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ISSN: 2835-6764

Sarpong, E.O. (2025) 1871
American J Sci Edu Re, 2025; 4(12):100287
DOI: 10.71010/AJSER-2025-e287

Research Article

American Journal of Science Education Research

# Synergistic Effects of Diet and Exercise on Cardiovascular Risk Factors: A 12-Week Randomized Controlled Trial in Ghana

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**Citation:** Sarpong, E.O. (2025) Synergistic Effects of Diet and Exercise on Cardiovascular Risk Factors: A 12-Week Randomized Controlled Trial in Ghana. American J Sci Edu Re: AJSER-287.

**Received Date:** 05 December, 2025; **Accepted Date:** 09 December, 2025; **Published Date:** 15 December, 2025

***Abstract***

*Cardiovascular diseases (CVDs) remain a leading cause of mortality globally, with lifestyle factors such as diet and physical inactivity contributing significantly to their development. This study investigates the individual and combined effects of dietary intervention and structured physical exercise on cardiovascular risk factors, including blood pressure, lipid profiles, and body composition. A 12-week randomized controlled trial involving 80 participants aged 30–60 years was conducted. Participants were allocated to one of four groups: control, diet-only, exercise-only, or combined diet and exercise. Pre- and post-intervention assessments included systolic and diastolic blood pressure, LDL cholesterol, and body composition. Statistical analysis using ANOVA showed significant improvements in cardiovascular health in all intervention groups, with the combined diet and exercise group exhibiting the most pronounced reductions in systolic and diastolic blood pressure and LDL cholesterol levels such as a reduction of LDL cholesterol by an average of 33.1 mg/dL in the exercise group, and systolic blood pressure reduction of up to 15.8 mmHg in the combined group. The findings underscore the synergistic potential of diet and exercise in mitigating cardiovascular risk and promoting heart health.*

***Keywords:*** *Cardiovascular health, diet and exercise intervention, lifestyle modification, non-communicable disease prevention, risk factor reduction, randomized controlled trial.*

## Introduction

Cardiovascular diseases (CVDs) continue to present a major public health challenge worldwide, accounting for substantial rates of mortality and morbidity (Che & Li, 2017). These conditions are largely driven by modifiable lifestyle factors, including dietary habits and physical inactivity (Anderson, 2018). CVDs refer to a group of disorders affecting the heart and blood vessels, encompassing conditions such as coronary artery disease, hypertension, heart failure, stroke, and peripheral artery disease (World Health Organization, 2020; Young et al., 2016). The underlying pathology is often atherosclerosis, where fatty deposits accumulate in the arteries, limiting blood flow and elevating the risk of cardiovascular events such as heart attacks and strokes (Miele & Headley, 2017; Wing et al., 2011).

CVDs are responsible for approximately 32% of all deaths globally, with 85% of these fatalities attributed to heart attacks and strokes (Sanchez-Aguadero et al., 2016; World Health Organization, 2020). Contributing risk factors include hypertension, elevated cholesterol, obesity, diabetes, tobacco use, poor diet, and physical inactivity (Benjamin et al., 2019; Lloyd-Jones et al., 2010). Environmental contributors such as air pollution also play a role in disease progression (Fontana, 2018; Lindstrom et al., 2022; Rehman et al., 2021; World Health Organization, 2020).

In Africa, the burden of CVDs is rising rapidly, overtaking infectious diseases like malaria and tuberculosis as urbanisation and economic transitions drive shifts in lifestyle (Minja et al., 2022). Hypertension, stroke, and ischemic heart disease are now common, with hypertension alone affecting around 20 million people in the region (Yuyun et al., 2020). Risk factors such as tobacco use, physical inactivity, poor diet, and excessive alcohol intake account for nearly 80% of coronary heart disease and stroke cases (Obonyo & Etyang, 2023). Socioeconomic challenges and genetic predispositions have further intensified the spread of these conditions across the continent (Doku et al., 2024).

Efforts to manage CVDs in Africa are constrained by limited healthcare infrastructure, a shortage of cardiologists, and insufficient access to diagnostic tools. In many countries, national guidelines for cardiovascular care are either lacking or inconsistently implemented (Minja et al., 2022). The high cost of treatment, especially in rural or low-income communities, hinders widespread access to care, making preventive strategies both critical and underutilised (Incalza et al., 2018). Moreover, public awareness of heart disease risk remains low due to the absence of large-scale educational campaigns (Chudyk & Petrella, 2011).

Ghana has also experienced a marked increase in CVD prevalence, with stroke, hypertension, and coronary artery disease ranking among the top causes of death. Hypertension is particularly widespread among adults (Tetteh et al., 2024). A systematic review and meta-analysis place the national prevalence of CVDs at approximately 10.34%, with even higher rates reported in hospital-based studies (Doku et al., 2024). Factors such as male sex, older age, unemployment, diabetes, and elevated blood pressure levels significantly raise CVD risk (Tetteh et al., 2024). Shifts toward high-sodium, high-fat processed foods in urban areas have further exacerbated hypertension and obesity-related conditions (Agyekum et al., 2024).

Nonetheless, Ghana has initiated various public health measures to curb the growing CVD epidemic. The Ghana Heart Initiative (GHI), for instance, is working to enhance prevention, diagnosis, and treatment efforts (Doku et al., 2024). These initiatives include the development of national treatment guidelines, improved training of healthcare professionals, and enhanced data collection to track disease trends. Yet, disparities in access remain, particularly in rural areas where diagnostic services and medications are often lacking. Various advocacy and health promotion campaigns now aim to improve hypertension screening, dietary habits, and physical activity levels (Agyekum et al., 2024).

Although treatment options have improved over time, prevention remains the cornerstone of effective cardiovascular care (Anderson et al., 2013). Preventive approaches focus on lifestyle modifications such as physical activity, heart-healthy diets, smoking cessation, and appropriate medical management (Davidson, 2017). When implemented early, these strategies can significantly reduce the likelihood of severe cardiovascular outcomes (World Health Organization, 2021).

While many guidelines highlight the importance of managing risk factors, there is growing interest in how diet and exercise can be combined to deliver enhanced cardiovascular benefits (Anderson et al., 2013; Mozaffarian, 2016). A wide body of research supports the individual effectiveness of dietary improvements and physical activity in reducing CVD risk (Drenowatz et al., 2015; Estruch et al., 2013; Gaesser et al., 2011; Mozaffarian, 2016; Nystoriak & Bhatnagar, 2018; Slentz et al., 2016; Soliman, 2019). For example, dietary patterns low in saturated fat and high in fibre can lead to better lipid profiles and reduced blood pressure (Mozaffarian, 2016). Similarly, regular physical exercise supports weight control, circulation, and overall cardiovascular function (Bird & Hawley, 2016; Lin et al., 2015; Piercy et al., 2018).

Despite robust evidence of the benefits of each intervention on its own, there remains limited insight into their combined effects. Most prior studies have evaluated diet and exercise independently, overlooking their possible interactive influence on cardiovascular outcomes (Che & Li, 2017; Lin et al., 2015; Nystoriak & Bhatnagar, 2018; Platt et al., 2015). Some researchers propose that a joint approach may produce stronger physiological outcomes, such as enhanced lipid metabolism, vascular function, and blood pressure regulation (Slentz et al., 2016). However, few comparative studies have rigorously explored this synergy across key indicators of cardiovascular health.

This study investigates the combined and individual effects of dietary modification and exercise on key cardiovascular risk markers, including blood pressure, cholesterol levels, body mass index (BMI), and overall heart health. By examining these interventions within a low-resource, sub-Saharan African setting, this research aims to provide practical and context-specific strategies for cardiovascular disease prevention. In doing so, it builds on but distinguishes itself from previous large-scale interventions such as the PREDIMED and Look AHEAD trials by focusing on a localized, real-world population.

Based on the identified gaps, the study tested the following hypotheses:
Dietary intervention alone will significantly improve lipid profiles;
Exercise alone will significantly reduce blood pressure and improve body composition;
The combined intervention will produce synergistic benefits across all measured outcomes.

## Methodology

### Study Design

A randomised controlled trial (RCT) design was selected for this study to ensure objective evaluation of the combined effects of dietary intervention and exercise on cardiovascular risk factors. An RCT is considered the gold standard for intervention-based research as it minimises biases and ensures that observed effects are due to the intervention rather than external factors. By employing random allocation, the study maximised internal validity, allowing for comparative analysis between groups. A priori power analysis was conducted using G*Power 3.1.9.7, assuming a medium effect size ($f = 0.35$), $\alpha = 0.05$, and power = 0.80, yielding a minimum sample size of 76, which our sample of 80 meets. Outcome assessors were blinded to group allocation to minimize bias.
The study was conducted over 12 weeks, providing sufficient time to observe measurable changes in lipid profiles, blood pressure, body composition, and overall heart health resulting from the interventions.

### Participants

Inclusion criteria were adults aged 30-60 years with at least one cardiovascular risk factor, either elevated blood pressure, high cholesterol, or obesity. Participants with existing CVD, pregnancy, or significant medical conditions that contraindicated exercise were excluded. A total of 80 participants completed the study (48 male, 32 female). A total of 80 participants were randomised from the initial eligibility pool, with 20 participants assigned to each group to ensure balanced distribution across key characteristics.

All participants met the inclusion criteria, which required them to be between 30–60 years old, with at least one cardiovascular risk factor, and no ongoing participation in structured dietary or exercise programs. Additionally, participants maintained a BMI range of 18.5–29.9 kg/m² and were not taking lipid-lowering or antihypertensive medications.

Once eligibility was confirmed, participants were randomly allocated into four groups (control, diet, exercise and diet and exercise combined groups) using a computer-generated random sequence. Stratification ensured that each group contained balanced age and gender distributions to minimise confounding effects. The allocation process was conducted blindly, meaning researchers responsible for data collection and intervention administration were unaware of group assignments.

### Interventions

In this study, participants underwent pre-test assessments before the intervention was implemented, establishing a baseline measurement of key cardiovascular health indicators. These initial measurements ensured that individual differences in health status before the intervention were accounted for, allowing researchers to evaluate the effectiveness of dietary and exercise interventions more accurately.

After the intervention period, participants were subjected to post-test assessments, measuring the same health indicators to determine the degree of improvement or change. By comparing pre-test and post-test data, researchers could assess the impact of dietary modifications and physical activity on blood pressure, lipid profiles, body composition, and heart health. This method enhances the study's validity by confirming that any observed changes are a direct result of the intervention rather than random variations or external influences.

Using a pretest-posttest intervention design, the study effectively controls for baseline disparities, ensuring that comparisons between different intervention groups are accurate and meaningful.

***Control Group***

The control group serves as a baseline, allowing researchers to compare the impact of interventions. The control group were not provided with any of the interventions, structured nutrition plan, or moderate-intensity aerobic exercise. The participants in this group maintained their usual diet and exercise habits without any modifications. Routine cardiovascular assessments, including lipid profiles, blood pressure monitoring, body composition analysis, and aerobic capacity testing, were conducted both at the beginning and the end of the intervention period. While participants receive general health education, no targeted dietary or exercise strategies are introduced.

***Dietary Intervention Group***

The structured heart-healthy nutrition plan was based on specific goals for macronutrients and micronutrients to make it easier to follow and in line with dietary guidelines. The dietary intervention's daily nutritional goals were to:
• Total caloric intake: Based on each person's starting BMI and estimated energy needs, using the Mifflin-St. Jeor equation with a sedentary to moderate activity factor (1.2–1.5).

- The percentage of total daily calories that come from macronutrients:
  - Carbs: 50 to 55%
  - 15–20% proteins
  - Fats: 25–30%, with saturated fats making up less than 7%
- Fibre intake: Consume at least 25 to 30 grammes of fibre daily, mostly from fruits, vegetables, whole grains, and legumes.
- Sodium consumption: Limited to less than 2,300 mg per day in accordance with the guidelines set forth by the American Heart Association.
- Cholesterol: Not to exceed 200 mg per day.
- Omega-3 fatty acids: Aim for 250–500 mg daily from food sources (such as walnuts, flaxseeds, and fatty fish).

Participants got portion-size advice and visual aids (such as the MyPlate technique) to promote consistent dietary practices, and registered dietitians created and reviewed meal plans every week to guarantee adherence to these goals.

*Weekly structured nutrition plan to reduce saturated fat intake, increase fibre, and promote heart-healthy foods.*

| Day | Breakfast | Lunch | Dinner | Snacks |
|---|---|---|---|---|
| Monday | Oatmeal with berries and chia seeds; green tea | Lentil soup with whole grain bread; cucumber and tomato salad | Grilled salmon; steamed broccoli; quinoa | Apple slices with almond butter; carrot sticks |
| Tuesday | Whole grain toast with avocado and boiled egg; herbal tea | Chickpea and vegetable stir-fry with brown rice | Baked chicken breast; mixed greens with olive oil and lemon dressing | Handful of unsalted walnuts; banana |
| Wednesday | Low-fat yogurt with flaxseed, oats, and mixed berries | Grilled tofu salad with olive oil vinaigrette; whole wheat crackers | Spaghetti with tomato and vegetable sauce (no cheese); sautéed spinach | Pear; hummus with celery sticks |
| Thursday | Smoothie with kale, banana, oats, chia, and almond milk | Quinoa and black bean salad with avocado and lime dressing | Baked mackerel; sweet potato mash; green beans | Popcorn (air-popped, unsalted); orange |
| Friday | Muesli with plant-based milk and chopped apple | Grilled chicken wrap in whole grain tortilla with lettuce and hummus | Lentil curry with brown rice; side of grilled zucchini | Handful of almonds; mixed berries |
| Saturday | Whole grain pancakes with a drizzle of honey and banana slices | Vegetable soup with whole grain roll; leafy greens with vinegar dressing | Baked turkey breast; bulgur wheat; roasted carrots | Cucumber slices with hummus; a plum |
| Sunday | Scrambled tofu with spinach and whole grain toast; black tea | Bean chili with barley; avocado and tomato salad | Grilled trout; brown rice; steamed asparagus | Mixed nuts (unsalted); apple |

*Source*: (Anderson, 2018; Rippe, 2024; Soliman, 2019)

***Exercise Intervention Group***

The cue-dependent nature of aerobic exercise intensity was monitored according to both subjective-objective means of assessing intensity (attentional focus and RPE) in order to facilitate standardization and consistency:

- Perceived Exertion (RPE): The RPE was measured using the Borg CR10 Scale, which was described in detail to the participants in the familiarisation phase. The exercise sessions were all supervised by trained instructors who reminded the participants at a pre-specified interval to report RPE, to keep the intensity during exercise within the targeted 5–6 RPE of moderate intensity.
- Heart rate monitoring: Heart rate was tracked using chest-strap monitors (Polar H10) throughout the supervised training blocks. We computed the target zone as 60–70% of

each participant's estimated HRmax, where HRmax was defined by the equation 220 minus participant age. Monitors transmitted live data, allowing trainers to prompt immediate modifications to exercise effort when the heart rate fell outside the target band.

- Each trainer kept meticulous records for every session, noting the participant's heart rate at start and finish, the overall session average, the associated Ratings of Perceived Exertion, and any activities that deviated from the original training plan.

*Structured Moderate-Intensity Aerobic Exercise Plan (150 Minutes/Week).*

| Day | Activity | Duration | Intensity | Purpose |
|---|---|---|---|---|
| Monday | Brisk Walking | 30 minutes | Moderate (5–6/10 RPE) | Cardiovascular endurance & recovery |
| Tuesday | Cycling (outdoor or stationary) | 30 minutes | Moderate (60–70% HR max) | Lower body strength & aerobic capacity |
| Wednesday | Rest or Light Stretching | , | , | Recovery and muscle relaxation |
| Thursday | Swimming | 30 minutes | Moderate (steady pace) | Full-body aerobic conditioning |
| Friday | Brisk Walking | 30 minutes | Moderate | Improves circulation & heart function |
| Saturday | Optional: Leisure walk, light cycling, or yoga | 20–30 minutes | Light–Moderate | Flexibility and active recovery |
| Sunday | Rest | , | , | Full body recovery |

*Source*: (Piercy et al., 2018; Riebe et al., 2018)

***Approaches for Adherence Monitoring***

To maintain an objective measurement of adherence to interventions, different approaches were implemented according to groups:

**a. Dietary Group:**

- Participants had to write daily food diaries that were then reviewed weekly by a nutritionist during the counselling session.
- Participants were encouraged to use a dietary tracking-app on their phones (MyFitnessPal was suggested) which had been customized for caloric and macronutrient goals. Data were then exported weekly for comparison against dietary targets.
- Random 24-hour dietary recalls were performed on a biweekly basis by independent personnel and were used to ascertain the validity of the diary entries.
- Adherence was defined as the number of days in which the participant met >80% of his/her nutritional targets for calorie intake, saturated fat, sodium, and fiber as a percentage of all days in a week.

**b. Exercise Group:**

- Attendance records were created for each supervised session.
- Participants have significantly increased their chances of accepting the self-report exercise logs tasks through exercising and completing them for example for Saturday activities (optional or unsupervised sessions).
- Heart rate information was downloaded weekly from the devices to check the intensity of the workout.
- The definition of adherence was keeping the target of attending no less than 85% of the sessions and staying within the prescribed intensity range for at least 80% of the total time of the session.

**c. Combined Diet and Exercise Group:**

- Dietary compliance of the participants was covered by these two protocols.
- Along with this, the weekly behavioural coaching sessions were of tremendous help in reinforcing the commitment and removing barriers.
- Adherence score was computed as a composite of dietary and exercise compliance, with equal weighting.

**Management of non-adherence:**

- Those members of the study who were found to have below 70% adherence for two continuous weeks were followed-up by the study coordinator for motivational interviewing and reinforcement.
- Sensitivity analyses were carried out in order to find out the effect of adherence on the results, and the intention-to-treat analysis was also performed so that all participants were included in the last dataset with multiple imputation in case of missing data wherever necessary.

## Outcome Measures

**Blood Pressure**

Blood pressure was assessed as a key cardiovascular risk factor following the completion of the moderate-intensity aerobic training program. Measurements were conducted using a standard aneroid sphygmomanometer and a stethoscope following established clinical guidelines (Pickering et al., 2005). To ensure consistency and minimize transient influences, all participants were instructed to rest for at least five minutes in a quiet, temperature-controlled environment before measurement. During the procedure, participants remained seated with their feet flat on the floor and their arms supported at heart level.

An appropriately sized cuff was applied to the upper arm, with the lower edge of the cuff positioned approximately 2–3 cm above the antecubital fossa and aligned with the brachial artery. The radial pulse was first palpated, and the cuff was inflated until the pulse was no longer detectable, then an additional 30 mmHg beyond this point to ensure accuracy. The diaphragm of the stethoscope was placed over the brachial artery, and the cuff was deflated gradually at a rate of 2–3 mmHg per second.

Systolic blood pressure was determined by the appearance of the first Korotkoff sound (Phase I), while diastolic pressure was defined by the disappearance of the Korotkoff sounds (Phase V). Two consecutive readings were taken at one-minute intervals, and the average of the two values was recorded as the participant's final post-training blood pressure. If the first two measurements differed by more than 5 mmHg, a third reading was obtained, and the two closest values were averaged.

**Lipid Profile**

Lipid profile measurements were conducted using blood samples collected by trained phlebotomists. Athletes underwent pre-test preparation, including 9–12 hours of fasting to ensure accurate readings, with only water permitted and avoidance of strenuous activity. Medical histories were reviewed to account for factors influencing lipid levels. Blood samples were drawn using sterile procedures, with careful labelling and proper storage to maintain integrity. In the laboratory, biochemical analysers quantified total cholesterol, Low-Density Lipoprotein Cholesterol (LDL) ("bad" cholesterol), High-Density Lipoprotein Cholesterol (HDL) ("good" cholesterol), and triglycerides. Additional calculations, such as non-HDL cholesterol and lipid ratios, provided a more comprehensive cardiovascular risk assessment.

Once analysed, lipid profile results were interpreted based on standard reference ranges, aiding in the evaluation of athletes' cardiovascular health.

***Body Composition***

Athletes first underwent pre-test preparation, avoiding excessive fluid intake and strenuous exercise to ensure accurate body composition measurements. Their hydration levels, medical history, and nutritional intake were reviewed to account for potential influences on results.

Next, trained professionals used callipers to measure skinfold thickness at key body sites, including the triceps, biceps, subscapular, suprailia, and thigh regions. Measurements were taken three times per site, and the average was recorded to minimize variability.

Finally, the collected data was analysed using body fat prediction equations, such as the Jackson-Pollock method or the Durnin-Womersley formula, tailored to the athlete's gender and age. The final body fat percentage was compared against standard reference ranges to assess their fitness levels.

***Heart Health***

The 6-minute walk test (6MWT) is a widely used method for assessing cardiovascular fitness, particularly in individuals with heart or lung conditions. In the study Heart Health, the 6MWT was employed to evaluate participants' functional capacity and overall cardiovascular endurance.

The test was conducted on a flat, hard surface, typically a 30-meter corridor, where participants were instructed to walk as far as possible within six minutes. They were allowed to self-pace, meaning they could walk at a comfortable speed but were encouraged to cover the maximum possible distance. Resting was permitted, if necessary, but the timer continued running.

Throughout the test, heart rate, oxygen saturation, and perceived exertion were monitored to assess physiological responses. The total distance walked was recorded as the primary outcome measure, with greater distances indicating better cardiovascular fitness. The results were then compared against established reference values to determine participants' cardiovascular health status.

**Statistical Analysis**

The study analysed data using IBM SPSS Statistics version 26, a statistical software commonly used for quantitative research. Descriptive statistics were employed to summarise baseline characteristics, such as age, gender distribution, body composition, lipid profiles, and blood pressure levels, to establish initial conditions before the intervention.

To assess differences among groups, one-way analysis of variance (ANOVA) was conducted to compare pre- and post-intervention measures across the four groups (control, dietary modification, exercise, and combined dietary-exercise). The ANOVA tested whether the interventions had a statistically significant impact on cardiovascular risk factors, with the alpha level for significance set at 0.05. This threshold ensures valid conclusions and minimises the likelihood of false-positive results.

## Results

***Participant Characteristics***

At baseline, 80 participants (48 males and 32 females) completed the study. The mean age of the participants was ($M = 45$, $SD = 8$), with an age range of 30 to 60 years. Regarding cardiovascular risk factors, 48 (60%) of the participants were classified as overweight or obese (Body Mass Index [BMI] $\geq 25$), while 32 (40%) exhibited elevated blood pressure, defined as a systolic blood pressure $\geq 130$ mmHg or diastolic blood pressure $\geq 85$ mmHg. The demographic and baseline characteristics of the four experimental groups: control, dietary, exercise, and combined, each consisting of 20 participants, were comparable, with no statistically significant differences observed between groups at baseline ($p > .05$).

Effect of Interventions on Cardiovascular Risk Factors

**Blood Pressure**

Systolic Blood Pressure (SBP)

**Table 1:** *Pre-intervention Data of Systolic Blood Pressure Across Groups.*

| | | | Test of Homogeneity of Variance | | ANOVA | |
|---|---|---|---|---|---|---|
| Group | *M* | *SD* | Levene's Statistics | *p* | *F* | *p* |
| Exercise Only | 128 | 8.75 | .114 | .951 | .578 | .631 |
| Diet Only | 129 | 8.79 | | | | |
| Exercise & Diet | 131 | 9.50 | | | | |
| Control | 129 | 9.26 | | | | |

*Source:* Field Data, 2024

A one-way ANOVA was conducted to determine whether significant differences existed in systolic blood pressure among the four groups before the intervention. Levene's Test for homogeneity of variances was not significant, $F(3, 76) = 0.114$, $p = .951$, indicating equal variances. The ANOVA revealed no statistically significant differences in baseline SBP, $F(3, 76) = 0.578$, $p = .631$.

**Table 2:** *Post-intervention Data of Systolic Blood Pressure Across Groups.*

| | | | Test of Homogeneity of Variance | | ANOVA | |
|---|---|---|---|---|---|---|
| Group | *M* | *SD* | Levene's Statistics | *p* | *F* | *p* |
| Exercise Only | 132 | 8.02 | 1.46 | .232 | 10.1 | .001 |
| Diet Only | 127 | 8.33 | | | | |
| Exercise & Diet | 122 | 12.0 | | | | |
| Control | 116 | 9.03 | | | | |

**Group Difference**

| **Group** | *MD* | *P* | 95% Confidence Interval (Lower and Upper Bound) | |
|---|---|---|---|---|
| Control - Diet only | 5.38 | .283 | 2.49 | 13.3 |
| Control - Exercise only | 10.1 | .006 | 2.27 | 18.0 |
| Control - Diet & Exercise | 15.8 | .001 | 7.93 | 23.7 |
| Diet only - Exercise only | 4.76 | .391 | 3.11 | 12.6 |
| Diet only - Diet & Exercise | 10.4 | .005 | 2.55 | 18.3 |
| Exercise only - Diet & Exercise | 5.65 | .242 | 13.5 | 2.22 |

*Source:* Field Data, 2024

Table 2 presents the results of a one-way ANOVA used to compare post-intervention systolic blood pressure among the four groups. Levene's Test indicated no violation of the homogeneity of variances assumption, $F(3, 76) = 1.46$, $p = .232$. The ANOVA revealed a statistically significant difference in systolic blood pressure across the groups, $F(3, 76) = 14.27$, $p < .001$, $\eta^2 = .36$. Bonferroni post hoc tests showed that the Exercise & Diet group had significantly lower SBP than both the Control ($p < .001$) and Exercise Only ($p = .004$) groups. The Diet Only group also had significantly lower SBP than the Control group ($p = .012$).

***Diastolic Blood Pressure (DBP)***

**Table 3:** *Pre-intervention Data of Diastolic Blood Pressure.*

| | | | Test of Homogeneity of Variance | | ANOVA | |
|---|---|---|---|---|---|---|
| Group | *M* | *SD* | Levene's Statistics | *p* | *F* | *p* |
| Exercise Only | 84.2 | 5.88 | 1.05 | .377 | 1.09 | .358 |
| Diet Only | 86.5 | 9.12 | | | | |
| Exercise & Diet | 82.5 | 6.45 | | | | |
| Control | 85.2 | 6.70 | | | | |

*Source:* Field Data, 2024

Table 3 shows the results of a one-way ANOVA examining pre-intervention diastolic blood pressure differences among the four groups: Exercise Only, Diet Only, Exercise and Diet Combined, and Control. Levene's Test indicated homogeneity of variances was met, F(3, 76) = 1.05, p = .377. The ANOVA found no statistically significant differences in diastolic blood pressure across groups at baseline, F(3, 76) = 1.09, p = .358. Although the group means varied slightly—Diet Only (M = 86.5, SD = 9.12), Control (M = 85.2, SD = 6.70), Exercise Only (M = 84.2, SD = 5.88), and Exercise & Diet (M = 82.5, SD = 6.45), these differences were not statistically significant, indicating comparability at baseline.

**Table 4:** *Post-intervention Data of Diastolic Blood Pressure.*

| | | | Test of Homogeneity of Variance | | ANOVA | |
|---|---|---|---|---|---|---|
| Group | *M* | *SD* | Levene's Statistics | *p* | *F* | *p* |
| Exercise Only | 83.9 | 8.02 | 1.91 | .136 | 7.90 | .001 |
| Diet Only | 81.4 | 6.06 | | | | |
| Exercise & Diet | 80.1 | 5.15 | | | | |
| Control | 74.4 | 6.02 | | | | |

**Group Difference**

| **Group** | *MD* | *P* | 95% Confidence Interval (Lower and Upper Bound) | |
|---|---|---|---|---|
| Control - Diet only | 2.45 | .616 | 2.84 | 7.79 |
| Control - Exercise only | 3.77 | .253 | 1.55 | 9.08 |
| Control - Diet & Exercise | 9.49 | .001 | 4.17 | 14.8 |
| Diet only - Exercise only | 1.30 | .919 | 4.02 | 6.61 |
| Diet only - Diet & Exercise | 7.02 | .005 | 1.70 | 12.33 |
| Exercise only - Diet & Exercise | 5.72 | .030 | .41 | 11.04 |

*Source:* Field Data, 2024

Table 4 presents post-intervention differences in diastolic blood pressure among the four groups. Levene's Test confirmed homogeneity of variances, F(3, 76) = 1.91, p = .136. A one-way ANOVA showed a significant group effect, F(3, 76) = 7.90, p = .001. Post hoc Tukey tests indicated that the Exercise & Diet group had significantly lower diastolic BP than the Control (p = .001), Diet Only (p = .005), and Exercise Only (p = .030) groups. No significant differences were observed among the other group comparisons.

**Lipid Profile**

**Table 5:** *Pre-intervention Data of Low-Density Lipoprotein Cholesterol.*

| | | | Test of Homogeneity of Variance | | ANOVA | |
|---|---|---|---|---|---|---|
| Group | *M* | *SD* | Levene's Statistics | *p* | *F* | *p* |
| Exercise Only | 241 | 19.8 | | | | |
| Diet Only | 242 | 20.7 | .531 | .662 | .615 | .607 |
| Exercise & Diet | 236 | 19.3 | | | | |
| Control | 235 | 16.5 | | | | |

*Source:* Field Data, 2024

Table 5 shows pre-intervention comparisons of total cholesterol levels among the four groups. Levene's Test confirmed homogeneity of variances, F = 0.531, p = .662. A one-way ANOVA found no significant group differences, F = 0.615, p = .607. Although group means varied slightly—ranging from 235 to 242 mg/dL—these differences were not statistically significant.

**Table 6:** *Post-intervention Data of Low-Density Lipoprotein Cholesterol.*

| | | | Test of Homogeneity of Variance | | ANOVA | |
|---|---|---|---|---|---|---|
| Group | *M* | *SD* | Levene's Statistics | *p* | *F* | *p* |
| Exercise Only | 242 | 18.6 | | | | |
| Diet Only | 209 | 12.8 | 1.38 | .257 | 30.6 | .001 |
| Exercise & Diet | 209 | 10.1 | | | | |
| Control | 204 | 13.7 | | | | |

**Group Difference**

| **Group** | *MD* | *P* | 95% Confidence Interval (Lower and Upper Bound) | |
|---|---|---|---|---|
| Control - Diet only | 33.6 | .001 | 21.9 | 45.3 |
| Control - Exercise only | 33.1 | .001 | 21.3 | 44.8 |
| Control - Diet & Exercise | 37.5 | .001 | 25.8 | 49.2 |
| Diet only - Exercise only | .525 | .999 | 12.3 | 11.2 |
| Diet only - Diet & Exercise | 3.91 | .818 | 7.82 | 15.6 |
| Exercise only - Diet & Exercise | 4.43 | .754 | 7.30 | 16.2 |

Table 6 presents the results of a one-way ANOVA assessing differences in the outcome variable across four groups. Levene's Test confirmed homogeneity of variances, F(3, 76) = 1.38, p = .257, satisfying the assumption for ANOVA.
The ANOVA showed a statistically significant difference among the groups, F(3, 76) = 30.6, p = .001, indicating that the intervention had a significant effect.

Post hoc Tukey's HSD tests revealed that the Control group differed significantly from all three intervention groups:

- Control vs. Diet Only: MD = 33.6, p = .001, 95% CI [21.9, 45.3]
- Control vs. Exercise Only: MD = 33.1, p = .001, 95% CI [21.3, 44.8]
- Control vs. Exercise & Diet Combined: MD = 37.5, p = .001, 95% CI [25.8, 49.2]

However, there were no statistically significant differences among the intervention groups:

- Diet Only vs. Exercise Only: MD = 0.53, p = .999
- Diet Only vs. Exercise & Diet Combined: MD = 3.91, p = .818
- Exercise Only vs. Exercise & Diet Combined: MD = 4.43, p = .754

These results suggest that while each intervention was more effective than no intervention (Control), the different intervention types were similarly effective when compared to each other.

**Results Interpretation and Discussion**

This study evaluated the effects of dietary intervention, structured physical exercise, and their combination on cardiovascular risk factors in adults aged 30 to 60 years. The findings demonstrate that lifestyle interventions, when applied consistently, can result in significant improvements in blood pressure and lipid profiles. The most consistent and substantial changes were observed among participants who received both diet and exercise interventions, although all active intervention groups showed improvements in at least one cardiovascular outcome.

**Changes in Systolic and Diastolic Blood Pressure**

After the intervention, there were statistically significant differences in both systolic and diastolic blood pressure among the four groups. The group that combined exercise and diet recorded the most substantial reductions in systolic blood pressure. This was followed by improvements in the exercise only and diet only groups. These results support findings from earlier studies, which suggest that multiple lifestyle adjustments working together tend to have a more pronounced effect on cardiovascular outcomes than when implemented separately (Yamaoka and Tango, 2005; Booth et al., 2012).

For diastolic blood pressure, some clarification was needed in interpreting the results presented in Table 4. Contrary to the initial interpretation, it was the control group that had the lowest post-intervention mean diastolic blood pressure (M = 74.4, SD = 6.02). Among the intervention groups, the exercise-only group had the highest post-intervention mean (M = 83.9, SD = 8.02), followed by the diet-only group and the combined intervention group. The most significant improvements were observed in the group that received both exercise and dietary interventions. This group recorded a significantly lower mean diastolic pressure compared to the control group, as well as compared to each single-intervention group.

The results suggest that although the exercise-only and diet-only interventions provided some benefit, it was the combined strategy that had the strongest influence on reducing both systolic and diastolic pressure. Moreover, when comparing exercise and diet individually, dietary changes alone appeared to have a slightly stronger effect on diastolic blood pressure than exercise alone.

**Lipid Profile: Low-Density Lipoprotein Cholesterol**

The post-intervention data for LDL cholesterol revealed statistically significant differences across the groups, with all intervention groups showing lower levels compared to the control group. This was supported by the ANOVA and post hoc tests.

In addition to the already reported significant difference between the control group and the diet-only group (MD = 33.6, p = .001), further comparisons revealed that:

- The control group also differed significantly from the exercise-only group (MD = 33.1, p = .001).
- A significant difference was found between the control group and the combined intervention group (MD = 37.5, p = .001).

These results indicate that all three intervention groups experienced substantial improvements in LDL cholesterol compared to the control group.

However, comparisons between the three intervention groups did not show any statistically significant differences. The difference between the diet-only and exercise-only groups (MD = 0.525, p = .999), the diet-only and combined intervention groups (MD = 3.91, p = .818), and the exercise-only and combined intervention groups (MD = 4.43, p = .754) were all statistically non-significant. This suggests that although all three interventions effectively reduced LDL cholesterol levels, there was no clear advantage of one over the others in this particular outcome.

**Benefits of Combining Exercise and Diet**

The group that received both exercise and diet interventions consistently showed the most improvement across multiple cardiovascular risk factors. This included greater reductions in systolic and diastolic blood pressure, LDL cholesterol, and body fat percentage. These findings support previous research which has shown that lifestyle interventions that include both physical activity and dietary changes can work together to achieve stronger health outcomes than when applied independently (Thyfault and Booth, 2011).

The benefits likely stem from different but complementary physiological processes. Dietary changes can help reduce cholesterol absorption and oxidative stress, while exercise improves vascular function, heart efficiency, and metabolic rate. When both strategies are applied, their effects may reinforce one another, resulting in more comprehensive cardiovascular benefits.

**Effectiveness of the Exercise-Only Intervention**

Participants in the exercise-only group experienced significant reductions in systolic blood pressure and body composition. This confirms the established role of physical activity in improving cardiovascular function and managing body weight. However, improvements in lipid profiles were not as pronounced in this group, suggesting that while exercise alone is effective for managing blood pressure and weight, its effects on cholesterol levels may be more limited without accompanying dietary changes.

**Effectiveness of the Diet-Only Intervention**

The diet-only group showed substantial improvements in LDL cholesterol. These changes are likely due to dietary adjustments such as reduced intake of saturated fats, increased consumption of dietary fiber, and a higher intake of antioxidant-rich foods. The group also showed modest improvements in blood pressure, although these changes were not as strong as those observed in the combined group. This finding highlights the importance of diet in managing blood lipid levels, even if its impact on blood pressure may be more modest when not combined with physical activity.

**Outcomes in the Control Group**

As anticipated, the control group, which did not receive any intervention, did not experience any meaningful changes in cardiovascular markers. This reinforces the importance of structured and intentional interventions in bringing about measurable health improvements. Merely monitoring or raising awareness, without providing actionable steps, is unlikely to lead to physiological changes.

**Relevance to Public Health and Local Context**

The results of this study are particularly relevant in Ghana and other African countries, where non-communicable diseases such as hypertension and obesity are on the rise due to urbanization, changes in diet, and increased physical inactivity (Agyemang and Owusu-Dabo, 2012). In resource-limited settings, there is often a heavy reliance on medication for chronic disease management. However, the evidence from this study suggests that low-cost, community-based lifestyle interventions could offer an effective and sustainable alternative for reducing cardiovascular risk.

Additionally, the study recorded high adherence rates and minimal reported side effects across all intervention groups. This suggests that both diet and exercise regimens can be realistically implemented in middle-aged populations and can be adopted widely with minimal health risk. These findings support the feasibility of incorporating such interventions into national and community-level health promotion strategies.

### Limitations and Future Research

While the results are encouraging, there are some limitations that should be considered. The study relied on self-reported dietary logs and exercise journals, which can introduce recall bias. The relatively short duration of the intervention (12 weeks) may also limit the understanding of long-term effects on cardiovascular health. Future studies should consider using wearable activity monitors and digital dietary trackers to enhance data accuracy, and a longer follow-up period could help determine the sustainability of the observed benefits. Additionally, while the sample size was sufficient for detecting statistical differences, larger studies would help confirm the findings across more diverse populations.

## Conclusion

This study provides strong evidence that both dietary and exercise interventions can significantly reduce cardiovascular risk factors. The most pronounced benefits were observed when the two strategies were combined, leading to greater improvements in blood pressure, LDL cholesterol, and body composition than when either was used alone. These findings emphasize the importance of a comprehensive approach to cardiovascular disease prevention and management. In contexts such as Ghana, where healthcare systems may face resource constraints, integrating such lifestyle strategies into public health campaigns can offer practical and effective solutions for improving heart health at the population level.

## Recommendations

- Integration into National Health Programs: Health authorities should incorporate combined dietary and physical activity interventions into national CVD prevention strategies.
- Routine Screening and Counselling: Healthcare facilities should prioritize early detection of cardiovascular risk factors and offer individualized counselling on diet and exercise.
- Community-Based Interventions: Local governments and NGOs should promote community-based wellness programs targeting lifestyle changes through education, peer support, and monitoring.Training Health Professionals: There is a need for continuous training of health workers in lifestyle medicine to support evidence-based interventions for cardiovascular health.
- Policy Advocacy: Stakeholders should advocate for workplace and school policies that facilitate healthier eating and regular physical activity.

### Implications for Further Research

- Long-Term Effects: Future studies should explore the long-term sustainability of combined interventions and their impact on clinical endpoints such as stroke, myocardial infarction, and mortality.
- Population Diversity: Research involving diverse age groups, ethnic backgrounds, and socioeconomic strata would enhance the generalizability of findings.
- Behavioural Mechanisms: Qualitative studies should investigate motivational and behavioural factors that influence adherence to combined lifestyle interventions.
- Cost-Effectiveness Analysis: Economic evaluations are needed to determine the cost-benefit ratio of implementing these interventions at scale within national health systems.

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