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ORIGINAL ARTICLE

Association of Omega-3 Fatty Acid Levels with Cardiovascular Disease Risk Factors and Metabolic Syndrome among Adults

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ABSTRACT

Background: Cardiovascular disease (CVD) remains a leading cause of morbidity and mortality worldwide. Omega-3 fatty acids (ω-3 FAs) have been suggested to have a beneficial effect on CVD risk factors and metabolic syndrome (MetS), but their role in adults remains unclear.

Objective: To investigate the association of omega-3 fatty acid levels with cardiovascular disease risk factors and the prevalence of metabolic syndrome among a cohort of 243 adults.

Methodology: This cross-sectional study was conducted at Shaikh Zayed Hospital, Lahore during January 2023 till August 2023. A total of 243 patients were added in the study. Data were collected using a combination of clinical assessments, laboratory tests, and self-reported questionnaires. Data collection for this study involved clinical assessments, laboratory tests, and self-reported questionnaires.

Results: The mean age of 45 years ranging from 18 to 65 years. There were 55% females and 45% males. The mean body mass index was 27.5±4.2 kg/m², indicating that the majority were overweight or obese, with a range of 18.5 to 38.0 kg/m². Waist circumference measurements revealed an average of 94 cm for men and 88 cm for women, reflecting central obesity. The relationship between Omega-3 Index (O3I) levels and insulin resistance, as measured by HOMA-IR, revealed that participants with an O3I of less than 4% had a higher mean HOMA-IR of 2.2±1.1, with 35% of them exhibiting insulin resistance (HOMA-IR ≥2.5). In contrast, participants with O3I levels between 4-6% showed a mean HOMA-IR of 1.9±0.9, with 25% demonstrating insulin resistance. Those with an O3I of 6% or higher had the lowest mean HOMA-IR of 1.5±0.7, and only 15% had insulin resistance.

Conclusion: Higher omega-3 fatty acid levels are inversely associated with cardiovascular disease risk factors and the prevalence of metabolic syndrome among adults. Omega-3 supplementation or dietary intake could be beneficial in mitigating cardiovascular and metabolic risks in the adult population.

Keywords: Patients, Omega-3 Fatty acids, CVD, Metabolic, Syndrome

INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of mortality and morbidity worldwide, accounting for a significant proportion of the global disease burden. WHO reports CVDs as the cause of 17.9 million annual deaths which represent 32% of worldwide fatalities. Patients face significant risks for cardiovascular disease development through hypertension disease and dyslipidemia and obesity together with insulin resistance as well as metabolic syndrome (MetS).[1] People with metabolic syndrome who have central obesity alongside insulin resistance coupled with dyslipidemia (high triglycerides and low HDL cholesterol) and high blood pressure face an increased danger of heart attack or stroke and sudden cardiac death. The medical community now focuses intensely on discovering preventable elements which can lower the presence of these risk factors so cardiovascular diseases become less frequent. Omega-3 fatty acids capture detailed dietary evaluation because meta-analysts focus on their health advantages which strengthen cardiovascular function.[2] The essential polyunsaturated fats omega-3 consist of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) together with alpha-linolenic acid (ALA) which exist mostly in fatty fish and walnut products and flaxseeds and vegetable oils.[3]

The body requires these polyunsaturated fatty acids to uphold cellular structures as well as to regulate inflammatory processes and oxidative conditions and metabolic control of lipids. How omega-3 fatty acids affect cardiovascular health and omega-3 fatty acids operate as both inflammation reducers and cholesterol controllers which fight against three main cardiovascular disease risk components including elevated triglycerides and high blood pressure and abnormal cholesterol results.[4] Medical research indicates that omega-3 fatty acids lower the vulnerability to develop atherosclerosis which leads to artery plaque build-up that causes heart attacks and strokes. The benefits of omega-3s extend to improve insulin sensitivity and lower oxidative stress and enhance endothelial functions which together form components that make up metabolic syndrome.[5]

The documented therapeutic properties of omega-3 fatty acids for single cardiovascular risk elements need additional research to determine their influence on complete metabolic syndrome factor clusters. The prevalence of metabolic syndrome becomes less likely when people consume higher amounts of omega-3 fatty acids either through diet or supplements. This indicates omega-3s help avoid and delay metabolic syndrome.[6] The experts have not completely clarified how omega-3 fatty acids affect cardiovascular risk factors and metabolic syndrome through biological mechanisms. The scientific community attributes the effect of omega-3 fatty acids on lipid metabolism to their ability to reduce liver triglyceride production and enhance cholesterol waste clearance in bloodstream.[7] These health benefits include improved endothelial function and reduced blood clotting and decreased systemic inflammation which jointly lead to better cardiovascular health. The composition of omega-3 acids appears to benefit both insulin sensitivity and adiposity levels that constitute metabolic syndrome.[8]

Current research demonstrates clear advantages from using omega-3 fatty acids yet scientists have not determined what specific amounts produce maximum benefits. Many investigations reveal a beneficial link between omega-3 amounts and enhanced heart health but research results remain inconsistent and scientists continue to debate omega-3's role in reducing metabolic syndrome risk elements. Genetic predispositions together with pre-existing health conditions act as factors that determine how individual patients respond to omega-3 fatty acids regarding improved metabolic along with cardiovascular health outcomes.[9]

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MATERIALS AND METHODS

This cross-sectional study was conducted at Shaikh Zayed Hospital, Lahore during January 2023 till August 2023. A total of 243 patients were enrolled. All adults aged >18 years, generally healthy without any history of major cardiovascular events or chronic diseases such as chronic kidney disease or liver disease and have not taken omega-3 supplements for at least 3 months prior to the study were included. All pregnant or lactating women, history of cardiovascular disease (e.g. myocardial infarction, stroke) or other chronic diseases (e.g. cancer, kidney disease), individuals on medications that significantly alter lipid profiles, blood pressure, or glucose metabolism (e.g. statins, antihypertensive drugs, insulin therapy) and severe obesity (BMI ≥40) were excluded.

Data were collected using a combination of clinical assessments, laboratory tests, and self-reported questionnaires. Data collection for this study involved clinical assessments, laboratory tests, and self-reported questionnaires. Anthropometric measurements were taken, including height, weight, waist circumference, and hip circumference, using standardized techniques. Researchers used the measurements to determine body mass index (BMI) and waist-to-hip ratio (WHR) because these metrics function as vital indicators of obesity status and metabolic well-being. An automatic blood pressure device measured blood pressure on participants once they had rested for five minutes. The research used ACC guidelines to sort blood pressure results into normal readings together with elevated pressure and stage 1 and stage 2 hypertension. The researchers extracted fasting blood samples to quantify total cholesterol and low-density lipoprotein (LDL) cholesterol together with high-density lipoprotein (HDL) cholesterol and triglycerides levels. Scientists must analyze lipid parameters because they establish cardiovascular risk levels. The Omega-3 fatty acid measurement procedure used gas chromatography-mass spectrometry (GC-MS) to analyze phospholipids extracted from participant blood plasma. Research investigated EPA and DHA and ALA levels to calculate the Omega-3 Index through red blood cell membrane measurements as the main indicator for omega-3 status assessment. The diagnosis of metabolic syndrome followed the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) framework by detecting three out of at least five metabolic risk factors including abdominal obesity together with elevated triglycerides and low HDL cholesterol and either high blood pressure or elevated fasting glucose levels. The assessment of insulin sensitivity included fasting blood glucose and insulin level measurements which allowed researchers to estimate insulin resistance using the Homeostasis Model Assessment of Insulin Resistance (HOMA-IR) at or above 2.5 to indicate insulin resistance. Data were analyzed using SPSS-23.

RESULTS

The mean age was 45 years ranging from 18 to 65 years. There were 134 (55%) females and 109 (45%) males. The mean BMI was 27.5±4.2 kg/m², indicating that the majority were overweight or obese, with a range of 18.5 to 38.0 kg/m². Waist circumference measurements revealed an average of 94 cm for men and 88 cm for women, reflecting central obesity. Blood pressure readings showed that 52.6% of participants had normal blood pressure, while 30% had elevated blood pressure, 13.2% had Stage 1 hypertension, and 4.2% had Stage 2 hypertension (Table 1).

The mean total cholesterol level was 210±45 mg/dL, with 40% of participants having levels above the normal range of <200 mg/dL. LDL cholesterol had a mean of 130±35 mg/dL, with 50% exceeding the normal threshold of <100 mg/dL. The average HDL cholesterol was 45 mg/dL for men and 50 mg/dL for women, which is below the optimal level of >60 mg/dL in 35% of participants. Triglyceride levels averaged 160±65 mg/dL, with 25% of individuals surpassing the recommended normal range of <150 mg/dL. The mean Omega-3 Index (O3I) was 5.6±1.4%, with 30% of participants having a low O3I (below 4%), suggesting inadequate omega-3 intake (Table 2).

The majority exhibited abdominal obesity, with 75% of participants having a waist circumference greater than 102 cm for men and 88 cm for women. Elevated triglycerides (>150 mg/dL) were observed in 60% of the sample, while 45% had low HDL cholesterol levels (<40 mg/dL in men and <50 mg/dL in women). Additionally, 30% of participants had elevated blood pressure (>130/85 mmHg), and 20% had elevated fasting glucose levels (>100 mg/dL), further contributing to the high rates of metabolic syndrome in the study population (Table 3).

Omega-3 levels are significantly correlated with HDL cholesterol (r=0.34, p<0.01) and triglyceride levels (r=-0.29, p<0.01), suggesting a positive impact on lipid profile. However, the correlation with LDL cholesterol was weak and not statistically significant (r=0.12, p=0.13). Omega-3 levels also showed a moderate inverse relationship with diastolic blood pressure (r=-0.18, p=0.05), though the association with systolic blood pressure was not significant (r=-0.15, p=0.07) [Table 4].

Table 1: Demographic and clinical characteristics of the participants (n=243)

Characteristics	Mean±SD	Range
Age (years)	45.2±12.3	18 - 65
Gender		
Female	134	55%
Male	109	45%
BMI (kg/m²)	27.5±4.2	18.5-38.0
Waist circumference		
Male	94 cm	72-120
Female	88 cm	
Blood pressure (mmHg)		
Normal	128	52.6%
Elevated	73	30%
Stage 1 Hypertension	32	13.2%
Stage 2 Hypertension	10	4.2%

Table 2: Lipid profile and omega-3 levels

Lipid Parameter	Mean±SD	Normal Range	% Above Normal Range
Total Cholesterol (mg/dL)	210±45	<200	40%
LDL Cholesterol (mg/dL)	130±35	<100	50%
HDL Cholesterol (mg/dL)	45 (men), 50 (women)	>60	35%
Triglycerides (mg/dL)	160±65	<150	25%
Omega-3 Index (%)	5.6±1.4	>8	30% (Low O3I <4%)

Table 3: Prevalence of metabolic syndrome and its components

Component of Metabolic Syndrome	%
Presence of Metabolic Syndrome	35.0
Abdominal Obesity (Waist >102 cm Men / >88 cm Women)	75.0
Elevated Triglycerides (>150 mg/dL)	60.0
Low HDL Cholesterol (<40 mg/dL Men / <50 mg/dL Women)	45.0
Elevated Blood Pressure (>130/85 mmHg)	30.0
Elevated Fasting Glucose (>100 mg/dL)	20.0

Table 4: Correlations between omega-3 levels and cardiovascular risk factors

Variable	r Value	p Value
HDL Cholesterol (mg/dL)	0.34	< 0.01
Triglycerides (mg/dL)	-0.29	< 0.01
LDL Cholesterol (mg/dL)	0.12	0.13
Systolic Blood Pressure (mmHg)	-0.15	0.07
Diastolic Blood Pressure (mmHg)	-0.18	0.05

Table 5: Omega-3 levels and insulin resistance (HOMA-IR)

Omega-3 Index (O3I) Range	Mean±SD HOMA-IR	% with Insulin Resistance (HOMA-IR ≥2.5)
O3I < 4%	2.2±1.1	35%
O3I 4-6%	1.9±0.9	25%
O3I ≥ 6%	1.5±0.7	15%

The relationship between Omega-3 Index (O3I) levels and insulin resistance, as measured by HOMA-IR, revealed that

participants with an O3I of less than 4% had a higher mean HOMA-IR of 2.2±1.1, with 35% of them exhibiting insulin resistance (HOMA-IR ≥2.5). In contrast, participants with O3I levels between 4-6% showed a mean HOMA-IR of 1.9±0.9, with 25% demonstrating insulin resistance. Those with an O3I of 6% or higher had the lowest mean HOMA-IR of 1.5±0.7, and only 15% had insulin resistance (Table 5).

DISCUSSION

The findings of this study suggest that omega-3 fatty acids are significantly associated with improved cardiovascular health and a reduction in metabolic syndrome risk factors among adults. Data shows that higher omega-3 concentrations detected through Omega-3 Index measurements produce beneficial lipid results with elevated HDL cholesterol and lower triglycerides as marks of cardiovascular wellness. Scientists previously established that omega-3 fatty acids protect cardiovascular health by improving lipids while decreasing inflammation and these research findings support that theory. Research evidence shows that increased omega-3 concentrations correspond to elevated levels of HDL cholesterol because omega-3 fatty acids stimulate HDL production which functions to eliminate excessive bloodstream cholesterol. Researchers have proved that increased levels of HDL correspond to decreased chances of experiencing coronary heart disease (CHD) as well as strokes.[10] The inverse connection between omega-3 amounts and triglycerides confirmed in our findings demonstrates how these fats lower triglyceride counts. Research supports the risk-lowering power of triglyceride levels because omega-3 supplementation effectively reduces triglyceride numbers which can protect against cardiovascular disease (CVD). The relation between elevated omega-3 levels and lower metabolic syndrome occurrence became statistically significant according to our study findings.[11]

Metabolic syndrome risk reduced in people who maintained higher levels of omega-3 fatty acids because abdominal obesity and hypertension alongside dyslipidemia and hyperglycemia did not cluster with them. Research supports earlier findings about omega-3 fatty acids since they protect metabolic health by enhancing insulin sensitivity while decreasing dangerous abdominal fat. The research data indicates that omega-3 fatty acids could influence blood pressure regulation behavior. The study showed that higher omega-3 levels created a negative relationship with systolic/diastolic blood pressure readings yet this association was weaker than the other cardiovascular markers.[12] Research has proven that EPA together with DHA among other omega-3 fatty acids helps decrease blood pressure especially for people who have hypertension. Research shows that omega-3 fatty acids affect blood pressure differently because various individual aspects play a part in these effects.[13,14]

Multiple limitations arise from the strong results measured in this research that require future consideration. The study adopts a cross-sectional research approach which prevents us from determining cause-and-effect relationships.[15] The study shows a possible link between omega-3 levels and cardiovascular/metabolic risk markers yet it does not establish whether higher omega-3 consumption reduces metabolic syndrome or cardiovascular disease incidence.[16,17] Both longitudinal studies and randomized controlled trials (RCTs) need implementation to verify direct causal links between omega-3 intake and health condition prevention and management while finding the best intake parameters. Additional confounding factors such as dietary ingestion of omega-3 along with lifestyle parameters such as exercise levels and alcohol consumption were omitted from our measurements which used the Omega-3 Index to track blood levels. Further research needs to evaluate these variables because it will help scientists better interpret omega-3 fatty acid relationships with health effects.

CONCLUSION

Omega-3 fatty acids are significantly associated with improved cardiovascular and metabolic health outcomes in adults. This study found that higher omega-3 levels, as indicated by the Omega-3 Index (O3I), were correlated with better lipid profiles, including increased HDL cholesterol and decreased triglyceride levels, which are important markers for cardiovascular disease risk.

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