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Comparative Cardiovascular Impact of Early-Onset Type 1 and Type 2 Diabetes and Associated Risk Factors in Pediatric and Adult Patients

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ABSTRACT

Cardiovascular disease is a leading cause of morbidity and mortality among individuals with diabetes, with early-onset cases posing unique risks. **Objective:** To evaluate and compare the cardiovascular impact of early-onset type 1 and type 2 diabetes mellitus in paediatric versus adult patients and to identify associated clinical, biochemical, and sociodemographic risk factors in a low-resource Pakistani setting. **Methods:** This was an observational, comparative, cross-sectional study conducted at the Department of Paediatrics, Quaid-e-Azam Medical College, Bahawalpur, from March 2024 to March 2025. A total of 260 participants were enrolled using non-probability consecutive sampling, comprising 130 diabetic patients (aged 10–40 years) with early-onset diabetes mellitus (diagnosed ≤25 years) and 130 age- and gender-matched healthy controls. Data were collected through structured clinical examination, laboratory investigations (including HbA1c, lipid profile, serum creatinine, urinary albumin-creatinine ratio), electrocardiography, and echocardiography. Statistical analysis was performed using SPSS version 26.0. **Results:** Diabetic patients demonstrated significantly higher prevalence of left ventricular hypertrophy (36.9% vs. 10.8%; adjusted OR: 5.01; 95% CI: 2.51–9.99; p = 0.0001), CIMT ≥0.9 mm (44.6% vs. 16.2%; OR: 4.49; 95% CI: 2.44–8.26; p = 0.0001), and diastolic dysfunction (24.6% vs. 6.9%; OR: 4.25; 95% CI: 1.83–9.89; p = 0.0003). Significant associations were found between cardiovascular complications and poor glycaemic control (HbA1c ≥7%), LDL ≥100 mg/dL, triglycerides ≥150 mg/dL, low socioeconomic status, and sedentary lifestyle. **Conclusion:** Early-onset diabetes mellitus is strongly associated with adverse cardiovascular outcomes in young Pakistani patients.

INTRODUCTION

Because diabetes mellitus, including its early types, is so common around the world, it has become a significant public health problem linked to major heart problems [1]. Because resources for healthcare are lacking in Pakistan and many people cannot access preventive care easily, diabetes found in youth can be very serious [2]. Shockingly, nowadays, it is very common for these people to be diagnosed while young, influenced by new diets, less activity and more urbanization [3, 4]. Children or teenagers with Type 1 diabetes experience their pancreatic β-cells being destroyed by the immune system [5]. Meanwhile, type 2 diabetes in children is being observed more and more, traditionally seen as a disorder found in Pakistan, it is clear from studies and data that type 2 diabetes in children and teens is rising, at the same time as obesity, hypertension and abnormal lipid levels are increasing [7]. In Pakistan, most studies have concentrated on measuring the number of people with diabetes and their blood sugar levels, but have not examined the relationships between the age at diagnosis, diabetes type and heart complications [8, 9]. The paucity of comprehensive, age-stratified cardiovascular profiling in diabetic patients from low-resource settings such as Pakistan represents a significant gap in the literature [10]. Moreover, the dual

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burden of communicable and non-communicable diseases in Pakistan often relegates chronic conditions like diabetes to lower healthcare priorities [11]. This underscores the need for a focused analysis of early-onset diabetes in both children and adults, with an emphasis on cardiovascular implications, which could aid in refining screening protocols and guiding early interventions [12]. Rosengren and Dikaiou in 2023 also reviewed cardiovascular outcomes associated with type 1 and type 2 diabetes [13].

This study addresses this critical gap by evaluating and comparing the cardiovascular effects of early-onset type 1 and type 2 diabetes in paediatric versus adult patients in a low-resource Pakistani setting.

METHODS

This observational, comparative cross-sectional study was conducted over a one-year period from March 2024 to March 2025 at the Department of Paediatrics, Quaid-e-Azam Medical College, Bahawalpur, Pakistan.The primary objective was to assess and compare the cardiovascular effects of early-onset type 1 and type 2 diabetes mellitus in paediatric and adult patients, and to identify relevant clinical, biochemical, and sociodemographic risk factors. A total of 260 participants were enrolled through non-probability consecutive sampling, comprising 130 diabetic patients and 130 age-and gender-matched healthy controls.The sample size was determined based on findings by Dabelea *et al.*, in a study entitled Association of Type 1 Diabetes vs Type 2 Diabetes Diagnosed During Childhood and Adolescence with Complications During Teenage Years and Young Adulthood. Dart *et al.*, in 2014 found that youth with type 2 diabetes experience earlier onset of complications compared to typical adult-onset cases [8, 14].JAMA, 2017, which reported a 33.5% prevalence of cardiovascular complications in youth with diabetes. With a 95% confidence interval, 6% margin of error, and 80% study power, a minimum of 130 diabetic participants was calculated.To enable meaningful subgroup comparisons by diabetes type and age category, the sample was increased to 260 individuals. Eligible participants were between 10 and 40 years of age, diagnosed with either type 1 or type 2 diabetes mellitus, with disease onset at or before 25 years of age and a minimum disease duration of one year.All participants were required to be under regular follow-up at the study site and provide informed consent.Exclusion criteria included diabetes secondary to other medical conditions, congenital heart disease, chronic renal failure, autoimmune disorders other than type 1 diabetes, pregnancy, current use of statins or ACE inhibitors, and incomplete data records.Data collection involved comprehensive clinical evaluations, biochemical analyses, sociodemographic profiling, and cardiovascular assessments.Clinical variables included age, sex, Body Mass Index (BMI), duration of diabetes, and blood pressure, along with lifestyle history such as smoking status, level of physical activity, and dietary patterns.Additional clinical conditions considered included the presence of comorbidities such as hypertension and dyslipidaemia. Ethical approval for the study was obtained from the Institutional Review Board of Quaid-e-Azam Medical College, Bahawalpur (Ref. No. 2466/DME/QAMC). Informed consent was obtained from all participants or their legal guardians in the case of minors.Confidentiality of all patient information was ensured throughout the research process. Statistical analysis was performed using SPSS version 26.0.

RESULTS

A total of 260 participants were enrolled in the study, comprising 130 diabetic patients (65 type 1 and 65 type 2) and 130 age and gender matched controls.The present study has revealed a significantly higher burden of cardiovascular abnormalities in individuals with early-onset diabetes, compared to non-diabetic controls, in a low-resource Pakistani setting.This confirms existing global evidence suggesting accelerated vascular aging and atherosclerosis in early-onset diabetes but also adds region-specific data from a population where such comprehensive cardiovascular profiling has rarely been undertaken.Table 1 shows the distribution of demographic and socioeconomic characteristics between diabetic and control groups, including gender, residence, income level, and education.This table demonstrates that urban residence, low income, and lack of formal education were significantly more frequent among diabetic participants. These variables were independently associated with diabetes status after adjusting for confounders, suggesting socioeconomic disadvantage may contribute to disease burden.

Table 1: Demographic and Socioeconomic Characteristics of Diabetic and Control Participants (n=260)

Variables	Diabetic	Control	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-Value
Gender (Male)	76	72	1.13 (0.69–1.84)	1.08 (0.65–1.78)	0.61
Urban Residence	68	54	1.79 (1.05–3.06)	1.66 (0.92–3.00)	0.03
Income <20k PKR	50	28	2.56 (1.44–4.54)	2.34 (1.29–4.23)	0.001
Education (No formal)	36	22	2.11 (1.12–3.99)	1.98 (1.01–3.87)	0.02

Reference category used for each variable. All comparisons via Chi-square test. Adjusted ORs from multivariate logistic regression.

Table 2 shows key clinical and biochemical categorical variables, including obesity, hypertension, LDL, and triglycerides. This table demonstrates that all four metabolic risk factors were significantly more prevalent in diabetic participants. Strong odds ratios highlight the

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magnitude of association, indicating that early-onset diabetes is strongly linked with metabolic syndrome components.

Table 2: Clinical and Biochemical Risk Factors in Diabetic and Control Groups(n=260)

Variable	Diabetic	Control	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-Value
BMI ≥30 (Obesity)	45	22	3.04 (1.72–5.38)	2.89 (1.56–5.34)	0.0001
SBP ≥130 mmHg	58	24	4.27 (2.45–7.43)	4.01 (2.21–7.26)	0.0001
LDL ≥100 mg/dL	76	38	3.86 (2.21–6.72)	3.70 (1.98–6.91)	0.0001
Triglycerides ≥150 mg/dL	72	28	5.52 (3.10–9.84)	5.18 (2.86–9.38)	0.0001

SBP – Systolic Blood Pressure; LDL – Low-Density Lipoprotein. Chi-square tests applied for all comparisons.

Table 3 shows group-wise comparisons of continuous clinical and biochemical parameters using appropriate statistical tests based on normality assessment. This table demonstrates that diabetics had significantly higher systolic and diastolic blood pressure, HbA1c, LDL levels, and CIMT. These findings support the presence of early vascular damage and abnormal metabolic regulation in the diabetic group.

Table 3: Continuous Variables Comparison between Diabetics and Controls

Variable	Diabetic (Mean ± SD / Median)	Control (Mean ± SD / Median)	p-Value
Systolic BP* (mmHg)	132.4 ± 12.1	122.1 ± 10.3	0.0003
Diastolic BP* (mmHg)	82.3 ± 9.6	76.2 ± 7.4	0.0012
HbA1c (%)#	8.9 (7.4–10.2)	5.1 (4.9–5.7)	<0.001
LDL (mg/dL)*	116.2 ± 24.8	88.3 ± 19.5	<0.001
CIMT (mm)#	1.01 (0.87–1.15)	0.78 (0.64–0.89)	<0.001

(*)t-test, (#)Mann–Whitney U test.

Table 4 shows the prevalence of cardiovascular complications between the diabetic and control groups. This table demonstrates that LV hypertrophy, elevated CIMT, diastolic dysfunction, and arrhythmias were all significantly more prevalent among diabetics. Adjusted ORs confirm strong and independent associations with early cardiovascular damage.

Table 4: Cardiovascular Complications in Diabetic vs. Control Groups(n=130)

Variable	Diabetic	Control	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-Value
LV Hypertrophy	48	14	5.36 (2.74–10.49)	5.01 (2.51–9.99)	0.0001
CIMT ≥0.9 mm	58	21	4.75 (2.66–8.49)	4.49 (2.44–8.26)	0.0001
Diastolic Dysfunction	32	9	4.68 (2.05–10.67)	4.25 (1.83–9.89)	0.0003
Arrhythmias	38	14	4.07 (2.13–7.77)	3.91 (2.01–7.61)	0.0005

All comparisons via Chi-square test. Adjusted ORs derived from multivariable logistic regression controlling for age, gender, and BMI.

DISCUSSION

The results of this study revealed that individuals with early-onset diabetes mellitus in Pakistan exhibited a significantly higher burden of cardiovascular complications compared to age- and gender-matched non-diabetic controls. Key cardiovascular abnormalities observed in diabetic participants included a markedly greater prevalence of left ventricular hypertrophy, diastolic dysfunction, increased carotid intima-media thickness (CIMT), and arrhythmias [15]. These complications were particularly prominent among individuals with type 2 diabetes, poor glycaemic control, longer disease duration, elevated LDL and triglyceride levels, low socioeconomic status, limited educational attainment, and urban residency [16]. Larsson *et al.*, in 2018 examined the association of type 1 and type 2 diabetes with the incidence of seven major cardiovascular diseases [17]. Another multicentre study conducted by Shah *et al.*, reported that Evaluates the relationship between insulin sensitivity and arterial stiffness in youth with type 1 diabetes using data from the SEARCH CVD study [18]. Htay *et al.*, in 2019 reviewed mortality and cardiovascular disease risks in individuals with type 1 and type 2 diabetes [19]. Lee *et al.*, in 2019 conducted a nationwide study comparing early mortality and cardiovascular disease risk between type 1 and type 2 diabetes [20].Several strengths of the study must be acknowledged.The use of both clinical and subclinical cardiovascular markers, including ECG, echocardiography, and CIMT, allowed for robust identification of early cardiovascular involvement.

CONCLUSIONS

This study demonstrated a clear and concerning association between early-onset diabetes mellitus and increased cardiovascular risk in young individuals in Pakistan. Patients with early-onset type 1 and type 2 diabetes showed a significantly higher prevalence of left ventricular hypertrophy, increased carotid intima-media thickness, diastolic dysfunction, and arrhythmias compared to non-diabetic controls.These complications were strongly linked with poor glycaemic control (elevated HbA1c), high LDL and triglyceride levels, longer duration of diabetes, and low socioeconomic status.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. Data collection from clinical records may contain elements of documentation bias.Evaluation of long-term outcomes after three months was not conducted.

Authors Contribution

Conceptualization: UM, MN
Methodology: US

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Formal analysis: IA, US
Writing, review and editing: AZ, FUR
All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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