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Review

Application of the concept 'avoidable mortality' in assessing the socioeconomic status related inequalities in health: a scoping review

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Abstract

Introduction Avoidable mortality is widely used by public health researchers to measure population health, and many related methodologies have been proposed for doing so. This scoping review presents a comprehensive view of global peer-reviewed and grey literature exploring the association between socioeconomic status (SES) and avoidable mortality.
Methods We searched Ovid Medline, Scopus, and Web of Science to find articles that investigated SES inequalities in avoidable mortality. We limited our review to articles in English published between 2000 and 2020. For grey literature, we searched leading global and Canadian health information websites. We extracted data on different study characteristics, avoidable mortality definition, SES indicator, method of analysis of the association between avoidable mortality and SES, and main findings of the studies.
Results We identified 34 articles to review, including 29 scientific papers and 5 grey literature documents. The findings of the selected articles consistently indicate a negative association between SES and avoidable mortality rates. Studies have not all used the same definitions of avoidable mortality or SES nor operationalized them in the same way.
Conclusion Our review highlights the absence of a globally standard definition in avoidable mortality health equity research. Additional work to establish a standardized definition is crucial for supporting global comparability.

Keywords Premature mortality · Socioeconomic factors · Health inequities · Health status disparities · Systematic review

1 Introduction

Addressing health inequities requires improved measurement, monitoring, and reporting of population health status and its association with social determinants of health [1–3]. Avoidable mortality, a subset of premature mortality, is widely used by public health researchers to measure population health, and many related methodologies have been proposed for doing so. This scoping review presents a comprehensive view of global peer-reviewed and grey literature exploring the association between socioeconomic status (SES) and avoidable mortality. The studies tend to vary not only in how they define avoidable mortality but also in how they measure SES and the association between them. We also report on

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how these studies do or do not standardize their results for age and sex and encapsulate their main findings with respect to SES inequalities. Our aim is to facilitate a more widespread and in-depth analysis of inequities in avoidable mortality by consolidating these resources in one location.

Avoidable mortality is a relatively new concept, with corresponding methodologies still under refinement. In 1976, the Working Group on Preventable and Manageable Diseases, chaired by Rutstein, introduced the new concept of "unnecessary untimely death" as a health outcome indicator designed to evaluate the quality of medical care [4]. Subsequently, an American research group empirically applied this concept to "demonstrate the usefulness of this approach" as a measure of healthcare quality [5, 6]. The term "avoidable mortality" came into use following a study by Charlton et al. investigating geographical variation in mortality across England and Wales [7]. While premature death is defined as mortality that happens before a certain age, for example, before 75 years of age [8], "avoidable mortality" refers to premature deaths that could have been avoided in the presence of timely and effective health and social policies and public health interventions aimed at addressing the social determinants of health or reducing risk factors contributing to ill health [8]. Nevertheless, researchers do not adopt a uniform approach to conceptualizing "avoidable mortality," and it is not always clear whether the terms "avoidable," "amenable," "preventable," and "unnecessary" causes of death are being used interchangeably in the literature [9, 10]. Over time, researchers have refined and updated the list of avoidable causes of death used to classify mortality events as avoidable to suit the situational context of their research [8, 11–16]. Recently, there have been efforts to propose standardized global definitions of avoidable mortality, as seen in the work of the Organization for Economic Co-operation and Development (OECD) and the Office for National Statistics (ONS) [17–19]. These standardized definitions are pivotal for reliable comparison of health indicators within or between countries [20].

Avoidable mortality is an important summary measure of overall population health status [8], and one of its many applications has been as an indicator of health equity [5, 21]. Researchers have used avoidable mortality to investigate health inequity with the goal of informing political decisions trying to address health inequity [11, 22–26]. Socioeconomic status (SES) is one of the most important "fundamental causes" of disparities in morbidity and mortality [27, 28]. People with lower SES have access to a limited range of resources, such as money, knowledge, prestige, social capital, and power, which could affect their health through many pathways; lack of these resources exposes individuals to a higher risk of mortality [27]. These deaths could be avoided by appropriate means such as timely and effective treatment or the application of health and social policies.

2 Methods

We used Arksey and O'Malley's framework [29] to conduct this scoping review in five stages:

2.1 Identification of studies

Our central question in this review was "How have avoidable mortality and inequalities therein been defined and operationalized in studies investigating SES inequalities in avoidable mortality?" To answer this question, we developed a search strategy (see Additional file: Appendix A) to find relevant articles by searching Ovid Medline, Scopus, and Web of Science, narrowing down the results to English language and publication dates from 2000 to 2020. We omitted PubMed in our search since the Ovid Medline interface allows a more focused search, excluding citations such as "in process" and "ahead of print" articles [30], which were not of interest to the current review. All the searches were conducted on June 18th, 2020. For grey literature, first, we searched several leading international websites, including Google, Google Scholar, The World Health Organization (WHO) [31], United Nations [32], and Organization for Economic Co-operation and Development (OECD) [33]. We expanded our search by choosing Canada as a sample for a more thorough grey-literature search since our research team is located in Canada. We searched leading Canadian health information websites, including Public Health Agency of Canada (PHAC) [34] restricting our review to the first 5 pages, with 10 results on each page. The following websites were also searched with no restriction on page numbers of the search results: Canadian Institute for Health Information (CIHI) [35]; National Collaborating Center for Determinants of Health [36]; and Ontario Public Health Libraries Association (OPHLA)-Custom Search Engine for Canadian Public Health information [37]. For this study we also partnered with the Urban Public Health Network (UPHN), an association of urban local public health units in Canada; in order to ensure coverage of their membership, we also included their websites in our grey literature search (see Additional file: Appendix B) with no restriction on the page numbers of the search results. The keywords searched to capture relevant grey literature included "avoidable mortality," "avoidable death," "preventable mortality," "preventable death," "amenable mortality," and "amenable death." We did not include the keyword "premature death" as we were focused on avoidable mortality.

2.2 Screening and identifying relevant studies

All the articles were imported into Rayyan® for deduplication and title and abstract screening. The first author reviewed the articles by title and abstract to find relevant studies using the inclusion–exclusion criteria in Table 1. We were only interested in articles investigating socioeconomic status indicators as they are amongst those most frequently implicated as a contributor to inequities in health [38]. Although there is debate about how and whether SES can be measured [39], researchers often consider factors such as income, education, employment, and occupation to assess SES, analyzing them either individually or combining them into a single indicator. These indicators are usually measured at the household or area level so that they can relate to children's health outcomes as well. We excluded articles investigating a specific cause of death or premature mortality since they are different from indicators of avoidable mortality. As we were interested in studies investigating the entire avoidable mortality at-risk population (aged 0 to 65 or 75), we excluded articles that limited their analysis to only a subset of this population, such as one sex, race, or children. The strict inclusion–exclusion criteria and minimal risk of misclassifying articles led us to use a single reviewer for screening and selecting the articles.

2.3 Selecting eligible studies

After screening the titles and abstracts, the selected articles were transferred from Rayyan® to Paperpile® for in-depth, full-text review. At this stage, the first author evaluated the complete texts using the inclusion–exclusion criteria, determining the final article selection. Once all articles from the searched databases were assessed, the first author applied the criteria outlined in Table 1 to evaluate results from the grey literature search and decide on their inclusion in the review. Finally, the reference lists of all chosen articles were examined to identify any additional pertinent studies.

2.4 Charting the data

We created a spreadsheet to catalog characteristics and data from the chosen articles and grey literature. This form captured details such as the study's timeframe, design, region examined, unit of analysis, population, SES indicators, definition of avoidable mortality, upper age boundaries, avoidable mortality measurement methods, and techniques used to analyze the relationship between avoidable mortality and SES. Additionally, we documented findings regarding the association between SES and avoidable mortality, the International Classification of Diseases (ICD) codes employed to identify avoidable deaths, and the classification of Ischaemic Heart Disease (IHD).

2.5 Collating, summarizing, and reporting the results

Finally, we compiled, summarized, and presented the gathered data. We highlighted the definitions of avoidable mortality used across the articles and determined whether Ischaemic Heart Disease was considered an avoidable cause of death. We summarized the insights from the articles regarding SES disparities in avoidable mortality and identified the

Table 1 Inclusion and exclusion criteria for selecting the articles and grey literature

Inclusion criteria
(1) Articles which quantitatively evaluated socioeconomic inequalities in any type of avoidable mortality, defined as premature mortalities which could have been potentially avoided through primary, secondary, or tertiary prevention measures
(2) Articles whose socioeconomic status of interest are one or more of income, education, and employment/occupation indicators
Exclusion criteria
(1) Articles investigating a specific cause of death (e.g., cancer mortality)
(2) Articles investigating premature mortality without mentioning avoidable/preventable/amenable mortality
(3) Articles that did not investigate the entire avoidable mortality at-risk population (i.e., 0 to 65 or 75 years of age,) assessing only a subsample of the population at-risk (e.g., recruitment of participants in a case–control study, a specific sex, children)

SES indicators employed. Moreover, we compared the list of avoidable mortalities of a sample of five articles that used different definitions of avoidable mortality to identify avoidable deaths.

3 Results

3.1 Search results

In total, we identified 2457 articles. Of these, 2436 articles were obtained by searching the three predetermined databases using our tailored syntax (see Additional file: Appendix A). From grey literature, we found 16 articles, and 5 more articles were identified by examining the reference lists of the included studies. The database search yielded 810 articles from Ovid Medline, 669 from Web of Science, and 957 from Scopus. After removing duplicates, 1393 potential records underwent title and abstract screening. Of these, 1301 were deemed irrelevant to our research and consequently excluded. This left 92 articles for a full-text review. From these, 58 were further excluded with the reasons for exclusion documented. Figure 1 offers a PRISMA flowchart detailing the selection process of this scoping review.

The grey literature search results were as follows: the World Health Organization (0 records); Public Health Agency of Canada (0 records); United Nations (1 record found and excluded after screening); OECD (1 record found and excluded after screening); CIHI (2 records found, 1 was included after screening); National Collaborating Center for Determinants of Health (1 record found and excluded after screening); OPHLA-Custom Search Engine for Canadian Public Health information (6 records found and 3 were included after screening). Additionally, we identified 5 records from the UPHN members' websites, of which one report was considered suitable for inclusion after the screening process.

In conclusion, 34 articles were selected for detailed review and data extraction, comprising 29 scientific papers and 5 grey literature documents.

3.2 Study designs and distribution by region and timeline

Studies of avoidable mortality heavily rely on having access to previously collected death data. Analyzing and disseminating this data demands time, so the study coverage years might not always match their publication dates. Figure 2 contrasts these trends, showcasing the years studied in blue and publication years in orange. A noteworthy observation is that a significant portion (7 out of 34 articles) were unveiled in 2019, with 4 classified as grey literature. Moreover, there's been a rising trend in the frequency of data collection annually from 1971 to 2016. Regarding the region of study, our findings indicate that the majority of the chosen articles originated from European nations, specifically England, Finland, Spain, France, Switzerland, and Hungary.

Most of the selected studies adopted quantitative observational approaches. To explore disparities in avoidable mortality, researchers employed a myriad of designs such as population-based, ecological, longitudinal, cross-sectional, prospective cohort surveys, exploratory spatial analysis, and official reports. The majority established an upper age threshold of 75 years. However, three distinct studies concentrated solely on deaths before age 65, covering the spans of 1971–2008, 1997–2001, and the 1990s, respectively [40–42].

3.3 Unit of analysis

The "unit of analysis" pertains to the level of grouping at which researchers measured avoidable mortality, subsequently stratifying these measurements based on SES to examine disparities. Most studies used small areas as their unit of analysis although the size of these areas varies between concepts and countries. These areas include the Lower Super Output Area (LSOA) in England [43, 44], Dissemination Area (DA) [8, 21, 44–47], health region [48], and Census Tract (CT) in Canada [49] and Spain [23, 24], commune and canton in France [41, 42], Local Government Area (LGA) [26, 50] and Statistical Local Area (SLA) [51, 52] in Australia, meshblock in New Zealand [53], districts in Brazil [54], neighborhoods [25, 55–57], and other small areas [11, 22, 58].

Only two studies used individual-level data for their analysis [59, 60]. A study carried out in Taiwan examined inequality between townships (city districts) [40], and three articles investigated SES inequality in avoidable mortality at the municipal level [61, 62]. Surenjav et al. examined both provincial and municipal (capital) data [63], and Neethling et al. compared provinces and population groups in their analysis [64]. Table 2 presents a summary of the selected articles' characteristics.

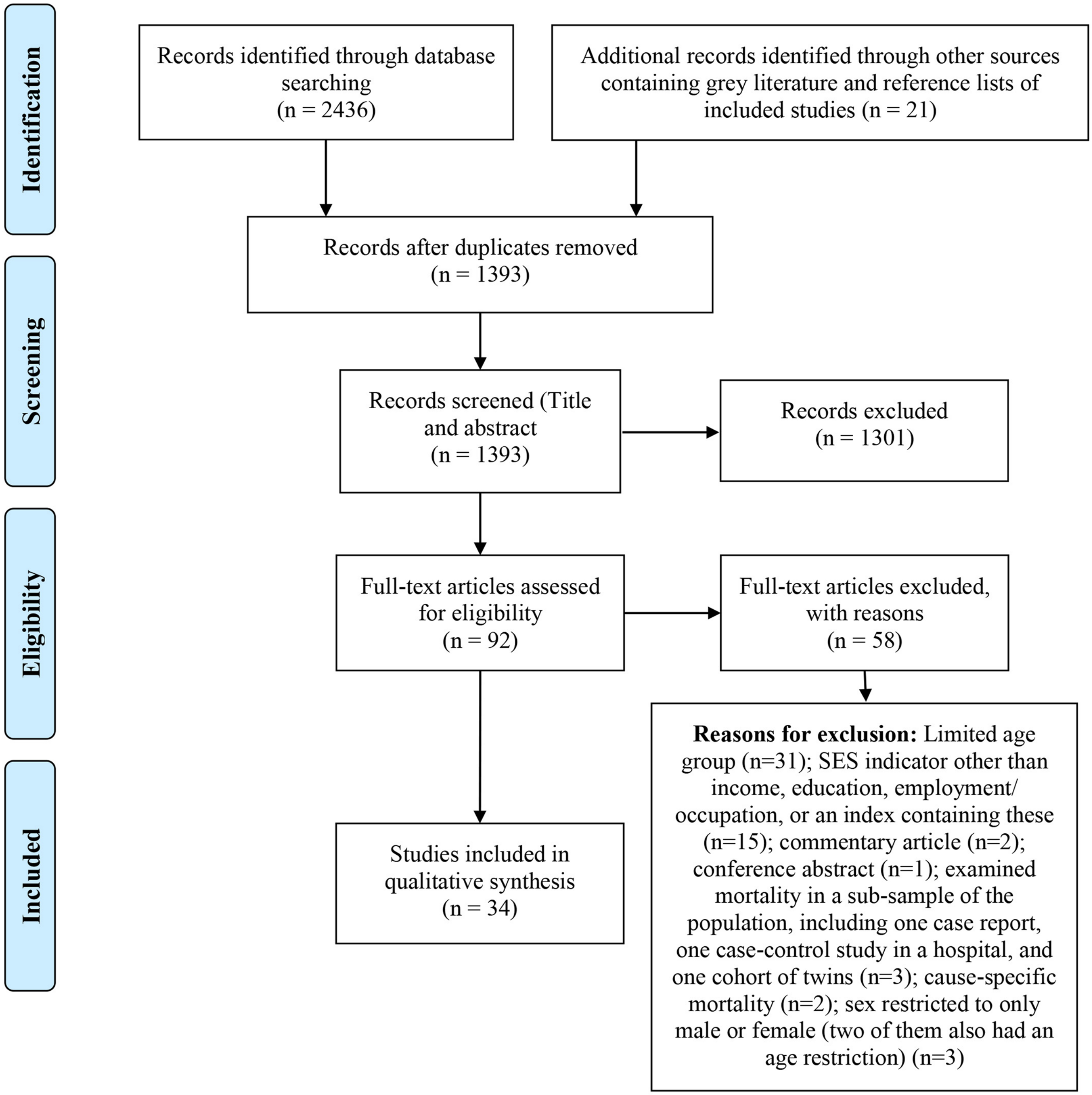

Fig. 1 PRISMA flow diagram

3.4 Avoidable mortality definitions and terminology

Researchers have used various definitions of avoidable mortality as the foundation for their studies and referred to it using different terminology. Table 3 displays the definitions adopted within the selected articles. While numerous studies adopted definitions proposed by other researchers or established organizations, several articles introduced their own distinct definitions of avoidable mortality, drawing from pertinent literature and consultations with expert panels.

There is a difference in how researchers phrase and conceptualize the type of mortality deemed avoidable. The term "amenable mortality" is mainly used to describe deaths that could have been averted through medical interventions. This term is often used interchangeably with "treatable mortality" in the literature [12, 65, 66]. A definition by

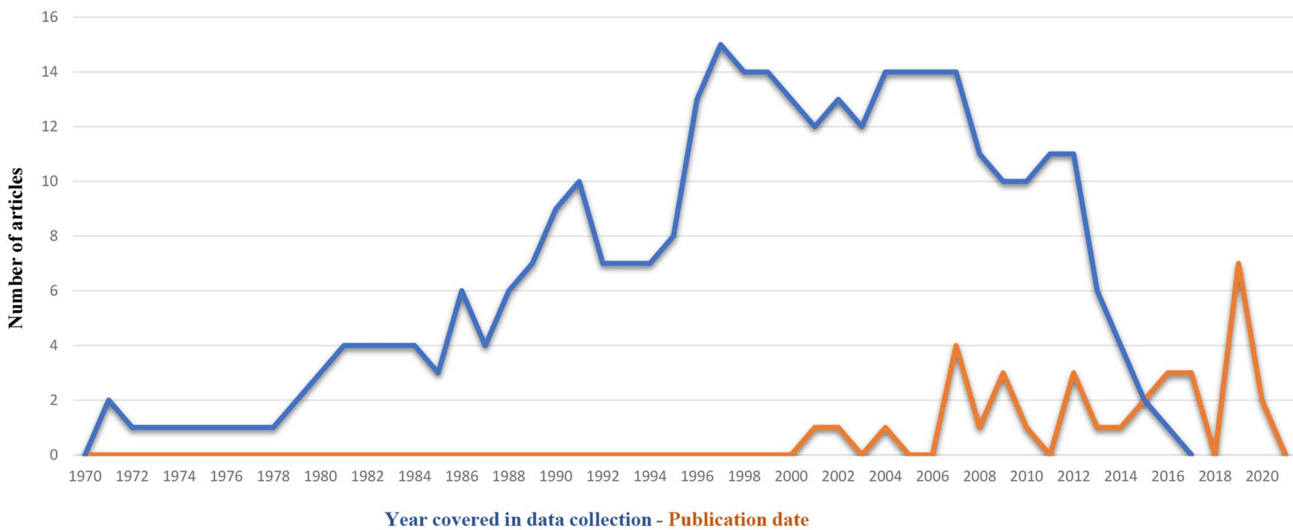

Fig. 2 Annual data collection frequency in selected studies (blue line) and publication dates (orange line)

Nolte and Mckee, which is widely used in the selected articles (cited in 11 studies when identifying avoidable deaths,) characterizes "amenable mortality" as premature deaths that could have been avoided through timely and effective health care (i.e., secondary and tertiary prevention) [12]. Consequently, their list of amenable causes does not include deaths preventable via public health policy interventions [12] which are referred to as "preventable mortality" and assessed by other researchers [46, 47, 67].

Conversely, certain definitions, such as the one tailored for the Canadian setting, do not use the term "amenable mortality" [8]. The Canadian Institute for Health Information (CIHI) categorizes "potentially avoidable mortality" into preventable and treatable mortality. Here, "preventable mortality" refers to deaths before the age of 75 that could have been potentially avoided through public health initiatives (i.e., primary prevention.) Meanwhile, "treatable mortality" pertains to premature deaths that could have been potentially avoided through health care interventions and treatments (i.e., secondary and tertiary prevention) [8].

Another important definition, which was published after our search, is that offered by the OECD [17]. In 2022, the OECD and Eurostat partnered to create joint lists of "avoidable" causes of death [17]. This definition builds upon the lists developed by Nolte and McKee [12], Eurostat [68], and CIHI [8], categorizing avoidable mortality into "preventable" and "treatable" mortalities. These categories are aligned with CIHI's definitions [17]. Within this framework, the term "amenable" from the prior Eurostat list has been rephrased as "treatable." Similarly, the NHS Outcome Framework [69] along with the Australian and New Zealand Atlas of Avoidable Mortality [66] classify avoidable deaths into "amenable" and "preventable" categories, resonating with CIHI's definition of "treatable" and "preventable" mortality.

Simonato et al. [13] and Tobias and Jackson [11] use unique terminology to define avoidable mortality. They partition avoidable mortality into three categories, each attributed to a set of mortalities that could be averted through one of the levels of prevention (i.e., primary, secondary, and tertiary levels). A detailed breakdown of the commonly used definitions in the selected articles is provided in Table 4.

3.5 Operationalization of avoidable mortality measures

Measures of avoidable mortality vary with respect to their operationalization using ICD codes (e.g., whether IHD is classified as avoidable). We evaluated the list of avoidable mortalities from five articles chosen at random and found significant variances. Table 5 presents these five articles, each tagged with a unique article code. These article codes serve as references when comparing their respective lists of avoidable mortality by ICD codes, as detailed in Additional file: Appendix C. These differences largely arise from the adoption of varied definitions of avoidable mortality. Another contributing factor is the timeframe in which these lists were created; perceptions of avoidability evolve over time due to advancements in healthcare services and public health.

Despite the diverse views on which causes of death are deemed avoidable across the selected articles (see Additional file: Appendix C) Ischemic Heart Disease (IHD) remains a focal point in discussions about avoidability and its

Table 2 Summary of the selected articles

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
ASIA						
Chen 2016	1971–2008	Longitudinal	Taiwan (354–358 townships)	Township (city district)	Mean annual household income	*Aggregated data*: In every period, the lowest income quartile had the highest age-standardized mortality rates, followed by areas in the second lowest, second highest and highest income quartiles. *Time trend*: Amenable mortality fell consistently form 1971–75 to 2006–08 across virtually all income quartiles, but fell faster in the more affluent townships than the less affluent townships
Surenjav 2016	2007–2014	Longitudinal	Mongolia	Provinces/capital	Percent of poor households	*Aggregated data*: Bivariate analysis did not reveal any significant association between crude AM and percent of poor households
AFRICA						
Neethling 2019	1997–2012	Population-based retrospective	South Africa	Province and population groups	Because of the existence of inequalities in education, income and welfare along racial lines due to the legacy of apartheid, apartheid classification was used as a proxy for SES	*Aggregated data*: In 2012, there were huge inequalities in amenable mortality between different population groups. The white population had a much lower proportion of amenable mortality (26.3%) compared with other population groups (> 48%), while the African population had the highest proportion (64.8%). *Time trend*: A disparity in age-standardized amenable mortality rate by population group in 2000 was evident, which widened each subsequent year until 2005 and narrowed thereafter. The African population had the highest age-standardized amenable mortality rate of all population groups over the period, which was 4.6 times that of the white population in 1997, increasing to 6.5 times in 2005
EUROPE						
Asaria 2016	2004/05–2011/12	Whole-population longitudinal	England	LSOA[c]	IMD[d] 2010	*Aggregated data*: There were substantial socio-economic gradients in amenable mortality indicators in 2004/2005. *Time trend*: Although amenable mortality indicators were improved between 2004/2005 and 2011/2012, the socio-economic gradient was persistent

Table 2 (continued)

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
Cookson 2017	2004/05–2011/12	Whole-population longitudinal	England and Ontario	LSOA (England), DA[e] (Ontario)	IMD 2010 (for England), ON-Marg[f] 2006 (for Ontario)	*Aggregated data*: A socioeconomic gradient was consistently observed for both jurisdictions in each year of the study period, with higher amenable mortality in more deprived areas
Feller 2017	1996–2010	Longitudinal	Switzerland and 16 high-income countries	Neighbourhood, country	Swiss-SEP[g]	*Aggregated data*: There was substantial socioeconomic inequalities in amenable mortality. All types of mortality showed increasing hazards with lower socioeconomic position
Hoffmann 2014	1995–2009	Ecological	15 large cities in Europe	Small area	Deprivation index	*Aggregated data*: All statistically significant rate ratios indicate a positive association between area deprivation and AM
Manderbacka 2013	1988–2007	Register- based cohort	Finland	Individuals	Household disposable income	*Aggregated data*: Mortality amenable to health policy measures contributed 35 per cent (4 years) to socio-economic differences in life expectancy at age 35. Mortality amenable to health care contributed 17 per cent (0.7 years) to the total difference between the highest and lowest income deciles
Nagy 2012	2004–2008	Ecological	Hungary	Municipality	Hungarian specific deprivation index	*Aggregated data*: Strong positive association was found between the risk of mortality amenable to health care and deprivation index
Nolasco 2009	1996–2003	Transversal ecological	Alicante, Castellon, and Valencia (Spain)	CT[h]	Deprivation index	*Aggregated data*: In all the three cities, the rate ratio of death for men in the least vs. highest privileged socioeconomic level was over 2; for women, these differences are only statistically significant in the city of Valencia
Nolasco 2015	1996–2001, 2002–2007	Ecological	33 Spanish cities	CT	SES variable	*Aggregated data*: The estimated rate ratios show the excess risk of death at the lowest level of SES compared to the highest level
Rey 2009	1997–2001	Cross-sectional	France	Commune[i]	Deprivation index (FDep99)[j]	*Aggregated data*: Avoidable mortality was much more strongly associated with the FDep99 index (+ 77% between the fifth and the first quintile), than the other causes for the same age group (+ 32%)

Table 2 (continued)

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
Windenberger 2012	1990s	Longitudinal ecological	France	'Commune' and 'canton'	Deprivation indexes (FDep)	*Time trend*: In 1988–92, the 'avoidable' mortality was 40% higher for the fifth deprivation quintile communes than for the first quintile communes (78% higher in 1997–2001). The increase in the association between the two periods was high for all the 'avoidable' causes of death considered separately
Weisz 2008	1988–90, 1998–2000	Cross-sectional	Paris, Inner London and Manhattan (France, England and Wales, US)	Neighbourhood	Pre tax average household income (for Paris and Manhattan), deprivation index (for London)	*Aggregated data*: The results from OLS[k] regression suggests a correlation between neighbourhood-level income and percentage of AM, during 1998–2000, in Manhattan at the 1% level, but no significant correlation in Paris or London at the 5% level. Despite this correlation, negative binomial regression results reveal that residence in a low income neighbourhood, as compared to the remainder of the city, is significantly correlated with increased AM rates per 1000 population in all three urban cores
OCEANIA						
Hayen 2002	1980–2000	Longitudinal	New South Wales, Australia	LGA[l]	IRSD[m]	*Trends in time*: Rates of PAM[n] have decreased steeply for the three SES groups. However, the decrease has been more rapid for the highest SES group. Therefore, there was an increased relative gap between the highest SES group and the two lower SES groups. By contrast, the relative gap between the lowest and middle decreased slightly for males and remained almost constant for females
Butler 2010	2002–06	Exploratory spatial analysis	Australia	SLA[o]	A composite score of deprivation (remoteness areas, physician to population ratios, and IRSD)	*Aggregated data*: There was a strong relationship between the combined score of deprivation and AM

Table 2 (continued)

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
Korda 2007	1986,1991, 1997, 2002	Longitudinal	Australia	SLA	Index of disadvantage (percentage of low-income families and percentage of early school leavers)	*Aggregated data*: The incidence rate differences and rate ratios comparing Q1 with Q5 in each year show significant absolute and relative socioeconomic inequality, respectively, in both avoidable and non-avoidable mortality. *Time trend*: The annual percentage decline in AM at the higher end of the socioeconomic continuum was larger than at the lower end, with increasing relative inequality between 1986 and 2002. The absolute inequality decreased between 1986 and 2002
Piers 2007	1979–2001	Longitudinal	Victoria, Australia	LGA	IRSD	*Aggregated data*: There was a clear gradient in total AM rates, highest in the most disadvantaged and lowest in the least disadvantaged IRSD quintile
Tobias 2001	1996, 1997	Cross-sectional	New Zealand	Small area	NZDep96[p] index	*Aggregated data*: With few exceptions, all the conditions included in the AM category show a socioeconomic gradient in cause specific mortality. The gradient is steepest for Secondary Avoidable Mortality (SAM) and flattest for Tertiary Avoidable Mortality (TAM)
Tobias 2007	2000–02	Cross-sectional	New Zealand	Small area	NZDep2001 index	*Aggregated data*: Variations in amenable mortality make a substantial contribution to inequalities in mortality for socioeconomic (deprivation) groups
Tobias 2009	1981–84 to 2001–04	Population-based	New Zealand	Meshblock (approximately 100 people)	Income	*Aggregated data*: Absolute income inequality was found in all-cause mortality. Amenable mortality contributed 20.8% and 27.4% to income inequality in all-cause mortality in 2001–04, and 28.4% and 32.6% in 1981–04, for males and females respectively

Table 2 (continued)

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
SOUTH AMERICA						
Grafova 2020	2003–2013	Ecological	São Paulo, Brazil	Districts as proxies for neighbourhood	Educational attainment and two measures of neighbourhood income	*Aggregated data*: In low-income districts, AM rate was more than 1.5 times greater than in high-income districts. Regarding Bolsa Familia and AM, no significant relationship was found. Increased literacy rates are predicted to improve significantly AM in high-income districts. *Time trend*: This difference is persistent during the 2003–2013, when AM rate declined across districts of different income levels
NORTH AMERICA						
Ronzio 2004	1989, 1990, 1991	Cross-sectional ecological	Central cities the United States	City	Percentage in poverty	*Aggregated data*: Income inequality has a stronger correlation with mortalities attributable to preventable or immediate causes compared with all cause mortality
Masters 2015	1986–2006	Retrospective longitudinal	United States	Individuals	Educational attainment	*Aggregated data*: Larger education gradients in mortality risk were found for causes of death that are under greater human control than for less preventable causes of death
James 2007	1971, 1986, 1991, 1996	Longitudinal	Canada- metropolitan areas	Neighbourhood (CT)	Income	*Aggregated data*: In 1996, avoidable causes of death together accounted for about half (49.6%) of all income-related excess mortality among men, and 42% among women
Khan 2017	2002–2012	Population-based longitudinal	Ontario, Canada	DA	Income and education	*Aggregated data*: There was a downward gradient in age-adjusted AM rates with increasing in the income and education level, for immigrants and long-term residents
Young 2019	2012–2014	Population-based	18 northern regions, Canada	Health region	Education, employment, income	*Aggregated data*: There was a strong influence of SES on PAM, with lower PAM in higher levels of SES. The correlation for income was less strong than attained education and employment
Zygmunt 2019	1993–2014	retrospective population-based	Ontario, Canada	Neighbourhood (DA)	ON-Marg	*Time trend*: Avoidable mortality rates almost haved (48.6%) from 1993 to 2014. The inequity gap in AM rate ratio between the most and least marginalized quintiles widened for all marginalization dimensions

Table 2 (continued)

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
Zygmunt 2020	1993–2014	Retrospective population-based	Ontario, Canada	Neighbourhood (DA)	ON-Marg	*Aggregated data*: Results from logistic regression shows decedents living in the most (Q5) materially deprived and residentially unstable neighbourhoods had significantly greater AM than those living in the least marginalized neighbourhoods (Q1). *Time trend*: Overall, AM rates were almost halved (48.6%) from 1993 to 2014. Compared with treatable AM, preventable AM contributed the greater proportion of all avoidable deaths, increasing from a ratio of approximately 1.5:1 in 1993 to approximately 2:1 in 2014
GREY LITERATURE—CANADA						
CIHI[q] 2012	2005–2007	Annual report	Canada	Neighbourhood (DA)	Income	*Aggregated data*: For both preventable and treatable mortality, there were gradients in the rates by socio-economic group. Mortality rates were consistently higher among people living in the least affluent neighbourhoods, with rates gradually decreasing as socio-economic status increased. Socio-economic gradients were steeper for preventable mortality than for mortality from treatable causes
Cui 2019	2007–2016	Provincial report	Manitoba, Canada	NA	Income	*Aggregated data*: There were strong relationships between income and potentially avoidable death rates in urban and rural areas in both time periods. In urban settings, the rate of potentially avoidable deaths for residents of the lowest income areas was about 3.7 times higher than residents of the highest income areas in T1 (2007–2011) and T2 (2012–2016). In rural settings, the rate of potentially avoidable deaths for residents living in the lowest income areas was about 2.2 times higher than for residents of the highest income areas in T2
MLHU 2019	2011–2012	Report	Middlesex-London, ON, Canada	Neighbourhood	ON-Marg	*Aggregated data*: Significant differences in potentially avoidable mortality existed between populations living in neighbourhoods with differing levels of socio-economic status. *Time trend*: Inequalities between low socioeconomic status and high socioeconomic status persisted for all years between 2003 and 2012
MLHU 2019	2011–2015	Report	Middlesex-London, ON, Canada	Neighbourhood	Material deprivation	*Aggregated data*: Preventable mortality increased with each material deprivation quintile and varied significantly by material deprivation quintile on average from 2011 to 2015

Table 2 (continued)

First author, year	Data years	Study design	Study region	Unit of analysis	SES[a] indicator	Findings (association between SES and AM[b])
Rasali 2019	2009–2013	Provincial report	British Columbia, Canada	DA	Income, education, employment, social and material deprivation indices	*Aggregated data*: Analysis of rates by income, education, employment, social deprivation, and material deprivation showed declines in preventable premature mortality as socio-economic conditions improve. Rates for treatable premature mortality showed a similar pattern, except having smaller disparity ratios for the socio-economic dimensions

[a]Socioeconomic status
[b]Avoidable mortality
[c]Lower super output area
[d]Index of multiple deprivation
[e]Dissemination area
[f]Ontario marginalization material deprivation index
[g]Area-based index of Swiss socioeconomic position
[h]Census tract
[i]The smallest administrative unit in France
[j]French deprivation index
[k]Ordinary least square
[l]Local government area
[m]Index of relative socioeconomic disadvantage
[n]Primary avoidable mortality
[o]Statistical local area
[p]New Zealand deprivation index
[q]Canadian institute for health information

Table 3 Avoidable mortality definition across the selected articles

First author, year	Nolte and McKee	Tobias and Jackson	Simonato et al	NHS[a] outcome framework	Australian and New Zealand Atlas of Avoidable Mortality	CIHI[b]	CAEC[c]	Other[d]	Not mentioned
Grafova 2020	✓								
Korda 2007	✓								
Nagy 2012	✓								
Weisz 2008	✓								
Nolasco 2009	✓								
Tobias 2001		✓							
Piers 2007		✓							
Rey 2009		✓							
Windenberger 2012		✓							
Asaria 2016				✓					
Cookson 2017				✓					
Tobias 2007					✓				
James 2007								✓	
Khan 2017	✓							✓	
Hoffmann 2014									✓
Manderbacka 2013	✓		✓		✓				
Ronzio 2004									✓
Neethling 2019	✓				✓				
Feller 2017	✓								
Chen 2016							✓		
Surenjav 2016	✓								
Masters 2015								✓	
Hayen 2002		✓							
Nolasco 2015	✓								
Butler 2010									✓
Young 2019									✓
Tobias 2009					✓				
Zygmunt, 2019						✓			
Zygmunt 2020						✓			
Grey literature									
CIHI 2012						✓			
Cui 2019						✓			
MLHU 2019						✓			
MLHU 2019						✓			
Rasali 2019						✓			

[a]National Health Service

[b]Canadian institute for health information

[c]Concerted Action of the European Community on Avoidable Mortality

[d]Includes articles that consulted related literature and/or expert panels to identify avoidable deaths

measurement. Among the chosen articles, there is no consensus on whether death due to IHD should be labelled as an avoidable cause. Numerous studies subdivide IHD into two [8, 21, 56, 57, 70] or even three [11, 50] subsets of avoidable mortality. Several studies included only half of the IHD mortality in their calculation of amenable mortality rates as proposed by Nolte and McKee [12, 25, 53, 55, 58]. Additionally, some articles opted out of classifying IHD as an avoidable cause, excluding it from their calculations of avoidable mortality rates [22, 24, 42]. (See Additional file: Appendix D for the number of studies that followed each approach). Taking note of these various approaches is particularly important in health inequality research as IHD is known to be one of the leading conditions in health inequality [71, 72].

Table 4 Description of frequently used definitions of avoidable mortality

Avoidable mortality definition	Description	Subcategories of avoidable mortality
Nolte and McKee	Amenable deaths are those that would not have occurred in the presence of effective health care (i.e., secondary prevention or medical treatment)	N/A
Tobias and Jackson	Avoidable deaths is partitioned among three subcategories	(1) *Primary avoidable mortality (PAM)* constitutes conditions that are preventable, whether throuhg individual behaviour change or population-level intervention (healthy public policy), i.e. primary prevention (2) *Secondary avoidable mortality (SAM)* constitutes conditions that respond to early detection and intervention, typically in a primary health care setting, as well as clinical preventive services such as screening, i.e. secondary prevention (3) *Tertiary avoidable mortality (TAM)* constitutes conditions whose case fatality rate can be significantly reduced by existing medical or surgical treatments, i.e. tertiary prevention
Australian and New Zealand Atlas of Avoidable Mortality	This is an update on Tobias and Jackson's 2001 list. Avoidable causes of death represents those conditions whose associated mortality is substantially avoidable, given existing health and social systems in Australia, either through incidence reduction (prevention) or case fatality reduction (treatment) or a combination of both. Avoidable conditions are further classified into 'amenable' causes and 'preventable' causes	(1) *Amenable causes* are defined as those causes whose case fatality could be substantively reduced by available health care technologies (2) *Preventable causes* are all other causes on the list, in that their associated mortality could be substantially reduced by preventing the condition from occuring in the first place, (i.e., incidence reduction)
Simonato et al.	Avoidable causes are classified into three subcategories	(1) *Causes avoidable through primary prevention* includes causes whose aetiology is in part attributable to lifestyle factors and/or to occupational risk factors. It also includes deaths from injury and poisoning, which are influenced in part by legal and societal measures such as traffic safety and crime reduction policies (2) *Causes amenable to secondary prevention through early detection and treatment* includes causes of death for which screening modalities have been established, as well as causes for which death is avoidable through early detection combined with adequate treatment (3) *Causes amenable to improved treatment and medical care* includes infectious diseases, deaths from which are 'avoidable' largely through antibiotic treatment and immunisation as well as causes that require medical and/or surgical intervention, deaths of which are related to complex interactions within the health care system, such as accurate diagnosis, transport to hospital, adequate medical and surgical care
NHS outcome framework	This framework adopts the definition of amenable mortality proposed by Office of National Statistics (ONS); avoidable deaths are all those defined as preventable, amenable, or both, where each death is counted only once. Avoidable causes of death are classified into two subcategorize	(1) *Amenable mortality* are deaths (subject to age limits if appropriate) that should not occur in the presence of timely and effective health care (2) *Preventable mortality* are deaths (subject to age limits if appropriate) that could be avoided by public health interventions in the broadest sense
Canadian Institute for Health Information	(Potentially) avoidable mortality is defined as premature mortality, i.e. death occured before the age of 75, that could have potentially been avoided in the presence of timely and effective health care services and public health policies, that is, through all levels of prevention. Avoidable causes of death are classified into two subcategories	(1) *Preventable mortality* includes deaths that could have been averted through primary preventions. Preventable mortality informs efforts for incidence reduction (2) *Treatable mortality* includes deaths that could have potentially been prevented through secondary and tertiary preventions. Treatable mortality informs efforts for case-fatality reduction

3.6 Socioeconomic status indicator

We classified the articles based on the type of indicator used for socioeconomic status (SES) into four categories, namely index, income, education, and employment. The index category includes any article using a predefined index for SES, such as the Ontario Marginalization Material Deprivation Index (ON-Marg) [44, 56], Index of Relative Socioeconomic Disadvantage (IRSD) [26, 50, 51], and Index of Multiple Deprivation (IMD) [43, 44]. Some authors constructed a variable representing SES in a population using indicators such as income and education [23, 24]. We placed these studies in the index group as well. To decide whether to include or exclude an article that used an SES index, we carefully examined the index to ensure that at least one of our indicators of interest (i.e., education, income, and employment/occupation) was taken into account in its construction. One study in South Africa used apartheid classifications (Africans, Whites, Asians, and Coloureds) as a proxy for socioeconomic status, arguing that income and education disparities continued to persist in the population even after apartheid was ended [64].

Most of the articles (n = 20) used an index to investigate SES inequality in avoidable mortality. This number was 13 for income indicators, 4 for education, and 2 for employment. If a study examined more than one category in its analysis, we counted each category separately. For example, if an article examined income and education inequality in avoidable mortality separately, we counted this article once for the income category and once for the education category.

3.7 Standardization for age and sex

Most of the included articles used directly age-standardized mortality rates to assess avoidable mortality. In some cases, mortality rates were also standardized by sex. However, some studies applied unique methodologies. For example, one study estimated smoothed standardized mortality rates using the Bayesian model proposed by Besag et al. [73], to address the problem of age standardization in small areas [22]. A Hungarian study calculated mortality amenable to health care ratios using full hierarchical Bayesian methods. In doing so, the authors calculated smoothed indirectly standardized mortality ratios using sex- and age-specific rates for the Hungarian population [62]. A Canadian study calculated the age-standardized expected years of life lost (SEYLL) rate instead of the mortality rate, using the life expectancies of the richest income quintile as the standard [49]. Another methodology examined the contribution of different groups of mortality, including death amenable to health care and death amenable to health policy, to life expectancy at age 35 and partial life expectancy between 35 and 75 [59]. Doing so, Manderbacka et al. were able to assess the impact of health policy and care on income disparities in life expectancy in Finland [59]. In a study conducted by Masters et al. the authors tested the central claims of Fundamental Cause Theory (FCT) and then performed a retrospective cohort study to examine the association between preventable mortality and educational attainment [60]. An ecological study conducted in France calculated the standardized mortality ratio by dividing the observed mortality in a spatial unit by the corresponding expected mortality [41].

3.8 Association between SES and avoidable mortality

The findings of the selected articles consistently indicate a negative relationship between SES and avoidable mortality rates, where the avoidable mortality rate is higher among those with lower socioeconomic status. This aligns with the substantial body of knowledge indicating the role of SES in population health [2, 3, 27, 74, 75]. Khan et al. found a similar trend among immigrants and long-term residents, with a downward gradient in age-adjusted avoidable mortality rates as income quintiles increase [45]. However, a study conducted in Mongolia reported no significant relationship between avoidable mortality rate and the percentage of poor households [63]. This could be due to the lack of individual or neighborhood-level data in this study, which focused on the capital and provincial levels [76]. Nevertheless, the study revealed higher amenable mortality rates in remote western provinces in Mongolia, characterized by harsh weather conditions, high poverty rates, lack of human resources for health, and poor infrastructure [63]. Details on the findings of the selected articles are provided in Table 2.

While some studies adopted a descriptive approach and compared the avoidable mortality rates between different SES groups, many articles examined SES inequality in avoidable mortality using various types of analysis, including Poisson regression models, calculating Slope Index of Inequality (SII) and Relative Index of Inequality (RII), disparity rate

Table 5 Articles chosen for comparison of their lists of avoidable causes of death

Article code	Article title	Avoidable mortality list basis	Author(s)	Publication date
1	Avoidable mortality in New Zealand, 1981–97	Based on Tobias and Jackson	Tobias, M; Jackson, G	2001
2	Trends in amenable deaths based on township income quartiles in Taiwan, 1971–2008: did universal health insurance close the gap?	Based on CAEC classification of Avoidable Deaths	Chen, Brian K; Yang, Y Tony; Yang, Chun-Yuh	2015
3	Avoidable mortality by neighbourhood income in Canada: 25 years after the establishment of universal health insurance	The list of avoidable deaths was created with reference to classification lists from other studies (Charlton, etc.)	James, Paul D; Wilkins, Russell; Detsky, Allan S; Tugwell, Peter; Manuel, Douglas G	2007
4	Trends and socioeconomic inequalities in amenable mortality in Switzerland with international comparisons	Based on Nolte and McKee	Feller, Anita; Schmidlin, Kurt; Clough-Gorr, Kerri M	2017
5	How much does health care contribute to health inequality in New Zealand?	Based on Australian and New Zealand Atlas of Avoidable Mortality	Tobias, M; Yeh, L C; Tobias, Martin; Yeh, Li-Chia	2007

ratio, incidence rate difference, random coefficient growth curve modeling approach, ecological regression, among other analytical methods.

The majority of findings from the captured studies indicate a decline in avoidable mortality rates over time while socioeconomic disparities persisted [43, 54, 56]. A study conducted in South Africa found that the socioeconomic disparity widened from 2000 to 2005 and narrowed thereafter until 2012 [64]. Similar patterns were observed in France, with a 40% higher avoidable mortality rate for the fifth deprivation quintile communes compared to the first quintile in 1988–92, and 78% higher in 1997–2001 [42]. A study conducted in Taiwan reported a faster decline in avoidable mortality from 1971 to 2008 in affluent townships compared to less affluent townships [40]. Similarly, an Australian study found a larger decline in avoidable mortality rates in higher socioeconomic groups, with increasing relative inequality and decreasing absolute inequality between 1986 and 2002 [52].

4 Discussion and conclusion

The findings of this review highlight the variability in terminology and definition for the concept of avoidable mortality used in health inequality research. Using common indicator definitions are essential for reliable comparison of health indicators within or between countries [20]. Recently, an OECD working group created a harmonized avoidable mortality definition to be used internationally [17, 77]. This definition can potentially address the gap we identified in the literature concerning the lack of consensus among researchers regarding the measurement of avoidable mortality. However, while there's a pressing need for standardized terminology and definition for avoidable mortality, it is important to recognize that a single, universal list of avoidable causes of death applicable in all countries and contexts is not likely feasible. The avoidability of specific causes of death may vary across countries with different levels of advancement in medical sciences. Therefore, it is crucial to consider the contextual factors and available healthcare technologies when developing lists of avoidable causes of death, acknowledging the variations across low-, middle-, and high-income countries. Nonetheless, this should not deter the establishment of a standardized definition, which is pivotal for supporting global comparability in this area of research.

The majority of studies captured in our scoping review were conducted in high-income countries, with Europe having the highest number of publications, followed by Australia and New Zealand. This trend may be attributed to the presence of national or regional standard definitions for avoidable mortality in these countries, such as the well-established list of avoidable causes proposed for use in the Australian [66] and European [78] contexts. Nonetheless, it is worth noting that the availability of the list of avoidable causes of death primarily designed for high-income countries may hinder the conduction of avoidable mortality research in lower-income countries.

The absence of an established list of avoidable causes of death can be one reason for the low number of research conducted in low-income countries as compared to high-income countries. This difference in the number of studies can also be explained by numerous other factors, including the unequal distribution of money, power, and other resources between low- and high-income countries. Nevertheless, the impact of the absence of an established list of avoidable causes of death on the number of studies can also be observed in high-income countries like Canada. The introduction of Canada's first list of potentially avoidable causes of death in 2012 by CIHI [8] has led to a significant increase in inequality research on avoidable mortality in the Canadian literature [8, 21, 56, 57, 70]. Four out of five Canadian governmental reports included in this review were published in 2019. These findings underscore the crucial role played by established definitions and lists of avoidable causes of death in promoting research on SES-related inequalities in avoidable mortality.

Furthermore, it should be noted that our data collection took place during the early stages of the COVID-19 pandemic. Consequently, the literature captured and discussed in this scoping review does not include the subsequent debates regarding the consideration of COVID-19 as an avoidable mortality and its association with SES. Since then, organizations such as CIHI [79] and OECD/Eurostat [17], have revised and updated their lists of avoidable causes of death to incorporate COVID-19.

4.1 Study limitations

A potential limitation of this scoping review is that only one reviewer screened the articles. However, given the rigorous inclusion–exclusion criteria we used, we are confident that the risk of misclassification of articles remains minimal. In addition, this scoping review focused on studies of avoidable mortality that included analysis of SES-related inequalities. However, there exists a body of literature exploring inequality in avoidable mortality in terms of social determinants of health other than socioeconomic status, such as ethnicity. For instance, in their study of avoidable mortality in South Africa, Debbie Bradshaw and colleagues used apartheid classifications as a proxy for socioeconomic status. While we decided to include this particular study in our scoping review, we acknowledge that studies not considering SES indicators in assessing inequalities and those that did not investigate disparities may have used additional conceptualizations and definitions of avoidable mortality.

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Author contributions Anousheh Marouzi conducted the data collection and analysis and prepared the first draft of the article. Anousheh Marouzi and Charles Plante designed the study and directed its implementation, including quality assurance and control. Charles Plante supervised the data collection and analysis; he also reviewed, edited, and finalized the text. Cordell Neudorf provided the overall guidance and funding for the research project. All authors approved the final version of the manuscript.

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Declarations

Competing interests The authors declare that they have no competing interests.

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