



## The Association Between Socioeconomic Standing and Surgical Outcomes of Cardiac Surgical Procedures: A Literature Review

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**Abstract.** Surgery is one of the most common treatments offered in the United States, and some of the most commonly performed procedures are cardiac procedures such as CABGs, valve replacements, and PCI. Even though surgical training and technological advancements have made surgical procedures much safer, when looking at cardiac surgery procedures, there is a greater association between socioeconomic status (SES) and negative post-surgical outcomes. The purpose of the study is to determine whether or not SES affects the postop complication, readmission, and mortality rate in CABG, PCI, and valve replacement surgeries. After a thorough literature search of several databases we concluded that though more data needs to be collected on the specific effects of SES on post-surgical outcomes in PCI and valve repair procedures, it can be said that SES does impact the mortality, readmission, and complication rates of patients post cardiac surgery. We also recommend that future studies on this topic could investigate the effects of proper secondary prevention through medication distribution in patient groups of various socioeconomic statuses.

### To cite this article

[Toriola, O. & Balgobin, B. (2023). The Association Between Socioeconomic Standing and Surgical Outcomes of Cardiac Surgical Procedures: A Literature Review. *The Journal of Middle East and North Africa Sciences*, 9(03), 1-5]. (P-ISSN 2412-9763) - (e-ISSN 2412-8937). [www.jomenas.org](http://www.jomenas.org). 1

**Keywords:** Cardiac Surgery, Valve Replacement, PCI, CABG, Socioeconomic Status, Surgical Complications, Racial Disparities.

### 1. Background & Introduction

Surgery is one of the most common and fastest-growing treatments offered in the United States (US). According to data submitted by the US Agency for Healthcare Research and Quality, there were 13 million total surgical procedures in 1995 and 19.2 million surgeries in 2018, additionally, despite the impact of the COVID-19 virus decreasing the number of surgical procedures; it is still forecast that the total number of surgeries will increase another 3-5% by 2027 (Mattingly, et al., 2021; Trends in Overall Healthcare Market, 2019, Procedure Trays Market Forecast, 2020). Some of the most commonly performed surgical procedures in the United States are cardiac procedures such as coronary artery bypass grafting (CABG), valve replacements, and percutaneous coronary intervention (PCI) primarily because of US obesity rates (iData Research, 2021). According to the World Health Organization, individuals with a BMI >30 are considered obese, and since 2018 obesity rates have increased from 30.5% to 41.9% (WHO). Obesity is associated with various comorbidities, including hypertension, leading to chronic cardiovascular complications like congestive heart failure and coronary artery disease, thus outlining the importance of cardiac surgical procedures (Adult Obesity Facts, 2022; Chan, 2016). Fortunately, since 1995 there has been an increase in surgical training and technological

advancements thus making surgical procedures much safer, however, compared to the total surgical postop complication rate; the burden of complications seems to be more prevalent among those of lower socioeconomic standing (Burke, 2021).

Specifically, when looking at cardiac surgery procedures, there is an apparent association between social determinants of health, such as socioeconomic status (SES), and negative post-operative patient outcomes (Shultz et al., 2018). According to the American Psychological Association, SES can be defined as the social standing of an individual or group within society and is often determined based on several factors such as race, education, median income, and occupation (Socioeconomic Status, n.d.). These determining factors of SES can be used to explain disparities in outcomes because they illustrate the unequal distribution of resources and power within the healthcare system. Unfortunately, these imbalances can lead to postop complications in lower-ranked populations such as atrial fibrillation, prolonged renal failure, bleeding requiring reoperation, stroke, and pneumonia which have all been associated with increased mortality and decreased long-term survival in postop cardiac patients (Agabiti et al., 2008; Ancona et al., 2000; Koch et al., 2010).



The purpose of the study is to determine if SES (race, median household income, high school graduation rate, age) affects the postop complication, readmission, and mortality rate in CABG, PCI, and valve replacement surgeries.

## 2. Methods

This review was formatted in adherence to the 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Prisma, 2009). Initially, an independent literature search in PubMed, PMC/Medline, JAMA, and ScienceDirect was conducted for data collection; to find the most relevant papers, keywords such as "Socioeconomic Status," "Surgical Outcomes," and "Cardiac Surgery," were used to refine the search within these databases. On PubMed specifically, these keywords were applied both separately and in conjunctively to yield the most relevant result.

For this review, there were no preferred languages or study designs so we have included: randomized control trials (RCTs), non-randomized control trials (NRCTs), systematic reviews, observational studies, and case studies so long as they met the rest of the inclusion criteria. That said, we chose to only pursue papers published from January 2015 onwards that focused on the socioeconomic impact of readmission, mortality, and complication rates associated with cardiac surgery procedures. For specificity, all patients had to be >18 years of age at the time of the operation, additionally, papers had to note their patient's median household income of their patients based on their zip code, and each patient's insurance status had to be included. Papers noting race and ethnicity alone were not included. Grey literature and animal studies were also not included in this review. Finally, patients with non-cardiac related comorbidities such as Type 2 Diabetes Mellitus or asthma were also included so long as it was identified that their cardiac indications were their most severe, however, no patients who had undergone previous cardiac procedures at the time of the study were included. The table provided below summarizes the keywords and search strategies used for this review (Table One).

A thorough literature search of all databases with the aforementioned filters resulted in a total of 260 articles after the removal of duplicates. Papers were subsequently screened by title, age of participants, and abstract leaving a total of 45 papers. These remaining papers were screened by reading through the full text and applying the inclusion and exclusion criteria. After the full screening process was complete, a total of 9 articles were to be included in our review.

## 3. Discussion

### 3.1. CABG

A study completed by Nielsen et al. (2020) investigated the dispensing of secondary prevention medications to patients of varying socioeconomic status after and CABG procedure.

*Table One: Summary of Search Strategy on PubMed*

Keyword	Regular/Mesh	Results
Socioeconomic Status	Regular	64 749
Cardiac Surgery	Regular	224 139
Postop Complications	Regular	200 164
Morbidity, Mortality, and Readmission	Regular	85 337
"Socioeconomic Status", "Cardiac Surgery", "Postop Complications", and "Morbidity, Mortality, and Readmission"	MeSH	22

The investigated medications included statins, platelet inhibitors, Renin Angiotensin Aldosterone System (RAAS) inhibitors, and beta blockers. During the study they discovered that while the amount of prevention medication being dispensed reduced over time, there were fewer medications initially given to patients with low SES; additionally, the study also showed that over time low SES individuals saw a more drastic reduction in medication. Based on these findings, Nielsen concluded that the under-dispensing of prevention medications and by extension SES played a role in increased mortality after CABG procedures (Nielsen et al., 2020). Another study by Coyan et al. (2021) investigated the rates of readmission, postop complications, and mortality associated with CABG procedures in patient groups of various SES. In this study, it was discovered that while there was no significant difference in 30-day mortality among patient groups, there was a greater risk of heart failure amongst patients with lower SES than the other groups. Additionally, when mortality was measured 5 years postop, it was also found that lower SES patients had higher mortality rates. In this study however, Coyan notes that the increased mortality could be due to the increased number of co-morbidities the low SES patient population had at baseline; regardless, Coyan concludes that socioeconomic standing does impact health and surgical outcomes and recommends that SES be used in risk prediction modeling (Coyan et al., 2021). Studies by Charles et al. (2019) and Hannan et al. (2022) also came to similar conclusions. Hannan's study showed that patients with a lower SES suffered higher mortality rates after CABG procedures than patients with a higher SES. They also concluded that the majority of the patients who suffered from readmission and postop complications were of racial minorities, particularly African Americans and Hispanics however this conclusion could also be due to co-morbidities found at baseline (Hannan et al., 2022). Charles' study came to a similar conclusion, however, his group used the Distressed Communities Index (DCI), a 7-



factor criterion that comprehensively looks at an area's SES, to differentiate their patients, the purpose of the DCI is to have a way to comprehensively evaluate an individual's or family's SES and group them into one of five economic classes; prosperous, comfortable, mid-tier, at risk, and distressed. The main effectiveness of the DCI though is to look deeper than the patient's race when evaluating SES (Kessler, 2022). The findings in Charles' study based on DCI support the idea that patients of lower SES have greater mortality and complication rates after CABG procedures than other patient groups and like Cohan, Charles suggests that socioeconomic factors should be used with measuring patient risk for interventions and procedures (Charles et al., 2019).

### 2.2. Valve Replacement

In a study done by Dalen et al, it was found that patients with lower SES were five times more likely to die from intracranial hemorrhages post-valve replacement than patients in higher socioeconomic groups. He also discovered that all-cause mortality significantly decreased in patients of higher socioeconomic standing. Dalen and his group believe that the increased bleeding seen in low SES patients could be attributed to the anticoagulation treatments used as secondary prevention because the study also reported that vitamin K treatment was used for the prevention of TIA and embolisms. However, the study reported suboptimal vitamin K treatment in 50% of participating patients, however, most patients were of low SES (Dalén, Persson, Glaser, Sartipy, 2022). Therefore, Dalen's study supports the notion that SES hurts post-surgical outcomes. A study completed by Hoyler et al came to a similar conclusion. They concluded that patients of lower SES suffered higher mortality rates than patients of higher SES, especially patients who had private health insurance versus patients who were either uninsured or on Medicare/Medicaid, the study also noted that race also had a significant impact on post-surgical outcomes because a significant difference was found in the mortality rates of black patients compared to white patients, which further supports the notion that SES does play a role in post-surgical outcomes (Hoyler et al., 2020). A paper by Okoh et al also presented interesting findings; in this paper, it was suggested that only open valve procedures increased mortality, readmission, and complication rates in low SES patients, however, a transcatheter approach did not affect any of these rates. Though this suggests that SES does impact surgical outcomes, Okoh mainly highlights the importance of proper risk assessment when choosing treatments for various patients, and supports the suggestion that SES should be included in risk prediction modeling (Okoh et al., 2021).

A study by McCarthy et al suggests a contrary opinion. The findings of this study suggest that the differences between mortality and complication rates are very similar amongst all SES subgroups and suggest that

SES does not have as great an impact on health outcomes as one might think (McCarthy et al., 2019).

### 2.3. PCI

A study by Hannan et al investigated the effect of SES on PCI and discovered that low SES was linked to worse postoperative outcomes. More specifically, Hannan suggests that these patients were more likely to suffer mortality and increased readmission as a result of this procedure. Additionally, this paper, like the ones presented by Okoh, Charles, and Cohan above suggests that SES measurement of some kind should be involved in patient risk assessment when discussing and deciding management plans (Hannan et al., 2022). A study by Jones et al agrees with the conclusions pulled from Hannan's paper because it also demonstrates low SES is associated with poor prognoses after PCI, including mortality. Jones's study also suggests that even after accounting for other health and risk factors that could impact mortality, the association between its rates and low SES is still present in PCI procedures (Jones et al., 2015). Therefore, both of these papers suggest that SES does have an impact on patient outcomes have surgery, however, more research should be done into the specific effects of SES and outcomes of PCI procedures.

### 4. Limitations

This study has several limitations. Firstly, this paper is a review meaning we were unable to conduct our study, therefore, none of the results extracted from the effects of SES on cardiac surgery outcomes can be compared to baseline data. Consequently, even though bias was limited we are unable to assess the accuracy of the papers we analyzed. Additionally, our inclusion criteria allowed papers published after January 2015, however, most of the papers detailing the effects of SES on the surgery are greater than 3 years old. This is a limitation because using dated information without a more recent study for comparison could affect the accuracy of the study, and highlights the importance of having a dataset. Finally, our last limitation is a lack of surgeon standardization. While all patients in this review underwent one of the same three procedures, they were operated on by surgeons all over and there is a chance that technique differences played a role in the mortality and complication rates seen in the following studies; however, it is never mentioned. Future studies should take place at a single institution to prevent this limitation.

### 5. Conclusions and Further Directions

Though more data needs to be collected on the specific effects of SES on surgical results in PCI and valve repair procedures, it can be said that based on the information presented above that SES does impact the mortality, readmission, and complication rates of patients post-cardiac surgery. As displayed above the reasons why



could be multifactorial including the increased number of comorbidities often associated with low SES populations or poor secondary prevention of complications through improper medication distribution as mentioned by Dalen and Nielsen respectively. As a result, potentially relevant future studies could investigate the effects of proper secondary prevention through medication distribution in patient groups of various SES. Additionally, because SES could help assess patient risk a cohort study assessing its effects on patient management and post-interventional outcomes could also be further investigated.

## 6. Conclusion

In this study, autistic children had reduced salivary flow rate, resting Ph, and buffering capacity. The prevalence of dental caries was observed to be higher in autistic children as compared to healthy children. A positive correlation was observed between the salivary parameters and the prevalence of dental caries in autistic children. Children with autism prefer soft and sweetened foods and tend to pouch food inside the mouth for a long duration instead of swallowing it. Added difficulties in brushing and flossing due to lack of motor coordination, leads to an increased propensity to caries for which a comprehensive, preventive educational approach needs to be implemented.

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Received January 23, 2023; reviewed February 14, 2023; accepted February 22, 2023; published online March 01, 2023