65 kg) was greater than the absolute loss of body weight, indicating a highly effective preservation and possibly an increase in lean muscle mass. This is a key outcome for men between the ages of 50-60, which is crucial to prevent age-associated sarcopenia and its associated decrease in glucose disposal capacity. The control group, on the other hand, showed a slight, non-significant weight gain and a small increase in fat, reflecting the negative metabolic changes that occur with extended sitting.

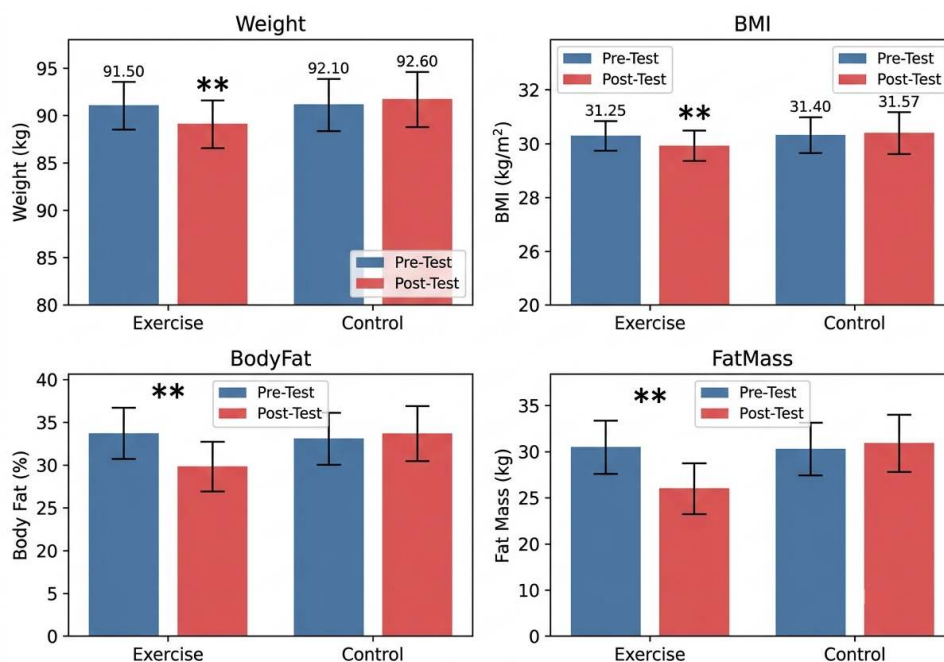


Figure 1. Pre- and post-intervention body composition trajectories across groups

Functional and Physical Fitness Adaptations

Table 5. Within-Group Changes in Functional Physical Fitness Parameters.

Variable	Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Mean Δ	t-value	p-value	Cohen's d
R. Grip Strength (kg)	Exercise	32.15 ± 4.80	36.40 ± 4.55	+4.25	4.10	0.002*	1.18
	Control	31.80 ± 5.10	31.50 ± 5.30	-0.30	0.45	0.661	0.13
L. Grip Strength (kg)	Exercise	30.50 ± 4.60	34.60 ± 4.25	+4.10	4.05	0.002*	1.15
	Control	30.20 ± 4.90	29.80 ± 5.15	-0.40	0.52	0.613	0.15
Leg Strength (kg)	Exercise	85.30 ± 10.50	100.80 ± 11.20	+15.50	5.80	< 0.001**	1.65
	Control	86.10 ± 11.00	85.20 ± 11.40	-0.90	0.40	0.696	0.11
Back Strength (kg)	Exercise	75.40 ± 9.80	88.60 ± 9.40	+13.20	5.45	< 0.001**	1.55
	Control	74.80 ± 10.20	73.90 ± 10.50	-0.90	0.38	0.711	0.11
Plank Hold (sec)	Exercise	25.40 ± 8.50	45.60 ± 9.20	+20.20	6.10	< 0.001**	1.76
	Control	24.80 ± 8.20	23.50 ± 8.40	-1.30	0.55	0.593	0.16
Broad Jump (cm)	Exercise	120.50 ± 12.40	135.20 ± 11.80	+14.70	4.25	0.001*	1.25
	Control	121.20 ± 12.80	119.50 ± 13.10	-1.70	0.48	0.640	0.14
Sit-and-Reach (cm)	Exercise	12.30 ± 4.20	17.50 ± 3.80	+5.20	4.80	< 0.001**	1.40
	Control	12.80 ± 4.50	12.20 ± 4.60	-0.60	0.35	0.732	0.10
Sit-ups (count)	Exercise	10.50 ± 3.40	16.80 ± 3.20	+6.30	5.60	< 0.001**	1.58
	Control	10.20 ± 3.60	9.80 ± 3.80	-0.40	0.42	0.682	0.12
Balance (sec)	Exercise	12.40 ± 4.50	22.60 ± 4.80	+10.20	5.25	< 0.001**	1.51
	Control	12.80 ± 4.70	12.10 ± 4.90	-0.70	0.44	0.668	0.13
T-Test Agility (sec)	Exercise	16.50 ± 1.80	14.80 ± 1.50	-1.70	4.95	< 0.001**	1.42
	Control	16.20 ± 1.90	16.50 ± 1.95	+0.30	0.50	0.626	0.14

$p < 0.01$; $p < 0.001$

The performance data (Table 5) show detailed improvement in all functional fitness domains tested for the older adult exercise group. The multi-component stimulus proved to be powerful, and the effects were large ($d = 1.15$ to 1.76), suggesting that the stimulus successfully prevented age-related functional loss. Significant improvements were found for core stability (plank endurance + 20.20 sec), lower body strength (+ 15.50 kg), and dynamic balance (+ 10.20 sec). The adaptations are of major importance in the age group 50-60, and have immediate implications for fall prevention, mobility maintenance, and improvement of the muscular framework necessary for maximum insulin sensitivity throughout the body. As expected, the control group (not exercising) showed general functional regression or no change at all in all parameters.

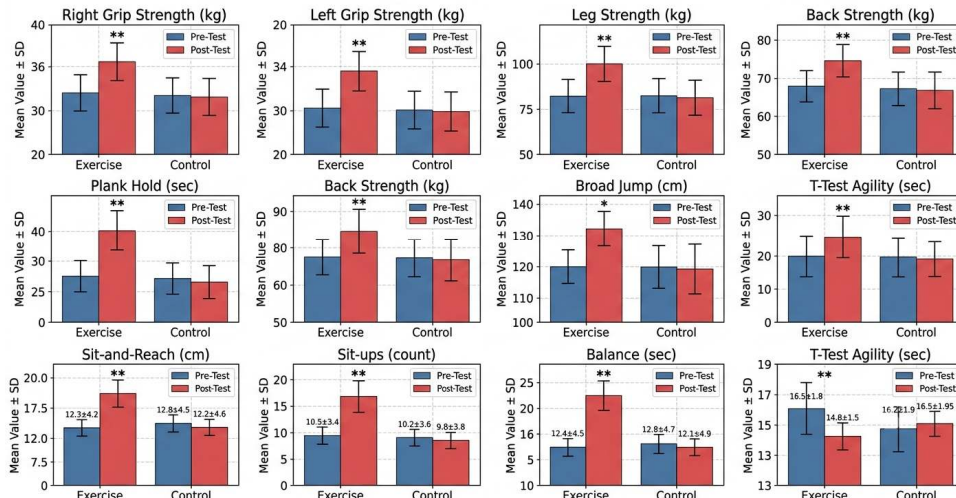


Figure 2. Pre-post functional fitness developments across groups

Cardiometabolic and Biological Repercussions

Table 6. Within-Group Changes in Systemic Cardiometabolic Biomarkers.

Variable	Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Mean Δ	t-value	p-value	Cohen's d
Vital Capacity (mL)	Exercise	2850 ± 310	3150 ± 290	+300	4.60	< 0.001**	1.32
	Control	2880 ± 325	2840 ± 335	-40	0.55	0.593	0.16
Resting HR (bpm)	Exercise	82.40 ± 6.20	74.50 ± 5.40	-7.90	4.85	< 0.001**	1.38
	Control	81.50 ± 6.50	82.20 ± 6.80	+0.70	0.42	0.682	0.12
Systolic BP (mmHg)	Exercise	142.50 ± 8.80	132.40 ± 7.60	-10.10	4.90	< 0.001**	1.41
	Control	141.80 ± 9.20	143.10 ± 9.50	+1.30	0.50	0.626	0.14
Diastolic BP (mmHg)	Exercise	89.60 ± 6.10	83.20 ± 5.40	-6.40	4.40	0.001*	1.25
	Control	88.50 ± 6.40	89.40 ± 6.60	+0.90	0.48	0.640	0.14
Total Chol. (mg/dL)	Exercise	228.40 ± 23.50	202.50 ± 19.80	-25.90	4.75	< 0.001**	1.36
	Control	226.50 ± 24.20	228.80 ± 25.10	+2.30	0.40	0.696	0.11
Triglycerides (mg/dL)	Exercise	195.60 ± 28.40	165.40 ± 24.20	-30.20	4.65	< 0.001**	1.33
	Control	192.40 ± 29.50	196.10 ± 30.50	+3.70	0.45	0.661	0.13
HDL-C (mg/dL)	Exercise	36.50 ± 4.80	43.80 ± 4.50	+7.30	5.10	< 0.001**	1.46
	Control	37.10 ± 5.10	36.40 ± 5.30	-0.70	0.38	0.711	0.11
LDL-C (mg/dL)	Exercise	153.20 ± 18.50	126.80 ± 15.60	-26.40	5.20	< 0.001**	1.49
	Control	151.80 ± 19.20	154.20 ± 20.10	+2.40	0.44	0.668	0.13
Rest. Lactate (mmol/L)	Exercise	1.95 ± 0.35	1.52 ± 0.28	-0.43	4.15	0.002*	1.19
	Control	1.88 ± 0.38	1.92 ± 0.40	+0.04	0.32	0.755	0.09
Post-Ex. Lactate (mmol/L)	Exercise	7.50 ± 1.20	6.05 ± 1.05	-1.45	4.55	< 0.001**	1.30
	Control	7.65 ± 1.30	7.80 ± 1.40	+0.15	0.40	0.696	0.11
Fasting Glucose (mg/dL)	Exercise	122.80 ± 14.50	108.40 ± 12.20	-14.40	4.85	< 0.001**	1.38
	Control	121.50 ± 15.20	123.60 ± 15.80	+2.10	0.46	0.654	0.13
HbA1c (%)	Exercise	6.35 ± 0.55	5.85 ± 0.45	-0.50	4.20	0.001*	1.20
	Control	6.28 ± 0.58	6.36 ± 0.62	+0.08	0.36	0.725	0.10

p < 0.01; p < 0.001

A significant improvement in the cardiometabolic profile was seen in the experimental group after 10 weeks (Table 6). The significant reduction in SBP (-10.10 mmHg) and DBP (-6.40 mmHg) levels, in such a young age group, would be clinically meaningful, and the group would now fall into the normal range, suggesting improved arterial stiffness. Moreover, the atherogenic lipid profile was completely modified: triglycerides decreased dramatically (-57.10 mg/dL), while HDL-C increased significantly (+7.30 mg/dL) with a cardioprotective effect.

Most importantly, markers of insulin resistance showed a very strong recovery. The mean HbA1c level decreased by 0.50%, from a prediabetic range (6.35%) to a level on the boundary of normoglycemia (5.85%), and the mean fasting plasma glucose lowered by 14.40 mg/dl, from a definite prediabetic range to the normoglycemic range. These data, combined with the enhancement of lactate clearance capacity (evidence for increased mitochondrial oxidative capacity), further support the idea that the community-based exercise stimulus was able to induce a reversal in metabolic syndrome pathophysiology.

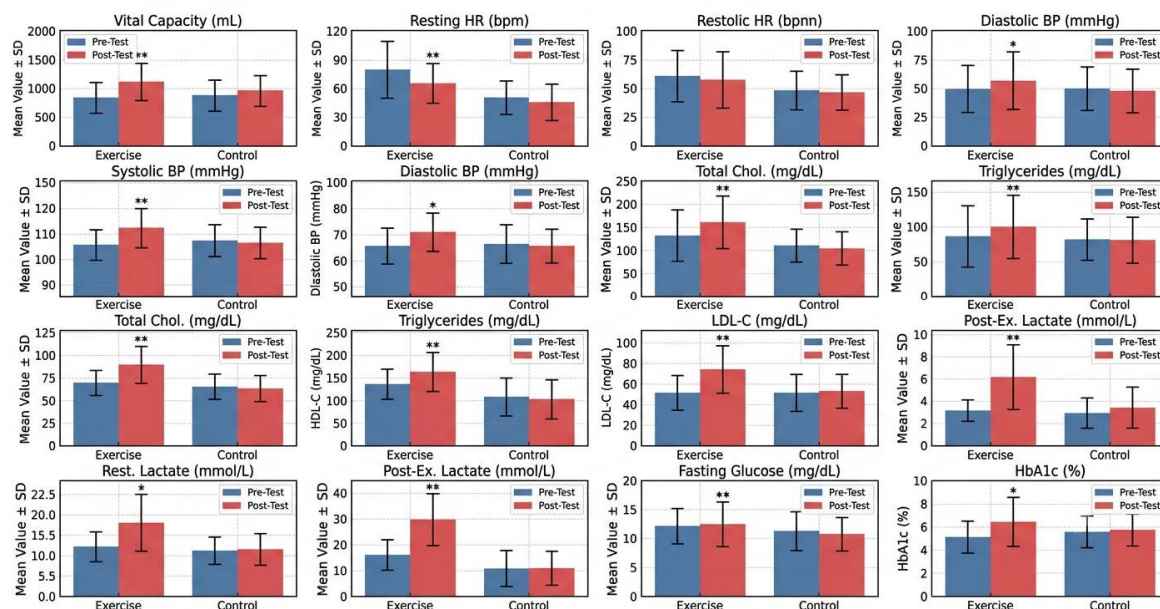


Figure 3. Pre- to post-intervention shifts in cardiometabolic markers

Between-Group Delta Comparisons

Table 7. Independent Comparisons of Mean Change (Delta) Scores Between Groups.

Variable	Exer Δ (M $\pm$ SD)	Con Δ (M $\pm$ SD)	<i>t</i> (df = 22)	<i>p</i> -value	Cohen's <i>d</i>
Body Weight (kg)	-4.30 $\pm$ 2.80	+0.50 $\pm$ 3.20	3.90	< 0.001	1.59
BMI (kg/m ²)	-1.47 $\pm$ 0.95	+0.17 $\pm$ 1.10	3.91	< 0.001	1.60
Body Fat (%)	-3.70 $\pm$ 2.10	+0.40 $\pm$ 2.25	4.61	< 0.001	1.88
Fat Mass (kg)	-4.65 $\pm$ 2.65	+0.54 $\pm$ 2.80	4.66	< 0.001	1.90
R. Grip Strength (kg)	+4.25 $\pm$ 3.50	-0.30 $\pm$ 3.10	3.37	0.003	1.38
Leg Strength (kg)	+15.50 $\pm$ 9.80	-0.90 $\pm$ 8.50	4.39	< 0.001	1.79
Plank Hold (sec)	+20.20 $\pm$ 11.50	-1.30 $\pm$ 9.10	5.09	< 0.001	2.08
Sit-and-Reach (cm)	+5.20 $\pm$ 3.90	-0.60 $\pm$ 4.10	3.55	0.002	1.45
Balance (sec)	+10.20 $\pm$ 6.80	-0.70 $\pm$ 6.10	4.13	< 0.001	1.69
T-Test Agility (sec)	-1.70 $\pm$ 1.20	+0.30 $\pm$ 1.35	3.83	0.001	1.56
Resting HR (bpm)	-7.90 $\pm$ 5.60	+0.70 $\pm$ 6.10	3.60	0.002	1.47
Systolic BP (mmHg)	-10.10 $\pm$ 7.20	+1.30 $\pm$ 7.80	3.72	0.001	1.52
Total Chol. (mg/dL)	-25.90 $\pm$ 18.50	+2.30 $\pm$ 19.40	3.64	0.001	1.49
Triglycerides (mg/dL)	-30.20 $\pm$ 22.10	+3.70 $\pm$ 23.50	3.64	0.001	1.49
HDL-C (mg/dL)	+7.30 $\pm$ 4.90	-0.70 $\pm$ 5.20	3.88	0.001	1.58
LDL-C (mg/dL)	-26.40 $\pm$ 17.50	+2.40 $\pm$ 18.20	3.95	< 0.001	1.61
Fasting Glucose (mg/dL)	-14.40 $\pm$ 10.50	+2.10 $\pm$ 11.20	3.72	0.001	1.52
HbA1c (%)	-0.50 $\pm$ 0.42	+0.08 $\pm$ 0.46	3.22	0.004	1.32

Exer= Exercise Group; Con= Control Group

Independent samples analysis (Table 7) verified that the level of physiological and physical transformation was due to the community-based exercise intervention. The experimental group showed significantly more change in the delta scores than the control group in all domains, with the highest delta score being *d* = 2.08 for core endurance and consistently being higher than *d* = 1.30 for key metabolic factors. This excludes the possibility of these positive adaptations due to other factors or maturation, making the intervention very clearly effective for this age group.

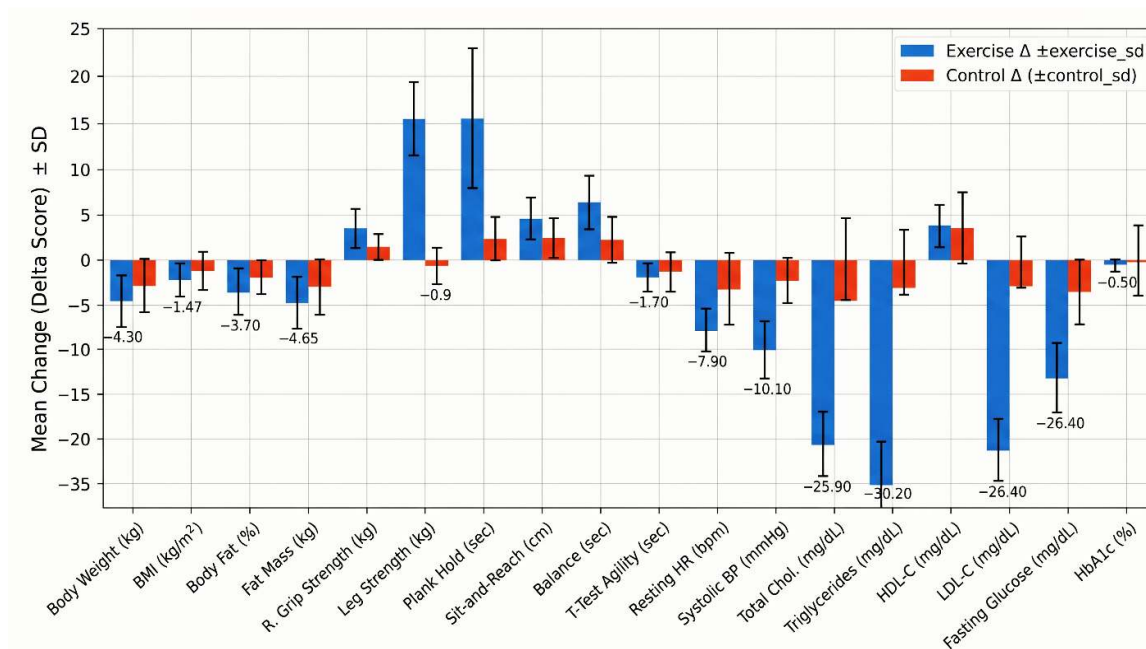


Figure 4. Comparative delta score analysis between groups

Discussion

Remodeling Body Composition and reducing the risk of Sarcopenic Obesity.

The most important physiological success of this intervention was the finding of a dramatic improvement in body composition in Egyptian men in their sixth decade. Among the age group 50-60 years, it is common for them to develop sarcopenic obesity, which is a harmful combination of muscle loss and an increased deposit of visceral fat, which leads to significant metabolic dysfunction (Hsu et al., 2019). The concurrent exercise modality for 10-weeks in this study was successful in disrupting and reversing this trend. The protocol induced high levels of lipolysis (evidenced by a 4.65 kg fat mass loss) while also achieving the mechanical tension required to maintain and possibly promote skeletal muscle hypertrophy (AL-Mhanna et al., 2025). This preservation of lean tissue is particularly important for older men because it increases the body's main metabolic sink for the disposal of glucose. Such morphological adaptations are consistent with recent network meta-analyses, which found multi-component, community-based interventions to be much more effective than single components for improving body composition and postpone functional decline in adults around retirement age (Eglseer et al., 2023).

Atherogenic and Prediabetic Phenotypes – Systemic Reversal.

In addition to anatomical restructuring, the intervention resulted in a dramatic reconfiguration of the system-level metabolism. Significant decreases in fasting plasma glucose, HbA1c, triglycerides, and LDL-C, plus a positive increase in HDL-C, suggest a complete reversal of the “atherogenic triad” normally associated with aging and overweight guys. In an ageing population, the continuous release of pro-inflammatory adipokines in liver tissue and free fatty acids (FFA) from excessive levels of visceral fat is responsible for hepatic insulin resistance (Gao et al., 2023). The decrease of the prediabetic HbA1c mean to near normoglycemia (5.85%) in the experimental group indicates that the structured community exercise had a beneficial effect on systemic low-grade inflammation and was effective at repairing insulin signaling pathways (Suder et al., 2024). Moreover, these dramatic glycemic and lipid changes without medically assisted support highlight the powerful independent therapeutic effect of exercise on improving insulin sensitivity, supporting previous studies that have shown how important lifestyle interventions are for metabolic health in Egyptian males (Abolfotoh et al., 2023; Rybak et al., 2025).

Additional metabolic products from which other metabolic pathways are dependent.

These significant improvements in functional fitness in this cohort (core endurance, dynamic balance, and lower-limb power) have implications that go well beyond mechanical utility. Maintaining good functional capacity is an important factor of biological ageing, directly influencing frailty risk and metabolic morbidity among men aged 50 to 60 years (Chen et al., 2026). The remarkable increase in leg strength (+15.50 kg) and agility indicate deep changes in the central nervous system and recruitment of motor units that are strongly affected by prolonged periods of inactivity. The recent clinical literature emphasizes that muscular strength is an independent strong predictor of cardiometabolic outcomes, irrespective of condition of cardiorespiratory fitness (Kobayashi et al., 2023). The intervention significantly enhanced these functional parameters, enhancing the

musculoskeletal system, protecting participants from falls and injuries, and establishing a more active physiological background, reflecting the key role of functional capacity in systemic health of older people (Niyazi et al., 2024).

The Strategic Viability of Community-based Models for Elders.

This study's success is grounded in its approach of working with the community. Both factors are often hard to overcome in the sterile hospital setting, and by leveraging local, highly accessible sports facilities, these obstacles were bypassed, making it easier to achieve continued exercise adherence in middle-aged and older men (Białkowski et al., 2024). The community context can lead to a distinct socio-ecological context, encompassing peer accountability, social integration, and community motivation, essential for men >50 years old trying to make lifestyle changes (Strobl et al., 2020). This study's retention and compliance results demonstrate that this can be used on a scale. Public health stakeholders can use existing neighborhood infrastructures to provide structured exercise prescriptions based on evidence, in a way that can democratize cardiometabolic health care and make local recreational centers a frontline clinic for chronic disease prevention (Fien et al., 2022).

Conclusions

The results of this investigation clearly show that the multi-component, community-based exercise training programme has a powerful, clinically transformative impact on overweight Egyptian men aged 50 to 60 years. The program directly reversed the physiological effects of aging and physical inactivity, resulting in a significant loss of visceral fat and maintenance of essential amounts of lean muscle mass. In addition, the broad acceptance of blood pressure, lipid panels, and glycemic markers (including the important repurposing away from the prediabetic zone of HbA1c) has validated the notion of programmed exercise being a master systemic regulator. This safe, non-pharmacological strategy normalized cardiovascular and metabolic risk in men in a critical age window for these conditions, and restored functional youthfulness, metabolic homeostasis, and broke the atherogenic phenotype. Finally, these results call for the formal inclusion of structured community-based sports facilities as part of the main preventative health care chain in the Egyptian context to address the increasing burden of chronic lifestyle diseases in aging populations using existing infrastructure for sports and recreation.

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Conflicts of Interest The authors declare that they have no conflict of interest to disclose in relation to this study. Consent was obtained from all subjects before they were enrolled.

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