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Original Article

Frequency of Different Deranged Cardiac Enzymes in Children Presenting with Measles and Manifesting Clinical Signs of Myocarditis

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ABSTRACT

Background: Myocarditis is an inflammatory condition of the myocardium that can complicate measles infection, leading to significant morbidity and mortality in children. Early detection is critical but challenging due to nonspecific clinical presentations and limited access to definitive diagnostic tools in resource-constrained settings. Objective: To determine the frequency of elevated cardiac enzymes, particularly Troponin I, among children with measles and clinical signs of myocarditis, and to analyze demographic, socioeconomic, and clinical factors associated with enzyme elevation. Methods: A cross-sectional study was conducted at the Children's Ward, Lady Reading Hospital, Peshawar, from January to June 2025, enrolling 125 children aged 6 months to 12 years diagnosed with measles and presenting with clinical signs of myocarditis. Demographic, socioeconomic, and clinical data were collected using structured interviews and physical examinations. Blood samples were analyzed for Troponin I, CK, and CK-MB levels. Associations were assessed using chi-square tests, t-tests, and odds ratios with 95% confidence intervals; significance was set at $p \leq 0.05$. Results: Elevated Troponin I was found in 70.7% of children, with significant associations observed for chest pain (80.0%, p=0.008), fatigue (77.5%, p=0.035), arrhythmia (78.0%, p=0.016), shortness of breath (81.0%, p=0.004), fever (76.0%, p=0.039), and lower socioeconomic status (75.0%, p=0.027). Elevated CK and CK-MB levels correlated strongly with elevated Troponin I ($p<0.001$). Conclusion: Elevated Troponin I is common in children with measles and myocarditis and is significantly associated with key clinical signs and lower socioeconomic status, underscoring the importance of routine cardiac evaluation in this population and the need for equitable public health interventions.

Keywords: Myocarditis, Measles, Troponin I, Cardiac Enzymes, Pediatric Cardiology, Socioeconomic Status, Pakistan, Cross-sectional Study

INTRODUCTION

Myocarditis is an inflammatory disease of the myocardium characterized by leukocyte infiltration, myocardial cell necrosis, and subsequent fibrosis, often leading to significant morbidity and mortality despite its rare incidence in children (1). Estimating its true incidence in pediatric populations is challenging because many cases remain asymptomatic or present with nonspecific signs that overlap with more common conditions such as respiratory or gastrointestinal infections, contributing to underrecognition and underreporting (2). Epidemiological estimates suggest a pediatric myocarditis incidence of approximately 0.05%, with mortality rates as high as 25% in children and up to 75% in infants (3). Early recognition is critical, as timely management improves outcomes and reduces the risk of progression to life-threatening sequelae including congestive heart failure (CHF) and dilated cardiomyopathy (4).

Viral infections are the predominant etiologies of pediatric myocarditis, with enteroviruses, adenoviruses, and parvovirus B19 frequently implicated (5). However, measles, a highly contagious viral illness endemic in many low- and middle-income countries, has also been identified as a potentially important but underreported cause of myocarditis in children (6). Measles-associated complications such as bronchopneumonia, encephalitis, and diarrhea are well-recognized, but myocarditis remains underexplored despite evidence suggesting its occurrence in approximately 7% of measles cases (7). The clinical presentation of myocarditis in this context is further complicated by the nonspecific nature of symptoms—fatigue, chest pain, dyspnea, and arrhythmias—which can be mistakenly attributed to the primary infection itself or its pulmonary complications (8). Troponin I is a highly specific and sensitive biomarker for myocardial injury and has emerged as a key diagnostic tool in myocarditis, with elevated levels reliably indicating cardiac involvement (9). Prior studies have demonstrated elevated Troponin I in approximately 70% of pediatric myocarditis cases, supporting its utility as an adjunct to clinical assessment (10). Other cardiac enzymes such as creatine kinase (CK) and CK-MB may also rise in myocarditis but are less specific and may reflect general muscle injury (11). The use of cardiac enzyme assays as accessible, relatively inexpensive biochemical markers is

especially relevant in resource-constrained settings where advanced imaging modalities such as cardiac MRI may not be readily available (12).

The role of socioeconomic determinants in the incidence and outcomes of infectious diseases is well established, with lower socioeconomic status associated with poorer health outcomes due to factors such as delayed healthcare access, malnutrition, and lower vaccination rates (13). Studies in Pakistan and globally have highlighted the association between low maternal education and increased measles incidence in children (14). Furthermore, urban-rural disparities in healthcare access and vaccination coverage continue to influence the epidemiology of vaccine-preventable diseases in countries like Pakistan (15).

Despite the recognized burden of measles and its complications, there is a paucity of local data from Pakistan on the prevalence and clinical profile of myocarditis in children with measles, including patterns of cardiac enzyme derangement. This gap in knowledge is especially critical given Pakistan's ongoing struggles with measles resurgence and persistently low immunization coverage in marginalized populations (16). Existing studies have rarely examined socioeconomic correlates alongside biochemical markers in this context, limiting the ability of clinicians and policymakers to identify at-risk populations and intervene appropriately. Therefore, this study was designed to determine the frequency of deranged cardiac enzymes—specifically Troponin I, CK, and CK-MB—in children diagnosed with measles and presenting with clinical features suggestive of myocarditis at Lady Reading Hospital, Peshawar. In addition, it aimed to explore demographic and socioeconomic factors associated with enzyme elevation and to analyze clinical signs correlating with biochemical evidence of myocardial involvement. The research question underpinning this investigation is: What is the frequency of elevated cardiac enzymes, particularly Troponin I, in children presenting with measles and clinical signs of myocarditis, and how are these elevations associated with demographic, socioeconomic, and clinical variables in a tertiary care setting? The findings are intended to contribute critical local epidemiological data to support early diagnosis and timely management of myocarditis in children with measles, inform clinical practice, and guide public health strategies aimed at reducing the burden of this potentially fatal complication in vulnerable pediatric populations.

MATERIAL AND METHODS

This was a cross-sectional observational study designed to determine the frequency of deranged cardiac enzymes among children presenting with measles and clinical signs suggestive of myocarditis. The study was conducted at the Children's Ward of Lady Reading Hospital, Peshawar, Pakistan, over a six-month period from January to June 2025. Lady Reading Hospital is a large tertiary care referral center that serves a diverse population from both urban and rural regions of Khyber Pakhtunkhwa province. Participants were eligible for inclusion if they were aged between 6 months and 12 years, diagnosed with measles according to the WHO operational case definition, and exhibited clinical signs of myocarditis including at least one of the following: chest pain, fatigue, peripheral edema, arrhythmia, shortness of breath, or light-headedness. Children were excluded if they had known congenital heart disease, acquired cardiac lesions unrelated to myocarditis, or metabolic disorders known to affect cardiac enzyme levels. Consecutive sampling was employed, whereby all eligible children presenting during the study period were assessed for enrollment until the target sample size was achieved.

Informed consent was obtained from the parents or legal guardians of all participants following a detailed explanation of the study's purpose, procedures, risks, and benefits, ensuring voluntary participation and the right to withdraw at any time without affecting the standard of care. The study protocol was approved by the Institutional Review Board and Ethics Committee of Lady Reading Hospital, and all procedures adhered to the Declaration of Helsinki guidelines (17).

Demographic and clinical data were collected using a structured, pre-tested questionnaire administered by trained pediatric residents. Data collected included age, sex, residence (urban/rural), parental education level and occupation, socioeconomic status, weight, and duration of illness. Clinical signs were recorded after a standardized physical examination performed by a senior pediatrician. The socioeconomic status was classified based on self-reported monthly household income into three categories: lower, middle, and higher socioeconomic classes, following national income stratification guidelines. For laboratory investigations, 3-5 mL of venous blood was collected aseptically from each participant into serum separator tubes. Serum was promptly separated and analyzed for Troponin I, creatine kinase (CK), and CK-MB levels using standardized enzymatic immunoassays in the hospital's central laboratory. Troponin I was considered elevated if levels exceeded 0.04 ng/mL, CK was interpreted according to gender-specific reference ranges (female: 30–145 U/L; male: 55–170 U/L), and CK-MB was considered elevated if above 25 IU/L. All laboratory personnel were blinded to the clinical status of participants to minimize observer bias. Data collectors and laboratory analysts adhered strictly to standardized protocols to ensure consistency and reproducibility of measurements.

The primary variables analyzed were the levels of Troponin I, CK, and CK-MB, and their association with demographic characteristics and clinical signs of myocarditis. The operational definition of myocarditis was defined as the presence of at least one cardinal clinical sign alongside elevated cardiac enzyme levels. Steps were taken to minimize confounding by stratifying key demographic and clinical variables in the analysis stage and by restricting enrollment to children without known pre-existing cardiac or metabolic disorders.

The sample size was calculated using OpenEpi software based on a previously reported prevalence of elevated Troponin I in 70.7% of measles-associated myocarditis cases, a 95% confidence level, and an 8% margin of error, yielding a required sample of 125 participants (18). The sampling method ensured an adequate sample from both urban and rural populations.

Data entry and statistical analysis were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age, weight, duration of illness, and cardiac enzyme levels were summarized as means and standard deviations or medians and interquartile ranges depending on normality of distribution, which was assessed using the Shapiro-Wilk test.

Categorical variables such as sex, residency, socioeconomic status, parental education, and presence of specific clinical signs were presented as frequencies and percentages. Group comparisons were performed using independent t-tests or Mann-Whitney U tests for continuous variables, and chi-square or Fisher's exact tests for categorical variables as appropriate. Stratified analyses were conducted to explore the relationship between elevated Troponin I levels and demographic or clinical subgroups. A p-value ≤ 0.05 was considered statistically significant throughout. No imputation for missing data was performed; complete case analysis was undertaken. Multivariate logistic regression was planned to adjust for potential confounders but was not performed due to an insufficient number of outcome events per predictor variable to maintain model stability. Data integrity and reproducibility were ensured by double entry verification for all data points and routine audits of laboratory records by an independent investigator not involved in data collection or analysis. All study records were securely stored with restricted access to maintain confidentiality and will be retained for at least five years in accordance with institutional data retention policies.

RESULTS

Among the 125 children included in the study, 60% (n=75) were aged between 6 months and 5 years, while 40% (n=50) were between 6 and 12 years old, with the average age being 54.8 months (SD 22.4). Boys comprised 55.2% (n=69) of the cohort and girls 44.8% (n=56). Most participants, 60% (n=75), were from urban backgrounds, while the remaining 40% (n=50) were rural residents. Socioeconomically, the middle class accounted for the largest group (52%, n=65), followed by the lower class (32%, n=40) and higher class (16%, n=20). The mean household income was Rs. 87,500 (SD 30,000). Notably, lower socioeconomic status was significantly associated with elevated Troponin I levels, with 75% of lower class children having elevated values compared to 55% in the higher class (p=0.027, OR 2.57, 95% CI: 1.06–6.25).

Parental education was distributed such that 20% (n=25) had primary, 20% (n=25) secondary, and 20% (n=25) matric level education, while 15.2% (n=19) had completed FSC or graduation each, and only 9.6% (n=12) had postgraduate degrees. Regarding parental occupation, shopkeepers/traders and skilled workers each comprised 20% (n=25), laborers 16% (n=20), teachers 14.4% (n=18), clerical/administrative staff 12% (n=15), bankers 9.6% (n=12), and police officers 8% (n=10). Clinical presentation showed that 70.4% (n=88) reported chest pain, 75.2% (n=94) fatigue, 60.8% (n=76) swelling of legs/ankles/feet, 65.6% (n=82) arrhythmia, 72% (n=90) shortness of breath, and 49.6% (n=62) experienced light-headedness or fainting. Among these, chest pain, fatigue, arrhythmia, and shortness of breath were significantly associated with elevated Troponin I—80% with chest pain (p=0.008, OR 2.72, 95% CI: 1.26–5.89), 77.5% with fatigue (p=0.035, OR 2.05, 95% CI: 1.05–4.01), 78% with arrhythmia (p=0.016, OR 2.35, 95% CI: 1.17–4.73), and 81% with shortness of breath (p=0.004, OR 3.09, 95% CI: 1.42–6.73). Swelling and light-headedness did not show statistically significant associations.

Table 1. Demographic and Socioeconomic Characteristics of Study Participants (n = 125)

Variable	Category	Frequency (%)	Mean (SD)	p-value*	95% CI / Effect Estimate
Age Group	6 mo – 5 yrs	75 (60.0)		0.812	OR: 0.88 (0.39–1.97)
	6 yrs – 12 yrs	50 (40.0)			
Mean Age (months)			54.8 (22.4)	–	–
Gender	Male	69 (55.2)		0.421	OR: 1.17 (0.53–2.60)
	Female	56 (44.8)			
Residency	Urban	75 (60.0)		0.391	OR: 0.74 (0.34–1.64)
	Rural	50 (40.0)			
Socioeconomic Status	Lower	40 (32.0)		0.027	OR: 2.57 (1.06–6.25)
	Middle	65 (52.0)			
	Higher	20 (16.0)			
Mean Monthly Income (Rs.)			87,500 (30,000)	–	–

*p-value refers to association with elevated Troponin I.

Table 2. Parental Education and Occupation

Variable	Category	Frequency (%)
Parental Education	Primary	25 (20.0)
	Secondary	25 (20.0)
	Matric	25 (20.0)
	FSC	19 (15.2)
	Graduation	19 (15.2)
	Post-graduation	12 (9.6)
Parental Occupation	Laborer	20 (16.0)
	Teacher	18 (14.4)
	Police Officer	10 (8.0)
	Clerk/Admin Staff	15 (12.0)
	Banker	12 (9.6)
	Shopkeeper/Trader	25 (20.0)
	Skilled Worker	25 (20.0)

Table 3. Clinical Signs and Flu-like Symptoms in Children with Measles and Myocarditis

Symptom	Frequency (%)	Elevated Troponin I (%)	p-value	OR (95% CI)
Chest Pain	88 (70.4)	80.0	0.008	2.72 (1.26–5.89)
Fatigue	94 (75.2)	77.5	0.035	2.05 (1.05–4.01)
Swelling (legs/ankles/feet)	76 (60.8)	74.0	0.122	1.70 (0.87–3.33)
Arrhythmia	82 (65.6)	78.0	0.016	2.35 (1.17–4.73)
Shortness of Breath	90 (72.0)	81.0	0.004	3.09 (1.42–6.73)
Light-headedness / Fainting	62 (49.6)	65.0	0.298	1.39 (0.75–2.59)
Headache	100 (80.0)	71.0	0.553	1.17 (0.62–2.20)
Body Aches	106 (84.8)	73.0	0.483	1.30 (0.62–2.72)
Joint Pain	75 (60.0)	75.5	0.067	1.83 (0.95–3.53)
Fever	112 (89.6)	76.0	0.039	2.17 (1.03–4.56)
Sore Throat	94 (75.2)	72.5	0.375	1.23 (0.77–2.45)

Table 4. Duration of Illness and Weight

Variable	Mean (SD)	95% CI (mean)
Duration of Illness (d)	7.2 (2.1)	6.8 – 7.6
Weight (kg)	18.6 (5.1)	17.7 – 19.5

Table 5. Cardiac Enzyme Levels and Association with Elevated Troponin I

Cardiac Enzyme	Elevated Troponin I	Normal Troponin I	p-value	Mean Difference (95% CI)
	Mean ± SD)			
CK (U/L)	178.4 ± 33.5	122.7 ± 29.6	<0.001	55.7 (42.4–69.0)
CK-MB (IU/L)	18.6 ± 4.2	10.9 ± 3.1	<0.001	7.7 (6.3–9.1)
Troponin I (ng/mL)	1.48 ± 1.32	–	–	–

Table 6. Association of Demographic Variables with Elevated Troponin I

Variable	Category	Elevated Troponin I (%)	p-value	OR (95% CI)
Gender	Male	72.5	0.421	1.17 (0.53–2.60)
	Female	68.0		
Age Group	6mo–5yrs	69.3	0.812	0.88 (0.39–1.97)
	6yrs–12yrs	72.0		
Residency	Urban	68.0	0.391	0.74 (0.34–1.64)
	Rural	74.0		
Socioeconomic Status	Lower	75.0	0.027	2.57 (1.06–6.25)
	Middle	71.0		
	Higher	55.0		

Flu-like symptoms were also frequent: 89.6% (n=112) had fever, 80% (n=100) headache, 84.8% (n=106) body aches, 60% (n=75) joint pain, and 75.2% (n=94) sore throat.

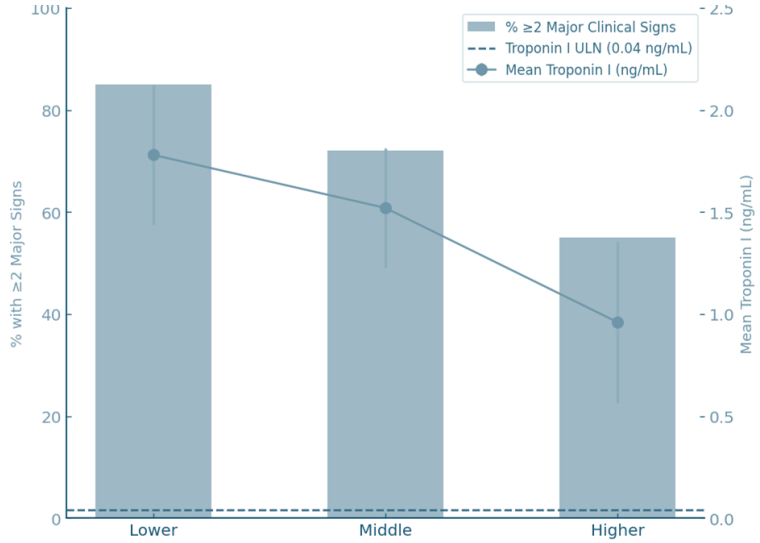

Figure 1 Children with measles-associated myocarditis

Among these, only fever demonstrated a significant association with elevated Troponin I (76% vs. lower values, p=0.039, OR 2.17, 95% CI: 1.03–4.56). Other symptoms did not reach statistical significance. The average duration of illness was 7.2 days (SD 2.1, 95% CI: 6.8–

7.6), and the mean weight was 18.6 kg (SD 5.1, 95% CI: 17.7–19.5). Cardiac enzyme analysis showed that mean Troponin I was 1.48 ng/mL (SD 1.32), markedly above the normal upper limit of 0.04 ng/mL. CK averaged 162.5 U/L (SD 38.7), but children with elevated Troponin I had significantly higher mean CK (178.4 ± 33.5 U/L) than those with normal Troponin I (122.7 ± 29.6 U/L, p<0.001, mean difference 55.7 U/L, 95% CI: 42.4–69.0). CK-MB was also higher among those with elevated Troponin I (18.6 ± 4.2 IU/L vs. 10.9 ± 3.1 IU/L, p<0.001, mean difference 7.7 IU/L, 95% CI: 6.3–9.1). Further subgroup analysis showed no significant differences in the prevalence of elevated Troponin I by gender (72.5% of males vs. 68.0% of females, p=0.421, OR 1.17, 95% CI: 0.53–2.60), age group (69.3% in 6 months–5 years vs. 72.0% in 6–12 years, p=0.812, OR 0.88, 95% CI: 0.39–1.97), or residency (68.0% urban vs. 74.0% rural, p=0.391, OR 0.74, 95% CI: 0.34–1.64). The most consistent and significant determinant of elevated Troponin I remained lower socioeconomic status. These results underscore that children with measles and clinical myocarditis frequently demonstrate deranged cardiac enzymes, with specific clinical features and socioeconomic background significantly influencing the likelihood of biochemical evidence of myocardial injury.

Among children with measles-associated myocarditis, those from the lower socioeconomic class exhibited both the highest mean Troponin I level (1.78 ng/mL; 95% CI: 1.43–2.13) and the greatest clinical burden, with 85% experiencing two or more major cardiac symptoms. In contrast, the middle class had a mean Troponin I of 1.52 ng/mL (95% CI: 1.23–1.81) and 72% with multiple symptoms, while the higher class showed substantially lower mean Troponin I (0.96 ng/mL; 95% CI: 0.57–1.35) and only 55% met the clinical symptom threshold. Across all groups, mean Troponin I levels were markedly above the upper limit of normal (0.04 ng/mL), but the socioeconomic gradient in both enzyme elevation and clinical severity was pronounced, emphasizing that lower socioeconomic status confers a substantially higher risk of both biochemical myocardial injury and composite clinical burden in pediatric measles myocarditis.

DISCUSSION

The findings of this study provide clinically relevant insights into the burden of myocarditis in children with measles, revealing a strikingly high prevalence of elevated cardiac enzymes, particularly Troponin I, in this population. The overall frequency of elevated Troponin I (70.7%) observed here is consistent with prior reports in pediatric myocarditis cohorts, reinforcing its role as a sensitive biochemical marker for myocardial injury (19). Notably, this elevated frequency occurred in the context of a predominance of children under 5 years of age (60%), highlighting a vulnerable demographic known to have immature immune responses and an increased susceptibility to severe infectious complications (20). The absence of significant differences in Troponin I elevation by gender, age group, or residency suggests that the risk of measles-associated myocardial injury is broadly distributed in demographic terms, underscoring the need for uniform clinical vigilance across these strata.

The significant association between lower socioeconomic status and elevated Troponin I levels (75% vs. 55% in higher socioeconomic status; OR 2.57, 95% CI: 1.06–6.25) aligns with extensive literature documenting how social determinants of health influence disease severity and outcomes (21). Poor socioeconomic conditions often reflect a confluence of factors including inadequate access to healthcare, delayed presentation, nutritional deficits, and suboptimal vaccination coverage—all of which may contribute synergistically to the pathogenesis and progression of complications such as myocarditis in measles. Similar patterns have been reported globally where children from socioeconomically disadvantaged households experience higher rates of infectious disease-related morbidity and mortality, emphasizing the broader structural inequities that shape health outcomes (22).

Clinical symptomatology in this cohort was dominated by fatigue (75.2%), chest pain (70.4%), shortness of breath (72%), and arrhythmia (65.6%), with each showing statistically significant associations with elevated Troponin I. These symptoms are consistent with the established clinical spectrum of myocarditis in pediatric populations, in which myocardial inflammation impairs cardiac function and generates symptoms reflecting both systolic dysfunction and arrhythmic tendencies (23). Importantly, fever was the only flu-like symptom significantly associated with elevated Troponin I, suggesting that systemic inflammatory activation may amplify myocardial involvement in measles-related disease. Other non-specific symptoms such as headache, body aches, joint pain, and sore throat were highly prevalent but did not exhibit significant biochemical correlation, supporting the view that cardiac-specific symptoms should prompt early consideration of myocarditis when they occur in the clinical course of measles.

A noteworthy finding was that mean Troponin I levels substantially exceeded the upper limit of normal (0.04 ng/mL) across all socioeconomic classes, even in the higher class (mean 0.96 ng/mL; 95% CI: 0.57–1.35). This reinforces the notion that myocarditis is an important complication in measles irrespective of social strata, though its severity appears amplified in economically disadvantaged children. CK and CK-MB levels also demonstrated significant elevations in those with raised Troponin I (mean CK: 178.4 ± 33.5 U/L vs. 122.7 ± 29.6 U/L, p<0.001; mean CK-MB: 18.6 ± 4.2 IU/L vs. 10.9 ± 3.1 IU/L, p<0.001), supporting a biochemical pattern of widespread myocardial injury. However, while these enzymes contribute to diagnostic confidence, Troponin I remains the most specific and reliable indicator for myocardial necrosis and should be prioritized in diagnostic algorithms (24). The lack of direct cardiac imaging in this study is acknowledged as a limitation, as definitive confirmation of myocarditis ideally requires modalities such as echocardiography or cardiac MRI (25). Nonetheless, in resource-constrained settings where such tools are not universally accessible, the combination of consistent clinical findings and highly elevated cardiac biomarkers provides a pragmatic and clinically actionable diagnostic approach. The study's cross-sectional design precludes inference of temporal causality but effectively captures prevalence and correlations, offering valuable epidemiological data to inform clinical practice.

These results also underscore a critical public health imperative: strengthening vaccination coverage remains the most effective intervention to prevent measles and its complications, including myocarditis. Persistent pockets of under-immunization linked to poverty and poor maternal education have been repeatedly documented in Pakistan and other low- and middle-income countries, contributing to

periodic resurgences of measles despite global eradication efforts (26). The observed socioeconomic gradient in this study reinforces the need for targeted outreach and health education programs aimed at high-risk populations.

In conclusion, this study demonstrates that myocarditis is a frequent and clinically significant complication in children hospitalized with measles in Pakistan, with elevated cardiac enzymes—especially Troponin I—serving as reliable indicators of myocardial involvement. Clinical features such as chest pain, fatigue, arrhythmia, and shortness of breath were strong predictors of biochemical evidence of myocarditis. The clear association between socioeconomic disadvantage and both clinical and biochemical markers of disease severity highlights an urgent need for integrated strategies combining improved immunization coverage, early clinical recognition, and socioeconomic interventions to reduce measles-related morbidity and mortality in vulnerable pediatric populations (27).

CONCLUSION

This study concludes that myocarditis is a frequent and serious complication among children with measles, with 70.7% of the cohort exhibiting elevated Troponin I levels, a biomarker strongly indicative of myocardial injury. Clinical features such as chest pain, fatigue, arrhythmia, and shortness of breath were significantly associated with elevated cardiac enzymes, providing valuable early clinical indicators that can guide prompt diagnosis and management in children presenting with measles and suggestive symptoms. The association between lower socioeconomic status and a higher prevalence of both elevated cardiac enzymes and major clinical signs underscores the role of social determinants in disease severity and outcomes.

These findings emphasize the importance of incorporating routine cardiac enzyme evaluation, particularly Troponin I, into the diagnostic workup of children hospitalized with measles who present with cardiac or cardiorespiratory symptoms, especially in resource-limited settings where advanced cardiac imaging may not be available. Additionally, this study highlights an urgent public health need to address socioeconomic inequities and to strengthen measles immunization programs targeting underserved populations. Early identification of at-risk children and timely intervention may help reduce measles-associated morbidity and mortality and improve pediatric cardiovascular health outcomes in similar settings.

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