Review Article

Incidence of Sudden Cardiac Death in Low- and Middle-Income Countries: A Systematic Review of Cohort Studies

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Abstract

Sudden cardiac death (SCD) is a leading cause of mortality worldwide and, in recent years, has become an urgent public health concern in low- and middle-income countries (LMICs). Data from LMICs, however, remains limited. As such, the aim of this article is to systematically review the current literature on the incidence of SCD in LMICs to inform policymakers and identify potential research gaps. A search of PubMed and Embase was utilized to capture the targeted condition, outcome, and setting. Only peer-reviewed cohort studies in LMICs reporting SCD incidence estimates in the general population of individuals aged ≥1 year were eligible for selection. Papers providing incidence data for specific types of SCD, including sudden coronary death or death from sudden cardiac arrest, were also included. After deduplication, 1941 citations were identified and screened. Seven studies representing four countries—Cameroon, China, India, and Iran—met the criteria for inclusion and were considered in our analysis. The crude incidence rate for SCD ranged from 19.9 to 190 cases per 100,000 person-years, while age-adjusted rates ranged from 33.6 to 230 cases per 100,000 person-years. There was notable variability in methods utilized to ascertain SCD cases. These findings suggest that the incidence of all-cause SCD in LMICs and may exceed that of high-income countries; however, observed disparities may be partly attributable to differences in case ascertainment methods. Additional research is needed to better understand the true incidence of SCD in developing countries. It is crucial that future studies across regions utilize standard diagnostic criteria and methodology for identifying SCD, which would provide a framework by which to compare outcomes between settings.

Keywords: Global health, incidence, low- and middle-income countries, risk factors, sudden cardiac death, systematic review

Introduction

Sudden cardiac death (SCD) is a leading cause of mortality—accounting for an estimated 15–20% of all deaths worldwide—and is responsible for almost half of all deaths from cardiovascular disease.[1,2] Research suggests that coronary artery disease (CAD) accounts for 70–80% of sudden cardiac deaths in Western countries.[3-5] Beyond CAD, there is evidence for a growing heterogeneity of mechanisms underlying SCD with additional etiologies, including cardiomyopathies, inherited arrhythmia syndromes, and valvular diseases.[6] As such, causes of SCD are both dynamic and elusive and may require a shift in focus toward less quantifiable entities such as psychosocial factors.[3]

Nonetheless, some common risk factors for SCD can be described through upstream determinants—such as smoking and family history of heart disease; substrate conditions—such as CAD; and environmental triggers such as diet and activity.[2,7,8] Sociodemographic factors such as age and gender also contribute to understanding the risk of SCD. In Western countries, for example, CAD is responsible for approximately 75% of SCDs among white men and 50% among women and black people.[6,9,10] Furthermore, less than 1% of SCD occurs in individuals under the age of 35 years.[6]

Although there is a lack of consensus on its definition, SCD is often reported as death from an unexpected circulatory arrest, usually

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due to a cardiac arrhythmia, occurring within an hour of symptom onset.[7,11,12] If not witnessed, unexpected deaths from cardiovascular causes where the individual was observed to be alive within the previous 24 hours are also considered cases of SCD.[11]

In recent years, SCD has become an increasingly urgent public health concern in low- and middle-income settings, causing a disproportionate number of preventable deaths.[7] Given the current burden of cardiovascular disease in low- and middle-income countries (LMICs), the incidence of SCD is projected to increase in LMIC settings.[7] Unlike countries in Europe and North America, however, data from LMICs remains scarce. In the absence of robust data, it is difficult to determine the true magnitude of SCD in LMICs and inform related public health policies.

Lack of research coupled with growing public health concerns make it important to explore available literature around SCD in LMICs. As such, the objective of this article is to systematically review cohort studies reporting on the incidence of SCD among the general population in LMICs, as well as identify potential research gaps.

Methods

This review was designed and implemented using guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [S3 Appendix].[13] It was also registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD42022353568).

Search strategy

A search strategy was developed to capture the targeted condition (i.e., SCD), outcome (i.e., incidence), and setting (i.e., LMICs). To capture LMICs, a popular search strategy developed by UNC Health Sciences Library was adapted.[14] Our final search of Embase and PubMed databases utilized a combination of MeSH terms and text words, including SCD, low-income country, middle-income country, incidence, and prevalence. The full search strategy can be found in the appendix [see: S1 Appendix].

Inclusion criteria

Only peer-reviewed cohort studies of primary data pertaining to LMICs were eligible for selection. World Bank classifications were referenced to identify LMICs.[15] Reviews, case reports/series, posters, abstracts, and editorials were excluded. No date restrictions were imposed. Only articles published in English or with an English translation were included.

We included studies that reported SCD incidence estimates among the general population of individuals aged ≥1 year. Papers providing incidence data for specific types of SCD, including sudden coronary death or death from sudden cardiac arrest, were also included. Articles without a subset analysis of individuals aged ≥1 year were removed to avoid the potential inclusion of sudden infant death syndrome in incidence estimates.

Included studies were also required to provide the protocol by which SCD cases were ascertained, but no specific tool or SCD definition was imposed as a requisite for selection. The protocols for included studies were noted during data extraction and informed our risk of bias assessments.

To ensure that reported SCD incidences applied to the general population, we excluded studies that only accounted for deaths in those with a previously known disease or those engaged in a particular activity (i.e., athletes). Furthermore, articles focused only on SCD cases that occurred during a specific time of day (i.e., mornings, during work, etc.) were removed.

Study selection and data extraction

Two independent reviewers screened articles for inclusion, utilizing a standard two-stage process: a title/abstract review followed by a full-text review. When discrepancies occurred, a consensus was achieved via discussion among reviewers.

Data from articles that met selection criteria were retrieved using an extraction form developed by the authors. If reported, we extracted SCD crude and age-adjusted incidence rates per 100,000 person-years with associated 95% confidence intervals. When rates were not reported, estimations were calculated from available data.

For all included studies, the authors extracted information relevant to any subgroup analysis of SCD incidence rates conducted and documented details regarding age criteria utilized and the total number of deaths observed. We also extracted details regarding the study design, data collection period, case ascertainment protocols, population characteristics, and setting.

Risk of bias assessments

Risk of bias assessments for included studies were conducted using the Joanna Briggs Institute (JBI) Checklist for Prevalence Studies.[16] Results from the 9-item JBI checklist can be found in the appendix (see: S2 Appendix).

Results

Our search was performed on July 27, 2022, and, after deduplication, 1941 citations were identified. Following the title and abstract review, 52 articles were retrieved and included in our full-text screen. Of these 52 studies, seven met the criteria for inclusion and were considered in our final analysis [Figure 1].[17-23]

Study characteristics and case ascertainment

While roughly 130 nations are classified as low- or middle-income by the World Bank, only four countries—Cameroon, China, India, Iran—had studies that met inclusion criteria and were represented in our analysis [Figure 2].

Of the included articles, five[17,20-23] were prospective studies, one[19] was retrospective, and one[18] utilized mixed methods [Table 1]. Each article reported the incidence of SCD in the general population of individuals aged greater than 1 year. Urban populations were sampled in most papers (n = 5)[17,19,20,22,23] and a majority (n = 6)[17,19-23] utilized data collected in the past twenty years.

Notably, while the definition for SCD varied across the studies, all studies included a time component in their reported criteria.

Three papers included unexpected deaths occurring during sleep.[19-21] One paper did not indicate SCD as the primary outcome of interest—instead only investigated the incidence of sudden coronary death, a subtype of SCD.[18] All studies excluded deaths from obvious extra-cardiac causes.

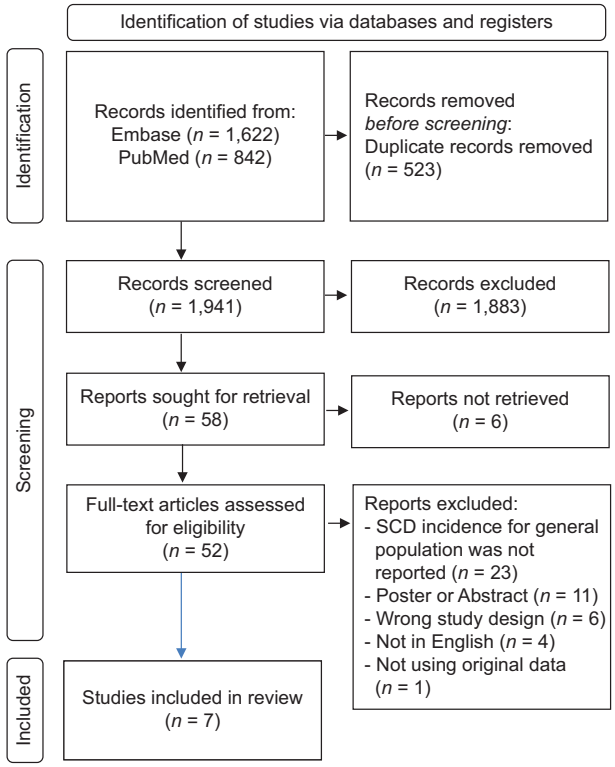

Figure 1: PRISMA Flow Diagram

There was variability in the methods utilized to identify cases of SCD. Studies employed different resources to collect information about each potential case, including autopsy reports (non-verbal or verbal), medical records, family interviews, government registries, and community-based surveys. Three studies used a multi-stage review of community-based surveys, employing a team of physicians with varying experience at each stage.[17,19,20] Two papers utilized a single-stage review of data from multiple sources conducted by a multidisciplinary panel of physicians.[22,23]

Sudden cardiac death: Incidence

There was variability in age cut-offs for studied populations [Table 2]. Three papers included adults aged 18–29 in their incidence estimates.[17,19,20] One study set an age cut off of 30 years, while three studies limited their cohorts to adults aged ≥35 years.[18,21-23]

Five studies reported a crude SCD incidence rate for the entire population under consideration—without stratifying results by age group or limiting estimates to a SCD subtype [Table 2].[17,20-23] Among these studies, the crude IR for SCD ranged from 19.9 to 190 cases per 100,000 person-years. One additional study reported a crude IR estimate of 7.1 per 100,000 person-years for sudden coronary death, a subtype of SCD.[18] Three papers provided age-adjusted SCD incidence rates, which were consistently higher than crude rates and ranged from 33.6 to 230 cases per 100,000 person-years. However, the difference between observed crude and age-adjusted rate was not statistically significant.

Risk factors for SCD

Furthermore, all studies reported incidence rates stratified by sex or gender, with a majority reporting higher rates of SCD in

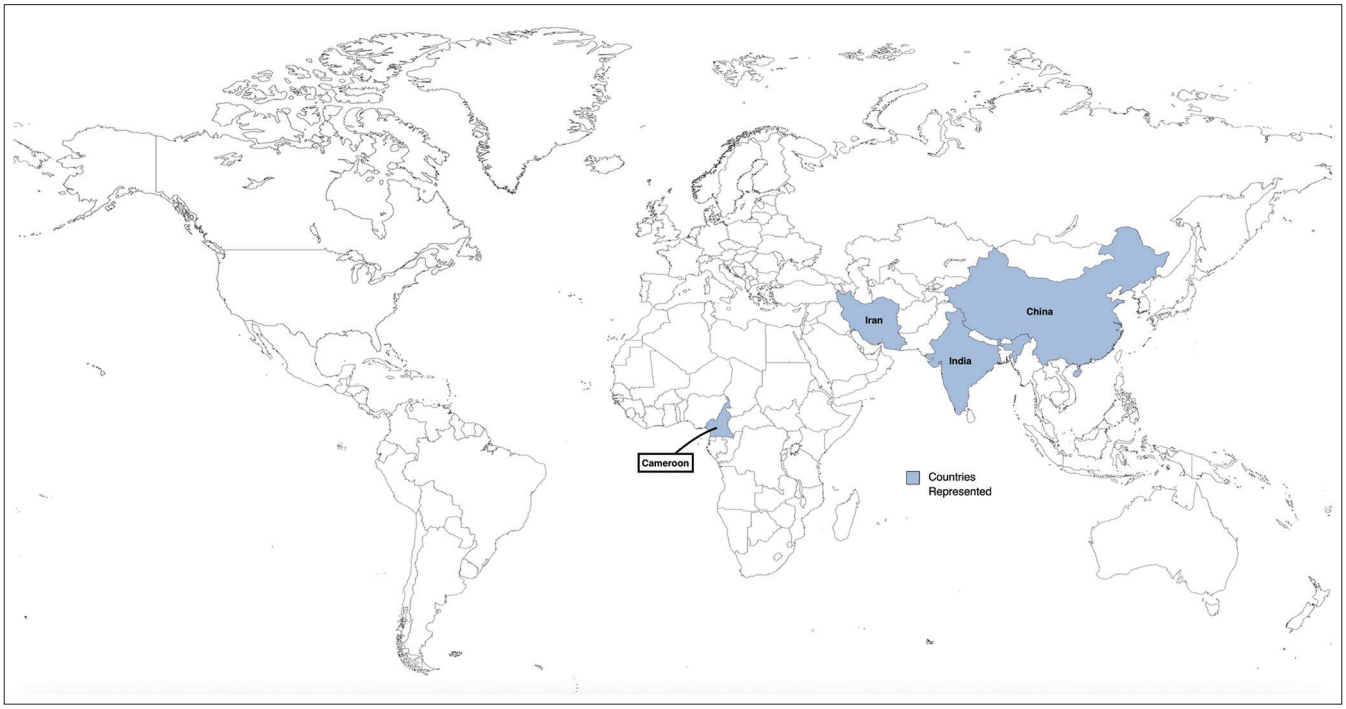

Figure 2: Map highlighting countries represented in systematic review

Table 1: Study characteristics

Study Ref.	Data Collection Period	Study Design	Country	Setting	Sudden Cardiac Death: Case Ascertainment	
					Criteria Utilized	Method of Determination
[17]	2013	PC	Cameroon	Urban	"Established SCD": unexpected death within one hour of symptoms onset. "Probable SCD": unexpected death within 24 h of symptom onset. For both groups, deaths with obvious extra-cardiac causes were excluded. Cases with known, prior terminal condition were excluded.	Two-level review of community-based surveys: 1st: Medical residents and senior general practitioners (GPs) identified unexpected deaths 2nd: Panel of cardiologists made final SCD determination
[18]	1974–80	PC, RC	China	Suburban	Outcome—Sudden Coronary Death: Death within 6 hours of symptoms with no history of violence or other apparent cause.	"Presumptive" diagnosis of sudden coronary death using available data from death certificates, medical records, and family interviews.
[19]	2015	RC	China	Urban, Rural	Unexpected death due to cardiac cause within 1 h of symptom onset. Deaths during sleep without a clear history of disease or illness or symptoms before falling asleep were also included. Deaths due to obvious noncardiac reasons were excluded.	Two-level review of community-based surveys: 1st (local center): Senior cardiologist reviewed deaths, selecting cases that met SCD criteria 2nd (provincial institute): Expert cardiologist panel (4 physicians) made final SCD determination
[20]	2005–06	PC	China	Urban, Rural	One of the following: 1) Death occurred unexpectedly within 1 h of symptom onset without a noncardiac cause 2) Unexpected death within 1 to 2 h of symptom onset without a noncardiac cause 3) Death that occurred during sleep with no symptoms before sleeping and without a noncardiac cause 4) Death occurred per category 1, 2, or 3 but for which supplemental data could not be obtained	Three-level review of government registry: 1st (local center): Local committee of physicians reviewed registry information and selected potential SCD cases 2nd (local center): For retained cases, local staff collected additional data from hospital records, autopsy data, witnesses, family members, etc., Local committee then made initial diagnosis 3rd (coordinating center): Central committee of cardiologists and epidemiologists made the final determination of SCD
[21]	2006-07	PC	India	Rural	One of the following: 1) Death occurring suddenly and unexpectedly within 1 h of cardiac symptoms in the absence of a prior cardiac illness 2) Death occurring within 1 h of cardiac symptoms in the setting of stable cardiac disease 3) Unexpected death during sleep 4) Death occurring unexpectedly within 24 h after last seen alive	Verbal Autopsy Review -Autopsy data collected from family members in close proximity to possible victims of SCD using validated questionnaire delivered by trained health worker -If possible, autopsy data was verified by medical records. -Trained physician determined the cause of death
[22]	2001-08	PC	Iran	Urban, Rural	Unexpected death that occurred out-of-hospital within 24 h of symptom onset if no other obvious cause of death was proposed.	Multidisciplinary panel of physicians made the final diagnosis using data from registries, medical records, and death certificates.
[23]	1999-2018	PC	Iran	Urban	"Definite SCD": sudden pulselessness attributable to a cardiac cause in a previously stable individual. "Possible SCD": unexpected death within 24 hours of last being seen alive, not attributable to noncardiac cause.	Multidisciplinary panel of physicians and other experts made the final diagnosis using data from medical records, death certificates, and verbal autopsies.

RC: Retrospective Cohort; PC: Prospective Cohort

males compared to females [Figure 3]. Four studies also reported incidence rates stratified by age group. While these papers utilized varying age cut-offs and categories, SCD incidence rates largely increased with age across all studies.[17-19,22]

Five studies also reported the prevalence of pre-existing cardiovascular risk factors or diseases in SCD victims.[17,19-21,23] Hypertension, CAD, prior myocardial infarction were among the most common conditions noted.

Discussion

Our review evaluated the available literature on the incidence of SCD in LMICs. Results indicate that the incidence of all-cause SCD in LMICs is highly variable with crude and age-adjusted estimates ranging from 19.9 to 190 cases per 100,000 person-years and 33.6 to 230 cases per 100,000 person-years, respectively. These results suggest that the burden of SCD in LMICs generally exceeds that of high-income countries; however, differences in observed rates may be attributable to disparities in case ascertainment methods.[24-28]

Our findings were consistent with global trends in premature cardiac death—as well as SCD trends observed in high-income countries—showing increasing incidence of SCD with age and typically higher rates among men compared to women.[28-30] Additional conditions linked to SCD in LMICs include hypertension, diabetes, CAD, and a history of prior myocardial infarction—all of which are well-established underlying causes or risk factors of SCD.[31-34]

Strengths and limitations

This article is one of the first to review current evidence on the incidence of SCD in LMICs as well as identify potential research gaps. Notably, our review highlights the scarcity of research on SCD in low- and middle-income settings and the inconsistencies across existing studies, such as the varied criteria used to define SCD and the methods used to ascertain deaths. Namely, included studies utilized different symptom timeframes and autopsy review protocols when defining SCD. As such, it was difficult to make direct comparisons of incidence between countries and draw firm conclusions.

Furthermore, most studies included in this review were conducted in only four countries—Cameroon, China, India, and Iran. This is a noteworthy limitation to the generalizability of the findings to other regions of the world. These limitations—namely the scarcity of available data and the observed heterogeneity across case ascertainment—also precluded the use of a meta-analysis. The absence of a meta-analysis underscores the challenges in making accurate predictions of SCD incidence in LMICs, given the restricted geographical representation, data scarcity, and methodological heterogeneity among the included studies.

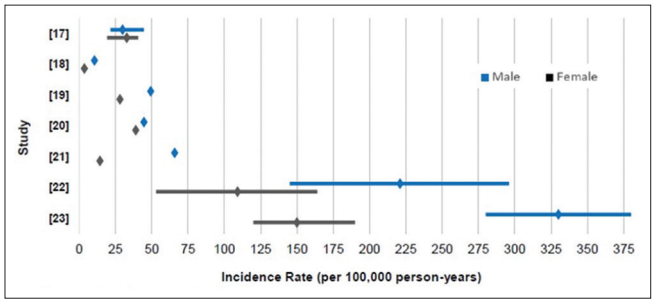

Figure 3: Crude incidence rate of sudden cardiac death stratified by sex (or gender)

Further research

Further research is urgently needed to better comprehend the burden of SCD in LMICs, particularly in regions with high rates of cardiovascular disease risk factors. Given the lack of research on SCD, there are abundant opportunities for contributions to the field. For example, the development of a standardized diagnostic methodology for the identification of SCD, similar to the criteria published by the American Heart Association and American College of Cardiology, would enhance the accuracy of incidence estimates and facilitate comparisons between studies and populations.[35]

While incidence is an important measure of the burden of SCD, research is also needed to understand the underlying causes and risk factors for SCD in LMICs. Investigation of such factors may aid healthcare workers and policymakers in efforts to develop targeted prevention programs.

Conclusion

In conclusion, our review suggests that the incidence of SCD in LMICs is relatively high, but current data is limited and

Table 2: Reported Incidence Rates for SC

Study Ref.	Country	Age Criteria	SCD cases (total)	Estimated IR (per 100,000 person-years)		IR Reported by Subgroup[a]			
				Crude [95% CI]	Age-Adjusted [95% CI]	Age	Sex	SES	Ethnicity
[17]	Cameroon	>18	27	31.3 [20.3-40.6]	33.6 [22.4-44.9]	✓	✓	--	--
[18]	China	≥35	35	7.1	--	✓	✓		
[19]	China	≥18[b]	NR	18-35 yrs: 4.2 35-60 yrs: 28.3 >60 yrs: 211.3[c]	--	✓	✓	✓	✓
[20]	China	>17	284	41.8	--	--	✓	--	--
[21]	India	≥35	178	19.9	--	--	✓	--	--
[22]	Iran	≥35	54	161 [123-210]	165 [118-212]	✓	✓	--	--
[23]	Iran	≥30	242	190 [170-220]	230 [210-270]	--	✓	--	--

IR: Incidence Rate; NR: Not reported; SES: Socioeconomic Status. [a]For sex, studies reporting IR by gender were considered; For SES, regional variables (i.e., development) were considered. [b]Observed SCD cases for age groups that included individuals <1 year old—this information was not tabulated. [c]Chi-squared test for trend indicated SCD increased with age and age groups differed significantly (P<0,05)

inconsistent, making it difficult to accurately estimate incidence across countries. Additional studies are needed to better understand the true incidence of SCD in developing countries as well as associated risk factors. This has the potential to inform interventions to prevent such deaths. It is crucial that future research across regions utilize standard diagnostic criteria and methodology for identifying SCD, which would provide a framework by which to compare outcomes between settings. By addressing these gaps, we can take steps toward effectively preventing and managing SCD in LMICs.

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Conflicts of interest

There are no conflicts of interest.

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S1 Appendix: Search Strategy

Search Strategy for Embase:

Incidence	*#1*	*(incidence)/exp OR ((prevalence)/exp) OR ((incidence):ti, ab, kw) OR ((prevalence):ti, ab, kw) OR ((frequency):ti, ab, kw)*	*3,584,020*
SCD	*#2*	*('sudden cardiac death')/exp OR (('heart arrest')/exp) OR (('sudden death')/exp)*	*171,966*
	#3	*(('sudden cardiac'):ti, ab, kw) OR (('sudden heart'):ti, ab, kw) OR (('unexplained cardiac'):ti, ab, kw) OR (('unexplained heart'):ti, ab, kw) OR (('sudden death'):ti, ab, kw) OR (('unexplained death'):ti, ab, kw) OR (('fatal arrhyth*'):ti, ab, kw) OR (('arrhythmic death'):ti, ab, kw) OR (('unexpected heart'):ti, ab, kw) OR (('unexpected cardiac'):ti, ab, kw) OR (('unexpected death'):ti, ab, kw)*	*72,791*
	#4	*#2 OR #3*	*195,249*
Low-and-Middle Income Countries	*#5 (economy terms)*	*("deprived countries":de, ti, ab OR "deprived country":de, ti, ab OR "deprived nation":de, ti, ab OR "deprived nations":de, ti, ab OR "deprived population":de, ti, ab OR "deprived populations":de, ti, ab OR "deprived world":de, ti, ab OR "developing countries":de, ti, ab OR "developing country":de, ti, ab OR "developing economies":de, ti, ab OR "developing economy":de, ti, ab OR "developing nation":de, ti, ab OR "developing nations":de, ti, ab OR "developing population":de, ti, ab OR "developing populations":de, ti, ab OR "developing world":de, ti, ab OR "lami countries":de, ti, ab OR "lami country":de, ti, ab OR "less developed countries":de, ti, ab OR "less developed country":de, ti, ab OR "less developed economies":de, ti, ab OR "less developed economy":de, ti, ab OR "less developed nation":de, ti, ab OR "less developed nations":de, ti, ab OR "less developed population":de, ti, ab OR "less developed populations":de, ti, ab OR "less developed world":de, ti, ab OR "lesser developed countries":de, ti, ab OR "lesser developed country":de, ti, ab OR "lesser developed economies":de, ti, ab OR "lesser developed economy":de, ti, ab OR "lesser developed nation":de, ti, ab OR "lesser developed nations":de, ti, ab OR "lesser developed population":de, ti, ab OR "lesser developed populations":de, ti, ab OR "lesser developed world":de, ti, ab OR "LMIC":de, ti, ab OR "LMICS":de, ti, ab OR "low gdp":de, ti, ab OR "low gnp":de, ti, ab OR "low gross domestic":de, ti, ab OR "low gross national":de, ti, ab OR "low income countries":de, ti, ab OR "low income country":de, ti, ab OR "low income economies":de, ti, ab OR "low income economy":de, ti, ab OR "low income nation":de, ti, ab OR "low income nations":de, ti, ab OR "low income population":de, ti, ab OR "low income populations":de, ti, ab OR "lower gdp":de, ti, ab OR "lower gnp":de, ti, ab OR "lower gross domestic":de, ti, ab OR "lower gross national":de, ti, ab OR "lower income countries":de, ti, ab OR "lower income country":de, ti, ab OR "lower income economies":de, ti, ab OR "lower income economy":de, ti, ab OR "lower income nation":de, ti, ab OR "lower income nations":de, ti, ab OR "lower income population":de, ti, ab OR "lower income populations":de, ti, ab OR "middle income countries":de, ti, ab OR "middle income country":de, ti, ab OR "middle income economies":de, ti, ab OR "middle income economy":de, ti, ab OR "middle income nation":de, ti, ab OR "middle income nations":de, ti, ab OR "middle income population":de, ti, ab OR "middle income populations":de, ti, ab OR "poor countries":de, ti, ab OR "poor country":de, ti, ab OR "Poor Economies":de, ti, ab OR "Poor Economy":de, ti, ab OR "poor nation":de, ti, ab OR "poor nations":de, ti, ab OR "poor population":de, ti, ab OR "poor populations":de, ti, ab OR "poor world":de, ti, ab OR "poorer countries":de, ti, ab OR "poorer country":de, ti, ab OR "Poorer Economies":de, ti, ab OR "Poorer Economy":de, ti, ab OR "poorer nation":de, ti, ab OR "poorer nations":de, ti, ab OR "poorer population":de, ti, ab OR "poorer populations":de, ti, ab OR "poorer world":de, ti, ab OR "third world":de, ti, ab OR "transitional countries":de, ti, ab OR "transitional country":de, ti, ab OR "Transitional Economies":de, ti, ab OR "Transitional Economy":de, ti, ab OR "under developed countries":de, ti, ab OR "under developed country":de, ti, ab OR "under developed economies":de, ti, ab OR "under developed economy":de, ti, ab OR "under developed nation":de, ti, ab OR "under developed nations":de, ti, ab OR "under developed population":de, ti, ab OR "under developed populations":de, ti, ab OR "under developed world":de, ti, ab OR "under served countries":de, ti, ab OR "under served country":de, ti, ab OR "under served nation":de, ti, ab OR "under served nations":de, ti, ab OR "under served population":de, ti, ab OR "under served populations":de, ti, ab OR "under served world":de, ti, ab OR "underdeveloped countries":de, ti, ab OR "underdeveloped country":de, ti, ab OR "underdeveloped economies":de, ti, ab OR "underdeveloped economy":de, ti, ab OR "underdeveloped nation":de, ti, ab OR "underdeveloped nations":de, ti, ab OR "underdeveloped population":de, ti, ab OR "underdeveloped populations":de, ti, ab OR "underdeveloped world":de, ti, ab OR "underserved countries":de, ti, ab OR "underserved country":de, ti, ab OR "underserved nation":de, ti, ab OR "underserved nations":de, ti, ab OR "underserved population":de, ti, ab OR "underserved populations":de, ti, ab OR "underserved world":de, ti, ab)*	*27,281*

Contd...

S1 Appendix: Contd...

Search Strategy for Embase:

	#6 (country names)	*(Afghanistan: de, ti, ab OR Albania: de, ti, ab OR Algeria: de, ti, ab OR "American Samoa":de, ti, ab OR Angola: de, ti, ab OR Argentina: de, ti, ab OR "Argentine Republic":de, ti, ab OR Armenia: de, ti, ab OR Azerbaijan: de, ti, ab OR Bangladesh: de, ti, ab OR Belarus: de, ti, ab OR Byelarus: de, ti, ab OR Belorussia: de, ti, ab OR Belize: de, ti, ab OR Benin: de, ti, ab OR Bhutan: de, ti, ab OR Bolivia: de, ti, ab OR Bosnia: de, ti, ab OR Botswana: de, ti, ab OR Brazil: de, ti, ab OR Bulgaria: de, ti, ab OR Burma: de, ti, ab OR "Burkina Faso":de, ti, ab OR Burundi: de, ti, ab OR "Cabo Verde":de, ti, ab OR "Cape verde":de, ti, ab OR Cambodia: de, ti, ab OR Cameroon: de, ti, ab OR "Central African Republic":de, ti, ab OR Chad: de, ti, ab OR China: de, ti, ab OR Colombia: de, ti, ab OR Comoros: de, ti, ab OR Comores: de, ti, ab OR Comoro: de, ti, ab OR Congo: de, ti, ab OR "Costa Rica":de, ti, ab OR "Cote d Ivoire":de, ti, ab OR Cuba: de, ti, ab OR Djibouti: de, ti, ab OR Dominica: de, ti, ab OR "Dominican Republic":de, ti, ab OR Ecuador: de, ti, ab OR Egypt: de, ti, ab OR "El Salvador":de, ti, ab OR Eritrea: de, ti, ab OR Ethiopia: de, ti, ab OR Fiji: de, ti, ab OR Gabon: de, ti, ab OR Gambia: de, ti, ab OR Gaza: de, ti, ab OR "Georgia Republic":de, ti, ab OR Georgian: de, ti, ab OR Ghana: de, ti, ab OR Grenada: de, ti, ab OR Grenadines: de, ti, ab OR Guatemala: de, ti, ab OR Guinea: de, ti, ab OR "Guinea Bissau":de, ti, ab OR Guyana: de, ti, ab OR Haiti: de, ti, ab OR Herzegovina: de, ti, ab OR Hercegovina: de, ti, ab OR Honduras: de, ti, ab OR India: de, ti, ab OR Indonesia: de, ti, ab OR Iran: de, ti, ab OR Iraq: de, ti, ab OR Jamaica: de, ti, ab OR Jordan: de, ti, ab OR Kazakhstan: de, ti, ab OR Kenya: de, ti, ab OR Kiribati: de, ti, ab OR Korea: de, ti, ab OR Kosovo: de, ti, ab OR Kyrgyz: de, ti, ab OR Kirghizia: de, ti, ab OR Kirghiz: de, ti, ab OR Kirgizstan: de, ti, ab OR Kyrgyzstan: de, ti, ab OR "Lao PDR":de, ti, ab OR Laos: de, ti, ab OR Lebanon: de, ti, ab OR Lesotho: de, ti, ab OR Liberia: de, ti, ab OR Libya: de, ti, ab OR Macedonia: de, ti, ab OR Madagascar: de, ti, ab OR Malawi: de, ti, ab OR Malay: de, ti, ab OR Malaya: de, ti, ab OR Malaysia: de, ti, ab OR Maldives: de, ti, ab OR Mali: de, ti, ab OR "Marshall Islands":de, ti, ab OR Mauritania: de, ti, ab OR Mauritius: de, ti, ab OR Mexico: de, ti, ab OR Micronesia: de, ti, ab OR Moldova: de, ti, ab OR Mongolia: de, ti, ab OR Montenegro: de, ti, ab OR Morocco: de, ti, ab OR Mozambique: de, ti, ab OR Myanmar: de, ti, ab OR Namibia: de, ti, ab OR Nauru: de, ti, ab OR Nepal: de, ti, ab OR Nicaragua: de, ti, ab OR Niger: de, ti, ab OR Nigeria: de, ti, ab OR Pakistan: de, ti, ab OR Palau: de, ti, ab OR Panama: de, ti, ab OR "Papua New Guinea":de, ti, ab OR Paraguay: de, ti, ab OR Peru: de, ti, ab OR Philippines: de, ti, ab OR Phillippines: de, ti, ab OR Philipines: de, ti, ab OR Phillipines: de, ti, ab OR Principe: de, ti, ab OR Romania: de, ti, ab OR Rwanda: de, ti, ab OR Ruanda: de, ti, ab OR Samoa: de, ti, ab OR "Sao Tome":de, ti, ab OR Senegal: de, ti, ab OR Serbia: de, ti, ab OR "Sierra Leone":de, ti, ab OR "Solomon Islands":de, ti, ab OR Somalia: de, ti, ab OR "South Africa":de, ti, ab OR "South Sudan":de, ti, ab OR "Sri Lanka":de, ti, ab OR "St Lucia":de, ti, ab OR "St Vincent":de, ti, ab OR Sudan: de, ti, ab OR Surinam: de, ti, ab OR Suriname: de, ti, ab OR Swaziland: de, ti, ab OR Syria: de, ti, ab OR "Syrian Arab Republic":de, ti, ab OR Tajikistan: de, ti, ab OR Tadzhikistan: de, ti, ab OR Tadjikistan: de, ti, ab OR Tadzhik: de, ti, ab OR Tanzania: de, ti, ab OR Thailand: de, ti, ab OR Timor: de, ti, ab OR Togo: de, ti, ab OR Tonga: de, ti, ab OR Tunisia: de, ti, ab OR Turkey: de, ti, ab OR Turkmen: de, ti, ab OR Turkmenistan: de, ti, ab OR Tuvalu: de, ti, ab OR Uganda: de, ti, ab OR Ukraine: de, ti, ab OR Uzbek: de, ti, ab OR Uzbekistan: de, ti, ab OR Vanuatu: de, ti, ab OR Venezuela: de, ti, ab OR Vietnam: de, ti, ab OR "West Bank":de, ti, ab OR Yemen: de, ti, ab OR Zambia: de, ti, ab OR Zimbabwe: de, ti, ab)*	*2,100,022*
	#7	*#5 OR #6*	*2,211,617*
Final		*#1 AND #4 AND #7*	*1,622*

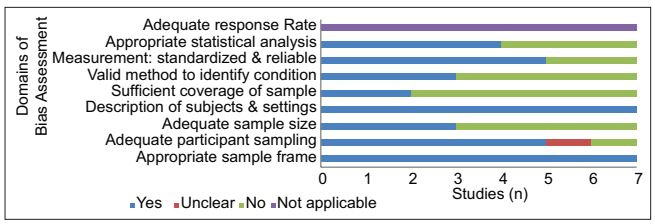
Search Strategy for PubMed

Incidence	*#1*	*(incidenc* [MeSH Terms]) OR (prevalenc* [MeSH Terms])*	*599,798*
	#2	*"incidenc*"[Title/Abstract] OR "prevalenc*"[Title/Abstract] OR "frequenc*"[Title/Abstract]*	*2,479,937*
	#3	*#1 OR #2*	*2,642,983*
SCD	*#4*	*"heart arrest"[MeSH Terms] OR "death, sudden, cardiac"[MeSH Terms] OR "death, sudden"[MeSH Terms]*	*73,777*
	#5	*"sudden cardiac"[Text Word] OR "sudden heart"[Text Word] OR "unexplained cardiac"[Text Word] OR "unexplained heart"[Text Word] OR "sudden death"[Text Word] OR "unexplained death"[Text Word] OR "fatal arrhyth*"[Text Word] OR "arrhythmic death"[Text Word] OR "unexpected heart"[Text Word] OR "unexpected cardiac"[Text Word] OR "unexpected death"[Text Word]*	*52,897*
	#6	*#4 OR #5*	*99,402*
Low-and-Middle Income Countries	*#7 (economy terms)*	*(Deprived Countries[tw] OR Deprived Population[tw] OR Deprived Populations[tw] OR Developing Countries[tw] OR Developing Country[tw] OR Developing Economies[tw] OR Developing Economy[tw] OR Developing Nation[tw] OR Developing Nations[tw] OR Developing Population[tw] OR Developing Populations[tw] OR Developing World[tw] OR LAMI Countries[tw] OR LAMI Country[tw] OR Less Developed Countries[tw] OR Less Developed Country[tw] OR Less Developed Economies [tw] OR Less Developed Nation[tw] OR Less Developed Nations[tw] OR Less Developed World[tw] OR Lesser Developed Countries[tw] OR Lesser Developed Nations[tw] OR LMIC[tw] OR LMICS[tw] OR Low GDP[tw] OR Low*	*186,837*

Contd...

S1 Appendix: Contd...

Search Strategy for PubMed			
		GNP[tw] OR Low Gross Domestic[tw] OR Low Gross National[tw] OR Low Income Countries[tw] OR Low Income Country[tw] OR Low Income Economies [tw] OR Low Income Economy[tw] OR Low Income Nations[tw] OR Low Income Population[tw] OR Low Income Populations[tw] OR Lower GDP[tw] OR lower gross domestic[tw] OR Lower Income Countries[tw] OR Lower Income Country[tw] OR Lower Income Nations[tw] OR Lower Income Population[tw] OR Lower Income Populations[tw] OR Middle Income Countries[tw] OR Middle Income Country[tw] OR Middle Income Economies [tw] OR Middle Income Nation[tw] OR Middle Income Nations[tw] OR Middle Income Population[tw] OR Middle Income Populations[tw] OR Poor Countries[tw] OR Poor Country[tw] OR Poor Economies [tw] OR Poor Economy[tw] OR Poor Nation[tw] OR Poor Nations[tw] OR Poor Population[tw] OR Poor Populations[tw] OR poor world[tw] OR Poorer Countries[tw] OR Poorer Economies [tw] OR Poorer Economy[tw] OR Poorer Nations[tw] OR Poorer Population[tw] OR Poorer Populations[tw] OR Third World[tw] OR Transitional Countries[tw] OR Transitional Country[tw] OR Transitional Economies[tw] OR Transitional Economy[tw] OR Under Developed Countries[tw] OR Under Developed Country[tw] OR under developed nations[tw] OR Under Developed World[tw] OR Under Served Population[tw] OR Under Served Populations[tw] OR Underdeveloped Countries[tw] OR Underdeveloped Country[tw] OR underdeveloped economies[tw] OR underdeveloped nations[tw] OR underdeveloped population[tw] OR Underdeveloped World[tw] OR Underserved Countries[tw] OR Underserved Nations[tw] OR Underserved Population[tw] OR Underserved Populations[tw])	
#8 (country names)	*(Afghanistan[tw] OR Albania[tw] OR Algeria[tw] OR "American Samoa"[tw] OR Angola[tw] OR Argentina[tw] OR "Argentine Republic"[tw] OR Armenia[tw] OR Azerbaijan[tw] OR Bangladesh[tw] OR Belarus[tw] OR Byelarus[tw] OR Belorussia[tw] OR Belize[tw] OR Benin[tw] OR Bhutan[tw] OR Bolivia[tw] OR Bosnia[tw] OR Botswana[tw] OR Brazil[tw] OR Bulgaria[tw] OR Burma[tw] OR "Burkina Faso"[tw] OR Burundi[tw] OR "Cabo Verde"[tw] OR "Cape verde"[tw] OR Cambodia[tw] OR Cameroon[tw] OR "Central African Republic"[tw] OR Chad[tw] OR China[tw] OR Colombia[tw] OR Comoros[tw] OR Comores[tw] OR Comoro[tw] OR Congo[tw] OR "Costa Rica"[tw] OR "Côte d'Ivoire"[tw] OR Cuba[tw] OR Djibouti[tw] OR Dominica[tw] OR "Dominican Republic"[tw] OR Ecuador[tw] OR Egypt[tw] OR "El Salvador"[tw] OR Eritrea[tw] OR Ethiopia[tw] OR Fiji[tw] OR Gabon[tw] OR Gambia[tw] OR Gaza[tw] OR "Georgia Republic"[tw] OR Georgian[tw] OR Ghana[tw] OR Grenada[tw] OR Grenadines[tw] OR Guatemala[tw] OR Guinea[tw] OR "Guinea Bissau"[tw] OR Guyana[tw] OR Haiti[tw] OR Herzegovina[tw] OR Hercegovina[tw] OR Honduras[tw] OR India[tw] OR Indonesia[tw] OR Iran[tw] OR Iraq[tw] OR Jamaica[tw] OR Jordan[tw] OR Kazakhstan[tw] OR Kenya[tw] OR Kiribati[tw] OR Korea[tw] OR Kosovo[tw] OR Kyrgyz[tw] OR Kirghizia[tw] OR Kirghiz[tw] OR Kirgizstan[tw] OR Kyrgyzstan[tw] OR "Lao PDR"[tw] OR Laos[tw] OR Lebanon[tw] OR Lesotho[tw] OR Liberia[tw] OR Libya[tw] OR Macedonia[tw] OR Madagascar[tw] OR Malawi[tw] OR Malay[tw] OR Malaya[tw] OR Malaysia[tw] OR Maldives[tw] OR Mali[tw] OR "Marshall Islands"[tw] OR Mauritania[tw] OR Mauritius[tw] OR Mexico[tw] OR Micronesia[tw] OR Moldova[tw] OR Mongolia[tw] OR Montenegro[tw] OR Morocco[tw] OR Mozambique[tw] OR Myanmar[tw] OR Namibia[tw] OR Nauru[tw] OR Nepal[tw] OR Nicaragua[tw] OR Niger[tw] OR Nigeria [tw] OR Pakistan [tw] OR Palau[tw] OR Panama[tw] OR "Papua New Guinea"[tw] OR Paraguay[tw] OR Peru [tw] OR Philippines[tw] OR Phillippines[tw] OR Philipines[tw] OR Phillipines[tw] OR Principe[tw] OR Romania[tw] OR Rwanda[tw] OR Ruanda[tw] OR Samoa[tw] OR "Sao Tome"[tw] OR Senegal[tw] OR Serbia[tw] OR "Sierra Leone"[tw] OR "Solomon Islands"[tw] OR Somalia[tw] OR "South Africa"[tw] OR "South Sudan"[tw] OR "Sri Lanka"[tw] OR "St Lucia"[tw] OR "St Vincent"[tw] OR Sudan[tw] OR Surinam[tw] OR Suriname[tw] OR Swaziland[tw] OR Syria[tw] OR "Syrian Arab Republic"[tw] OR Tajikistan[tw] OR Tadzhikistan[tw] OR Tadjikistan[tw] OR Tadzhik[tw] OR Tanzania[tw] OR Thailand[tw] OR Timor[tw] OR Togo[tw] OR Tonga[tw] OR Tunisia[tw] OR Turkey[tw] OR Turkmen[tw] OR Turkmenistan[tw] OR Tuvalu[tw] OR Uganda[tw] OR Ukraine[tw] OR Uzbek[tw] OR Uzbekistan[tw] OR Vanuatu[tw] OR Venezuela[tw] OR Vietnam[tw] OR "West Bank"[tw] OR Yemen[tw] OR Zambia[tw] OR Zimbabwe[tw])*	*1,797,106*
#9	*#7 OR #8*	*1,885,006*
Final	*#3 AND #6 AND #9*	*842*



S2 Appendix: Risk of Bias Assessment: Joanna Briggs Institute -- Checklist for Prevalence Studies (16)

S3 Appendix: PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
		TITLE	
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
		ABSTRACT	
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
		INTRODUCTION	
Rationale	3	Describe the rationale for the review in the context of what is already known.	3, 4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
		METHODS	
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4 (registration information)
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix A (pg. 18-19)
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias in individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
		RESULTS	
Study selection	17	Give the numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6, 7 Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7-9 Table 1.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
		DISCUSSION	
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policymakers).	11-13

Contd...

S3 Appendix: Contd...

Section/topic	#	Checklist item	Reported on page #
		DISCUSSION	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias).	12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	11-13
		FUNDING	
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	14

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6 (7): e1000097. doi: 10.1371/journal.pmed1000097