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THE SOCIOECONOMIC PROFILE OF CARDIAC PATIENTS PRESENTING AT A TERTIARY CARE HOSPITAL IN SOUTH INDIA AND FACTORS ASSOCIATED WITH CATASTROPHIC HEALTH EXPENDITURE

Cardiology

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ABSTRACT

Background: The catastrophic financial burden borne by Indian households after cardiac admission remains under-quantified. We quantified catastrophic health expenditure (CHE) and its predictors at a high-volume tertiary cardiac institute in South India. **Methods:** Hospital-based cross-sectional analytical study of adult cardiology patients at Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bengaluru. Socioeconomic status (SES) was classified with the Modified Kuppuswamy scale (Consumer Price Index for Industrial Workers [CPI-IW] = 148.2). CHE was defined as out-of-pocket cardiac expense exceeding 10% of estimated annual family income. Predictors were identified by univariable and multivariable logistic regression. **Results:** A total of 805 patients were analysed (796 with income data). CHE occurred in 251 patients (31.5%; 95% CI 28.4-34.8%), rising from 6.6% in Upper Middle Class (II) to 53.1% in Lower Middle Class (III) and 70.9% in Upper Lower Class (IV). Low socioeconomic status (Kuppuswamy IV/V; adjusted odds ratio [aOR] 10.19; 95% CI 6.91-15.02) and coronary artery bypass grafting (CABG; aOR 2.09; 95% CI 1.35-3.23) were independently associated with CHE; an income-free SES score (education and occupation) was also associated with CHE (OR 0.85 per point; 95% CI 0.78-0.92). Patients with CHE more often took formal loans (24.3% vs 12.8%; $p < 0.001$). **Conclusions:** Catastrophic health expenditure affects nearly one in three patients following cardiac admission and is associated principally with socioeconomic position rather than clinical complexity.

KEYWORDS

Catastrophic Health Expenditure, Out-Of-Pocket Expenditure, Socioeconomic Status, Kuppuswamy Scale

INTRODUCTION

Cardiovascular disease is the leading cause of mortality in India, accounting for approximately 28% of all deaths (India State-Level Disease Burden Initiative CVD Collaborators, 2018). While the clinical burden is well-documented, the catastrophic financial burden borne by Indian households remains under-quantified. In 2022-23, out-of-pocket payments at the point of care still financed 43.4% of India's total health expenditure (National Health Systems Resource Centre, 2026).

Inpatient cardiac care - encompassing acute coronary syndrome management, percutaneous transluminal coronary angioplasty (PTCA), coronary artery bypass grafting (CABG), and valve replacement surgery - accounts for a large share of the cardiovascular financial burden borne by households (Gupta et al., 2022; Kastor & Mohanty, 2018). The average annual out-of-pocket expenditure for heart failure patients in India exceeds ₹1 lakh, constituting approximately 93% of total healthcare spending, with nearly 38% of households experiencing catastrophic health expenditure (CHE; defined in that study as ≥ 40% of capacity to pay) (Jeemon et al., 2026).

Catastrophic Health Expenditure, as defined by the World Health Organization, refers to out-of-pocket payments exceeding 10% of household income or consumption - a threshold beyond which a household must forgo essential consumption, sell assets, take on debt, or otherwise compromise future welfare to meet immediate healthcare costs (World Health Organization & World Bank, 2017).

Previous Indian studies, in national and cardiac samples, have largely examined demographic or clinical predictors of CHE in isolation, with limited integration of contemporary socioeconomic status (SES) measurement (Daivadanam et al., 2012; Mohanan et al., 2019; Nanda & Sharma, 2023).

This study quantifies the socioeconomic burden of cardiac admission at a high-volume tertiary cardiac institute in South India, using the updated Modified Kuppuswamy scale (Consumer Price Index for Industrial Workers [CPI-IW] = 148.2; November 2025) to identify the independent predictors of catastrophic health expenditure, and characterises the spectrum of self-reported financial-coping mechanisms used by affected households.

MATERIALS AND METHODS

Study Design

This was a hospital-based, cross-sectional, analytical study conducted in the Department of Cardiology (wards and outpatient department) of Sri Jayadeva Institute of Cardiovascular Sciences and Research (SJICSR), Bengaluru, Karnataka, India. Data were collected from July to December 2025. The study received institutional ethics approval from SJICSR, and informed consent was obtained from every participant before enrolment.

Study Population

Inclusion Criteria: Adult patients (≥18 years) attending the cardiology wards or outpatient department during the study period, with a cardiology admission and a primary cardiovascular diagnosis documented in their hospital file, who gave informed consent.

Exclusion Criteria: Patients who did not give consent. Patients without income data (n = 9) were retained for descriptive analyses but excluded from analyses of CHE.

Sample Size

Sampling was voluntary: every eligible patient who gave informed consent during the study period was enrolled, giving a total of 805 patients. Assuming a CHE prevalence of 30%, between the national household estimate of 16.5% (Sriram & Albadrani, 2022) and the 38% reported among Indian patients with heart failure (Jeemon et al., 2026), a 95% confidence level and a 4% margin of error, the minimum required sample size was 504. After exclusion of patients without income data, the analytic sample of 796 exceeded this requirement (achieved margin of error ±3.2%).

Data Collection and Statistical Analysis

Patient data were collected via structured questionnaire-based interviews and admission/discharge record review. For patients recruited in the outpatient department, clinical details refer to the cardiology admission recorded in their hospital file; index admissions were dated June 2021 to December 2025, and 800 (99.4%) were in 2025. Left ventricular ejection fraction (LVEF) was taken from the echocardiography report in the file. The structured tool captured:

Demographics: age, sex, location, caste category, and occupation and education of the head of household.

Clinical: morbidity profile (diabetes mellitus [DM], hypertension

[HTN], dyslipidaemia, obesity, overweight, smoking history, chronic kidney disease [CKD], chronic obstructive pulmonary disease [COPD]), primary cardiac diagnosis, ejection fraction (EF), body-mass-index (BMI) category, angiographic findings, procedures performed (medical management, PTCA, CABG, implantable cardioverter-defibrillator [ICD] implant, valve replacement), and duration of stay.

Financial: number of household members, per-capita family income, and total out-of-pocket cardiac expense. Self-reported financial coping (catastrophic expenditure, borrowing from relatives, taking a loan, reduced earning capacity, reduced spending on essentials, withdrawal of children from school) was captured on a multi-select observation grid.

Descriptive and Univariable Analysis: Continuous variables are presented as mean ± SD or median (IQR); categorical variables as absolute frequencies and proportions. The prevalence of CHE is reported with a 95% confidence interval calculated by the Wilson score method. Univariable associations between predictors and CHE were assessed by Pearson Chi-square test (without continuity correction), Fisher exact test (when any expected cell count was below 5), Mann-Whitney U test or Kruskal-Wallis test, as appropriate. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were obtained from univariable binary logistic regression. Correlations were assessed with Spearman's rank correlation coefficient.

Multivariable Logistic Regression: Variables with $p < 0.20$ in univariable logistic regression were entered into a multivariable binary logistic regression with CHE as the dependent variable. The education, occupation and income sub-scores and the composite Kuppuswamy score were not entered alongside the low-SES indicator because they define it; household size was not entered because family income was derived from it; and 'medical management only' was not entered because it is the complement of the procedure indicators; continuous ejection fraction was represented by the reduced-EF indicator. Because the Kuppuswamy class includes household income, which is also the denominator of CHE, a sensitivity model replaced the low-SES indicator with an income-free SES score (education plus occupation scores). Further sensitivity analyses repeated the model with CHE defined at ≥ 10% and > 25% of annual income, with absolute expense added, with the variables just above the screening threshold added, and restricted to admissions dated 2025. Overall model significance was assessed with the likelihood-ratio test, discrimination with the C-statistic, calibration with the Hosmer-Lemeshow test and collinearity with variance inflation factors. Results are reported as adjusted odds ratios (aORs) with 95% confidence intervals; $p < 0.05$ was considered statistically significant. Analyses were performed in Python 3 using pandas, SciPy (version 1.17) and statsmodels (version 0.15).

Operational Definitions

- **Catastrophic Health Expenditure (CHE):** Out-of-pocket cardiac expense exceeding 10% of estimated annual family income, per WHO threshold (World Health Organization & World Bank, 2017).
- **Acute Coronary Syndrome (ACS):** Documented coronary artery disease, ischaemic heart disease, ST-elevation myocardial infarction (STEMI; anterior or inferior wall) or non-ST-elevation myocardial infarction (NSTEMI), unstable angina, OR angiographic evidence of single-, double-, or triple-vessel disease, OR PTCA/CABG performed.
- **Valvular Heart Disease (VHD):** Documented aortic regurgitation, mitral regurgitation, mitral valve prolapse, aortic stenosis, rheumatic heart disease, OR patient underwent valve replacement.
- **Heart Failure (HF):** Documented left ventricular failure (LVF) or acute decompensated heart failure (ADHF) on admission.
- **Reduced Ejection Fraction:** LVEF < 40% (Ponikowski et al., 2016).
- **Obesity and Overweight:** Body-mass index ≥ 30 kg/m² and 25-29.9 kg/m², respectively (World Health Organization, 2000).
- **Family Income:** Estimated as the average per-capita income band value multiplied by the number of household members; annualised by multiplying monthly income by 12. Band values were ₹2,500, ₹7,500, ₹12,500 and ₹17,500 per person, and ₹25,000 for the open-ended top band.

Socioeconomic Classification

Socioeconomic status was classified using the Modified Kuppuswamy Scale incorporating the education score (1-7) and occupation score (1-10) of the head of household and the monthly family income score (1-12), updated using the real-time CPI-IW-based revision (CPI-IW = 148.2; base 2016 = 100; November 2025) (Sharma & Varshney, 2025). The updated monthly-income thresholds were: score 12 ≥ ₹65,827; score 10 ₹32,914-65,826; score 6 ₹24,685-32,913; score 4 ₹16,457-24,684; score 3 ₹9,874-16,456; score 2 ₹3,324-9,873; score 1 ≤ ₹3,323. Composite scores classified patients as: Upper Class (I) = 26-29; Upper Middle Class (II) = 16-25; Lower Middle Class (III) = 11-15; Upper Lower Class (IV) = 5-10; Lower Class (V) < 5. For multivariable modelling, classes IV and V were combined as the binary low-SES indicator.

RESULTS

Sociodemographic Profile (n = 805)

Age Distribution

Mean age was 52.9 ± 16.3 years (range 25-86 years; Table 1). The cohort was distributed across all working and post-working age groups: under 40 years 204 (25.3%), 40-49 years 149 (18.5%), 50-59 years 146 (18.1%), and ≥60 years 306 (38.0%). More than one-third of patients were of post-working age, a group for whom income shocks are difficult to absorb.

Sex Distribution

The cohort comprised 400 males (49.7%) and 405 females (50.3%) - a near-equal sex distribution. Chi-square analysis revealed no statistically significant sex difference in CHE incidence ($p = 0.703$).

Education Level

Heads of household had a predominantly lower educational profile: 403 (50.1%) had below-Class-10 schooling, 137 (17.0%) had completed Class 10, 171 (21.2%) Class 12, 44 (5.5%) were graduates, 3 (0.4%) were postgraduates, and 47 (5.8%) were illiterate. In more than half of households (55.9%), the head had less than high-school education, reflecting the predominantly working- and lower-middle-class composition.

Occupation

The occupations of heads of household were diverse. By Kuppuswamy occupation score, the largest group was skilled workers (score 4; auto and other drivers, tailors, masons, mechanics; 288 households, 35.8%), followed by arithmetic-skill occupations (score 5; shopkeepers, farmers, clerks; 156, 19.4%), unemployed or dependent persons (score 1; students, retirees, homemakers; 119, 14.8%), semi-skilled workers (score 3; factory workers, cooks, cleaners; 107, 13.3%), unskilled workers (score 2; daily wagers, labourers; 78, 9.7%), and semi-professionals (score 6; teachers, nurses; 57, 7.1%). This occupational spread mirrors the predominantly blue-collar catchment of the institute.

Family Income

The mean estimated monthly family income was ₹45,019 (SD ± ₹33,593; median ₹37,500; IQR ₹15,000-₹62,500; n = 796).

Kuppuswamy Socioeconomic Class

When combining education, occupation and income scores using the CPI-IW = 148.2 (November 2025) revision, the largest segment fell into the Upper Middle Class (II) (438 of 796 patients; 55.0%), followed by Upper Lower Class (IV) (179; 22.5%) and Lower Middle Class (III) (179; 22.5%). No patient belonged to Upper Class (I) or Lower Class (V).

The composite Kuppuswamy score had a mean of 15.0 ± 4.4, placing the cohort at the boundary between Lower Middle (III) and Upper Middle (II) classes. Importantly, more than one in five patients (22.5%) fell into the Upper Lower Class, the stratum at greatest risk of catastrophic expenditure.

Table 1 ***Sociodemographic Profile of Study Participants (n = 805)***

Characteristic	N	(%)
TOTAL PATIENTS	805	100.0%
AGE (years)		
Mean ± SD	52.9 ± 16.3	-
< 40 years	204	25.3%
40-49 years	149	18.5%
50-59 years	146	18.1%
≥ 60 years	306	38.0%
SEX		
Male	400	49.7%
Female	405	50.3%

EDUCATION OF HEAD OF HOUSEHOLD		
Illiterate	47	5.8%
< Class 10	403	50.1%
Class 10	137	17.0%
Class 12	171	21.2%
Graduate	44	5.5%
Postgraduate	3	0.4%
MONTHLY FAMILY INCOME ( ) (n = 796)		
Mean ± SD	45,019 ± 33,593	-
Median (IQR)	37,500 (15,000-62,500)	-
KUPPUSWAMY CLASS (CPI-IW = 148.2) (n = 796)		
Class II Upper Middle (16-25)	438	55.0%
Class III Lower Middle (11-15)	179	22.5%
Class IV Upper Lower (5-10)	179	22.5%
Composite score: mean 15.0 ± 4.4 | median 16	-	-

Clinical Profile

Comorbidities

The most prevalent comorbidity (Table 2) was obesity (body-mass index ≥ 30 kg/m²; 353 patients; 43.9%), followed by diabetes mellitus (307; 38.1%), hypertension (231; 28.7%), smoking history (199; 24.7%), dyslipidaemia (134; 16.6%), chronic kidney disease (109; 13.5%), and chronic obstructive pulmonary disease (108; 13.4%). The high prevalence of metabolic risk factors clustering with smoking is consistent with the South Asian cardiometabolic phenotype (Anjana et al., 2023; Gupta et al., 2016).

Disease Categories

Acute coronary syndrome (ACS) - encompassing documented coronary artery disease, myocardial infarction subtypes, unstable angina, angiographic vessel disease, or coronary intervention - was present in 795 of 805 patients (98.8%), reflecting the predominantly ischaemic case-mix of this cardiology service. Heart failure (LVF/ADHF) was documented in 251 patients (31.2%), and valvular heart disease in 40 patients (5.0%).

Only 10 patients (1.2%) had no documented coronary involvement, predominantly isolated heart failure or valvular heart disease; this group was too small for a meaningful comparison of CHE risk by disease category (CHE in 2 of 10).

Procedures Performed

Of 805 patients, 771 (95.8%) underwent coronary angiography during admission; 288 (35.8%) underwent PTCA and 132 (16.4%) CABG. Implantable cardioverter-defibrillator (ICD) was implanted in 37 patients (4.6%), and valve replacement was performed in 7 (0.9%). Of the 797 patients whose procedure was recorded, 325 (40.8%) were managed exclusively with medical therapy without any coronary or valvular intervention.

Left Ventricular Ejection Fraction

Mean LVEF was 37.8 ± 3.9% (median 40%, IQR 35-40%; n = 793). By category: severely reduced (< 30%) 0 patients (0%); reduced (30-39%) 360 (45.4%); mildly reduced (40-49%) 432 (54.5%); and preserved (≥ 50%) 1 (0.1%). Reduced EF (< 40%) was therefore present in 360 patients (45.4%), a high-risk subgroup in which financial constraints on follow-up and medication adherence may carry mortality consequences.

Length of Stay

Mean duration of hospital stay was 5.6 ± 2.7 days (median 6 days, IQR 3-8 days, range 1-10 days). Length of stay was modestly longer for CABG patients (mean 6.2 vs 5.4 days for non-CABG; p = 0.005) but was not associated with out-of-pocket expense (Spearman r = 0.05; p = 0.148; see Discussion, Length of Stay and Scheduling).

Table 2 ***Clinical Profile (n = 805)***

Characteristic	N	(%)
COMORBIDITIES		
Obesity (BMI ≥ 30 kg/m²)	353	43.9%
Diabetes Mellitus (DM)	307	38.1%
Hypertension (HTN)	231	28.7%
Smoking History	199	24.7%
Overweight (BMI 25-29.9 kg/m²)	166	20.6%
Dyslipidaemia	134	16.6%
Chronic Kidney Disease (CKD)	109	13.5%
COPD	108	13.4%
DISEASE CATEGORIES		
Acute Coronary Syndrome (ACS)	795	98.8%
Non-ACS (HF / VHD without coronary involvement)	10	1.2%
Heart Failure (LVF / ADHF)	251	31.2%
Valvular Heart Disease	40	5.0%
PROCEDURES		
Coronary Angiography Performed	771	95.8%
PTCA	288	35.8%
CABG	132	16.4%
ICD Implantation	37	4.6%
Valve Replacement	7	0.9%
Medical Management Only (of 797 with procedure recorded)	325	40.8%
LEFT VENTRICULAR EJECTION FRACTION (n = 793)		
Mean ± SD	37.8 ± 3.9 %	-
Reduced (30-39%)	360	45.4%
Mildly Reduced (40-49%)	432	54.5%
Preserved (≥ 50%)	1	0.1%
Reduced EF total (< 40%)	360	45.4%
LENGTH OF STAY		
Mean ± SD (days)	5.6 ± 2.7	-
Median (IQR)	6 (3-8)	-

Out-of-Pocket Expenditure

Total Expenditure

The mean total out-of-pocket cardiac expense was ₹33,683 (SD ± ₹19,254; median ₹33,578; IQR ₹17,678-₹45,927; range ₹1,115-₹87,960). SJICSR is a high-volume government cardiac institute, yet, as the following sections show, even these charges were catastrophic for nearly one in three households, because whether a bill is catastrophic depends on what the household can afford as well as on what the hospital charges.

Expenditure as Proportion of Annual Family Income

When out-of-pocket expense was expressed as a percentage of estimated annual family income, the median burden was 6.6% (IQR 3.9-12.6%), meaning the upper quartile of patients had already crossed the WHO 10% catastrophic threshold from a single admission. The mean expense burden was 10.3% ± 10.3% of annual income, with a maximum of 79.4% - nearly four-fifths of a year's income from one hospitalisation.

Prevalence of Catastrophic Health Expenditure

CHE occurred in 251 of 796 patients (31.5%; 95% CI 28.4-34.8%). Nearly one in three households therefore experienced cardiac-admission expenses exceeding 10% of annual income - by definition a financial catastrophe. At more stringent thresholds, 74 patients (9.3%) exceeded the 25% threshold and 12 patients (1.5%) exceeded the 40% threshold.

Nearly one in three patients (31.5%) crossed the WHO catastrophic threshold from a single cardiac admission.

Catastrophic Expenditure by Socioeconomic Class

The prevalence of CHE rose steeply and monotonically across descending Kuppuswamy classes (Table 3). Upper Middle Class (II) patients experienced only 6.6% CHE (29/438); Lower Middle Class (III) 53.1% (95/179); and Upper Lower Class (IV) 70.9% (127/179). The steep gradient - from 6.6% to 70.9% - is the most striking finding of the study and demonstrates that catastrophic financial risk is overwhelmingly concentrated in the lowest socioeconomic stratum. A formal Chi-square test confirmed the association was highly significant (p < 0.001).

Table 3 ***CHE Prevalence by Socioeconomic Class, Threshold, and Clinical Subgroup (n = 796 with Income Data)***

Subgroup	N	CHE N	CHE (%)
KUPPUSWAMY CLASS			
Class II Upper Middle	438	29	6.6%
Class III Lower Middle	179	95	53.1%

Class IV Upper Lower	179	127	70.9%
TOTAL	796	251	31.5%
CHE AT HIGHER THRESHOLDS			
Expense > 25% annual income	796	74	9.3%
Expense > 40% annual income	796	12	1.5%
BY DISEASE / PROCEDURE			
ACS	786	249	31.7%
Non-ACS	10	2	20.0%
CABG performed	130	53	40.8%
Medical management only	323	86	26.6%

Financial Coping Mechanisms and Their Relationship to CHE

The major coping mechanisms as mentioned by the study participants included borrowing from relatives, taking a formal loan, reducing spending on essentials, and withdrawing children from school (Table 4).

Critically, these objective coping behaviours move in synchrony with the CHE outcome. Patients who crossed the CHE threshold were significantly more likely to deploy at least one coping mechanism than those who did not (84.9% vs 72.5%; $p < 0.001$), used a greater mean number of mechanisms (1.32 vs 1.11 per patient; $p = 0.001$), and were markedly more likely to resort to formal borrowing (24.3% vs 12.8%; $p < 0.001$). This convergence between an objective financial calculation (CHE) and independently-reported coping behaviour provides internal validation that the CHE threshold captures a genuine point of household financial distress.

**Table 4 `*Financial Coping Mechanisms by CHE Status (n = 805; CHE Comparison n = 796)*

Coping Mechanism	Overall n (%)	CHE patients	Non-CHE patients	p-value
Borrowed money from relatives	427 (53.0%)	56.6%	51.0%	0.144
Took out a formal loan	132 (16.4%)	24.3%	12.8%	< 0.001
Reduced spending on essentials	307 (38.1%)	39.4%	37.6%	0.622
Withdrew one or more children from school	83 (10.3%)	12.0%	9.7%	0.339
Used ≥ 1 coping mechanism	617 (76.6%)	84.9%	72.5%	< 0.001
Mean mechanisms per patient	1.18	1.32	1.11	0.001

These coping behaviours were also socioeconomically graded. Formal loan-taking differed significantly across Kuppuswamy classes (11.9% in Class II vs 22.3% in Class III and 21.8% in Class IV; $p < 0.001$), as did reduced spending on essentials ($p = 0.038$). Although patients across all income groups felt the financial strain, the poorer households were almost twice as likely to take on formal debt (22% vs 12%).

When restricted to objective coping actions, coping behaviour rises in step with CHE: patients who experienced catastrophic expenditure borrowed more, took more formal loans, and used more coping mechanisms overall, internally validating the CHE threshold. 10.3% of admissions resulted in a child being withdrawn from school, an inter-generational consequence of a single adult hospitalisation.

Univariable Predictors of Catastrophic Health Expenditure

Univariable binary logistic regression was performed for each candidate predictor against CHE in the analytic sample (n = 796). Statistically significant predictors ($p < 0.05$) and borderline candidates ($p < 0.20$) are summarised in Table 5.

Significant univariable predictors of CHE were dominated by socioeconomic variables: low SES (crude OR 9.71, $p < 0.001$) and the income score (OR 0.64 per point, $p < 0.001$), education score (OR 0.82 per point, $p = 0.003$) and occupation score (OR 0.86 per point, $p = 0.003$), higher scores carrying lower odds. Among clinical and procedural variables, CABG was a significant positive predictor (OR 1.63, $p = 0.014$) and medical management only was significantly protective (OR 0.67, $p = 0.013$). Dyslipidaemia was also associated with CHE (OR 1.48, $p = 0.048$); age ≥ 60 years ($p = 0.168$), length of stay > 5 days ($p = 0.166$) and smoking ($p = 0.182$) were borderline candidates, while NSTEMI ($p = 0.217$) and heart failure ($p = 0.219$) fell just outside the screening threshold. No demographic factor (age, sex, caste), no other comorbidity, and no EF measure was associated with CHE.

Table 5 *Univariable Logistic Regression for CHE (n = 796)*

Predictor	Crude OR	95% CI	p-value
Low SES (Kuppuswamy IV/V)	9.71	6.65-14.17	< 0.001
Income score (1-12, per unit)	0.64	0.60-0.68	< 0.001
Kuppuswamy composite score	0.68	0.64-0.71	< 0.001
Education score (per unit)	0.82	0.72-0.94	0.003
Occupation score (per unit)	0.86	0.78-0.95	0.003
CABG performed	1.63	1.10-2.40	0.014
Medical management only	0.67	0.49-0.92	0.013
ICD implant	1.34	0.68-2.65	0.399
NSTEMI	0.77	0.50-1.17	0.217
STEMI (anterior/inferior wall MI)	1.09	0.79-1.50	0.603
Heart failure	1.22	0.89-1.68	0.219
Obesity (BMI ≥ 30 kg/m²)	0.91	0.67-1.23	0.534
Dyslipidaemia	1.48	1.00-2.17	0.048
Valvular heart disease	1.32	0.68-2.55	0.406
Acute coronary syndrome	1.85	0.39-8.80	0.437
Age ≥ 60 years	1.24	0.91-1.68	0.168
PTCA performed	1.02	0.75-1.39	0.903
Hypertension	0.85	0.61-1.19	0.353
Reduced EF (< 40%)	1.06	0.79-1.44	0.687
Ejection fraction (continuous)	0.98	0.94-1.02	0.268
Scheduled Caste	1.15	0.79-1.66	0.461
Chronic kidney disease	1.25	0.82-1.92	0.305
Male sex	0.94	0.70-1.27	0.703
Diabetes mellitus	0.95	0.69-1.29	0.726
COPD	0.98	0.63-1.52	0.924
Smoking	1.26	0.90-1.77	0.182
Length of stay > 5 days	0.81	0.60-1.09	0.166

Multivariable Logistic Regression

After simultaneous adjustment for all variables with univariable $p < 0.20$ (low SES, CABG, dyslipidaemia, age ≥ 60 years, length of stay > 5 days and smoking), two variables emerged as independent predictors of CHE (Table 6). The fitted model (n = 796) was statistically significant (likelihood-ratio $\chi^2 = 173.6$, df 6, $p < 0.001$), with a C-statistic of 0.743 and adequate calibration (Hosmer-Lemeshow $p = 0.406$).

Table 6 *Multivariable Logistic Regression - Independent Predictors of CHE*

Predictor	Adjusted OR	95% CI	p-value	Significant?
Low SES (Kuppuswamy IV/V)	10.19	6.91-15.02	< 0.001	Yes
CABG performed	2.09	1.35-3.23	< 0.001	Yes
Dyslipidaemia	1.21	0.77-1.90	0.405	No
Age ≥ 60 years	1.25	0.88-1.77	0.217	No
Length of stay > 5 days	0.76	0.54-1.07	0.122	No
Smoking	1.26	0.85-1.85	0.246	No

The adjusted odds ratio for low SES (10.19) was virtually identical to the crude estimate (9.71), indicating that the SES-CHE association was not explained by the measured clinical, comorbid, or procedural variables. Importantly, CABG retained and indeed strengthened its independent association after adjustment (aOR 2.09; $p < 0.001$), identifying the single procedure that compounds socioeconomic risk. Apart from low SES and CABG, no variable remained associated with CHE after adjustment; the other comorbidities, disease categories, procedures and demographic factors did not pass univariable screening ($p \geq 0.20$). In a sensitivity model that replaced the low-SES indicator with an income-free SES score (education plus occupation scores), each additional point was associated with 15% lower odds of CHE (OR 0.85; 95% CI 0.78-0.92; $p < 0.001$), and CABG remained associated with CHE (aOR 1.68; 95% CI 1.13-2.50), as did dyslipidaemia (aOR 1.56; 95% CI 1.05-2.32). Sensitivity analyses gave consistent results for low SES: aOR 12.13 (95% CI 8.13-18.10) with CHE defined at ≥ 10%, 9.00 (5.32-15.23) at > 25%, 10.13 (6.87-14.94) with NSTEMI and heart failure added, and 9.94 (6.74-14.66) when restricted to admissions dated 2025 (n = 791). The CABG association was similar at ≥ 10% (aOR 2.05; 95% CI 1.32-3.17), with NSTEMI and heart failure added (2.09; 1.35-3.23) and for 2025 admissions (2.07; 1.34-3.21), but was not statistically significant at > 25% (1.75; 0.92-3.32).

Two independent predictors of catastrophe emerged: low socio-economic status (≈10-fold higher odds) and CABG (≈2-fold higher

odds). The socioeconomic association was not explained by clinical complexity.

DISCUSSION

Catastrophic health expenditure from a single cardiac admission affects nearly one in three patients at SJICSR and is associated principally with socioeconomic position rather than clinical complexity. With the sole exception of CABG, interventions should therefore focus on financial protection rather than on the clinical profile.

Sociodemographic Profile

Age. Mean age 52.9 ± 16.3 years; 38.0% aged ≥ 60. Consistent with the earlier-onset South Asian cardiovascular disease phenotype compared with Western populations, as documented by Gupta et al. (2016) and Prabhakaran et al. (2016).

Sex. Near-equal distribution (49.7% male, 50.3% female) with no significant gender difference in CHE risk ($p = 0.703$), suggesting the financial burden did not differ by sex.

Education. In 55.9% of households, the head had less than high-school education. The education sub-score was a strong univariable predictor of CHE (OR 0.82 per unit; $p = 0.003$), but because education forms part of the composite SES indicator it was not modelled separately; in the income-free sensitivity model, education and occupation together remained associated with CHE.

Clinical Profile

Comorbidities. Obesity (43.9%), DM (38.1%), HTN (28.7%), smoking (24.7%), dyslipidaemia (16.6%), CKD (13.5%) and COPD (13.4%) demonstrate the typical South Asian cardiometabolic clustering (Anjana et al., 2023; Gupta et al., 2016). Yet no individual comorbidity independently predicted CHE in the primary adjusted analysis. The financial catastrophe attached to cardiac admission does not discriminate by comorbidity profile.

Ejection Fraction. 45.4% of the cohort had reduced EF (< 40%) - the highest-risk subgroup: in India's National Heart Failure Registry, 14.2% of patients died within 90 days, and those with reduced EF not receiving guideline-directed therapy had higher mortality (Harikrishnan et al., 2022). Notably, EF itself showed no correlation with expense burden (Spearman $r = -0.016$; $p = 0.661$), underscoring that clinical severity and financial catastrophe are decoupled.

Disease Distribution. ACS, as operationally defined (including angiographic vessel disease), dominated the case-mix (98.8%). Only 10 patients (1.2%) had no documented coronary involvement, too few to compare CHE risk by disease category.

The Magnitude of Catastrophic Expenditure

CHE prevalence in our cohort (31.5%) was lower than in several prior Indian studies, although definitions differ. In the nationally representative National Sample Survey 2017-18, Nanda and Sharma (2023) reported CHE in 48% of households seeking outpatient care and 43% of those seeking hospital care, and a multicentre Indian heart-failure survey found catastrophic spending in 38% of households (Jeemon et al., 2026); both used a threshold of 40% of household capacity to pay. An even higher prevalence was reported from Kerala, where CHE affected 84% of 210 ACS patients from six hospitals in Thiruvananthapuram district (Daivadanam et al., 2012). That figure is not directly comparable with ours: the Kerala study used the capacity-to-pay threshold, and its out-of-pocket measure included follow-up medicines, investigations and non-medical costs rather than hospital charges alone. Our lower prevalence may also reflect a different socioeconomic case-mix and inter-state variation in patient-care subsidies.

The median expense burden of 6.6% of annual family income (IQR 3.9-12.6%) indicates that the upper quartile of patients crossed the catastrophic threshold from a single admission, and that a small but non-trivial minority faced expenses approaching 80% of annual family income.

Objective financial coping reveals consequences invisible to the hospital bill: 53.0% borrowed from relatives, 38.1% cut spending on essentials, 16.4% took formal loans, and 10.3% withdrew children from school. The last is particularly alarming: it represents inter-generational transmission of the financial consequence of a single adult cardiac admission (Daivadanam et al., 2012).

Socioeconomic Status as the Dominant Factor

Patients in Kuppuswamy classes IV/V faced approximately 10-fold higher odds of CHE (aOR 10.19; 95% CI 6.91-15.02; $p < 0.001$) than higher-class patients. The adjusted estimate was virtually identical to the crude (OR 9.71), indicating that the association was not explained by the measured clinical variables. Because the Kuppuswamy class includes household income, which is also the denominator of CHE, part of this association is built into the measures; with an income-free SES score (education and occupation), the association persisted but was smaller (OR 0.85 per point; 95% CI 0.78-0.92).

Expense burden (expense as a percentage of income) was strongly inversely correlated with monthly income, as expected since income is its denominator (Spearman $r = -0.672$; $p < 0.001$) and with the Kuppuswamy composite score ($r = -0.592$; $p < 0.001$), but showed no correlation with ejection fraction ($r = -0.016$; $p = 0.661$). Absolute expense did not rise with deprivation: Class IV households paid a lower median bill than Class II households (₹26,491 vs ₹35,592), whereas median monthly family income fell four-fold (₹52,500 to ₹12,500); it was the denominator that varied dramatically. The median admission cost a Class II household 4.7% of annual income but a Class IV household 16.7% (upper quartile 27.0%). Catastrophe tracks the denominator (income) more closely than the numerator (cost), consistent with national data in which CHE was concentrated among the poorest households (Sriram & Albadrani, 2022).

Our findings are consistent with the Kerala study (Daivadanam et al., 2012), in which low socioeconomic status (OR 14.5, with a wide confidence interval) and undergoing an intervention (OR 3.2) were also associated with CHE, and with the Prospective Urban Rural Epidemiology (PURE) study (Khatib et al., 2016), in which cardiovascular medicines were least affordable for households in lower-income countries and unaffordability was associated with lower use of these medicines.

This finding has direct policy implications. Lowering the cost of admission through cost control, bulk purchasing, or generic medicines would ease the burden but cannot eliminate CHE in the poorest households, because their incomes are simply too low. Even full inpatient subsidy or cardiac insurance would fall short, since these cover only the hospital bill while the out-of-hospital costs - follow-up visits, long-term medication, lost wages, and transport - remain just as crippling for this population (Garg et al., 2024; Jeemon et al., 2026; Selvaraj et al., 2018). Ultimately, raising household income, alongside protection that extends beyond the hospital walls, is likely to be needed.

CABG as an Independent Compounding Factor

CABG was the only clinical variable to independently predict CHE (aOR 2.09; 95% CI 1.35-3.23; $p < 0.001$). This finding, which strengthened after multivariable adjustment, is consistent with the distinct cost structure of bypass surgery relative to medical management and to percutaneous intervention, whose cost fell after coronary stent prices were capped in 2017 (Daivadanam et al., 2012; Narayan et al., 2024; Wadhera et al., 2017). In this cohort, CABG patients had a median expense of ₹38,648 (vs ₹31,833 for non-CABG; $p < 0.001$) and a modestly longer length of stay (mean 6.2 vs 5.4 days), reflecting higher ancillary costs of post-operative care, intensive monitoring, and complex pharmacotherapy even within a standardised pricing structure. The CHE rate among CABG patients was 40.8%, compared with 29.7% in non-CABG patients. When absolute expense was added to the model, the CABG association was no longer significant (aOR 1.53; 95% CI 0.93-2.50), consistent with CABG acting through its higher out-of-pocket cost. CABG patients in low-SES strata therefore represent a clearly identifiable priority subgroup for pre-procedural financial counselling, advance insurance verification, and proactive enrolment in financial-protection schemes before the surgical episode begins (Kamath et al., 2024).

The Protective Signal of Medical Management

Medical management only was significantly protective against CHE on univariable testing (OR 0.67; 95% CI 0.49-0.92; $p = 0.013$). This signal was not explained by a lower bill or a shorter stay: median expense (₹33,876 vs ₹32,450; $p = 0.46$) and mean length of stay (5.5 vs 5.6 days) were similar in patients managed medically and those who underwent intervention. This association must, however, be interpreted with caution: medically managed patients may represent a lower-acuity subgroup, and the protective signal should not be read as a causal treatment effect. The finding is reported descriptively and must never be read as a clinical argument to withhold indicated procedures - the appropriate policy response is to protect patients financially, not to deny them appropriate care.

Coping Behaviour, CHE Synchrony, and Inter-Generational Consequences

The objective coping actions - borrowing, formal loans, reductions in essential spending, and child withdrawal from school - move in synchrony with the CHE outcome and validate it. Patients who experienced CHE were significantly more likely to use at least one coping mechanism (84.9% vs 72.5%; $p < 0.001$), used more mechanisms on average (1.32 vs 1.11; $p = 0.001$), and were more likely to take formal loans (24.3% vs 12.8%; $p < 0.001$). This convergence is important: an objective financial threshold (CHE, computed from expense and income) and an independently-collected behavioural questionnaire point to the same households in distress. These coping strategies carry their own long-term costs - indebtedness, loss of human capital, and erosion of household resilience to future health shocks (Daivadanam et al., 2012; Kastor & Mohanty, 2018). Formal loan-taking and reduced essential spending were significantly graded by socioeconomic class ($p < 0.001$ and $p = 0.038$ respectively), suggesting that lower-SES households more often absorb the financial burden through compromises that may affect the next generation. We deliberately distinguish these active coping behaviours from reduced earning capacity, which is a clinical consequence of illness (the patient being unable to work) rather than a financial coping action, and from the subjective perception of catastrophe, which is conceptually distinct from the objectively-defined CHE outcome.

Length of Stay and Scheduling

Length of stay and admission-scheduling factors merit specific consideration. In this cohort, median length of stay was 6 days (IQR 3-8); stay was modestly longer after CABG (mean 6.2 vs 5.4 days; $p = 0.005$), but length of stay was not associated with out-of-pocket expense (Spearman $r = 0.05$; $p = 0.148$) or with CHE ($p = 0.46$). Within this institution's pricing structure, additional inpatient days therefore did not measurably raise the out-of-pocket bill, and shortening stays is unlikely by itself to prevent catastrophe. Scheduling reforms that minimise non-clinical bed-days (e.g. avoiding Friday admissions for elective work that will incur weekend idle days, and streamlining pre-operative workup) may still reduce indirect costs such as lost wages and caregiver time, which this study did not capture, and merit prospective evaluation.

Clinical Neutrality

Strikingly, with the single exception of CABG, no procedure (PTCA, ICD, valve replacement), comorbidity (DM, HTN, dyslipidaemia, CKD, COPD, smoking, obesity), disease category (heart failure, VHD, ACS itself) or demographic factor (age, sex, caste) was associated with CHE after adjustment for SES; most did not reach even the univariable screening threshold. The clinical complexity of the admission was not, in general, associated with financial catastrophe. This is the central, perhaps counter-intuitive, finding of the study: financial catastrophe in cardiac care is associated principally with who the patient is socioeconomically rather than with what is wrong with their heart - with CABG the one procedure whose distinct cost structure adds an independent layer of risk.

Limitations

Geographic and Institutional Scope: Single-centre design at SJICSR, Bengaluru. Findings may have limited direct generalisability to rural populations, district hospitals, or states with different insurance-coverage profiles.

Expense Capture: Out-of-pocket expense captures hospital charges only; it does not include lost wages during hospitalisation, transport costs, post-discharge medications, or informal payments. The true financial burden is therefore almost certainly higher than the 31.5% CHE prevalence reported.

Cross-sectional Design: Precludes inference about the longer-term consequences of catastrophic expenditure - impoverishment, sustained indebtedness, onward health-care avoidance, or mortality downstream of financial distress.

ACS Prevalence: The predominance of ACS in this cohort (98.8%) and the very small non-ACS group (n = 10) preclude inference about disease-category effects.

Income Estimation: Monthly family income was estimated from per-capita income bands multiplied by household size rather than measured directly. Because CHE depends on this denominator, some misclassification near the 10% threshold is possible.

Shared Income Component: Household income contributes to the Kuppuswamy class and is also the denominator of CHE, so the size of the low-SES association partly reflects this shared component. With an income-free SES score (education and occupation), the association persisted but was considerably smaller.

Body-mass Index: Obesity was taken from the recorded body-mass-index category (BMI ≥ 30 kg/m^2; 43.9%) because the obesity entry in the comorbidity field did not agree with it; obesity was not associated with CHE (crude OR 0.91; $p = 0.53$).

CONCLUSION

Catastrophic health expenditure affects nearly one in three patients following cardiac admission at this tertiary care institute in South India. The principal findings of this study are:

Socioeconomic Position is the Dominant Correlate. Patients in the lower Kuppuswamy classes (IV/V) had approximately ten-fold higher odds of catastrophe (aOR 10.19; $p < 0.001$), largely unchanged after adjustment for clinical factors; part of this reflects income, which enters both the class and the CHE definition.

A Steep Socioeconomic Gradient Exists. CHE prevalence rose from 6.6% in Upper Middle Class (II) to 53.1% in Lower Middle Class (III) to 70.9% in Upper Lower Class (IV).

CABG is Independently Associated with CHE. CABG was the only clinical variable to independently predict CHE (aOR 2.09; $p < 0.001$), reflecting its higher out-of-pocket cost - identifying a specific priority subgroup for pre-procedural financial protection.

Catastrophe is Principally Income-related. Class IV households paid lower bills than Class II households yet had the highest CHE, and expense burden was unrelated to ejection fraction ($r = -0.016$), suggesting that household income, more than the absolute cost, shapes catastrophe.

Coping Behaviour Validates the CHE Measure and is Inter-generational. Objective coping actions - borrowing, formal loans, reduced essential spending, and child withdrawal from school (10.3%) - rose in step with CHE (patients with CHE used more coping mechanisms; formal loans 24.3% vs 12.8%, $p < 0.001$), confirming the financial impact cascades well beyond the hospital bill into long-term household welfare and the next generation.

Strengthening the reach and depth of cardiac insurance - and explicitly addressing the indirect costs of admission, and the CABG-specific cost burden - should be a public-health priority. The clinical treatment of cardiac disease in India is increasingly sophisticated; the financial protection of its sufferers must now catch up.

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