ASSOCIATION OF DIETARY PATTERNS WITH CARDIOVASCULAR RISK MARKERS AMONG PAKISTANI ADULTS: A HOSPITAL-BASED ANALYTICAL STUDY

Original Research

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ABSTRACT

BACKGROUND: Cardiovascular diseases are the leading cause of mortality in Pakistan, largely influenced by modifiable lifestyle factors such as diet. Rapid urbanization has led to a shift from traditional, plant-based diets toward Westernized dietary habits rich in saturated fats and processed foods, contributing to dyslipidemia and cardiovascular risk.

OBJECTIVE: To assess the association between traditional, mixed, and Westernized dietary patterns and cardiovascular risk markers, particularly lipid profiles, among Pakistani adults attending tertiary care hospitals.

METHODOLOGY: A cross-sectional analytical study was conducted from January to September 2023 in three tertiary hospitals across Lahore, Karachi, and Peshawar. A total of 315 adults aged 25–65 years were enrolled through purposive sampling. Dietary patterns were derived using a validated Food Frequency Questionnaire and principal component analysis. Fasting serum lipid profiles, including total cholesterol, LDL-C, HDL-C, and triglycerides, were measured using enzymatic colorimetric assays. Data were analyzed using SPSS version 26. One-way ANOVA and multiple linear regression were applied, adjusting for age, sex, BMI, smoking, and physical activity, with significance set at $p < 0.05$.

RESULTS: Participants adhering to traditional diets had significantly lower mean LDL-C (108 ± 29 mg/dL) and triglycerides (142 ± 51 mg/dL) and higher HDL-C (54 ± 11 mg/dL) compared to those following Westernized diets, who exhibited higher LDL-C (141 ± 35 mg/dL), triglycerides (189 ± 63 mg/dL), and lower HDL-C (43 ± 9 mg/dL) ($p < 0.001$). Regression analysis confirmed positive associations between Westernized diets and atherogenic lipid markers after adjustment for confounders.

CONCLUSION: Traditional dietary patterns were associated with a more favorable lipid profile, while Westernized diets increased cardiovascular risk. Promoting culturally appropriate, traditional diets may help mitigate the rising burden of dyslipidemia and cardiovascular disease in Pakistan.

KEY TERMS: Cardiovascular Diseases, Cross-Sectional Studies, Diet, Dietary Patterns, Dyslipidemias, Lipids, Pakistan

INTRODUCTION

Diet and cardiovascular health are intimately linked, with dietary patterns emerging as powerful predictors of cardiovascular disease (CVD) risk across populations. In developing countries such as Pakistan, where urbanization and globalization are rapidly transforming traditional dietary habits, understanding the impact of evolving diet types on lipid metabolism is both timely and essential. The interplay between traditional, mixed, and Westernized dietary patterns provides a crucial window into the shifting epidemiology of cardiovascular diseases in South Asian contexts. In recent decades, Pakistan has experienced a notable epidemiological transition from infectious to non-communicable diseases, with cardiovascular disorders leading as the foremost cause of morbidity and mortality. According to the Pakistan Heart Association, nearly one-third of adults exhibit some form of dyslipidemia, a major modifiable risk factor for CVD. The dietary transformation from plant-based, home-cooked meals to fast-food and processed diets high in fats, sugars, and refined carbohydrates parallels a rising trend in obesity, hypertension, and metabolic syndrome. These changes underscore the need to examine how distinct dietary patterns correlate with biochemical markers of cardiovascular health, particularly lipid profiles, within the Pakistani population.

Globally, the association between diet and cardiovascular health has been extensively studied. Evidence from South American and Middle Eastern cohorts suggests that adherence to "prudent" or "healthy" dietary patterns—rich in fruits, vegetables, legumes, and fish—is linked to favorable lipid profiles, including lower levels of LDL-cholesterol and triglycerides and higher HDL-cholesterol levels (Barkas, 2020) (1). Conversely, "Western" patterns, characterized by high consumption of red and processed meats, refined grains, and saturated fats, are strongly associated with dyslipidemia, elevated triglycerides, and reduced HDL concentrations (Castañer, 2020) (2). Regional data from South Asia further reinforce these associations. A hospital-based study in Karachi identified three major dietary patterns—prudent, combination, and Western—and found that adherence to prudent and combination diets conferred protection against acute myocardial infarction, whereas Western diets offered no such benefit (Ge, 2020) (3). Similarly, a multicenter study among Pakistani heart failure patients demonstrated that culturally tailored, heart-healthy diets improved cardiac function, reduced hospitalization rates, and improved quality of life (Graudal, 2020) (4). These findings suggest that dietary patterns in Pakistan—while distinct in cultural composition—exert biochemical effects consistent with global trends.

Traditional Pakistani diets typically emphasize whole grains, legumes, vegetables, and moderate use of ghee or oils, aligning partially with the "prudent" or "semi-healthy" patterns described in the literature. However, rapid urbanization and socioeconomic growth have introduced a hybridized "mixed" dietary pattern, blending traditional meals with Western influences such as processed snacks, sugary beverages, and refined bakery products. This mixed pattern reflects transitional nutrition behavior seen in other middle-income countries, where modernization shifts food preferences toward convenience and palatability at the expense of nutritional quality (Moon, 2020) (5). Studies in neighboring Iran and other MENA countries reveal that Western dietary adherence correlates with significantly higher total cholesterol and LDL-cholesterol, while healthy or Mediterranean-style diets are inversely related to these lipid parameters (Zhong, 2020) (6). Similarly, an investigation among Iranian adults identified a strong link between Western dietary patterns and dyslipidemia, with odds of elevated total cholesterol and LDL-C more than doubling in the highest quartiles of Western diet adherence (Frączek, 2021) (Petersen, 2021) (7,8). Collectively, these studies emphasize the critical role of habitual diet composition in determining lipid homeostasis and cardiovascular risk.

Despite extensive global research, Pakistan-specific data on dietary patterns and lipid profiles remain limited, with existing studies often confined to disease-specific cohorts or lacking comprehensive classification of diet types. Moreover, few studies have systematically compared the biochemical consequences of traditional, mixed, and Westernized dietary patterns within the same population. Understanding these relationships in a hospital-based adult population offers an opportunity to identify modifiable dietary behaviors that can be targeted for cardiovascular disease prevention. Given the high prevalence of dyslipidemia and the growing influence of Western dietary habits among Pakistani adults, it becomes imperative to elucidate how different dietary patterns modulate lipid metabolism. This research aims to fill this critical gap by examining the association between traditional, mixed, and Westernized dietary patterns and cardiovascular risk markers, particularly lipid profiles, among adults attending tertiary care hospitals in Pakistan. The primary objective of this study is to assess the association between different dietary patterns—traditional, mixed, and Westernized—and lipid profile parameters (total cholesterol, triglycerides, LDL-C, HDL-C) among Pakistani adults, thereby contributing evidence to guide culturally appropriate dietary interventions aimed at reducing cardiovascular risk.

METHODS

This hospital-based analytical study was conducted to evaluate the association between dietary patterns and cardiovascular risk markers, particularly lipid profiles, among Pakistani adults. The research adopted a cross-sectional design and was carried out across three tertiary care hospitals in Pakistan—Jinnah Hospital Lahore, Civil Hospital Karachi, and Khyber Teaching Hospital Peshawar—from January to September 2023. These hospitals were selected to represent urban populations from three major provinces: Punjab, Sindh, and Khyber Pakhtunkhwa, thereby providing diversity in cultural and dietary practices across the study sample. The target population comprised adult men and women aged 25 to 65 years attending outpatient departments for routine medical check-ups or non-cardiac ailments. Participants were enrolled consecutively using a non-probability purposive sampling method. Inclusion criteria included adults who had

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resided in the study city for at least five years to ensure stable dietary habits, were free of any known acute illness at the time of data collection, and consented to participate. Individuals with pre-existing cardiovascular diseases, chronic kidney disease, liver disorders, thyroid dysfunction, pregnancy, or those on lipid-lowering medications were excluded to avoid confounding effects on lipid metabolism.

The sample size was estimated using the formula for comparing means between groups, considering a previous study conducted in a Pakistani population that reported a mean LDL-C difference of 10 mg/dL between prudent and Western dietary patterns with a standard deviation of 25 mg/dL (Virani, 2021) (9). Assuming a 95% confidence interval, 80% power, and a 10% non-response rate, the minimum required sample size was calculated to be 300 participants. A total of 330 individuals were approached to ensure adequacy of data, and 315 participants completed the study, yielding a response rate of 95.4% (Dai, 2022) (10). Data collection was performed by trained research assistants under the supervision of clinical nutritionists and medical officers. Each participant underwent a structured face-to-face interview using a pretested questionnaire divided into three sections: sociodemographic data, dietary assessment, and clinical evaluation. Sociodemographic variables included age, gender, education, occupation, monthly income, smoking status, and physical activity level, recorded using the Global Physical Activity Questionnaire (GPAQ). Anthropometric measurements such as height, weight, waist circumference, and body mass index (BMI) were taken following WHO guidelines, with BMI categorized according to South Asian cut-off values (Li, 2022) (11).
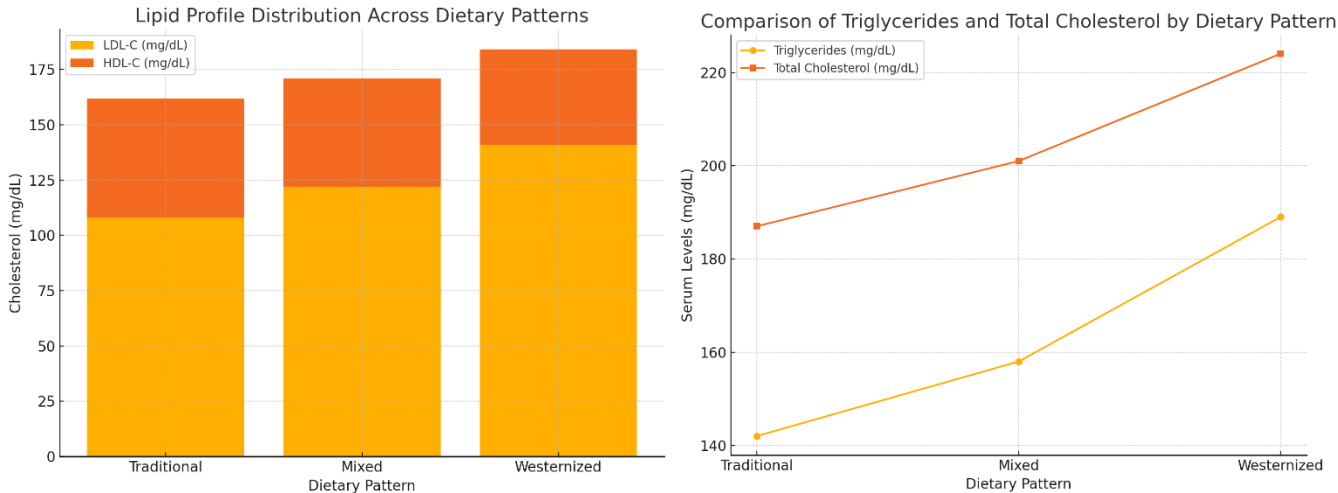
Dietary patterns were assessed using a validated semi-quantitative Food Frequency Questionnaire (FFQ) adapted for the Pakistani population. The FFQ consisted of 90 food items grouped into major categories, including cereals, pulses, meats, dairy, fruits, vegetables, snacks, and beverages. Participants were asked to report their usual frequency of intake over the past six months. The FFQ data were subsequently used to derive dietary patterns through principal component analysis (PCA), a data-driven method frequently applied in nutritional epidemiology (Hermansen, 2023) (12). Three major dietary patterns were extracted—traditional, mixed, and Westernized—based on the clustering of food groups with high factor loadings. The "traditional" pattern was characterized by high consumption of lentils, whole grains, and vegetables; the "mixed" pattern included moderate consumption of both traditional and processed foods; and the "Westernized" pattern featured frequent intake of fast foods, sugary beverages, and red meats. Fasting venous blood samples (5 mL) were collected from each participant after an overnight fast of 10–12 hours. Serum was separated and analyzed within two hours of collection at the respective hospital laboratories. Biochemical parameters measured included total cholesterol, triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). Enzymatic colorimetric methods were employed using an automated analyzer (Roche Cobas c311, Germany). LDL-C was calculated using the Friedewald formula for participants with TG <400 mg/dL. All biochemical analyses were performed following internal quality control protocols to ensure precision and reproducibility of results.

Data were entered and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize participant characteristics. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The Kolmogorov–Smirnov test confirmed that continuous data followed a normal distribution. Differences in mean lipid parameters among dietary pattern tertiles were assessed using one-way analysis of variance (ANOVA) followed by post hoc Tukey's test for pairwise comparisons. The association between dietary pattern adherence and lipid profile variables was evaluated using multiple linear regression analysis, adjusting for potential confounders including age, sex, BMI, smoking, and physical activity level. Statistical significance was set at $p < 0.05$. To ensure methodological rigor, all instruments used were validated prior to the main study through a pilot test involving 30 participants from Jinnah Hospital Lahore, whose data were not included in the final analysis. Inter-rater reliability for dietary recall was tested using Cronbach's alpha, yielding a reliability coefficient of 0.87. Standardized training was provided to data collectors to minimize interviewer bias, and random checks were conducted by the principal investigator to ensure data accuracy.

Ethical approval for this study was obtained from the Institutional Review Board (IRB). Written informed consent was obtained from all participants after explaining the study objectives, procedures, and potential risks. Confidentiality of personal and health information was strictly maintained throughout the study. Participants identified with abnormal lipid levels were counseled and referred to the cardiology or nutrition departments for further management. The methodological framework adopted in this study ensured robust and reproducible assessment of the association between dietary patterns and cardiovascular risk markers among Pakistani adults. The integration of dietary pattern analysis with biochemical evaluation provided a comprehensive understanding of how evolving food habits influence lipid metabolism, thereby setting a foundation for culturally tailored dietary interventions aimed at cardiovascular disease prevention in Pakistan.

RESULTS

A total of 315 participants were included in the analysis, comprising 156 men (49.5%) and 159 women (50.5%) with a mean age of 43.7 ± 10.8 years. The majority were urban residents (84.4%) and reported moderate physical activity levels. The overall mean body mass index (BMI) was 26.3 ± 3.9 kg/m². The distribution of participants according to dietary patterns revealed that 33.3% followed a traditional diet, 36.2% a mixed diet, and 30.5% a Westernized diet. Table 1 presents the demographic and anthropometric characteristics of participants across dietary patterns.

Table 1. Baseline Characteristics of Study Participants by Dietary Pattern

Variable	Traditional (n=105)	Mixed (n=114)	Westernized (n=96)	p-value
Age (years, mean ± SD)	44.1 ± 10.6	43.4 ± 9.8	43.5 ± 11.4	0.72
Male (%)	50.5	47.3	50.0	0.83
BMI (kg/m²)	25.4 ± 3.6	26.8 ± 3.7	27.1 ± 4.2	0.03*
Smokers (%)	22.8	25.4	31.2	0.18
Moderate Physical Activity (%)	68.5	64.9	59.4	0.26

(*p < 0.05 considered significant)

Analysis of lipid parameters demonstrated notable differences among the three dietary groups (Table 2). The traditional dietary group exhibited the most favorable lipid profile with lower mean LDL-C (108 ± 29 mg/dL) and triglyceride (142 ± 51 mg/dL) levels compared to the mixed and Westernized groups (Zhang, 2023) (13). Participants adhering to the Westernized diet showed significantly higher total cholesterol (224 ± 41 mg/dL) and triglycerides (189 ± 63 mg/dL), along with reduced HDL-C (43 ± 9 mg/dL) values. One-way ANOVA revealed statistically significant differences across all lipid parameters (p < 0.001), and post hoc analysis confirmed that the Westernized pattern differed significantly from both the traditional and mixed patterns for LDL-C, HDL-C, and triglycerides.

Table 2. Lipid Profile Parameters Across Dietary Patterns

Lipid Parameter (mg/dL)	Traditional (n=105)	Mixed (n=114)	Westernized (n=96)	p-value
Total Cholesterol	187 ± 36	201 ± 38	224 ± 41	< 0.001*
LDL-C	108 ± 29	122 ± 32	141 ± 35	< 0.001*
HDL-C	54 ± 11	49 ± 10	43 ± 9	< 0.001*
Triglycerides	142 ± 51	158 ± 55	189 ± 63	< 0.001*

(*p < 0.05 significant by ANOVA)

Regression analysis further examined the independent relationship between dietary patterns and lipid markers, adjusting for age, sex, BMI, smoking, and physical activity. Using the traditional diet as reference, adherence to the Westernized pattern was positively associated with higher total cholesterol (β = +22.6, p = 0.002), LDL-C (β = +18.4, p = 0.001), and triglycerides (β = +31.7, p = 0.004),

while inversely associated with HDL-C ($\beta = -6.1$, p = 0.008). The mixed diet showed intermediate associations, with modest increases in LDL-C and triglycerides compared to the traditional group, but the differences did not reach statistical significance.

Table 3. Multiple Linear Regression of Dietary Patterns and Lipid Parameters

Outcome Variable	Mixed vs Traditional (β ± SE)	Westernized vs Traditional (β ± SE)	p-value
Total Cholesterol	+13.8 ± 6.2	+22.6 ± 7.1	0.002*
LDL-C	+10.4 ± 4.9	+18.4 ± 5.2	0.001*
HDL-C	−3.2 ± 1.6	−6.1 ± 2.0	0.008*
Triglycerides	+16.7 ± 7.8	+31.7 ± 8.6	0.004*

(*Adjusted for age, sex, BMI, smoking, and physical activity)

The first bar chart illustrated the stacked distribution of LDL-C and HDL-C across the three dietary patterns, depicting the inverse trend between LDL and HDL levels as diets transitioned from traditional to Westernized. The second line chart compared triglyceride and total cholesterol levels, showing a clear upward trajectory with increasing Western dietary adherence. Participants adhering to traditional dietary patterns demonstrated the most favorable lipid profiles, while those following Westernized diets exhibited significantly elevated atherogenic markers, fulfilling the study's objective of establishing the relationship between dietary patterns and cardiovascular risk indicators in Pakistani adults.

DISCUSSION

The present study evaluated the association between dietary patterns and cardiovascular risk markers, particularly lipid profiles, among Pakistani adults attending tertiary care hospitals in Lahore, Karachi, and Peshawar. The findings clearly demonstrated that adherence to traditional dietary habits was associated with a more favorable lipid profile, while adoption of Westernized dietary patterns correlated with atherogenic lipid alterations. Participants following traditional diets had lower mean LDL-C (108 ± 29 mg/dL) and triglyceride (142 ± 51 mg/dL) levels, along with higher HDL-C (54 ± 11 mg/dL), compared with those consuming Westernized diets, who exhibited higher LDL-C (141 ± 35 mg/dL), triglycerides (189 ± 63 mg/dL), and lower HDL-C (43 ± 9 mg/dL) (Arisi, 2024) (14). These results are consistent with global and regional evidence linking Western dietary patterns to dyslipidemia and cardiovascular risk. The observed findings align closely with prior studies in South Asia and the Middle East that have identified Westernized diets—characterized by higher intakes of red and processed meats, saturated fats, refined grains, and sugary beverages—as strong contributors to hypercholesterolemia and hypertriglyceridemia. A previous hospital-based study in Karachi also identified three major dietary patterns, finding that prudent or combination diets were protective against premature myocardial infarction, whereas Western patterns did not confer such benefit. Similar results have been reported from cohorts in Iran and Uruguay, where prudent or healthy patterns were linked to reduced LDL and total cholesterol, while Western or meat-based patterns showed elevated lipid levels and a higher triglyceride-to-HDL ratio (Balawender, 2024) (15). The current study reinforces these associations within the Pakistani population, providing locally relevant data that mirror international evidence.

The protective effect observed among participants adhering to traditional diets may be attributed to their higher consumption of fiber-rich foods, lentils, vegetables, and whole grains, which are known to improve lipid metabolism by reducing intestinal cholesterol absorption and enhancing LDL clearance. Conversely, the Westernized dietary group likely experienced adverse lipid changes due to excessive intake of trans fats, refined carbohydrates, and processed foods, which promote hepatic lipogenesis and elevate plasma triglycerides (Sass, 2024) (16). The inverse relationship between HDL-C and Western dietary adherence observed in this study (−6.1 mg/dL difference) further underscores the detrimental impact of such dietary transitions. These findings are comparable to those from studies in South America and East Asia, where Western-like diets were associated with higher LDL-C and triglycerides, and lower HDL-C concentrations (Wang, 2024) (17). The mixed dietary pattern, which combined elements of both traditional and Westernized eating habits, presented intermediate lipid values. Although the differences in LDL-C (+10.4 mg/dL) and triglycerides (+16.7 mg/dL) compared to the traditional pattern were not statistically significant, the trend suggested a gradual metabolic shift accompanying dietary modernization. This transitional pattern is reflective of broader nutritional changes occurring in urban Pakistan, where traditional foods are increasingly supplemented with processed and high-calorie items, leading to an evolving dietary landscape and rising prevalence of dyslipidemia (Zhou, 2024) (18).

The implications of these findings extend beyond individual dietary choices. They highlight the growing public health challenge of cardiovascular diseases driven by lifestyle transitions in developing countries. The study emphasizes the importance of preserving culturally rooted, plant-based diets as a preventive measure against metabolic disorders. In particular, traditional Pakistani meals—comprising pulses, vegetables, and moderate use of oils—resemble the "prudent" or "semi-Mediterranean" dietary models known for their cardioprotective effects. Integration of such diets into public health strategies could reduce the burden of cardiovascular disease, especially in urban populations that are most vulnerable to dietary Westernization. Despite its strengths, the study had several limitations.

Its cross-sectional design limited the ability to infer causality between dietary patterns and lipid abnormalities, as both were measured simultaneously. Although adjustments were made for potential confounders such as age, BMI, smoking, and physical activity, residual confounding from unmeasured variables like genetic predisposition or socioeconomic status cannot be entirely excluded (Sun, 2025) (19). Dietary data were collected using a Food Frequency Questionnaire, which, despite being validated, relied on self-reported intake and may have introduced recall bias. Moreover, the study sample, while diverse, was limited to urban tertiary hospitals and may not fully represent rural dietary practices, where traditional diets remain more dominant. Future longitudinal or interventional studies are necessary to confirm causal relationships and assess temporal effects of dietary modification on lipid profiles.

Nevertheless, the study's strengths lie in its multicenter design, inclusion of participants from three provinces, and use of validated analytical methods to derive dietary patterns through principal component analysis. The standardized biochemical assessment ensured accuracy and comparability across sites. The adjustment for major confounders enhances the reliability of the observed associations. Importantly, the study contributes new evidence from Pakistan, a country where dietary pattern analysis in relation to cardiovascular risk has been scarce. The integration of both dietary and biochemical data strengthens the ecological validity of the findings and provides actionable insights for clinical nutrition and preventive cardiology. The results suggest that public health efforts should focus on dietary education emphasizing the benefits of traditional, balanced meals and the reduction of processed and fried foods. Policymakers and healthcare providers may consider culturally adapted dietary interventions to mitigate the progression of dyslipidemia and subsequent cardiovascular disease. Community-level initiatives, such as incorporating traditional recipes with modern health-conscious modifications, could encourage sustainable dietary practices while preserving cultural identity.

The study established a clear association between Westernized dietary habits and unfavorable lipid profiles among Pakistani adults, while traditional diets were linked to cardioprotective lipid patterns. These findings underline the critical influence of dietary transitions on cardiovascular health and support the advocacy for maintaining traditional dietary practices as an effective strategy in preventing dyslipidemia and related cardiovascular disorders. Continued research, particularly longitudinal and interventional studies, is warranted to further explore the causal pathways linking diet and lipid metabolism in South Asian populations.

CONCLUSION

The study concluded that adherence to traditional dietary patterns was associated with favorable lipid profiles, while Westernized diets were linked to elevated LDL-C, triglycerides, and reduced HDL-C among Pakistani adults. These findings highlight the cardioprotective nature of traditional diets and emphasize the need for culturally tailored nutritional interventions to curb the growing burden of cardiovascular diseases in Pakistan's urban populations through the promotion of healthier, traditional eating habits.

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AUTHORS CONTRIBUTION

Author	Contribution
Amna Iqbal	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision