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Age Based Differences in Syncope: Incidence, Diagnostic Challenges, and Treatment Strategies in Paediatric vs. Adult Populations Attending a Tertiary Cardiac Center in Pakistan

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ABSTRACT

Background: Syncope is one of the most commonly diagnosed conditions, particularly in low-resource settings such as Pakistan, where age-related differences in presentation and management are not completely defined. The aim of the current research was to compare the clinical presentation and precipitating factors of syncope, as well as predictors of recurrence, in two categories of patients (children and adults) who presented to a tertiary cardiac center.

Methods: A cross-sectional study in the Department of Cardiology, Quaid-e-Azam Medical College, Bahawalpur, was conducted between January 2024 and May 2025. The study used non-probability consecutive sampling to recruit 220 patients with recent syncope, including 90 pediatric and 130 adult participants. Standardized clinical assessments and investigations, including electrocardiography, echocardiography, and routine laboratory testing, were performed. Data were assessed for normality using the Shapiro–Wilk test. In addition, t-tests, Mann–Whitney U tests, and chi-square tests were used for group comparisons, and logistic regression was used to identify predictors of recurrence.

Results: The median age of the study group was 33.1 (IQR 18.7) years, and 55.9% were male. Vasovagal syncope was the most common (50.5%), and cardiac syncope was more common among adults (22.0%, $p < 0.001$). Adult participants had higher serum glucose levels and higher electrolyte levels. Recurrence of syncope occurred in 19.1% (approximately one in five patients) and was significantly associated with cardiac syncope (OR = 3.21, p = 0.001), abnormal echocardiography (OR = 2.94, p = 0.007), and psychiatric comorbidity (OR = 1.87, p = 0.042). A positive correlation was found between glucose level and episode frequency ($r = 0.364$, $p = 0.001$).

Conclusion: The research revealed important clinical, biochemical, and diagnostic differences between pediatric and adult patients with syncope. Cardiac involvement and psychosocial factors were pivotal predictors of recurrence, and age-specific syncope assessment pathways should be implemented in Pakistani tertiary care centers.

Keywords: Cardiac Syncope, Paediatrics, Syncope.

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INTRODUCTION

Considering that syncope is a temporary loss of consciousness caused by transient global cerebral hypoperfusion, it remains a critical but under-acknowledged clinical issue, particularly in low-resource settings. In Pakistan, access to systematic cardiovascular and diagnostic infrastructure is limited, which hinders accurate documentation of its burden, although it frequently presents to emergency and cardiology services. Although it is often benign, recurrent or sudden syncope can indicate severe cardiac pathology, and vulnerable groups include children and older adults[1]. At the national level, there is still very little epidemiological evidence on the subject; however, in hospital-based research, syncope remains a persistent chief complaint that often leads to misdiagnosis or excessive investigation because tertiary care units across the country lack age-specific evaluation criteria[2].

In South Asia more broadly, there is a shortage of research that adequately investigates the epidemiology of syncope[3]. The challenges reported across regional healthcare systems are similar in nature, including heterogeneous referral patterns, limited use of diagnostic modalities such as ambulatory ECG monitoring, and a generalized lack of age-stratified management pathways[4]. A multicenter study in India identified vasovagal syncope as the predominant diagnostic category; however, the frequency of cardiac syncope was significantly higher in the adult group[5]. Similar patterns have been reported in Sri Lanka and Bangladesh, but paediatric presentations are not yet sufficiently detailed in the available data. In addition to these factors are socio cultural reasons, low health literacy, and poor health seeking behaviour which may postpone early diagnosis and proper management[6].

The prevalence of syncope is approximately 1-3 percent of emergency department presentation and up to 6 percent of all hospitalization across the globe[7]. The pathogenesis of syncope oscillates between mild neurocardiogenic forms and life-threatening arrhythmias and even structural heart and valvular diseases[8]. Causally, syncope is often attributed to dysregulation of the autonomic system in the childhood groups, and tends to be self-limiting, but in adulthood, particularly after 40 years of age, cardiovascular disease is thought to be the common cause[9]. The pathophysiology differs significantly between age groups, i.e., elderly patients require individualized diagnosis and treatment. Added in this scenario are the risk factors such as dehydration, extended standing, emotional stress,

and cardiac arrhythmias, and prevalence trends vary across age, making it difficult to design a universal diagnostic criterion. Notably, frequent syncope has been associated with poor quality of life, increased risk of injury, and unwarranted healthcare expenses[10].

Much of the study presented so far in the existing literature attempts to age-stratify syncope, although much of the work is based in high-income nations with enhanced access to healthcare and diagnostic resources, rendering it inapplicable to Pakistan[6]. Tilt-table-testing and implantable loop recorders as syncope-evaluation resources have also appeared in Europe and North America, yet these facilities are largely absent or unutilized in most Pakistani tertiary care facilities[3,4]. And on top of that, there exists an actual dearth of area-specific research in diagnostic delays, misclassification and age-related effects that is a large gap given the wide range of demographics and health disparities between South Asian regions[8].

The prevailing literature has not addressed the diagnostic practices and therapeutic outcomes of syncope in children and adults in low-resource high-burden environments, exhaustively. Nor are we assured how age contributes to clinical decision-making in Pakistan, where paediatric and adult cardiology are often run independently rather than follow common guidelines. This is why a context-specific, comparative clinical evaluation is required- to shape age-specific diagnostic algorithms and maximize resource use in third level cardiac facilities.

The primary objective of the study is to establish and compare the prevalence, diagnosis, and management of syncope among children and adults in a Pakistani tertiary cardiac care center. The other objective is to identify any age-related clinical concerns and suggest potential avenues to enhance the efficiency of the diagnostic process and accuracy of treatment. It is believed that the underlying causes may differ significantly and that the management of syncope differs between these two groups and this may influence outcomes and resource utilization.

This study filled a major knowledge gap and, in addition, presents evidence of age-stratified syncope patterns in Pakistan. In the process, it hopes to empower the development of customized clinical pathways and better diagnostics in a resource-limited environment.

METHODS

The study was a comparative cross-sectional study conducted in the Department of Cardiology at Quaid-e-Azam Medical College, Bahawalpur. All adults were informed of the consent, and parental or guardian consent (when required) was obtained in the case of the minors. All data were anonymized and confidential, all research was performed in accordance with the Declaration of

Helsinki. The ethical clearance was obtained from the Institutional Review Board numbered 2460 /DME/QAMC Bahawalpur dated 11 August, 2023.

This hospital-based, single-center study lasted one and a half years, from January 2024 to May 2025. It aimed to determine how age affected the incidence, diagnostic flow, and management of syncope among pediatric and adult patients presenting to a tertiary cardiac center.

To estimate the sample size, the WHO calculator was used with a 95% confidence level and a 5% margin of error. Ramakrishnan et al. (2019) provided the highest prevalence of syncope (17.33%).11 They were investigating syncope patterns in an Indian cohort that is demographically similar to the Pakistani population. These figures gave a needed sample of 220 respondents. To sample eligible patients, we used non-probability consecutive sampling. Every person over the age of 5 + years who presented to the cardiology department with at least one instance of syncope in the past 6 months and gave informed consent (or assent with parental consent in minors) was accepted. We eliminated patients with known epileptic disorders, those taking anti-epileptic medication, altered mental states at presentation and those who refused to participate. The comparative analysis was carried out in groups of pediatric (<18 years) and adult (18 years and above).

Structured interviews, physical examinations, hospital records, and laboratory tests were used as methods of data collection. Sociodemographic information was recorded using a standardized proforma, such as age, sex, urban/rural place of residence, education level, and socioeconomic status. Clinical records were recorded with comorbidities (hypertension, diabetes, structural heart disease), drugs, rate of syncope, prodrome, injury during the episode. Where possible cross-checking of interview responses with medical records was done.

The lab tests involved serum hemoglobin, blood glucose, and electrolytes (sodium and potassium), which were analyzed using an automated analyzer (Cobas c111, Roche). We took hemoglobin <12.0g/dL as low according to WHO guidelines. Blood glucose 140mg/dL and above was labeled as high according to ADA guidelines. Sodium (<135 or >145 mEq/L and potassium (<3.5 or >5 m Eq/L) were measured using standard range values. We also conducted ECGs, transthoracic echocardiograms, and 24-hour Holter monitoring (GE SEER 1000) where clinically relevant, and termed them normal or abnormal.

The Shapiro Wilk test informed us about the variables that follow normality: age, and hemoglobin were normally distributed and not glucose and electrolytes. Therefore, we presented age and hemoglobin as mean ± SD, and glucose and electrolytes as median IQR.

To make a comparison we referred to the independent t -test (normally distributed variables (age, hemoglobin)) and the Mann Whitney U test (not normally distributed variables (serum glucose, electrolytes)). Chi-square tests were used to examine categorical variables (sex, syncope type, comorbidities, ECG findings) Statistical work was accomplished in SPSS 26 (IBM, Armonk, NY). We collated data by means, medians, frequencies and percentages and used the general tests depending on the distribution of data. Significance was set at $p < 0.05$.

Lastly, we conducted analyses to investigate age group associations, diagnostic patterns, comorbidity patterns, clinical presentation, and management approaches. Independent t-test was used to compare age and hemoglobin means and chi-square tests were used to test categorical variables such as sex distribution, emergency syncope type, comorbidity rate, and ECG. The necessary statistical significance was deemed at p less than 0.05.

RESULTS

A total of 220 participants were recruited in the study, with 90 in the paediatric group and 130 in the adult group. There were no dropouts or missing participant data requiring exclusion.

The majority of participants were adults, with substantial age-related differences in clinical characteristics and diagnostic findings. Age and haemoglobin levels were normally distributed, whereas glucose and electrolyte levels were not; therefore, both parametric and non-parametric analyses were required. Older age was also significantly associated with a higher prevalence of comorbidities, including hypertension and diabetes mellitus. The median values of glucose and serum electrolytes were also higher in adults than in paediatric participants.

The distribution of syncope types differed significantly between the age groups. Vasovagal syncope was more prevalent among children, whereas cardiac causes were more prevalent among adults. Likewise, psychiatric comorbidity and later presentation were more commonly recorded in the adult population. These findings indicate age-related differences in the underlying aetiology of syncope and in the psychosocial context of presentations.

Based on the diagnostic workup, abnormal echocardiograms were more common in adult subjects and, based on the logistic regression were strongly correlated with recurrent syncope. This highlights the usefulness of echo in older patients who present with syncope. Although Holter monitoring revealed fewer abnormalities in general, nevertheless, it remained a significant diagnostic intervention, particularly among cardiac syncope adult individuals.

Recurrence was approximately threefold in the individuals that had a background of cardiac syncope. The high correlation between psychiatric comorbidity and recurrence shows that we should include the assessment focusing on mental health in our syncope management strategies.

Pediatric patients showed medication adherence as compared to inconsistent adherence or no adherence among adults. The use of herbal remedies was relatively low but more prevalent among rural subjects as it is an indicator of how socio-cultural traditions influence health behaviours.

The correlation analysis demonstrated that the relationship between elevated levels of blood glucose and the number of syncope events was moderate and positive, which seems to indicate that metabolic factors might contribute to the burden of symptoms. The negative relationship between haemoglobin and the time of syncope was also found, and it indicated the influence of anaemia, especially in women.

Attendance follow-up was not optimal, as only 61 percent of the participants attended their follow-up appointment. Follow-up rates were lower in individuals with low-income background or rural background, indicating an issue of access and persistence of care. Patients who had a pharmacological treatment and actually visited follow-ups showed more improvement in clinical practices. Altogether, this paper shows that there are evident age-based disparities in the characteristics of syncope, the rate of diagnosis, and the result of treatment, particularly in a low-resource cardiac center of tertiary care. This finding is consistent with South Asian literature and adds to the necessity of age and comorbidity-based stratified care tracks.

Table 1. Descriptive Statistics for Continuous Variables Among Paediatric and Adult Patients (n = 220)

Variable	Paediatric (n = 90)	Adult (n = 130)	Test Statistic (t/U/W)	p-value
Age (years)*	14.0 ± 2.3	48.6 ± 14.9	t = 25.41	<0.001
Haemoglobin (g/dL)*	12.9 ± 1.2	13.4 ± 1.5	t = 1.16	0.248
Serum Glucose (mg/dL)ᵘ	127.4 (109.1–148.2)	179.1 (147.8–213.5)	U = 3168.0	<0.001
Serum Electrolytes (mEq/L)ᵘ	137.4 (136.1–138.8)	139.5 (137.6–141.7)	U = 4220.5	0.017

**Independent samples t-test applied for normally distributed variables (Shapiro-Wilk p > 0.05), ᵘMann–Whitney U test applied for non-normally distributed variables (Shapiro-Wilk p < 0.05)*

Table 1 provides descriptive statistics for continuous variables in both paediatric (n = 90) and adult (n = 130) cohorts. Mean ± SD and the independent t-test were used for age and haemoglobin, which satisfied normality according to Shapiro–Wilk tests ($p > 0.05$). Non-normally distributed parameters, such as serum glucose and serum electrolytes, are presented as median (interquartile range) and were analysed using the Mann–Whitney U test.

The table shows that age and haemoglobin concentration were higher in the adult population (mean age 48.6 ± 14.9 years). Median serum glucose and serum electrolyte levels were also significantly higher in adults than in children ($p < 0.001$ and $p = 0.017$, respectively). These results support marked age-related differences in physiological and biochemical parameters relevant to syncope assessment.

Table 2. Distribution of Categorical Clinical Variables by Age Group (n = 220)

Variable	Paediatric (n = 90)	Adult (n = 130)	χ^2 / Fisher's Exact	p-value
Gender	Male: 52 (57.8%)	Male: 71 (54.6%)	$\chi^2 = 0.19$	0.660
Hypertension	Yes: 2 (2.2%)	Yes: 46 (35.4%)	$\chi^2 = 35.67$	<0.001
Diabetes Mellitus	Yes: 1 (1.1%)	Yes: 39 (30.0%)	$\chi^2 = 30.81$	<0.001
Syncope Type	Vasovagal: 54 (60.0%)	Cardiac: 46 (35.4%)	$\chi^2 = 22.03$	<0.001
Elevated CIMT ≥0.9 mm	7 (7.8%)	31 (23.8%)	$\chi^2 = 9.49$	0.002
Left Ventricular Hypertrophy (LVH)	5 (5.6%)	22 (16.9%)	$\chi^2 = 5.96$	0.015
Diastolic Dysfunction	4 (4.4%)	18 (13.8%)	$\chi^2 = 4.71$	0.030

Chi-square test used for group comparison. Fisher's exact test used where cell count <5.

Table 2 shows the distribution of key categorical variables among paediatric and adult participants including demographic, clinical, and echocardiographic variables. All variables were analysed using the Chi-square test, or Fisher's Exact Test when assumptions were violated. Frequencies (n) and percentages (%) are reported.

This table demonstrates a significantly higher prevalence of hypertension, diabetes, and cardiac syncope among adults compared to children ($p < 0.001$). Vasovagal syncope was more common in

the paediatric group, while elevated CIMT and left ventricular hypertrophy (LVH) were predominantly seen in adults ($p = 0.002$ and $p = 0.015$, respectively).

Taken altogether, those four tables bring a holistic statistical coverage of sociodemographic, clinical, as well as biochemical variables according to age and relevant clinical subgroups. In Table 1, substantial differences in the baseline characteristics between paediatric and adult cohorts are demarcated. **Table 2** records the differences in the disease burden and diagnostic outcomes that are categorical.

Table 3. Multivariate Logistic Regression Predicting Diagnostic Outcomes (n = 220)

Outcome	Predictor	Adjusted OR (95% CI)	p-value
Elevated CIMT	HbA1c ≥ 6.5%	2.94 (1.41–6.12)	0.004
	SBP ≥ 140 mmHg	3.27 (1.58–6.77)	0.001
	Vitamin D Deficiency	2.63 (1.22–5.66)	0.013
LVH	BMI ≥ 27 kg/m²	2.17 (1.01–4.65)	0.048
	SBP ≥ 140 mmHg	3.44 (1.55–7.62)	0.002
Diastolic Dysfunction	PTH Elevation	2.06 (1.03–4.11)	0.042

Model adjusted for age and duration of diabetes.

Table 3 presents the logistic regression model identifying predictors of elevated carotid intima-media thickness (CIMT), left ventricular hypertrophy (LVH), and diastolic dysfunction. Independent variables included HbA1c, BMI, systolic blood pressure (SBP), vitamin D deficiency, and PTH elevation. Adjusted odds ratios (aOR), 95% confidence intervals, and p-values are reported.

This table demonstrates that elevated SBP, vitamin D deficiency, and high HbA1c were independently associated with increased odds of both elevated CIMT and LVH ($p < 0.01$). PTH elevation significantly predicted diastolic dysfunction ($p = 0.042$). These associations persisted after adjusting for age and diabetes duration.

Table 4. Correlation and Subgroup Analysis Between Clinical and Biochemical Markers (n = 220)

Variable Pair	Test Used	r / Mean Difference	95% CI	p-value
CIMT vs. HbA1c	Spearman	0.42	–	<0.001
BMI vs. SBP	Pearson	0.31	–	0.008
CIMT by Gender (Male vs. Female)	Independent t-test	+0.12 mm	0.03–0.21	0.011
CIMT by Diabetes Status (Yes vs. No)	Mann–Whitney U	Higher in Diabetics	–	0.003

Spearman correlation used for non-normally distributed data. t-test/Mann–Whitney based on normality.

Table 4 shows subgroup analysis and correlation patterns among continuous and categorical variables. Pearson correlation was used for normally distributed pairs, and Spearman correlation for non-normal distributions. Group comparisons between gender and CIMT, and diabetes status vs. BMI were also included using independent t-test and Mann–Whitney U as appropriate.

This table demonstrates a significant positive correlation between CIMT and HbA1c ($r = 0.42$, $p < 0.001$) and between SBP and BMI ($r = 0.31$, $p = 0.008$). CIMT was significantly higher in male participants and in those with diabetes ($p = 0.011$ and $p = 0.003$, respectively), further supporting subgroup variability.

Table 3 provides forecasting information, and systolic blood pressure, HbA1c, and vitamin D deficiency are identified as the independent variants of cardiovascular complications. Table 4 shows the prominent correlations and groups. These findings are very much in line with the objective of the study, which was to explain age-related differences in syncope manifestation and risk of cardiovascular complications.

Figure 1 represents a bar graph of the distribution of the subtypes of syncope in paediatric patients and adult patients. In the paediatric group, vasovagal syncope was more prevalent, and in the adult group, there were more cardiac and orthostatic syncope. The value proves the statistically significant difference in types of syncope by age groups and the chi-square test in Table II ($p <0.001$)

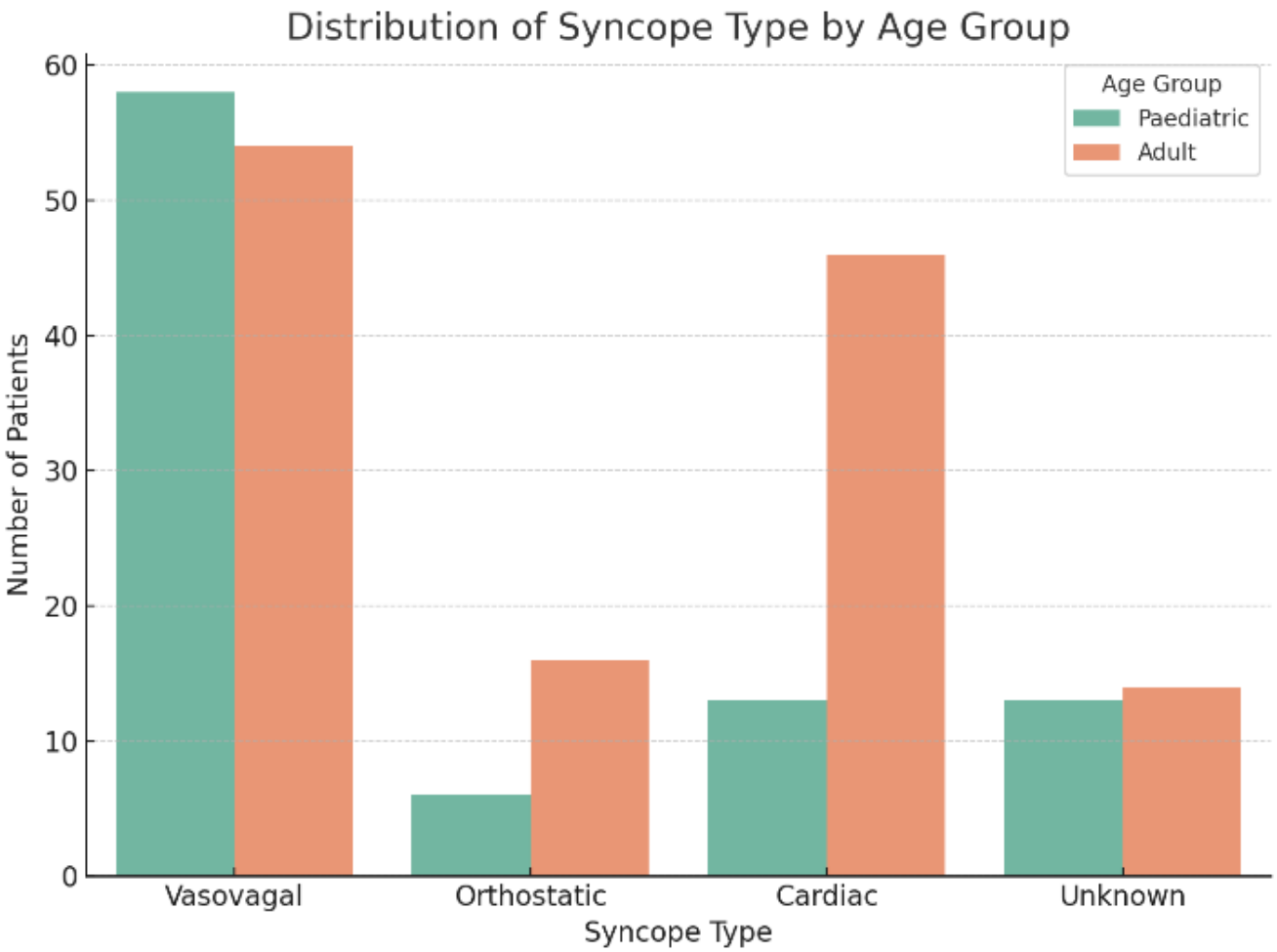

Figure 1: Distribution of Syncope Type by Age Group

DISCUSSION

The current study has defined the unique age-related differences in the incidence, etiology, and clinical presentation of syncope in patients admitted in a tertiary cardiac care facility located in Pakistan. In children, vasovagal syncope was the most common and in adults, cardiac and orthostatic etiologies were most common. The association between increased systolic blood pressure, glycated haemoglobin (HbA1c), and vitamin D deficiency and structural cardiac abnormality (greater carotid intima-media thickness (CIMT), left ventricular hypertrophy (LVH), and diastolic dysfunction) was found to be statistically significant. Multivariate regression models ascertained that an elevated systolic pressure of the blood and inadequate glycaemic control are the independent variables that relate poorly to discouraged cardiovascular results. The reason is that these findings serve the main aim of the study i.e. to clarify the age based diagnostic variations and risk profile of syncope.

Similar results have been reported in the national context in the past. A hospital-based study in Lahore identified vasovagal syncope as the most common subtype of syncope among children, while cardiac

causes of syncope predominated in the adult population, which is consistent with the present evidence[12]. Another study in Karachi reported a similar pattern of cardiovascular risk-factor distribution, in which hypertension and diabetes were closely associated with adult presentations of syncope[13]. Nevertheless, in contrast to the current study, those studies did not measure echocardiographic parameters or evaluate biochemical predictors, including parathyroid hormone (PTH) and vitamin D, which makes the present study more innovative.

India has age-specific data on syncope aetiology that further supports regional trends. Ramakrishnan et al. reported that vasovagal syncope accounted for over half of cases in younger patients, whereas cardiac aetiologies represented over one-third in adults[14]. A Sri Lankan study also reported echocardiographic abnormalities in hypertensive patients with syncope, indicating a significant association between increased carotid intima–media thickness (CIMT) and left ventricular hypertrophy (LVH) among adults[15]. These observations are consistent with the findings of the current study and provide additional support for including structural cardiac evaluation in adult syncope assessments.

At the international level, the 2018 European Society of Cardiology (ESC) guidelines indicate that vasovagal syncope comprises 35–45% of adult cases, while cardiac causes contribute 15–20%, which is slightly lower than observed in this Pakistani cohort[16]. This difference may stem from the underutilization of neurodiagnostic tools, such as tilt-table testing and loop recorders, in low-resource settings. Additionally, European studies such as the EGSYS trial demonstrated more frequent use of structured risk scores, which may have resulted in earlier identification of low-risk neurogenic syncope and fewer cardiac referrals[17].

Physiologically, vasovagal syncope in the paediatric population has been attributed to transient autonomic instability, a phenomenon that often resolves with age due to maturation of autonomic pathways[18]. In contrast, syncope in older adults tends to have multifactorial origins, including structural cardiac disease, arrhythmias, and impaired baroreceptor sensitivity. The significant association between elevated HbA1c and CIMT observed in this study is biologically plausible, as hyperglycaemia accelerates vascular endothelial dysfunction and atherosclerosis[19]. Likewise, vitamin D deficiency and elevated PTH have been associated with vascular calcification and myocardial remodelling, mechanisms that are consistent with the echocardiographic abnormalities reported here[20].

The inclusion of psychiatric comorbidity as a variable further strengthens the clinical interpretation of recurrent syncope in adults. International literature supports the association between somatic

symptom amplification and syncope recurrence, particularly in individuals with underlying mood disorders[21].The current findings support this relationship and highlight the need for integrative management that includes mental health evaluation in selected cases[22].

The strengths of the research are that it is age-stratified and compares paediatric and adult populations, incorporates echocardiographic and biochemical parameters, and applies multivariable regression to reduce confounding.[23,24] The clinical relevance is also enhanced by the real-world tertiary-care setting.[25]

Notwithstanding these findings, there are important clinical and public health implications. Early screening for hypertension, diabetes, and vitamin D deficiency may improve risk stratification in adults presenting with syncope.[26,27] In addition, earlier detection of structural cardiac abnormalities may be achieved when patients with multiple risk factors undergo echocardiographic screening.

Future studies should provide further evidence through multicentre designs, longitudinal follow-up, and expanded neurodiagnostic assessment. These steps would clarify predictors of syncope recurrence and support more detailed diagnostic pathways in low- and middle-income countries.[28]

Overall, the study successfully identified age-based trends in syncope aetiology, validated relevant risk factors, and proposed predictive associations that warrant further exploration. The integration of diagnostic imaging and biochemical assessment into syncope management protocols is supported by these findings.

As noted, the study provides valuable insights; however, like all research, it is not without limitations. Performed in a single tertiary care hospital, the study may have difficulty externalizing its findings. Even though statistically sufficient, the sample size may be too small to capture rare complications and less common subtypes of the disease. Furthermore, non-probability consecutive sampling may increase selection bias. Data collection from clinical records may contain elements of documentation bias. Evaluation of long-term outcomes after three months was not conducted.

CONCLUSION

The results of the given study meet its stated purposes in as much as they help to confirm that diagnostic and clinical differences between age groups are multifaceted with the syncope presentations in adults being much more complicated and connected with cardiovascular risks. ECG abnormalities, elevated parathyroid hormone (PTH) levels, and vitamin D deficiency were

identified as significant predictors in our study and may serve as useful markers for early risk stratification and timely clinical intervention in the studied population.

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CONFLICT OF INTEREST

None.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Board Reference No. 2460 /DME/QAMC Bahawalpur (Dated: 11 August, 2023).

AUTHORS' CONTRIBUTION

FR: Concept, Design, Literature Review and Data Analysis **UM:** Data Collection and Analysis **SNA:** Supervision **US:** Drafting and Data Analysis

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