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# Association of health insurance status with coronary risk factors, coronary artery disease, interventions and outcomes in India

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ABSTRACT

*Objective:* Coronary artery disease (CAD) related hospitalization and interventions are associated with catastrophic out-of-pocket health expenditure in India. To evaluate differences in risk factors, disease severity, management and outcomes in uninsured vs insured CAD patients we performed a study.

*Methods:* Successive CAD patients who underwent percutaneous intervention (PCI) at our centre were enrolled from January 2018 to June 2021. Clinical, angiographic and intervention data were periodically uploaded in the American College of Cardiology CathPCI platform. Descriptive statistics are reported.

*Results:* 4672 CAD patients (men 3736, women 936) were included; uninsured were 2166 (46%), government insurance was in 1635 (36%) and private insurance in 871 (18%). Mean age was 60.1 ± 11 years, uninsured <50y were 21.6% vs 14.0% and 20.3% with government and private insurance. Among the uninsured prevalence of raised total and non-HDL cholesterol, any tobacco use, ST-elevation myocardial infarction (STEMI) and ejection fraction <30% were more ($p < 0.01$). In the STEMI group ($n = 1985$), rates of primary PCI were the highest in those with private insurance (38.7%) compared to others. Multivessel stenting (≥2 stents) was more among the insured patients. Median length of hospital stay was similar in the three groups. In-hospital mortality was slightly more in the uninsured (1.43%), compared to government (0.88) and privately insured (0.82) ($p = 0.242$). The cost of hospitalization and procedures was the highest among uninsured (US$ 2240, IQR 1877–2783) compared to government (US$ 1977, IQR 1653–2437) and privately insured (US$ 2013, IQR 1668–2633) ($p < 0.001$).

*Conclusions:* Uninsured CAD patients in India are younger with more risk factors, acute coronary syndrome, STEMI, multivessel disease and coronary stenting compared to those with government or private insurance. The uninsured bear significantly greater direct costs with slightly greater mortality.

## 1. Introduction

Coronary artery disease (CAD) is endemic in most middle and lower-middle countries including India [1,2]. It imposes significant economic burden on patients and families not only in India [3–12], but also in other low- and lower-middle income countries [13–17]. In recent years, number of strategies have been deployed for financial protection in India and include government funded insurance schemes focused on the poor (*Ayushman Bharat* and other health insurance schemes for the poor), state-specific government funded insurance schemes, government-employee focused schemes (central government health scheme, employees state insurance, ex-servicemen health schemes, etc.) and reimbursements from private insurers [18,19]. A recent government of India policy document identifies health insurance as important

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intervention to provide financial protection to reduce out-of-pocket (OOP) expenditure [20]. It has been reported that existing health insurance schemes can potentially cover 70% of the population and include government subsidized schemes, social health insurance schemes and private voluntary health insurance (Fig. 1). An important innovation, that is being implemented, is provision of universal health insurance (51% of population) through central government led schemes (36%) and state-specific schemes (15%). On the other hand, studies have reported that despite such insurance schemes most CAD patients pay OOP in India. This leads to catastrophic health expenditures and financial bankruptcy [6,7,10,12]. It has been estimated that more than 10 million families are impoverished in India annually due to catastrophic health expenditure [21]. These numbers have increased significantly during the Covid-19 epidemic [22].

A number of healthcare related financial protection schemes exist in most high- and upper-middle income countries such as government sponsored universal health care systems (National Health Service, UK), government funded universal health insurance schemes (Western European countries, Central and South American countries), private insurer-based healthcare (USA) and hybrid models (Canada, Brazil, Southern Europe) [23]. Studies from some of these countries have reported that the uninsured CAD patients have greater prevalence of unhealthy lifestyles and risk factors and have more severe disease at presentation to hospital as compared to the better insured [24,25]. In-hospital as well as long-term adverse clinical outcomes are also more in these patients [26–28]. These trends have continued in recent decades despite availability of multiple financial protection schemes for health care in these countries [29]. In lower-middle and low-income countries, the government funded insurance schemes are either non-existent or just evolving and OOP is the norm for CAD treatments [18]. This includes medical management of acute coronary event, percutaneous interventions (PCI), coronary bypass surgery and long term primary and secondary prevention treatment. CAD risk factor profile, disease severity and outcomes following coronary interventions in insured vs uninsured patients in these countries have not been well studied. Some studies In India have reported that more than two-thirds of CAD patients have to bear OOP for CAD management [6,7,10]. Risk factor profile among the insured and uninsured patients is not known and no study has focused on differences in short- or long-term outcomes following PCI or direct financial costs in these patients. We enrolled successive patients undergoing PCI at our centre to determine influence of insurance status on CAD risk factors, type and severity of CAD, differences in interventional management, medical treatments, costs and in-hospital outcomes.

## 2. Methods

The Cath-PCI Registry at our hospital is part of the American College of Cardiology (ACC) National Cardiovascular Disease Registry (NCDR) Centre of Excellence program [30]. The registry has been approved by the institutional ethics committee (Government of India, CDSCO Registration No. ECR/615/Inst/RJ/2014/RR-20). Informed consent was obtained from each patient included in the registry with specific consent for inclusion of anonymized data. Successive patients undergoing PCI were enrolled over a 3½ -year period from January 2018 to June 2021. This institution is a tertiary care cardiovascular care centre providing state-of-the-art cardiovascular care (acute coronary syndrome management, urgent and non-urgent PCI, coronary bypass surgery, surgical and non-surgical valvular heart disease management, heart failure management and cardiac transplants) (www.eternalheart.org). The hospital is accredited with various state and central governments, government institutions and government and private insurers for acute and chronic cardiovascular disease management.

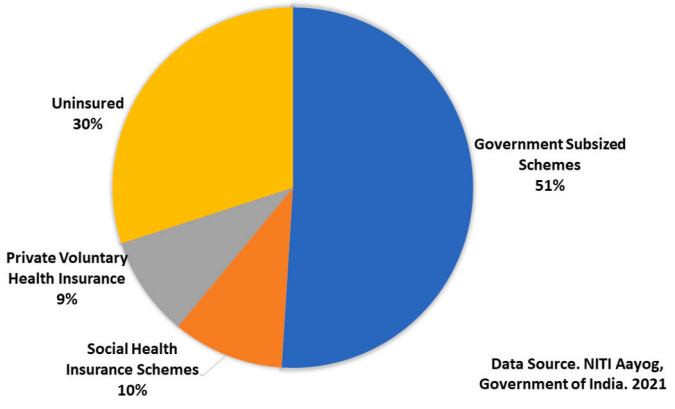


**Fig. 1.** Proportion of Indian population potentially financially protected by various health insurance schemes (Data source: Reference 20).

**Patients:** Successive patients who underwent PCI at the hospital were enrolled. Clinical data were prospectively obtained and entered into the NCDR database by a dedicated team. We obtained details regarding demographic and socioeconomic variables, insurance status (self paying, privately insured or central and state government insured), risk factors-hypertension, diabetes, hypercholesterolemia (total cholesterol ≥200 mg/dl or non-high density lipoprotein (HDL) cholesterol ≥130 mg/dl), smoking or smokeless tobacco use, chronic kidney disease (admission serum creatinine ≥2.0 mg/dl), symptoms and physical findings, laboratory investigations, echocardiography for left ventricular function (ejection fraction) and coronary angiography. Details and timing of the intervention and number of stents deployed were also recorded. More than 99% of the stents deployed at our hospital are drug-eluting and only rarely non-drug eluting stents are used. Details of pre-hospital, in-hospital and post-discharge medications were also recorded. All these data were entered into the NCDR database periodically. In hospital follow-up was recorded. Details of long-term follow-up are not yet available.

We also obtained the billing data for individual patient from the hospital accounts department. The billing monies which in India is equivalent to the received monies in Indian Rupees (INR) were converted to US Dollars (USD) (1 USD = 75 INR). We also obtained data on costs of hospital services including physician fee, and medicines, disposables and stents. Data were obtained for the uninsured, and those with government full insurance, government subsidized insurance and private insurance groups. We also obtained data on co-payments from the insured patients.

**Statistical analyses**: The data were downloaded from the ACC-NCDR website and transferred to MS Excel work-sheets. Data analyses have been performed using SPSS software. Continuous variables are reported as mean ± 1 SD and categorical variables as percent. Inter-group differences have been determined using *t*-test or ANOVA for continuous variables and $\chi^2$ test for categorical variables. Financial calculations have been performed after calculation of cost of the index admission along with costs of procedure, disposables, medicines and stents and patient co-payments. The data are provided as median and 25–75th interquartile intervals (IQR) in US dollars. Inter-group comparisons have been performed using Kruskal-Wallis test. P vales <0.05 are considered significant. To identify extent of inter-group difference for in-hospital mortality we calculated odds ratio (OR) and 95% confidence intervals (CI) by comparing uninsured group with government-insured and privately-insured patients. Unadjusted, age, sex and coronary risk factor adjusted and multivariate (age, sex, risk factors, clinical diagnosis, left ventricular ejection fraction and extent of CAD) adjusted OR's and 95% CI were determined.

## 3. Results

We enrolled 4672 successive CAD patients (men 3736, women 936) who underwent coronary interventions at this hospital from Jan 2018 to June 2021 in the CathPCI Registry of ACC-NCDR [30]. About half of the

patients (2166 (46.4%) had no insurance, private insurance was in 871 (18.6%) and central or state government insurance in 1635 (35.0%). Clinical details in the total cohort and among men and women in Supplementary Table 1. Mean age was 60.1 ± 11 years (men 59.8 ± 11, women 61.5 ± 11 years) and 874 (18.7%) were aged <50 years. Prevalence of hypertension, diabetes, raised non-high density lipoprotein (HDL) cholesterol, any tobacco use and anemia were high. Details of previous cardiovascular status, clinical diagnosis, baseline left ventricular function (ejection fraction, EF) and prehospital medications are also shown in the Supplementary Table 1. Most of the patients presented with unstable or acute coronary syndromes (n = 4446, 95%) and ST-elevation myocardial infarction was in half (n = 1985, 44.6%). Angiographic findings revealed that majority of patients had disease of left anterior descending artery and either single or double vessel disease. Single vessel disease was more in men while triple vessel disease more in women. Number of stents deployed and in-hospital mortality was similar in men and women. Incidence of in-hospital deaths was low (n = 54, 1.0%) and similar in men and women. Median duration of hospital; stay was 4 days (IQR 2–6). At discharge from the hospital almost all patients received aspirin, P2Y12 inhibitors (predominantly ticagrelor) and statins.

The cohort was classified into three groups based on insurance status-uninsured (n = 2166), government insurance (n = 1635) and private insurance (n = 871). Clinical data in the three groups is shown in Table 1 and detailed data for men and women in Supplementary Table 2. The uninsured were significantly younger with more premature CAD (<50 years) (21.6%) than those with government insurance (14.0%) ($p < 0.001$). Among the uninsured there was higher prevalence of raised total and non-HDL cholesterol and tobacco use compared to other groups. Among the uninsured vs government and privately insured patients respectively, ST-elevation myocardial infarction (STEMI) (43.4%, vs 42.1% and 34.6%) and low EF <30% (5.0 vs 4.1% and 3.4%) was also more common. In the STEMI patients (n = 1985), the rates of primary PCI were the highest in those with private insurance (38.7%) compared to the other groups. Rates of pharmaco-invasive therapy were more in government insurance and uninsured patients (Fig. 2). Details regarding coronary anatomy, interventions and outcomes among the uninsured, government and privately insured CAD patients are in Table 1. Emergency angioplasty was performed in similar proportions in the three insurance groups and type of CAD was also identical (Table 1). Multivessel stenting (≥2 stents) was more among the insured patients. We subdivided the patients with government insurance (n = 1635) into government health insurance schemes (n = 1534) and subsidized insurance scheme for the below-poverty line (BPL) patients (n = 101). The patients in the BPL scheme vs general government insurance schemes were significantly younger (57.4 ± 9 vs 62.1 ± 11 years, <50 years 23.8% vs 14.0%), had higher prevalence of any tobacco use (26.7% vs 14.9%), lower prevalence of hypertension (38.6 vs 57.6%) and diabetes (24.8 vs 36.6%), and higher presentation with acute coronary syndrome (97.0 vs 95.9%). The type of interventions and clinical outcomes were similar to other government insurance patients (Supplementary Table 3). Prescription of hospital discharge medications were similar in the three groups. The median length of hospital stay was also identical in the three groups.

In-hospital mortality was slightly greater in the uninsured as compared to the other groups (Fig. 3), however the difference was not statistically significant ($\chi^2 = 2.84$, $p = 0.242$). Fig. 2 also shows unadjusted (black markers), age, sex and risk factor adjusted (grey markers) and multivariate adjusted (off-white markers) OR and 95% CI in the government and privately insured patients compared to the uninsured. Odds ratios and 95% CI in the government vs uninsured patients [unadjusted (0.68, 0.37–1.25), age, sex and risk factor adjusted (0.68, 0.37–1.26) and multivariate adjusted (0.72, 0.38–1.36)], as well as in the privately insured patients [unadjusted (0.57, 0.24–1.27), age, sex and risk factor adjusted (0.56, 0.24–1.28) and multivariate adjusted (0.77, 0.33–1.79)] are not significantly different.

**Table 1**
Risk factors, clinical profile and outcomes in uninsured and insured (government and private) patients.

| | Uninsured (n = 2166) | Government Insurance (n = 1635) | Private insurance (n = 871) | Statistics[#] (p value) |
|---|---|---|---|---|
| Age mean (years) | 59.3 ± 11.2 | 61.8 ± 10.5 | 59.1 ± 10.2 | 31.14 (<0.001)* |
| ≤50y | 468 (21.6) | 229 (14.0) | 177 (20.3) | 25.9 (0.001) |
| 51-64y | 972 (44.9) | 764 (46.7) | 421 (48.3) | 1.21 (0.545) |
| ≥65y | 727 (33.6) | 642 (39.3) | 273 (31.3) | 9.55 (0.008) |
| **Risk factors** | | | | |
| Hypertension | 1137 (52.5) | 922 (56.4) | 521 (59.8) | 14.86 (0.001) |
| Diabetes | 817 (37.7) | 586 (35.8) | 367 (42.1) | 9.61 (0.008) |
| Cholesterol ≥200 mg/dl | 324 (15.0) | 113 (6.9) | 94 (10.8) | 60.2 (<0.001) |
| Non-HDL ≥ 130 mg | 700 (32.3) | 268 (16.4) | 216 (24.8) | 125.1 (<0.001) |
| Creatinine ≥2 mg | 46 (2.1) | 36 (2.2) | 16 (1.8) | 0.38 (0.826) |
| Smoking/ tobacco | 295 (13.6) | 129 (14.0) | 75 (8.6) | 19.5 (<0.001) |
| **Previous cardiovascular status** | | | | |
| Percutaneous coronary intervention | 262 (12.1) | 183 (11.2) | 117 (13.4) | 2.71 (0.258) |
| Coronary bypass surgery | 70 (3.2) | 53 (3.2) | 28 (3.2) | 0.001 (0.999) |
| Congestive heart failure | 12 (0.6) | 17 (1.0) | 10 (1.1) | 3.92 (0.140) |
| **Clinical presentation** | | | | |
| Acute coronary syndromes | 2055 (94.9) | 1569 (96.0) | 816 (93.7) | 0.16 (0.921) |
| STEMI | 953 (43.4) | 660 (42.1) | 282 (34.6) | 15.26 (0.001) |
| Non-STEMI/ UAP | 1102 (53.6) | 909 (57.9) | 534 (65.4) | 8.28 (0.016) |
| Chronic coronary syndrome | 111 (5.1) | 66 (4.0) | 55 (6.3) | 5.84 (0.054) |
| Mean ejection fraction (EF) | 44.7 ± 10.2 | 45.4 ± 10.2 | 47.4 ± 9.7 | 21.80 (<0.001)* |
| EF <30% | 107 (5.0) | 66 (4.1) | 29 (3.4) | 4.04 (0.132) |
| EF 30–45% | 1213 (56.2) | 860 (53.5) | 386 (44.6) | 10.92 (0.004) |
| EF >45% | 838 (38.8) | 681 (42.4) | 450 (52.0) | 16.84 (0.001) |
| **Prehospital medicines** | | | | |
| Aspirin | 699 (32.3) | 464 (28.4) | 295 (33.9) | 10.11 (0.006) |
| Beta-blockers | 563 (26.0) | 811 (49.6) | 324 (37.2) | 224.8 (<0.001) |
| Statins | 694 (32.0) | 969 (59.3) | 409 (47.0) | 282.7 (<0.001) |
| **PCI** | | | | |
| Elective | 1866 (86.1) | 1446 (88.2) | 760 (87.1) | 0.30 (0.861) |
| Emergency | 301 (13.9) | 193 (11.8) | 113 (12.9) | 2.78 (0.248) |
| **Coronary anatomy** | | | | |
| Left main coronary artery | 127 (5.9) | 87 (5.3) | 53 (6.1) | 0.78 (0.677) |
| Right coronary artery | 1099 (50.7) | 756 (46.2) | 423 (48.6) | 7.57 (0.023) |
| Left anterior descending artery | 1731 (79.9) | 1244 (76.1) | 692 (79.4) | 8.68 (0.013) |

(continued on next page)

**Table 1** (*continued*)

| | Uninsured (n = 2166) | Government Insurance (n = 1635) | Private insurance (n = 871) | Statistics[#] (p value) |
|---|---|---|---|---|
| Circumflex artery | 1059 (48.9) | 754 (46.1) | 419 (48.1) | 2.92 (0.252) |
| **CAD extent** | | | | |
| Single-vessel disease | 904 (41.7) | 781 (47.8) | 375 (43.1) | 5.46 (0.065) |
| Double vessel disease | 777 (35.9) | 556 (34.0) | 326 (37.4) | 1.49 (0.474) |
| Triple vessel disease | 477 (22.0) | 287 (17.6) | 169 (19.4) | 7.92 (0.019) |
| **Stents deployed** | | | | |
| 1 | 1386 (64.0) | 1001 (61.2) | 537 (61.7) | 0.79 (0.673) |
| 2 | 575 (26.5) | 454 (27.8) | 239 (27.4) | 0.43 (0.806) |
| ≥3 | 163 (7.5) | 140 (8.6) | 83 (9.5) | 3.03 (0.219) |
| **Discharge medications** | | | | |
| Aspirin | 2129 (98.3) | 1602 (98.0) | 850 (97.6) | 1.67 (0.433) |
| P2Y12 inhibitors | 2126 (98.2) | 1499 (91.7) | 824 (94.6) | 86.7 (<0.001) |
| Beta blockers | 1472 (68.0) | 1189 (72.7) | 611 (70.1) | 10.1 (0.006) |
| ACE inhibitors/ ARBs | 1073 (49.5) | 780 (47.7) | 399 (45.8) | 3.71 (0.157) |
| Statins | 2129 (98.3) | 1607 (98.3) | 850 (97.6) | 1.93 (0.382) |
| Novel oral anticoagulants | 5 (0.2) | 3 (0.2) | 7 (0.8) | 7.86 (0.020) |
| PCSK9 inhibitor | 4 (0.2) | 3 (0.2) | 1 (0.1) | 0.20 (0.905) |
| **In-hospital outcome** | | | | |
| Median (IQR) length of stay, days | 4.0 (3.0–4.0) | 4.0 (3.0–4.0) | 4.0 (3.0–4.0) | 1.96 (0.319)** |
| Deaths (%) | 31 (1.43) | 16 (0.98) | 7 (0.81) | 2.83 (0.243) |

[#]Statistics: $\chi^2$ test for categorical data; *unpaired *t*-test for continuous variables; **Kruskal-Wallis h-test for non-parametric data.

ACE angiotensin converting enzyme; ARB angiotensin receptor blockers; CAD coronary artery disease; HDL high density lipoprotein; IQR interquartile range; PCI percutaneous intervention; STEMI ST-elevation myocardial infarction; UAP unstable angina pectoris.

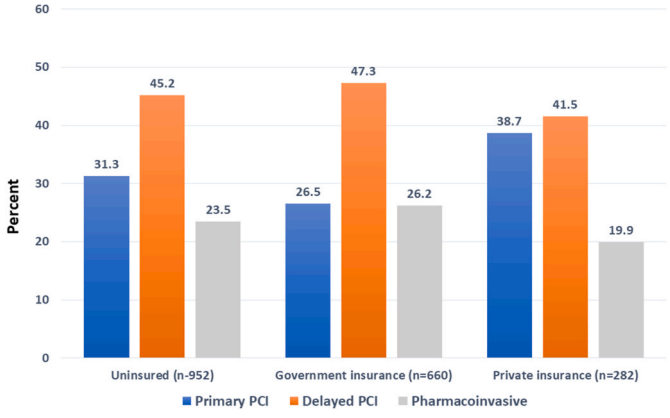


**Fig. 2.** Management of ST-elevation myocardial infarction (STEMI) patients (n = 1985) among the uninsured and in various insurance groups.

Direct costs of hospitalization which included cost of hospital services and procedures (including physician reimbursements) and cost of medicines, disposables and coronary stents in the three groups were calculated using billing information. Median and IQR values in US Dollars (US$) are shown in Table 2. Overall total costs were significantly greater among the uninsured (US$ 2240, IQR 1877–2783) as compared to the government insured (US$ 1977, IQR 1653–2437) and privately insured (US$ 2013, IQR 1668–2633) patients ($p < 0.001$). Costs were low for subsidized government insurance patients (US$ 1040, IQR 785–1495). Compared to the uninsured, the total hospital costs for the government insurance patients were 11.7% lower and private insurance patients 10.1% lower ($p < 0.001$). In uninsured and insured groups, 59–61% of the total bill were spent on medicines, disposables and stents while for patients with subsidized government insurance 83% of the bill was for medicines and disposables ($p < 0.001$) (Table 2).

## 4. Discussion

This study in a cohort of unselected patients undergoing percutaneous coronary intervention (PCI) at a tertiary care centre in India shows that a majority of patients are uninsured and pay the costs of hospitalization and procedure out-of-pocket. Uninsured patients have more premature disease, hypercholesterolemia, tobacco use and higher incidence of STEMI and have lower left ventricular function as compared to those with government or private insurance. Multivessel stenting is less in the uninsured and they have slightly higher incidence of in-hospital mortality compared to the insured patients. The direct costs of hospital treatment are significantly greater among the uninsured compared to the insured groups.

Studies among the uninsured in US and most developed countries have reported greater prevalence of CAD risk factors (smoking, hypertension, diabetes, poor quality diet, low physical activity, low socioeconomic status), delayed presentation to health care systems, more severe disease at presentation, lower rates of coronary interventions and adverse cardiovascular outcomes at short-term as well as long-term follow-up [23,31]. Low socioeconomic status and lack of insurance, apart from structural racism, have been considered important for both short term and long term outcomes among these patients [26,27,32]. Our study shows greater risk factor burden and more severe coronary disease among the uninsured patients, similar to the data from other countries [32,33]. Long term follow-up data on outcomes is not yet available in our study and this is an important study limitation. Lack of health insurance is high in India and OOP is the norm for most of the medical treatments [34,35]. Our study shows that even in a corporate hospital, that caters to middle and upper middle socioeconomic status patients, there is more severe disease along with delayed presentation among the uninsured. Among the privately insured CAD patients there is lower prevalence of cardiovascular risk factors, less severe CAD, more primary PCI in STEMI and trends towards lower in-hospital mortality. This could be due to better educational and socioeconomic status of these patients with more awareness of disease prevention and easier decision-making in favor of early coronary interventions similar to data reported from developed countries [36–38]. Although the quality of discharge medications was similar among the uninsured and insured patients, we cannot comment on adherence and long-term outcomes in absence of follow-up data.

Previous studies in India and some lower-middle income countries, have reported usefulness of universal health care, driven by universal health insurance, for better outcomes in communicable diseases and maternal and childhood conditions [20,21]. Government funded health insurance schemes in Indian states of Tamilnadu, Andhra Pradesh and Maharashtra have reported lower incidence of hospitalizations and lesser OOP among the insured compared to uninsured for acute as well as chronic diseases related hospitalizations [39,40]. Multiple health insurance models are being considered by various state governments in the country [20,41], the major drawback being lack of substantial health-economics data availability. The present study shows lower CAD and risk factors and lower in-hospital deaths among the insured, both government and private, and would act as a catalyst for more

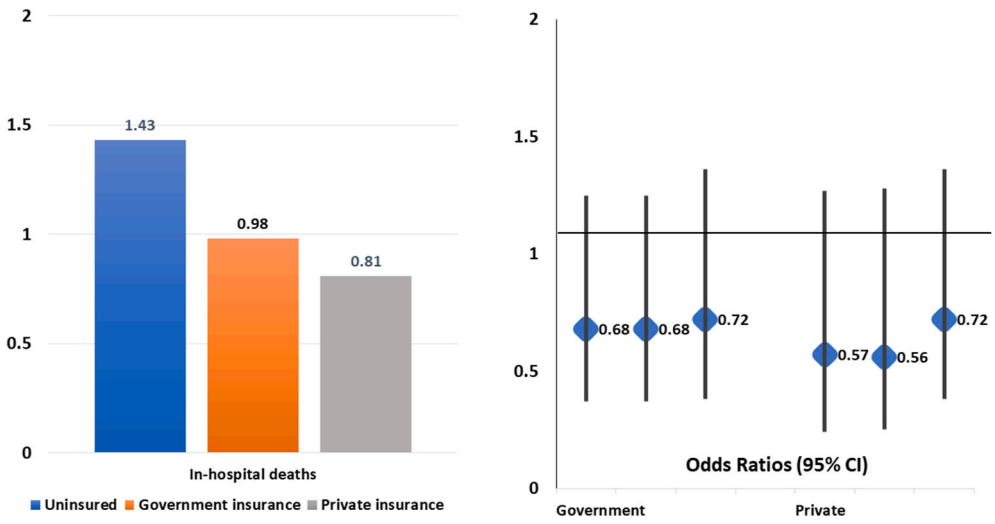


**Fig. 3.** In-hospital deaths (%) in the uninsured and government and privately insured patients. Unadjusted, age-sex-risk factor adjusted and multivariate adjusted odds ratios and 95% confidence intervals in the government and privately insured patients compared to the uninsured are shown.

**Table 2**
Direct cost of hospitalization and other expenses in different insurance groups (US dollars median, IQR)[a].

| | Uninsured (n = 2166) | Government Insurance (n = 1635) | | | Private insurance (n = 871) |
|---|---|---|---|---|---|
| | | Total (n = 1635) | Regular government insurance (n = 1534) | Subsidized government insurance (n = 101) | |
| Total cost of hospitalization | 2240 (1877–2783) | 1977 (1653–2437) | 2001 (1689–2478) | 1040 (785–1495) | 2013 (1668–2633) |
| **Cost components** | | | | | |
| • Hospital services | 900 (707–1068) | 809 (587–1007) | 833 (617–1018) | 160 (9–344) | 838 (573–1028) |
| • Disposables, stents and medicine | 1299 (950–1798) | 1276 (956–1733) | 1308 (993–1779) | 808 (679–959) | 1324 (933–1822) |
| **Total cost index admission and procedures (Indian rupees)** | 167,982 (140,705–208761) | 148,268 (124,000–182,802) | 150,047 (125,167–185,894) | 78,000 (58,850–112,119) | 150,940 (125,103–197,469) |

[a] Prices in US dollars, for conversion to Indian rupees multiply by 75; **Kruskal-Wallis h-test, $p < 0.001$ for inter-group comparisons.

widespread deployment of health insurance schemes in the country. Quality of healthcare provided to the uninsured is also important [42], and the present study shows a very low use of preventive therapies at admission. Better quality healthcare is associated with better cardiovascular health and needs more studies in the context of India and other lower income countries [43]. The study also shows that costs of most of the central-government and private health insurance models, although lower than OOP, but are not substantially different (Table 2). There is a need to more widespread debate on this issue as the US experience shows that lack of insurance is an important social determinant of health [33,38].

The study has multiple limitations. Firstly, the study has been conducted at a corporate hospital and the data may not be applicable to government or not-for-profit hospitals in India. However, in India, a substantial proportion of coronary interventions are performed at hospitals that are identical to ours [31,44], and the data are therefore important. Secondly, this is not a population-based study and the clinical characteristics are restricted to patients belonging to middle socioeconomic status individuals. However, the risk factor profile is similar to population based urban CAD patients in previous studies from India [2], and we believe that data are externally valid. Thirdly, Indian national data have reported that currently about 60–65% pay OOP for their medical treatments and penetration of private insurance in the country is low [5,7,20], both are significantly more than the present study (46% and 10%, respectively). Fourthly, although we have robust data on clinical presentation, angiographic profile and type of interventions, in hospital management and outcomes, lack of short-term and long-term follow-up data is a major study limitation. Continuing follow-up within the NCDR CathPCI Registry framework is being pursued and results shall be reported when all the data are available. On the other hand, this is one of the largest studies from India that have assessed CAD angiographic profile and PCI in the country and the only study that has correlated insurance status with the clinical features and outcomes and this is important. Low in-hospital mortality is an outstanding feature and indicates that extant quality improvement programs at the hospital could be important determinant.

In conclusion, our study shows that uninsured in India have greater prevalence of coronary risk factors and more severe angiographic CAD compared to the insured, they also have slightly greater in-hospital adverse outcomes. The study confirms observations that being uninsured (financially unprotected) is an important social determinant of health, similar to developed and developing countries [32,38,45], and focus on financial protection is important for primary and secondary prevention [46]. Increasing financial protection with universal health coverage [47] and delivery of universal healthcare free-at-point-of-care are important to decrease the disproportionate CAD mortality in India and other low and lower-middle income countries.

## CREDIT statement

Rajeev Gupta: Conceptualization, methodology, validation, investigation, data curation, writing original draft, review and editing, supervision, project administration. Jitender S Makkar: Investigation, methodology, data curation, writing review and editing, project administration. Sanjeev K Sharma: Investigation, methodology, data curation, writing review and editing, project administration. Ansh Agarwal: Methodology, data curation, writing review and editing. Krishna K Sharma: Methodology, data curation, writing review and

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## Declaration of competing interest

The authors report no relationships that could be construed as a conflict of interest.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcrp.2022.200146.

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