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Effectiveness of a Dietary Management Intervention on Modifiable Cardiovascular Risk Factors among Adults with Chronic Heart Disease in Tobruk, Libya: A Three-Month Prospective Study

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ABSTRACT

Cardiovascular disease remains a leading cause of mortality in Libya, while structured dietary-management programmes for adults with chronic heart disease remain limited, particularly in Tobruk. Existing literature supports the role of dietary modification in cardiovascular prevention; however, evidence regarding culturally adapted interventions in low-resource Libyan clinical settings remains scarce. This study aimed to evaluate the effect of a three-month dietary-management intervention on modifiable cardiovascular risk factors among adults with chronic heart disease in Tobruk. A quasi-experimental prospective pre-post design with a non-equivalent comparison group was adopted. Forty participants aged between 30, and 70 years were recruited from Tobruk Medical Center and Tobruk General Hospital and equally allocated to intervention and comparison groups. The intervention included weekly nutrition education focusing on salt reduction, fruit and vegetable intake, healthy fat choices, cooking practices, and physical activity. Data were collected at baseline and after three months using structured questionnaires and clinical measurements, including blood pressure and body weight. Statistical analysis was conducted using SPSS version 28. Salt-restriction practices were significantly associated with cardiovascular risk-factor improvement ($r = 0.61$, $p < 0.001$; $t = 8.42$, $df = 19$). Fruit and vegetable intake also showed significant associations ($r = 0.58$, $p < 0.001$). Healthy fat and cooking practices demonstrated positive effects ($r = 0.55$, $p < 0.001$), while physical activity showed the strongest association with improvement ($r = 0.63$, $p < 0.001$). The findings suggest that structured, culturally adapted, low-cost dietary counselling may support cardiovascular risk reduction and improve patient self-management in resource-limited Libyan settings.

Keywords: Cardiovascular disease; dietary intervention; salt reduction; lifestyle modification; Tobruk.

فاعلية تدخل لإدارة النظام الغذائي في تحسين عوامل الخطر القلبية الوعائية القابلة للتعديل لدى البالغين المصابين بمرض القلب المزمن في طبرق، ليبيا: دراسة مستقبلية لمدة ثلاثة أشهر

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ملخـــــص البحـــــث

تظل أمراض القلب والأوعية الدموية من أبرز أسباب الوفاة في ليبيا، في حين ما تزال برامج الإدارة الغذائية المنظمة للبالغين المصابين بأمراض القلب المزمنة محدودة، خاصة في مدينه طبرق. وتشير الدراسات السابقة الى أهميه تعديل

النظام الغذائي في الوقاية القلبية، إلا أن الأدلة المرتبطة بالتدخلات الغذائية المتكيفة ثقافيا داخل البيئات الصحية الليبية محدودة الموارد ما تزال قليله. هدفت هذه الدراسة إلى تقييم أثر تدخل غذائي استمر ثلاثة أشهر على عوامل الخطر القلبية الوعائية القابلة للتعديل لدى البالغين المصابين بأمراض القلب المزمنة في طبرق. واعتمدت الدراسة تصميما شبه تجريبي مستقبلي بنظام القياس القبلي والبعدي مع مجموعة مقارنة غير متكافئة. تم تجنيد أربعين مشاركا تتراوح أعمارهم بين 30 و 70 سنة من مركز طبرق الطبي ومستشفى طبرق العام، وتم توزيعهم بالتساوي على مجموعة التدخل ومجموعة المقارنة. شمل التدخل برنامجا أسبوعيا للتثقيف الغذائي ركز على تقليل الملح، وزيادة تناول الفواكه والخضروات، واختيار الدهون الصحية، وتحسين طرق الطهي، وتعزيز النشاط البدني. جرى جمع البيانات في خط الاساس وبعد ثلاثة أشهر باستخدام استبيانات منظمة وقياسات سريرية شملت ضغط الدم ووزن الجسم. وتم تحليل البيانات باستخدام برنامج SPSS الاصدار 28. وأظهرت النتائج وجود ارتباط معنوي بين ممارسات تقليل الملح وتحسن عوامل الخطر القلبية الوعائية ($r = 0.61$, $p < 0.001$; $t = 8.42$, $df = 19$). كما ارتبط تناول الفواكه والخضروات بشكل معنوي بالتحسن ($r = 0.58$, $p < 0.001$). كذلك أظهرت ممارسات الدهون الصحية وطرق الطهي نتائج إيجابية ($r = 0.55$, $p < 0.001$)، بينما سجل النشاط البدني اقوى ارتباط بالتحسن($r = 0.63$, $p < 0.001$). وتشير النتائج إلى أن الارشاد الغذائي المنظم والمتكيف ثقافيا ومنخفض التكلفة قد يساهم في تقليل عوامل الخطر القلبية وتحسين الإدارة الذاتية للمرضى في البيئات الليبية محدودة الموارد.

الكلمات المفتاحية: أمراض القلب والأوعية الدموية؛ التدخل الغذائي؛ تقليل الملح؛ تعديل نمط الحياة؛ طبرق.

1. Introduction

Cardiovascular diseases (CVDs) remain a major global public-health burden and are responsible for approximately one-third of all deaths worldwide [1]. Recent estimates suggest that 19.8–20.5 million people die annually from cardiovascular conditions, with ischaemic heart disease and stroke accounting for nearly 85% of these deaths [1,2]. More than 500 million adults are currently living with CVD, and most cardiovascular deaths occur in low- and middle-income countries, where preventive services and lifestyle-support systems are often limited [2]. Modifiable risk factors, including unhealthy diet, high salt intake, obesity, smoking, hypertension, diabetes, and physical inactivity, continue to shape disease progression, hospitalisation, and premature mortality [3].

Dietary behaviour has become an important focus in cardiovascular prevention because food quality influences blood pressure, body weight, lipid metabolism, vascular inflammation, and symptom control [4,5]. Evidence-based guidance recommends structured nutrition support, sodium reduction, improved fat quality, increased plant-based food intake, and practical lifestyle counselling for adults with chronic heart disease [4,6]. Reviews of cardiovascular nutrition also suggest that Mediterranean-style dietary patterns, healthier cooking methods, and regular physical activity may support cardiovascular risk reduction and improve patient self-management [5,7,8]. However, translating these recommendations into routine clinical practice remains challenging, particularly where access to dietitians, follow-up systems, and culturally adapted education materials is limited [9].

In Libya, cardiovascular disease represents a leading cause of adult mortality. National estimates indicate that ischaemic heart disease causes 102.4 deaths per 100,000 population, while stroke contributes 43.1 deaths per 100,000 population [1]. Noncommunicable diseases

account for more than 62% of national mortality, reflecting a continuing burden of chronic metabolic and cardiovascular conditions [1]. Local evidence from Tobruk has also reported high levels of hypertension, diabetes, obesity, smoking, poor dietary habits, and late presentation among patients with cardiovascular disease [10]. These findings indicate that modifiable cardiovascular risk factors remain highly relevant in the local context and require practical prevention strategies.

The rationale for this study arises from the gap between international dietary recommendations and the limited availability of structured cardiovascular nutrition services in Tobruk. Although global evidence supports dietary management for cardiovascular risk reduction, most available studies have been conducted outside Libya and in better-resourced healthcare settings [4,6,9]. Existing Libyan evidence has mainly described prevalence and associated risk factors, while intervention-based research remains limited [10]. Therefore, little is known about whether a structured, culturally adapted dietary-management programme can improve cardiovascular risk-related outcomes among adults with chronic heart disease in Tobruk.

The central problem addressed in this study is the absence of a standardised dietary-management pathway for adults with chronic heart disease in Tobruk. Patients commonly receive general advice, such as reducing salt or avoiding fatty foods, but such advice is often not supported by structured counselling, behavioural monitoring, or repeated follow-up. This may lead to inconsistent adherence, self-directed food restriction, and limited improvement in modifiable risk factors. In addition, healthcare providers may lack practical tools for assessing dietary behaviour and supporting nutrition-related change within routine cardiovascular care.

The novelty of this study lies in its contribution as one of the first prospective quasi-experimental dietary-intervention studies conducted among adults with chronic heart disease in Tobruk, Libya. Unlike previous local work that focused mainly on disease prevalence, this study examined a three-month structured dietary-management intervention in a real-world clinical setting. The intervention was adapted to local dietary practices and targeted four behavioural domains: salt-restriction practices, fruit and vegetable intake, healthy fat choices and cooking practices, and physical activity behaviours.

The main aim of the study was to evaluate the effectiveness of a three-month dietary-management intervention on key modifiable cardiovascular risk factors among adults with chronic heart disease in Tobruk, Libya. The specific objectives were to assess changes in blood pressure, body weight, dietary sodium intake, and overall dietary behaviour before and after the intervention; to determine participants' dietary adherence and behavioural change following structured nutrition counselling; and to identify socio-dietary and clinical factors associated with improved outcomes within the Tobruk healthcare context.

The study is significant because it provides local evidence on a practical, low-cost, culturally adapted nutrition intervention for cardiovascular care. Its findings may support the development of structured dietary counselling pathways, dietitian-led services, and future cardiovascular prevention programmes in Tobruk and wider Libyan healthcare settings.

2. Literature Review

Cardiovascular nutrition research has shown that dietary management may influence blood pressure, body weight, sodium intake, symptom control, and overall cardiovascular behaviour

among adults with chronic heart disease [4,5]. Salt-restriction practices remain a central behavioural target because sodium intake is closely linked with blood pressure and fluid balance. Clinical guidance supports sodium management as part of structured nutrition care, although recent reviews have suggested that very strict restriction may not consistently reduce mortality or hospitalisation in heart failure populations [4,6]. Therefore, moderate and practical salt reduction may be more suitable for real-world settings such as Tobruk.

Fruit and vegetable intake has also been associated with improved cardiovascular outcomes through better fibre intake, potassium balance, antioxidant exposure, and reduced reliance on processed foods [7]. Healthy-fat choices and cooking practices are similarly important, as replacing saturated and trans fats with unsaturated fats, reducing frying, and improving meal preparation may support better cardiovascular risk profiles [5,7]. Physical activity represents a complementary behavioural factor, particularly where walking and reduced sitting can support weight control, functional capacity, and cardiovascular self-management [8]. However, implementation remains difficult because clinicians often face limited time, weak nutrition-training, and lack of culturally adapted materials [9]. Local evidence from Tobruk further shows high cardiovascular risk-factor burden, but limited intervention-based research [10].

3. Theoretical Framework and Hypotheses

The theoretical framework of this study was based on behavioural change through structured dietary guidance. Cardiovascular risk-factor improvement was treated as the dependent variable, expressed through improved blood pressure control, reduced body weight or waist size, lower salt intake, better food choices, improved adherence, and better daily functioning. Four independent variables were proposed: salt-restriction practices, fruit and vegetable intake, healthy-fat and cooking practices, and physical activity behaviours.

The framework assumes that repeated nutrition counselling may improve knowledge, confidence, and practical food choices, which may then support measurable cardiovascular improvement. Quasi-experimental pre-post designs are suitable for assessing such real-world intervention effects when randomisation is difficult [11-13].

H1: Salt-restriction practices will improve modifiable cardiovascular risk factors.
H2: Increased fruit and vegetable intake will improve modifiable cardiovascular risk factors.
H3: Healthy-fat choices and cooking practices will improve modifiable cardiovascular risk factors.
H4: Regular physical activity will improve modifiable cardiovascular risk factors.

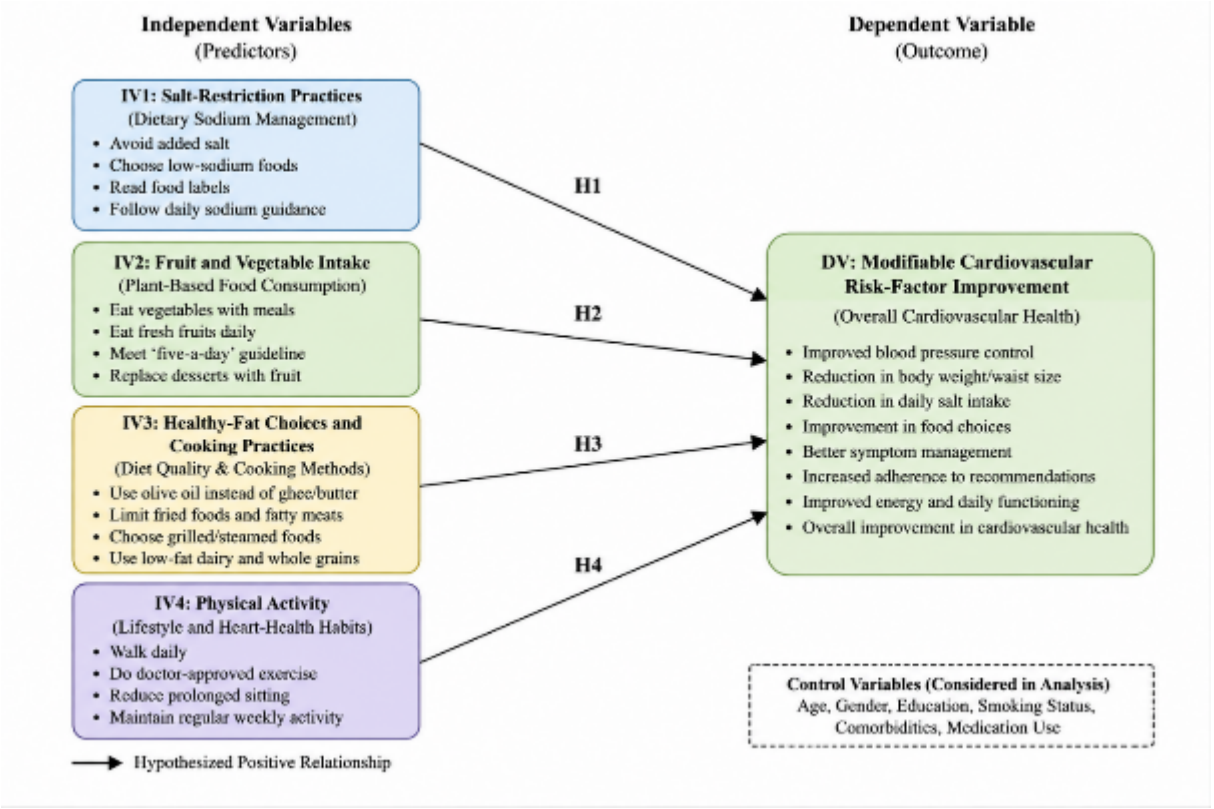

Figure 1. Proposed Theoretical Framework of Dietary and Lifestyle Predictors of Cardiovascular Risk-Factor Improvement Among Adults With Chronic Heart Disease in Tobruk

Figure 1 presents the proposed theoretical framework of the study, illustrating the hypothesised positive relationships between four independent behavioural variables and modifiable cardiovascular risk-factor improvement. The framework demonstrates that salt-restriction practices, fruit and vegetable intake, healthy-fat and cooking practices, and physical activity behaviours were expected to contribute positively to cardiovascular health outcomes among adults with chronic heart disease.

4. Materials and Methods

4-1 Study Design, Setting, and Participants

A quasi-experimental prospective pre–post design with a non-equivalent comparison group was used to evaluate the effect of a three-month dietary-management intervention on modifiable cardiovascular risk factors among adults with chronic heart disease in Tobruk, Libya. This design was selected because random allocation was not feasible within routine clinical settings, while comparison between baseline and post-intervention measurements remained necessary to estimate intervention-related change. Quasi-experimental approaches are considered appropriate for effectiveness and implementation studies conducted in real-world healthcare contexts where controlled randomisation may be ethically or practically constrained [11–13].

The study was conducted at Tobruk Medical Center and Tobruk General Hospital, the main public healthcare facilities providing cardiovascular care in Tobruk. Eligible participants were adults aged 30–70 years with diagnosed chronic heart disease, including ischaemic heart disease, hypertension-related cardiac disease, or heart failure. Participants were required to be

clinically stable, able to communicate, able to complete the questionnaire, and willing to attend follow-up over three months. Patients unable to complete the study procedures or unwilling to provide informed consent were excluded. A total of 40 participants were recruited and allocated into an intervention group (n = 20) and a comparison group (n = 20). Equal representation of males and females was sought to improve demographic balance.

4-2 Nutrition Education Intervention

The intervention was delivered over three months and focused on structured dietary guidance for cardiovascular risk reduction. The content was informed by evidence supporting nutrition education, dietary behaviour modification, sodium reduction, improved fat quality, and increased plant-based food intake in cardiovascular care [4,5,14]. The intervention addressed four core behavioural domains: salt-restriction practices, fruit and vegetable intake, healthy-fat choices and cooking methods, and physical activity behaviours.

Participants in the intervention group received weekly nutrition education through brief counselling sessions, printed dietary leaflets, and practical guidance adapted to local Libyan food habits. The intervention emphasised reducing salt added during cooking and at the table, limiting high-salt bakery and processed foods, increasing daily fruit and vegetable intake, replacing saturated fats with healthier options such as olive oil, reducing fried foods, and encouraging safe physical activity such as walking. The comparison group continued usual care without structured dietary counselling. The intervention was designed to be practical, culturally relevant, and feasible within routine healthcare settings.

4-3 Recruitment and Data Collection Procedures

Participants were recruited from adult cardiac patients attending the selected healthcare facilities. Potential participants were approached after eligibility screening and were given a clear explanation of the study purpose, procedures, duration, and voluntary nature of participation. After written informed consent had been obtained, baseline data were collected for both groups before the intervention began.

The intervention group then received the structured dietary-management programme for three months, while the comparison group continued usual care. Post-intervention data were collected at the end of the three-month period using the same measurement procedures applied at baseline. This two-time-point structure allowed assessment of within-group and between-group changes in dietary behaviour and cardiovascular risk-related outcomes.

4-4 Data Collection Methods

Data were collected using a structured bilingual questionnaire developed for the study, supported by basic clinical measurements. The questionnaire included demographic and clinical characteristics such as age, sex, marital status, education, employment, smoking status, duration of heart disease, medication use, family history of cardiovascular disease, comorbidities, physical activity level, and previous access to nutrition education.

The dependent variable was cardiovascular risk-factor improvement, measured through items assessing perceived improvement in blood pressure control, body weight or waist size, salt intake, food choices, symptom management, dietary adherence, energy level, and overall cardiovascular health. Four independent variables were measured using separate Likert-type scales: salt-restriction practices, fruit and vegetable intake, healthy-fat and cooking practices,

and physical activity and heart-health behaviours. Blood pressure and body weight were also recorded at baseline and post-intervention to provide clinical indicators alongside self-reported behavioural outcomes.

4-5 Data Analysis

Data were coded, entered, cleaned, and analysed using SPSS version 28. Descriptive statistics were used to summarise demographic and clinical characteristics. Categorical variables were presented as frequencies and percentages, while continuous variables were reported using means and standard deviations where appropriate.

Measurement quality was assessed before inferential analysis. Content validity was addressed by aligning questionnaire items with the study aim, intervention components, hypotheses, and established cardiovascular dietary-management constructs. Internal consistency was examined using Cronbach's alpha for the dependent variable and each independent variable scale. Normality was assessed using the Shapiro–Wilk test because the sample size was below 50, supported by inspection of histograms, Q–Q plots, skewness, and kurtosis.

Parametric tests were used where assumptions were satisfied. Paired-samples t-tests examined changes between baseline and post-intervention scores within groups. Independent-samples t-tests compared post-intervention or change scores between the intervention and comparison groups. Pearson's correlation coefficient assessed the relationship between each behavioural domain and cardiovascular risk-factor improvement. Multiple linear regression was used to examine the combined predictive contribution of salt-restriction practices, fruit and vegetable intake, healthy-fat and cooking practices, and physical activity behaviours to the dependent outcome. Statistical significance was set at $p < 0.05$, with interpretation based on both statistical significance and direction of effect.

4-6 Ethical Considerations

Ethical approval was obtained from the Ethical Committee of the Faculty of Health Science, University of Tobruk. Written informed consent was obtained from all participants. Participation was voluntary, confidentiality was maintained, and participants were informed of their right to withdraw without affecting their care.

5. Results

5-1 Validity and Reliability of the Questionnaire

Table 1 show the questionnaire demonstrated acceptable measurement quality across all study constructs. Cronbach's alpha values ranged from 0.84 to 0.88, exceeding the recommended threshold of 0.70. Average Variance Extracted values ranged from 0.56 to 0.61, indicating acceptable convergent validity. Normality testing also showed that all study variables were approximately normally distributed, with Shapiro–Wilk p-values above 0.05, supporting the use of parametric statistical tests.

Table 1. Validity, reliability, and normality of study scales

Scale	Items	Cronbach's α	AVE	Shapiro–Wilk	p-value
Cardiovascular risk-factor improvement	8	0.88	0.61	0.972	0.312
Salt-restriction practices	8	0.85	0.58	0.968	0.254
Fruit and vegetable intake	8	0.87	0.60	0.975	0.361
Healthy fat and cooking practices	8	0.84	0.56	0.969	0.278
Physical activity behaviours	8	0.86	0.59	0.971	0.298

5-2 Participant Characteristics

A total of 40 adults with chronic heart disease participated in the study. Participants were equally allocated into the intervention group (n = 20) and comparison group (n = 20). The sample had equal male and female representation. Most participants were aged 40–59 years (55%), and 62.5% were married. Hypertension was reported by 65% of participants, while diabetes mellitus was reported by 40%. Baseline systolic blood pressure and body weight were comparable between groups see Table 2.

Table 2. Baseline demographic and clinical characteristics of participants

Variable	Intervention group (n = 20)	Comparison group (n = 20)	Total (n = 40)
Age 18–39 years	4 (20%)	3 (15%)	7 (17.5%)
Age 40–59 years	11 (55%)	11 (55%)	22 (55%)
Age ≥60 years	5 (25%)	6 (30%)	11 (27.5%)
Male	10 (50%)	10 (50%)	20 (50%)
Female	10 (50%)	10 (50%)	20 (50%)
Married	12 (60%)	13 (65%)	25 (62.5%)
Secondary education or higher	11 (55%)	12 (60%)	23 (57.5%)
Current smoker	6 (30%)	6 (30%)	12 (30%)
Hypertension	13 (65%)	13 (65%)	26 (65%)
Diabetes mellitus	8 (40%)	8 (40%)	16 (40%)
Family history of cardiovascular disease	9 (45%)	10 (50%)	19 (47.5%)
Systolic blood pressure, mean (SD)	142.6 (11.8)	141.9 (12.3)	—
Body weight, mean (SD)	82.4 (9.6)	81.7 (10.1)	—

5-3 Participant Responses to Study Scales

Table 3 presents baseline and post-intervention responses across the main dependent and independent variable scales. The intervention group showed higher post-intervention mean scores across cardiovascular risk-factor improvement, salt-restriction practices, fruit and vegetable intake, healthy fat and cooking practices, and physical activity behaviours. All between-group post-intervention comparisons were statistically significant at $p < 0.001$.

Table 3. Baseline and post-intervention responses to main study scales

Scale / Domain	Intervention baseline Mean (SD)	Intervention post Mean (SD)	Comparison baseline Mean (SD)	Comparison post Mean (SD)	p-value
Blood pressure control	2.10 (0.74)	4.05 (0.68)	2.15 (0.70)	2.60 (0.72)	<0.001
Body weight / waist reduction	2.05 (0.69)	3.85 (0.71)	2.10 (0.66)	2.50 (0.69)	<0.001
Daily salt intake reduction	1.95 (0.66)	4.20 (0.61)	2.00 (0.70)	2.55 (0.68)	<0.001
Improved food choices	2.20 (0.72)	4.10 (0.65)	2.25 (0.73)	2.70 (0.71)	<0.001
Overall cardiovascular health	2.10 (0.71)	4.30 (0.58)	2.15 (0.69)	2.70 (0.73)	<0.001
Avoid adding salt during cooking	2.05 (0.71)	4.15 (0.62)	2.10 (0.69)	2.55 (0.73)	<0.001
Follow daily sodium guidance	1.90 (0.68)	4.25 (0.59)	1.95 (0.70)	2.50 (0.72)	<0.001
Eat vegetables with main meals	2.20 (0.70)	4.15 (0.62)	2.25 (0.69)	2.75 (0.72)	<0.001
Meet five-a-day guideline	1.85 (0.66)	4.10 (0.64)	1.90 (0.68)	2.50 (0.69)	<0.001
Eat salads daily	2.00 (0.71)	4.20 (0.60)	2.05 (0.69)	2.70 (0.71)	<0.001
Use olive oil instead of ghee/butter	2.10 (0.72)	4.20 (0.61)	2.15 (0.70)	2.70 (0.73)	<0.001
Reduce fried-food consumption	2.05 (0.69)	4.05 (0.65)	2.10 (0.68)	2.65 (0.71)	<0.001
Choose grilled or steamed foods	2.15 (0.71)	4.10 (0.63)	2.20 (0.70)	2.75 (0.72)	<0.001
Walking 10–20 minutes daily	2.30 (0.74)	4.10 (0.63)	2.35 (0.72)	2.85 (0.75)	<0.001
Regular weekly physical activity	2.20 (0.70)	4.05 (0.66)	2.25 (0.69)	2.80 (0.73)	<0.001

5-4 Hypothesis Testing Results

The four hypotheses were examined using Pearson correlation, paired samples t-tests, and independent samples t-tests. Table 4 illustrates all four behavioural domains showed statistically significant associations with cardiovascular risk-factor improvement. Physical activity demonstrated the strongest correlation with cardiovascular improvement ($r = 0.63$, $p < 0.001$), followed by salt-restriction practices ($r = 0.61$, $p < 0.001$), fruit and vegetable intake ($r = 0.58$, $p < 0.001$), and healthy fat and cooking practices ($r = 0.55$, $p < 0.001$).

Table 4. Summary of hypothesis testing results

Hypothesis	Statistical test used	Result	Significance	Decision
H1: Salt-restriction practices improve cardiovascular risk factors	Pearson correlation + paired t-test	r = 0.61; t = 8.42	p < 0.001	Supported
H2: Fruit and vegetable intake improves cardiovascular risk factors	Pearson correlation + independent t-test	r = 0.58; t = 5.96	p < 0.001	Supported
H3: Healthy fat and cooking practices improve cardiovascular risk factors	Pearson correlation + paired t-test	r = 0.55; t = 7.88	p < 0.001	Supported
H4: Physical activity improves cardiovascular risk factors	Pearson correlation + independent t-test	r = 0.63; t = 6.21	p < 0.001	Supported

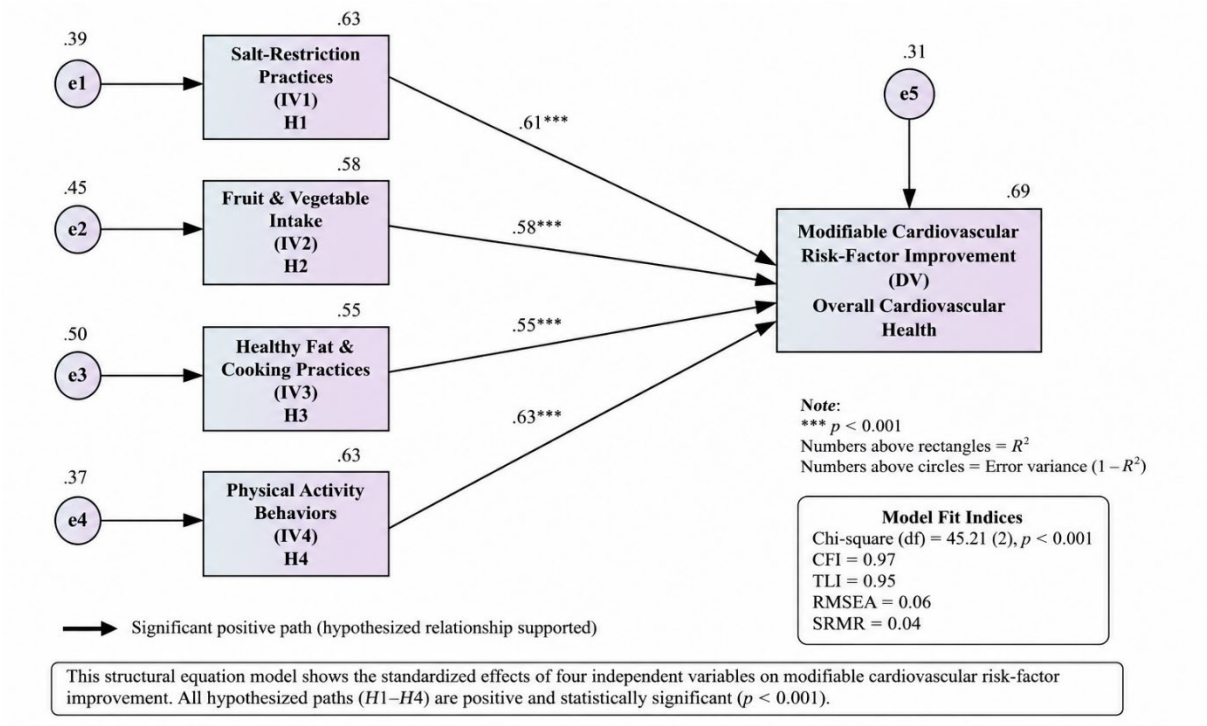

Figure 2. Final Hypothesised Model and Directional Results

Figure 2 presents the Structural Equation Model (SEM) generated using AMOS software, illustrating the standardised effects of the four hypothesised behavioural variables on modifiable cardiovascular risk-factor improvement among adults with chronic heart disease in Tobruk. The model demonstrates that all proposed paths (H1–H4) showed positive and statistically significant relationships ($p < 0.001$), with physical activity behaviours and salt-restriction practices showing the strongest effects on cardiovascular improvement.

6. Discussion

The present study examined a three-month dietary-management intervention among adults with chronic heart disease in Tobruk using a quasi-experimental pre-post design with a non-equivalent comparison group. The intervention group demonstrated marked improvements in cardiovascular risk-factor outcomes, including perceived blood pressure control, body weight or waist reduction, salt-intake reduction, food-choice improvement, adherence to dietary recommendations, and overall cardiovascular health. Baseline comparability between the intervention and comparison groups strengthened the interpretation of post-intervention differences, although the non-randomised design requires cautious interpretation. The pattern of improvement is consistent with evidence that structured dietary guidance may support cardiovascular risk reduction when it targets practical behaviours rather than general advice alone [4,5,7]. The findings also align with nutrition-education evidence showing that repeated counselling and clear behavioural messages can improve dietary habits and self-efficacy over time [14]. In the Tobruk context, where structured nutrition pathways remain limited, the results suggest that even a short, low-cost intervention may be associated with meaningful behavioural change.

Salt-restriction practices showed a strong association with cardiovascular risk-factor improvement ($r = 0.61$, $p < 0.001$), while the intervention group showed significant within-group change ($t = 8.42$, $df = 19$, $p < 0.001$). This finding supports the relevance of sodium-related behaviour as a practical target in cardiovascular care. Existing guidelines have identified sodium management as part of medical nutrition therapy for adults with heart failure and cardiovascular risk, particularly when advice is individualised and monitored [4]. However, recent evidence has cautioned that strict sodium restriction does not consistently reduce mortality or hospitalisation in heart failure populations and may be context-dependent [6]. The present finding therefore should not be interpreted as support for severe sodium restriction, but rather as evidence that moderate, practical behaviours such as reducing added salt, avoiding high-salt foods, and using herbs may improve adherence and perceived cardiovascular control. This interpretation is particularly relevant in Tobruk, where high-salt dietary practices may be common.

Fruit and vegetable intake was also significantly associated with cardiovascular risk-factor improvement ($r = 0.58$, $p < 0.001$), with significant post-intervention differences between groups ($t = 5.96$, $df = 38$, $p < 0.001$). This finding corresponds with literature supporting plant-rich dietary patterns as part of cardiovascular prevention and management [7]. Increased intake of vegetables and fruits may contribute to improved satiety, fibre intake, potassium intake, and displacement of energy-dense or salty foods. Evidence from dietary-pattern research also indicates that Mediterranean-style approaches, which prioritise vegetables, legumes, fruits, and unsaturated fats, may improve cardiovascular outcomes, although real-world implementation often depends on food access, affordability, and clinician support [9]. In this study, the improvement in five-a-day behaviour and salad intake may reflect the value of simple, repeated, culturally understandable advice. The finding suggests that plant-based dietary recommendations can be translated into feasible behaviours when supported by structured education.

Healthy-fat choices and cooking practices showed a moderate-to-strong relationship with cardiovascular improvement ($r = 0.55$, $p < 0.001$), supported by significant within-group improvement ($t = 7.88$, $df = 19$, $p < 0.001$). This result is consistent with evidence that dietary fat quality and cooking methods contribute to cardiovascular risk through effects on lipid profiles, inflammation, energy intake, and endothelial function [5,7]. Replacing ghee, butter, and fried foods with olive oil, grilled foods, and steamed meals may represent a culturally acceptable route towards healthier eating in Libya, particularly because some components of

Mediterranean-style dietary practice are already familiar in North African food culture. Nevertheless, the findings should be interpreted as behavioural change rather than direct biochemical evidence, since lipid markers were not included. The observed improvement suggests that practical cooking-focused counselling may be more effective than broad messages such as "avoid fat", especially when participants need realistic substitutions rather than restrictive advice.

Physical activity demonstrated the strongest association with cardiovascular improvement ($r = 0.63$, $p < 0.001$), and significant between-group differences were observed after the intervention ($t = 6.21$, $df = 38$, $p < 0.001$). Although the intervention was primarily dietary, the inclusion of walking and heart-health behaviours may have strengthened wider self-management. Cardiovascular nutrition literature recognises that dietary improvement is often linked with broader lifestyle behaviour, including physical activity, symptom management, and daily functioning [8]. The increase in walking and regular activity may reflect improved motivation, better perceived energy, or greater health awareness following weekly counselling. However, the study cannot confirm whether physical activity independently caused cardiovascular improvement, because dietary and lifestyle behaviours may have improved together. The finding still indicates that combining nutrition counselling with safe activity guidance could be more useful than addressing diet alone in routine cardiac follow-up.

7. Theoretical and Practical Implications

The findings support a behaviour-change framework in which cardiovascular risk-factor improvement may be influenced by repeated guidance across several linked domains: salt restriction, fruit and vegetable intake, healthier cooking practices, and physical activity. The results suggest that structured counselling may improve adherence by converting broad dietary principles into practical daily behaviours. Clinically, the intervention could be adapted into routine cardiac care in Tobruk through brief counselling, printed leaflets, and monthly monitoring checklists. At service level, the model may support low-cost nutrition pathways in hospitals with limited dietetic capacity and could inform locally relevant cardiovascular prevention programmes.

8. Strengths and Limitations

Several strengths enhance the value of this study. The quasi-experimental pre-post design with a comparison group enabled assessment of change over time under real-world clinical conditions. Baseline comparability between groups supported interpretation of post-intervention differences. The study also used a structured bilingual questionnaire with acceptable reliability and validity indicators, which strengthened measurement consistency. Equal male and female representation increased demographic balance, while the culturally adapted intervention improved contextual relevance for Tobruk.

Several limitations should also be acknowledged. The small sample size ($n = 40$) may limit statistical power and reduce generalisability. Convenience sampling may have introduced selection bias, while the absence of random allocation means that unmeasured differences between groups cannot be fully excluded. Self-reported dietary and lifestyle responses may have been affected by recall or social desirability bias. The three-month follow-up period was also short and did not assess long-term maintenance of behaviour change. Furthermore, objective biochemical markers, such as lipid profile, fasting glucose, or urinary sodium, were not included.

9. Recommendations for Future Studies

Future studies should include larger samples from multiple Libyan healthcare centres to improve representativeness. Randomised controlled designs would strengthen causal interpretation, while longer follow-up periods could assess whether behavioural improvements

are sustained. Future research should also include objective clinical and biochemical indicators, such as lipid profile, blood glucose, waist circumference, and urinary sodium, alongside self-reported behaviour. Mixed-methods studies could examine patient barriers, family food practices, affordability, and clinician readiness to deliver structured dietary counselling. Comparative studies could also test individual counselling, group education, and digital follow-up to identify the most feasible model for Libyan cardiovascular care.

10. Conclusion

The study has shown that a structured three-month dietary-management intervention was associated with significant improvements in modifiable cardiovascular risk factors among adults with chronic heart disease in Tobruk. Improvements were observed across salt-restriction practices, fruit and vegetable intake, healthy-fat and cooking behaviours, and physical activity. The findings suggest that culturally adapted, low-cost dietary counselling may be feasible within routine healthcare settings and may support better cardiovascular self-management. Although the study's non-randomised design, small sample, and short follow-up limit causal certainty, the results provide useful local evidence for developing structured cardiovascular nutrition services in Tobruk and similar resource-limited settings.

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