Review

Socioeconomic status and in-hospital cardiac arrest: A systematic review

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ABSTRACT

Aim: To perform a review of the literature on the association between socioeconomic status and risk of and outcomes after in-hospital cardiac arrest.

Data sources: PubMed and Embase were searched on January 24, 2020 for studies evaluating the association between socioeconomic status and risk of and/or outcomes after in-hospital cardiac arrest. Two reviewers independently screened the titles/abstracts and selected full texts for relevance. Data were extracted from included studies. Risk of bias was assessed using the Quality In Prognosis Studies (QUIPS) tool.

Results: The literature search yielded 4960 unique records. We included nine studies evaluating the association between socioeconomic status and risk of and/or outcomes after in-hospital cardiac arrest. All studies were observational cohort studies, of which seven were from the USA. Seven studies were in an adult population, while two studies were in a pediatric population. Results were overall inconsistent although some studies found a higher in-hospital cardiac arrest incidence in patients from low-income communities. There was no clear association between other socioeconomic factors (i.e. education, occupation, marital status, and insurance) and risk of or outcomes after in-hospital cardiac arrest. Due to the scarcity and heterogeneity of available studies, meta-analyses were not performed.

Conclusion: There are limited data regarding the association between socioeconomic status and risk of and outcomes after in-hospital cardiac arrest and further research is warranted. Understanding the association between socioeconomic status and in-hospital cardiac arrest may reveal strategies to mitigate potential inequalities.

Introduction

Socioeconomic status (SES) is a composite measure of an individual's relative position in society as it relates to various factors such as income, education, and occupation.[1,2] SES has been observed to be associated with risk of and outcomes after out-of-hospital cardiac arrest (OHCA),[3] and previous studies have also identified socioeconomic disparities in numerous other acute conditions including sepsis[4–6] and acute myocardial infarction.[7,8] However, in-hospital cardiac arrest (IHCA) may differ from OHCA in both patient and disease characteristics, including comorbidities, proportion of witnessed arrests, time to cardiopulmonary resuscitation, and outcomes.[9–12] Thus, little is known about the association between SES and risk of and outcomes after IHCA. SES may be associated with outcomes by various mechanisms including differences in treatments and quality of care.[13–15] Moreover, SES has been shown to increase the risk of comorbidities including risk factors for cardiovascular disease,[16–19] which may worsen outcomes after IHCA.[20–22] Identifying socioeconomic disparities in the risk of and outcomes after IHCA may provide an understanding of healthcare inequality pertinent to IHCA.

We therefore performed a systematic review of the literature on the association between SES and risk of and outcomes after IHCA.

Methods

We planned to perform a systematic review including meta-analyses. The protocol for this can be found in the supplementary material. The

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protocol was not registered.

Two research questions were framed according to the PICO format: 1) In adults and children in an in-hospital setting (P), is a specific SES (I), as compared to a different SES (C), associated with risk of IHCA (O)? and 2) In adults and children with IHCA (P), is a specific SES (I), as compared to a different SES (C), associated with clinical outcomes, including but not limited to return of spontaneous circulation, and survival/survival with a favorable neurological outcome (O)? We aimed to address the research questions in all populations, including adult, pediatric, and neonatal populations. SES measures in relation to economic status, educational status, occupational status, marital status, and insurance status were considered for inclusion. The included outcomes depended on the data available. Observational studies (cohort and case-control studies) were included. Case reports, case series, reviews, abstracts, editorials, letters to the editor, comments, and non-English manuscripts were excluded. All years were considered for inclusion.

On January 24, 2020, we searched PubMed and Embase in which we utilized a variety of indexing search terms and text words related to cardiac arrest and SES (see protocol in the supplementary material). Two reviewers independently screened all titles and abstracts following the systematic search by utilizing pre-defined screening criteria. Kappa-values for inter-observer variance were calculated, and a third reviewer screened all excluded titles and abstracts to optimize sensitivity. The bibliographies of the included articles were reviewed for potentially additional articles. Full texts of articles passing the initial screening were assessed by two reviewers. Any disagreements were resolved by discussions. Two reviewers extracted data pertinent to the PICO by utilizing a pre-defined standardized data extraction form.

For each included study, two authors independently reviewed the risk of bias using the Quality In Prognosis Studies (QUIPS) tool.[23] Risk of bias was assessed by each exposure and outcome pair. Bias assessment was tabulated with explanations when studies were downgraded. Any disagreements were resolved by discussion between the authors. As noted in the protocol, we had originally planned to use the I-ROBINS tool for bias assessment. However, upon preliminary review of the studies, it was deemed that the QUIPS tool would be more appropriate.

Results

The systematic search yielded 4960 unique titles/abstracts, of which 4949 were excluded during the initial screening (Kappa = 0.37 [Fig. 1]). The full manuscript of 11 studies were reviewed, of which five were included. One additional study was identified by the third reviewer. Three studies were identified through review of references. A total of nine studies were included.[24–32]

Years of patient inclusion spanned from 1984 to 2014. All studies were observational and mainly based on multicenter registries or administrative data[24,27–32] while two were single-center studies.[25,26] Seven studies were in an adult population,[24–27,29,30,32] whereas two studies were in a pediatric population.[28,31] Only three studies examined the association between SES and risk of and/or outcomes after IHCA as the primary objective.[24,25,27] A total of four studies included patient-level
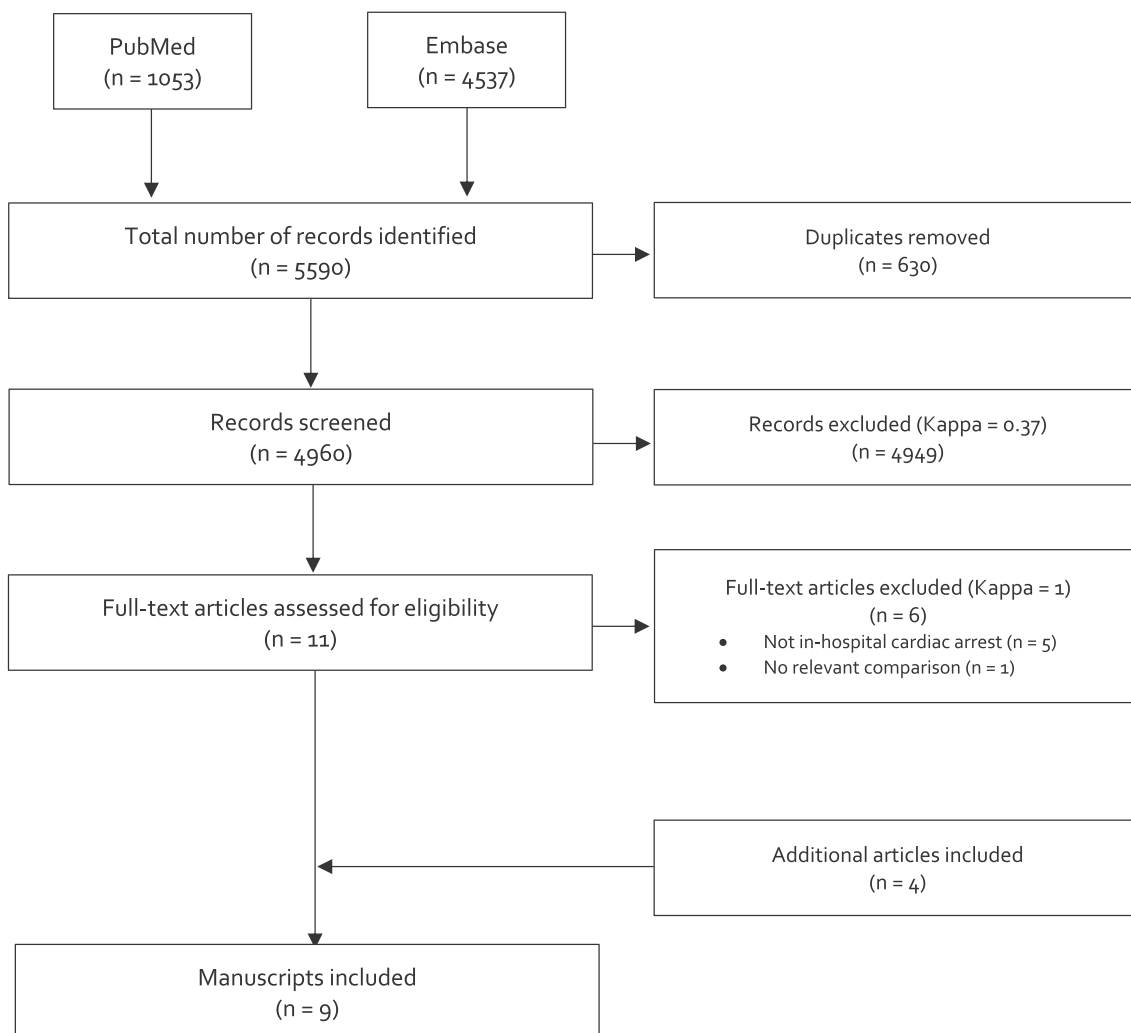

Fig. 1. PRISMA diagram. Diagram demonstrating the flow of articles throughout the selection process.

SES only,[24,26,29,31] while four studies reported area-level SES only.[27,28,30,32] One study reported a combination of patient-level and area-level SES.[25] The sample size varied substantially between studies. Additional details are provided in Table 1.

Income

We identified five studies that addressed the association between income and risk of and/or outcomes after IHCA,[25,27,28,30,32] of which one study was in a pediatric population.[28] All studies were performed in the USA based on census data. The income cutoffs for different SES groups varied between studies.

Three studies addressed the association between income and risk of IHCA.[27,28,32] Two studies reported a higher risk of IHCA in patients with lower compared to higher area-level income.[27,28] Similarly, one study demonstrated some support of a lower incidence of IHCA in the high compared to the low area-level income group, but the findings were not significant (rate ratio: 0.84, 95%CI 0.71–1.00).[32]

Three studies addressed the association between income and outcomes after IHCA.[25,28,30] The studies found no association between area-level income and survival[28,30] or favorable neurological outcome at hospital discharge.[25]

Educational status

We identified one study, which was from Australia, addressing the association between educational status and outcomes after IHCA.[24] It was not reported how data on educational status was obtained. The study did not find an association between educational status and survival at 28 days; however, confidence intervals were wide.

No study addressed the association between educational status and risk of IHCA.

Occupational status

We identified one study addressing the association between occupational status and outcomes after IHCA, which was based on data from medical records.[25] The study found no association between occupational status and neurological outcome at hospital discharge, although confidence intervals were wide (odds ratio [OR] 1.04, 95%CI 0.35–3.11).

No study evaluated the association between occupational status and risk of IHCA.

Table 1
Characteristics of studies reporting the association between socioeconomic status and in-hospital cardiac arrest.

Study	Country	Years of patient inclusion	IHCA identified by ICD codes	Main inclusion criteria[a]	IHCA patients analyzed	Type of socioeconomic variables	Main results
Heller, 1995[24]	Australia	1984–1985 + 1988–1991	No	Adults aged 25–69 years with suspected acute myocardial infarction	308	Patient-level marital status Patient-level educational status	No clear association between marital status or educational level and survival
Ehlenbach, 2009[30]	USA	1992–2005	Yes	Adults aged ≥65 years with Medicare	433,985	Area-level income	No association between median household income for the ZIP Code of the patient's residence and survival
Meert, 2009[31]	USA	2003–2004	No	Children aged 1 day to 18 years	353	Patient-level insurance status	No association between insurance type and survival
Merchant, 2012[32]	USA	2003–2007	No	Adults aged ≥18 years	103,117[b]	Hospital area-level income	No clear association between hospital-level median household income and IHCA incidence, although a potential lower incidence was noted in high-income vs. low-income hospital areas (rate ratio 0.84 [95%CI: 0.71–1.00])
Uray, 2015[25]	USA	2010–2012	No	Adults aged 18–64 years	156	Patient-level occupational status Patient-level marital status Patient-level insurance status Area-level income	No clear association between any of the socioeconomic variables and favorable neurological outcome
Martinez, 2016[28]	USA	1997–2012	Yes	Children aged <18 years	29,577	Area-level income	Higher IHCA incidence among patients with lower median ZIP code household income No association between median ZIP code household income and mortality
Wang, 2016[26]	Taiwan	2006–2014	No	Adults aged ≥18 years	1524	Patient-level marital status	Worse neurological outcome among females without a living spouse[c] No clear association between marital status and survival
Song, 2017[27]	USA	2010–2012	No	Adults aged ≥19 years who underwent non-emergency, non-obstetrical, surgical procedures	1,800,506	Area-level income	Higher intraoperative cardiac arrest incidence among patients with lower median ZIP code household income
Akintoye, 2020[29]	USA	2005–2011	Yes	Adults aged ≥18 years	125,082	Patient-level insurance status	Worse survival outcomes among self-payed insurance compared to Medicare Higher survival among privately insured compared to Medicare No clear survival difference between Medicaid and Medicare

[a] In addition to in-hospital cardiac arrest.
[b] 433 hospitals.
[c] Unclear in the manuscript exactly what is being reported as only one odds ratio is provided for an interaction term.

Marital status

We identified three studies addressing the association between marital status and outcomes after IHCA.[24–26] The studies were located in Australia, Taiwan, and the USA. Two studies based marital status on data from medical records,[25,26] while one study did not report how marital status was obtained.[24]

Two studies addressing the association between marital status and survival showed no clear association (OR 0.70, 95%CI 0.43–1.13 and OR 0.63, 95%CI 0.36–1.09, respectively).[24,26] Similarly, studies showed no clear association between marital status and favorable neurological outcome at hospital discharge.[25,26]

No study addressed the association between marital status and risk of IHCA.

Insurance status

We identified three studies that addressed the association between insurance status and outcomes after IHCA.[25,29,31] All studies were located in the USA. In two studies, insurance status was obtained from medical records[25] and a national database,[29] while it was unclear how insurance status was obtained in one study.[31]

The studies did not show a consistent association between insurance status and outcomes of IHCA.[25,29,31] One study found no association between insurance type and survival.[31] Another study showed worse survival among self-payers (OR 0.65, 95% 0.60–0.70) and increased survival at hospital discharge among privately insured patients (OR 1.11, 95% 1.06–1.15) compared to patients with Medicare.[29] A third study found no clear association between patients with no insurance vs. patients with insurance and favorable neurological outcome at hospital discharge (OR 2.33, 95%CI 0.80–7.63).[25]

Table 2
Bias assessment of included studies.

Study	Exposure	Outcome	Rating of Risk of Bias						
			Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Study confounding	Statistical analysis and reporting	Overall
Heller, 1995[24]	Patient-level marital status	Survival at 28 days	Moderate[a]	Low	Moderate[b]	Low	Moderate[c]	Low	Moderate
	Patient-level educational status	Survival at 28 days	Moderate[a]	Low	Moderate[b]	Low	Moderate[c]	Low	Moderate
Ehlenbach, 2009[30]	Area-level income	Survival to hospital discharge	High[d]	Low	Moderate[e]	Low	High[f]	Low	High
Meert, 2009[31]	Patient-level insurance status	Survival to hospital discharge	Moderate[g]	Low	Low	Low	High[f]	Low	High
Merchant, 2012[32]	Hospital area-level income	IHCA incidence	Low	Low	Low	Low	Moderate[c]	Low	Moderate
Uray, 2015[25]	Patient-level occupational status	Favorable neurological outcome at hospital discharge	Low	Low	Moderate[h]	Moderate[i]	High[f]	Low	High
	Patient-level marital status	Favorable neurological outcome at hospital discharge	Low	Low	Low	Moderate[i]	High[f]	Low	High
	Patient-level insurance status	Favorable neurological outcome at hospital discharge	Low	Low	Low	Moderate[i]	High[f]	Low	High
	Area-level income	Favorable neurological outcome at hospital discharge	Low	Low	Moderate[e]	Moderate[i]	High[f]	Low	High
Martinez, 2016[28]	Area-level income	IHCA incidence	Low	Low	Low	High[d]	High[f]	Low	High
	Area-level income	Hospital mortality	High[d]	Low	Low	Low	High[f]	Low	High
Wang, 2016[26]	Patient-level marital status	Favorable neurological outcome at hospital discharge	Moderate[j]	Low	Low	Moderate[i]	Moderate[c]	High[k]	High
	Patient-level marital status	Favorable neurological outcome at hospital discharge	Moderate[j]	Low	Low	Low	Moderate[c]	High[k]	High
Song, 2017[27]	Area-level income	Intraoperative cardiac arrest incidence	Low	Low	Moderate[e]	High[l]	Moderate[c]	Low	High
Akintoye, 2020[29]	Area-level insurance status	Survival to hospital discharge	High[d]	Low	Low	Low	Moderate[c]	Low	High

[a] 16% of the patients had no data on whether cardiopulmonary resuscitation was performed.
[b] Not described how the exposure was obtained. Some missing data on exposure.
[c] Few potential confounding factors were considered.
[d] Used ICD-9 codes to identify the patient population.
[e] Some missing data on exposure.
[f] No potential confounding factors were considered.
[g] Used ICD-9 codes to identify IHCA patient population, however other methods were also used.
[h] Obtained from medical records. Some missing data on exposure.
[i] Based on review of medical records.
[j] Unclear if all IHCAs were captured in the screening process.
[k] Unclear what the control group was in the statistical analysis.
[l] Definition of cardiac arrest may have varied across institutions. Some missing data on the outcome.

No study reported on the association between insurance status and risk of IHCA.

Risk of bias for individual studies

An overview of the risk of bias assessment is provided in Table 2. Overall, the risk of bias was high for the majority of the included studies. Two studies were at a moderate risk of bias and no studies were at low risk of bias.

Discussion

In this systematic review, we describe the body of literature on the association between SES and risk of and outcomes after IHCA. While the association between SES and OHCA has been examined in numerous studies,[3] we identified only nine studies addressing the association between SES and risk of and/or outcomes after IHCA. All studies were observational cohort studies and mostly based on data from the USA. The available SES measures included income, education, occupation, marital status, and insurance.

Only three studies reported on the association between SES and risk of IHCA,[27,28,32] of which one was in a pediatric population.[28] None of these studies evaluated SES on the patient-level and only one of the studies reported assessment of SES as the primary objective of the study.[27] Two studies showed a higher risk of IHCA in patients with lower income.[27,28] In addition, *Merchant* et al. reported a potentially lower risk of IHCA in the high income group compared to the low income group, however the study did not find an overall association between income and risk of IHCA.[32]

A total of six studies reported on the association between SES and outcomes after IHCA,[24–26,29–31] of which one study was in a pediatric population.[31] The studies showed inconsistent results, both within and between SES variables. Only two studies assessed SES as the primary objective of the study.[24,25] Overall, there was no clear association between SES and outcomes after IHCA. Five studies reported patient-level SES variables, which included education, marital status, and insurance. Two studies reported area-level SES variables, which consisted of income only.

The paucity of studies addressing SES highlights an important knowledge gap within the field of IHCA. We identified only nine studies (as compared to 32 studies in a recent review of OHCA[3]), of which only three studies[24,25,27] included assessment of SES as the primary objective of the study. Only few studies evaluated multiple SES measures, why potential interaction between SES measures cannot be excluded. The outcome measures were limited to survival and favorable neurological outcome at hospital discharge and at 28 days, why data on shorter and longer-term outcome measures are lacking (e.g. return of spontaneous circulation and survival at one year). Moreover, the risk of bias was assessed as high for the majority of the included studies. Most studies did not adjust for characteristics that may confound the relationship between SES and risk of and outcomes after IHCA (e.g. age and sex), which may have introduced biased results. Similarly, no studies addressed how potential mediating factors on the causal pathway between SES and risk of and outcomes after IHCA (e.g. comorbidities, post-resuscitation care) may have influenced the relationship. Furthermore, some of the studies were relatively small and consequently, the results were imprecise (e.g. wide confidence intervals).

While five studies reported on area-level income, no studies reported on patient-level income. Ecological correlations may not validly correspond to individual correlations.[33] This may underestimate the true association between income and risk of and outcomes after IHCA, since patient-level SES may reveal larger disparities in outcomes compared to area-level SES.[34–36] In a previous systematic review, *Van Nieuwenhuizen* et al. reported that low SES (including income, education, and occupation) compared to high SES was associated with higher risk of and worse outcomes after OHCA.[3] However, none of the included studies in

that review evaluated the association between patient-level SES and risk of OHCA. As compared to IHCA, area-level SES may provide more relevant information in the OHCA setting, since low area-level SES has been shown to be associated with less availability and use of automated external defibrillators and decreased chance of receiving bystander cardiopulmonary resuscitation, which may lead to worse outcomes after OHCA.[3,37,38] However, it is less clear how area-level SES may correlate directly to outcomes after IHCA.

Three of the included studies identified IHCA from registries based on ICD-9 codes. Identifying IHCA by ICD-9 codes has been shown not to accurately capture IHCA and may not fully distinguish IHCA from OHCA, which in turn may impact reported outcomes.[39,40]

Of the studies included in this systematic review, seven out of nine studies were based in the USA. The association between SES and risk of and outcomes after IHCA may vary across countries and healthcare systems. Additionally, the measures used to define SES may vary substantially from different countries based on available data in national registries, which could limit the validity of direct comparison between individual countries.[41] Additional studies from outside of the USA are therefore needed.

This review provides initial insights on the current state of potential inequalities with regard to the risk of and outcomes after IHCA. A better understanding of such inequalities may inform future research on socioeconomic disparities in clinical decision-making and treatments of patients with IHCA. In turn, this may reveal strategies, including clinical initiatives and quality improvement projects, to mitigate inequalities related to IHCA. In addition to a higher focus on IHCA research, future studies on the association between SES and risk of and outcomes after IHCA should include patient-level SES measures from various healthcare systems in both adult and pediatric populations.

Limitations

Our study has limitations to be considered. First, a limitation of this review included that the interrater reliability for screening of the literature resulted in low agreement (Kappa = 0.37). This was related to the difficulty of accurately identifying relevant studies among the relatively large number of title/abstracts. However, only one additional study was found by the third reviewer within the excluded studies. Since many of the studies did not assess SES as the primary objective, we may have missed other similar studies, where SES was not mentioned in the abstract and therefore could not be identified. Second, databases were limited to PubMed and Embase. Inclusion of further databases may have yielded more studies for evaluation. Moreover, our search strategy was limited to English manuscripts only. Finally, we aimed to provide a synthesis of evidence from studies with meta-analyses. However, the included studies were few and heterogenous, which did not allow for a meaningful evaluation.

Conclusions

There are inconsistent results and a knowledge gap regarding the association between SES and risk of and outcomes after IHCA. The studies were few, heterogenous, and generally had a high risk of bias. Future research evaluating the association between patient-level SES and risk of and outcomes after IHCA is warranted. Understanding the association between SES and IHCA may reveal strategies to mitigate potential inequalities related to IHCA.

Declaration of competing interest

The authors have no conflicts of interest.

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https ://doi.org/10.1016/j.resplu.2020.100016.

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