FRESHER

FORESIGHT AND MODELLING FOR EUROPEAN HEALTH POLICY AND REGULATION

2.1
A Systematic Review of the Impact of Inequalities on non-communicable diseases (NCDs)

Report - Summary

Report Information

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Authors:	Berta Rivera, Bruno Casal, Santiago Lago, David Cantarero, Marta Pascual, Francisco Reyes, Carla Blazquez, GEN
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1 BACKGROUND

Non-communicable diseases (NCDs) have become a primary health concern for most countries around the world. According to the World Health Organization (WHO) (2015), NCDs are responsible for almost 38 million global deaths each year, accounting for 63% of these annually deaths. Almost three quarters of NCD deaths – around 28 million – occur in low- and middle-income countries (Lozano et al, 2012; Lim et al., 2012). The global financial burden of NCDs is staggering, with an estimated 2010 global cost of $6.3 trillion (US dollars), which is projected to increase to $13 trillion by 2030, and millions of people trapped in poverty (WHO, 2013). Cardiovascular diseases account for most NCD deaths, or 17.5 million people annually, followed by cancers (8.2 million), respiratory diseases (4 million), and diabetes (1.5 million). These four groups share more or less the same risk factors (tobacco use, unhealthy diet, physical inactivity and the harmful use of alcohol).

Nowadays, lifestyle and behaviour are linked to 20-25 % of the global burden of disease. In the next coming decades, as a result of epidemiological transition, NCDs diseases will replace infectious diseases and malnutrition as the leading causes of disability and premature deaths in countries of low and middle income. By the year 2020, NCDs diseases are expected to account for seven out of every ten deaths in the developing regions. In developed countries, NCDs have replaced communicable diseases as the main source of ill -health. (WHO, 2015). The epidemiologic transition from a predominance of infectious diseases to NCDs is thought to arise be due to a population that has acquired acquired life-styles related to economic development.

According to Krieger (2001), the social determinants of health refer to both specific features of social conditions and pathways by which affect health and that potentially can be altered by informed action. Examples are income, education, occupation, family structure, service availability, sanitation, social support, racial discrimination and access to resources linked to health. The WHO (2004) has indicated that the social determinants of health are the conditions in which people are born, grow, live, work and age, including the health system. The social determinants of health are mostly responsible for health inequalities understood as unfair and avoidable differences in health status within and between countries.

A range of factors have been identified as social determinants of health, among them: the socioeconomic context; inequality; poverty; social exclusion; socioeconomic position; income; public policies; health services; employment; education; housing; transport; environment; health behaviors or lifestyles, and social and community support networks.

The aim of this paper is to provide an overview of evidence about the effect of inequalities on the incidence and prevalence of NCDs. This evidence is particularly relevant in terms of determining inequalities in the burden of these diseases and their determinants across social groups. We first describe the methodology developed, which is common to all diseases analyzed. Then, we report the results for three main groups of chronic diseases: cardiovascular and heart diseases, cancer and diabetes.

2 METHODS

A systematic literature search was performed in PubMed, Cochrane Library and Web of Science (until 30 December 2015) to identify the most relevant published evidence regarding the relationship between income inequalities and NCDs. In all databases, terms related to ‘‘NCDs,’’ ‘‘non-communicable diseases’’ and “inequalities,” “socioeconomic status” or “socioeconomic position” were combined (for full search queries see Table 1). The searches were refined to include papers published in the English language from 2005 to limit the scope of this review to the most recent evidence. Hence, we considered firstly a ten-year retrospective horizon to be sufficient.

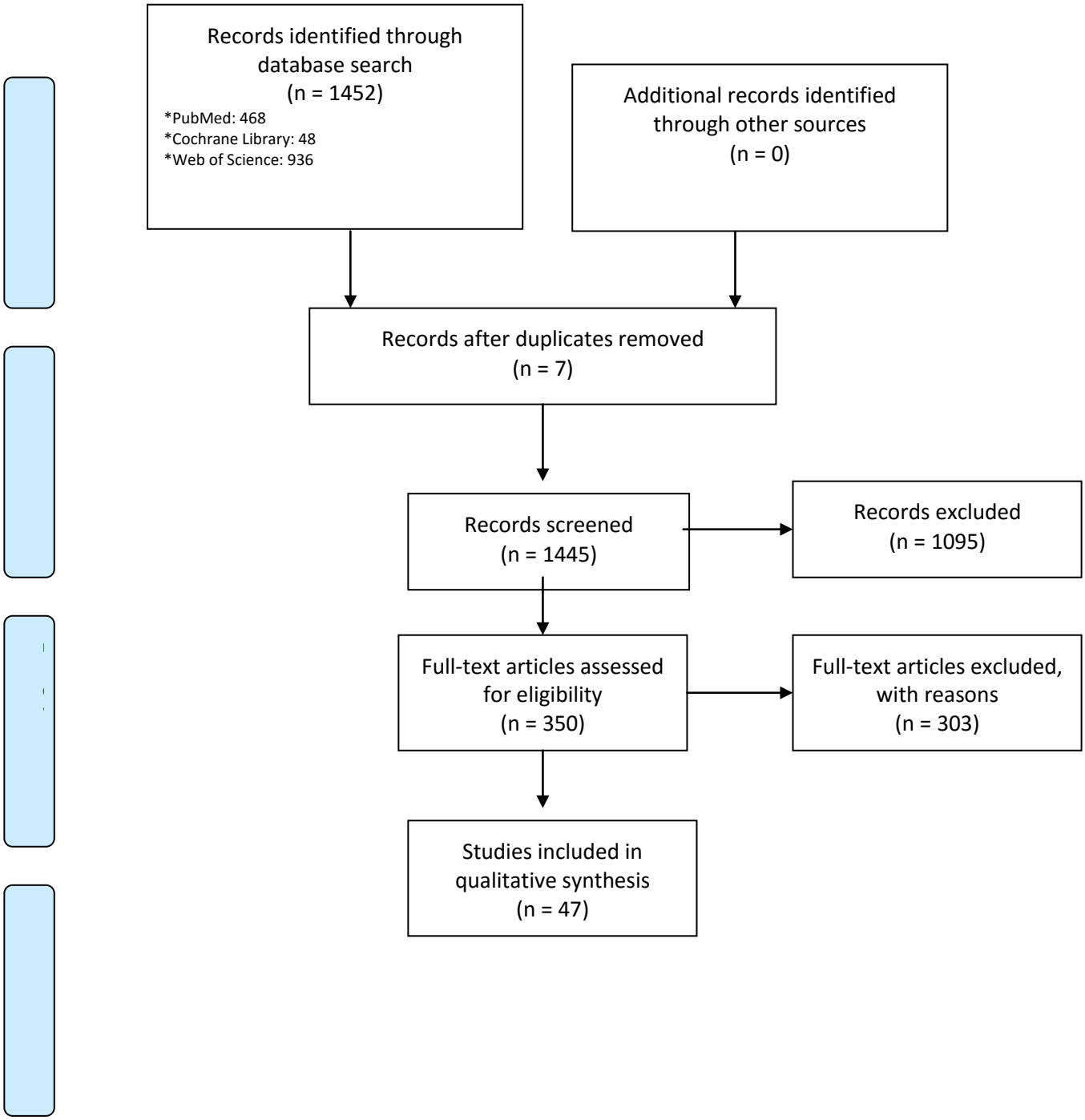
TABLE 1. Search strategy: PubMed, Cochrane Library and Web of Science

#	Search term
	PubMed
#1.	NCDs [Title/Abstract]
#2.	Non-communicable diseases [Title/Abstract]
#3.	Inequality [Title/Abstract]
#4.	Socioeconomic status [Title/Abstract]
#5.	Socioeconomic position [Title/Abstract]
#6.	Limit to: journal article; year of publication >= 2005; English; human subjects, free-full text
	Cochrane Library
#1.	NCDs [Title/Abstract]
#2.	Non-communicable diseases [Title/Abstract]
#3.	Inequality [Title/Abstract]
#4.	Socioeconomic status [Title/Abstract]
#5.	Socioeconomic position [Title/Abstract]
#6.	Limit to: year of publication >= 2005; English; free-full text
	Web of Science
#1.	NCDs[Topic]; [Title]
#2.	Non-communicable diseases [Topic]; [Title]
#3.	Inequality [Topic]; [Title]
#4.	Socioeconomic status [Title/Abstract]
#5.	Socioeconomic position [Title/Abstract]
#6.	Limit to: journal article; year of publication >= 2005; English; free-full text; public environmental occupational health OR social issues OR healthcare sciences and services

After identifying publications by electronic searches, duplicate records were removed. The final selection of papers was based on the following eligibility criteria: applied studies focusing on OECD countries (including European Union and other countries) or articles referring to high- or middle-income countries.

The selected literature search located 1452 publications. A total of seven duplicates were removed, resulting in 1445 unique papers. After screening titles against the eligibility criteria, 350 papers were selected. Of these, 303 articles were excluded as they did not fit with the previously indicated criteria. Therefore, a final set of 47 selected studies were fully taken into account in this review. Nevertheless, further papers are considered to allow for a robust overview. Figure 1 shows the diagram of the paper selection process following PRISMA.

FIGURE 1.
Flow diagram of paper selection process.



3 RESULTS

The included articles varied greatly from the perspective of primary purpose, design and analytic approaches, making formal homogeneous synthesis impossible. The heterogeneity of studies made it difficult to synthesize the results and assess the impact of factors considered on outcomes. Despite these differences, evidence suggests that a large number of socioeconomic factors were associated with morbidity and mortality caused by non-communicable diseases.

From a broad consideration of NCDs, in a recent study, Sommer et al. (2015) carried out a review of literature to study the relationship between socioeconomic inequalities, morbidity and mortality of NCD diseases and their risk factors. The authors searched for relevant systematic reviews published between 2003 and December 2013. Out of a total of 3302 abstracts, 22 systematic reviews were chosen. The studies analysed show that having low socioeconomic status and/or living in low- or middle-income countries increased the risk of developing cardiovascular disease, lung or gastric cancer, type 2 diabetes or chronic obstructive pulmonary disease. Furthermore, low socioeconomic status increases the risk of mortality from lung cancer and chronic obstructive pulmonary disease. It also reduces breast cancer survival in high-income countries. The literature review concludes that the studies show an association between socioeconomic inequalities and NCDs and risk factors for NCDs. However, this evidence is incomplete and is limited by the fairly low methodological quality of the reviews, including shortcomings in the study selection and quality assessment process.

The remaining evidence analysed is reported in three main groups of chronic diseases: cardiovascular and heart diseases, cancer and diabetes.

Cardiovascular Diseases

We identify 21 studies on socioeconomic inequalities and cardiovascular and heart diseases, with seven of them reporting on CVD in general, seven on stroke and heart failure, two on myocardial infarction, five on coronary disease and one on ischemic illness.

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Socioeconomic circumstances featuring childhood may be relevant to influence risk of CVD in adulthood. Galobardes et al. (2005) retrieved individual-level studies of morbidity and mortality from CVD linked to early-life influences up to 2004. They searched for childhood socioeconomic circumstances as a generic term and specific indicators such as parental education, parental occupation, housing conditions and overcrowding. They also considered proxy indicators of poor socioeconomic circumstances, such as number of siblings, maternal marital status or residence in an orphanage or similar. The results obtained from the analysis of 40 studies found a robust inverse association between childhood circumstances and adult CVD risk. The results present variations depending on specific outcomes, socioeconomic measures or sex.

The impact of socioeconomic inequalities on CVD among people with and without diabetes was investigated by Dray-Spira et al. (2007). The study analyses a sample of 255,966 people from 25 years or above in the National Health Interview Survey between 1997 and 2005 in the United States. Among adults with diabetes, the prevalence of CVD is higher for those people that do not complete high school in the university graduate, although the incidence varies throughout the period studied. Among adults without diabetes, educational disparities in the CVD increased significantly during the period analysed. In general, the age and the breed of the CVD-adjusted prevalence were about 2.5 times higher in adults, in those with diabetes, regardless of sex. Similar results were obtained by Kavanagh et al. (2010), who studied the associations between socioeconomic position (education and household income) and biomarkers of diabetes and CVD in Australia. They concluded that low socioeconomic position is more consistently associated with a worse profile of biomarkers for CVD and diabetes for women.

The study designed by Schulz et al. (2008) provides evidence of a cascade effect linking socioeconomic position to anthropometric indicators of CVD risk through effects on psychosocial stress, psychological distress and health-related behaviors, and considers implications for disease prevention and health promotion. Socioeconomic position is associated with multiple CVD risk factors such as smoking and physical inactivity.

Li et al. (2008), in a study developed for Sweden, concluded that the incidence, recurrence

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and case fatality of stroke increased with decreasing socioeconomic status. In addition, the relationship differed by gender and subtype of events. In a macro-level analysis, Sposato and Saposnik (2011) selected population-based studies reporting incident stroke risk and/or 30-day case fatality. They use three macro-socioeconomic status indicators: per capita gross domestic product (GDP) adjusted for purchasing power parity; total health expenditure per capita at purchasing power parity; and unemployment rate. They examine the correlation of each indicator with incident stroke risk. Age-adjusted incident stroke risk was associated with lower per capita gross domestic product and total health expenditure per capita. Thirty-day case fatality rates and proportion of hemorrhagic strokes were also related to lower per capita gross domestic product and total health expenditure per capita. Moreover, stroke occurred at a younger age in populations with low per capita gross domestic product and total health expenditure per capita. There was no correlation between unemployment rates and outcome measures. The authors suggest that the macroeconomic status indicators considered may be used as proxy measures of quality for primary prevention and acute care in order to improve stroke care.

Andersen et al. (2014) carried out a study that analysed the relationship between socioeconomic position, measured as household income and length of education, and hospital admissions for a first ischemic stroke. The authors also studied the cardiovascular risk factor profile associated with socioeconomic position in stroke patients. The date used in the analysis cover all citizens of Denmark over the age of 40 who lived in that country during some or all of the period 2003–2012 (23,517,408 individuals). The results indicated a highly significant stepwise relation between income and risk of hospitalization for stroke, with the risk being almost two times higher in the lowest income group than in the highest. Diabetes, obesity, smoking and high alcohol consumption in particular and, to a lesser extent, previous myocardial infarction or intermittent arterial claudication were significantly overrepresented among stroke patients with lower socioeconomic position.

Nordhal et al. (2014) also confirmed inequalities in stroke incidence for Denmark when studying the combined effects of socioeconomic position, smoking and hypertension on the risk of ischemic and hemorrhagic stroke. Fischbacher et al. (2014) linked self-reported socioeconomic position and ethnicity data for Scotland to hospital admission and mortality

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data for cardiovascular disease in ten ethnic groups. Authors obtained wide socioeconomic variation between groups.

In Gebreab et al. (2015), data from the Jackson Heart Study are used to examine the associations of multiple measures of life course SEP with CVD in a large cohort of African Americans. The results indicated that adult SEP was more associated with CVD risk in women than in men, that adult SEP was a stronger predictor of CVD events in younger than in older participants and that childhood SEP was not associated with CVD risk in women or men.

Adherence to therapy in cardiovascular medication constitutes a relevant subject of study. Laba et al. (2013) developed a systematic review about adherence to medication for cardiovascular diseases in socioeconomically disadvantaged populations in order to determine the effects of strategies to improve that adherence. A total of 14 articles were analyzed from a total of 945 studies identified through database searching. Disadvantage was defined by place of residence, education and income. The most effective strategies were simultaneously directed at patients and physicians/practices, targeting physicians' prescribing behavior as well as interventions to reduce patient social, financial and treatment-related barriers to patients.

We can also find evidence regarding socioeconomic position and myocardial infarction. Ljung and Hallqvist (2006), using information about Sweden, concluded that accumulated experience of adverse socioeconomic position over the entire life course increases the risk of myocardial infarction for both men and women. They pointed out that the accumulation effect is partly mediated by the acquisition of health-damaging experiences.

Malki et al. (2014) analyzed temporal trends in the incidence of myocardial infarction and ischemic stroke in Sweden in relation to socioeconomic position and investigated whether social inequalities in the incidence of these diseases changed over time. Their results confirmed that social inequalities exist in the incidence of cardiovascular diseases. Dzayee et al. (2014) applied a cox proportional hazard model for Sweden to analyze trends in, and risk of, a second myocardial infarction (SMI) 28 days after the first myocardial infarction taking

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into consideration any association with gender, educational level and country of birth. The results showed that men had a higher risk of SMI than women and that low educational level increased the hazard rate (HR) of SMI irrespective of gender or country of birth. Foreign-born men and women had a slightly higher HR than those born in Sweden.

Using data from the British Women's Heart and Health Study, Lawlor et al. (2005 a, b) analyzed the association between socioeconomic status and coronary heart disease. The results showed an increased prevalence. Again for the UK, Lawlor et al. (2006) used the Aberdeen Children of the 1950s cohort study to analyze the association between father's social class and coronary heart disease. Their findings provided evidence regarding how rates of coronary heart disease and stroke increased across the social class distribution from highest to lowest.

Thurston et al. (2005) examined the association between socioeconomic position and coronary heart disease using data from the first National Health and Nutrition Examination Survey in the USA. Low education was associated with greater social and psychological risks for women than men. Models showed that education and income were inversely associated with incident coronary heart disease in age-only and multivariate models. Risk associated with education varied by gender, with less than high school education associated with stronger risk of coronary heart disease in women than in men in age-adjusted models. In a more recent study, life course socioeconomic position and the incidence of coronary heart disease in a well-characterized US cohort (the Framingham Offspring Study) are analyzed by Loucks et al. (2009). The results confirmed that cumulative socioeconomic position is associated with incident coronary heart disease after adjustment for age and sex. Fiska et al. (2015), using Cox proportional hazard analyses hazard ratios for coronary heart disease mortality, assessed linkages to the Norwegian Cause of Death Registry. For subgroup analyses, the authors created an index of life course socioeconomic position. The results indicated that those with self-reported family history did not have worse life course socioeconomic position than those without.

Calvillo-King et al. (2013) developed a systematic review that considers the impact of social factors on the risk of readmission or mortality in pneumonia (CAP) and heart failure (HF). The

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authors analyze 72 articles (20 CAP and 52 HF) that evaluate the variables of age, gender and race and their association with readmission and mortality in patients hospitalized with CAP or HF. A classification of sociodemographic characteristics is made on three levels. Level 1 factors include gender and race; level 2 factors include socioeconomic variables, such as education, employment, income, insurance and marital status; level 3 considers factors related to the underlying social environment (social support, housing situation), behavioral factors (diet, smoking, medication, substance use), sociocognitive factors (health, literacy) and neighborhood factors (urban/rural, community poverty, proximity to healthcare). For level 1, older age was the most common risk factor. Among level 2 factors, low income and education and Medicaid insurance increased risk. There was little evidence about the variables of level 3, but housing stability and social support (environment), smoking and substance abuse (behavioral), and rurality and distance to hospital (neighborhood) were predictors of poor post-hospital outcomes. Roberts et al. (2010) showed the relation between early-life socioeconomic position and incidence of, hospitalized heart failure among middle-aged US (black and white) participants.

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Table 2. Summary of results for socioeconomic inequalities and cardiovascular diseases

CARDIOVASCULAR DISEASES				
STUDY	**YEAR**	**COUNTRY**	**METHODOLOGY**	**RESULTS (COMPARATIVE RISKS)**
Andersen et al. (2012)	2003–2012	Denmark	**Log-linear Poisson regression models** to estimate incidence rate ratios for education and disposable income. **Logistic regression models** to estimate the association between socioeconomic position and cardiovascular risk factors for stroke.	A highly significant stepwise relation was found between **income** and risk of hospitalization for stroke, with the risk being almost two times higher in the lowest income group than in the highest. Adjusted analysis: RR=0.85 for higher **education** and RR=0.99 for vocational education (reference = basic education). The risk of stroke hospitalization in the higher education groups was lower than in the vocational and short education group. Adjusted analysis: RR=0.56 for level of income 5 and RR=0.83 for level of income 2 (reference = level of income 1). Diabetes, obesity, smoking and high alcohol consumption in particular and, to a lesser extent, previous myocardial infarction or intermittent arterial claudication were significantly overrepresented among stroke patients with lower **socioeconomic position**. Atrial fibrillation and hypertension were not.
Calvillo-King et al. (2013)	1980–2012	Several countries	Authors developed a **systematic review** that considers the impact of social factors on risk of readmission or mortality in cases of pneumonia (CAP) and heart failure (HF). Authors analyze 72 articles (20 CAP and 52 HF) that evaluate variables of age, gender and race and their association with readmission and mortality in patients hospitalized with CAP or HF.	A broad range of social factors affect the risk of post-discharge readmission and mortality in CAP and HF. Older age was the most common risk factor. Low **income** and **education** and Medicaid **insurance** increased risk. Housing stability, social support, smoking, substance abuse, rurality and distance to hospital were predictors of poor post-hospital outcomes. For heart failure (HF), there were

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				36 retrospective and 14 prospective cohort studies, one case control and one cross-sectional study. Focusing on social factors associated with readmission and short-term mortality in heart failure (HF), several related measures of low socioeconomic status were found to significantly increase readmission. Insurance, education and socioeconomic status were examined but were not significant in the association between social factors and short-term mortality in HF.
Dray-Spira et al. (2007)	1997–2005	United States	**Poisson regression models** with robust estimation of variance were used for studying the socioeconomic disparities in cardiovascular disease (CVD) among US adults with and without diabetes. The analysis is performed in three time periods using the National Center for Health Statistics (NHIS) between 1997 and 2005.	Among the group with diabetes, the differences in the prevalence of CVD were higher in the group that had not completed a bachelor degree (1.20) than among graduates: 1.05–1.38 (in 1997 to 1999) and 1.12 and between 1.00 and 1.25 (2003–2005). Among the group of adults without diabetes educational differences in relation to CVD increased over time (1.22 without high school completed in 1997–1999 and 1.35 in 2003–2005).
Dzayee et al. (2014)	1987–2007	Sweden	**Cox proportional hazard model** to analyze trends in, and risk of, second myocardial infarction (SMI) after day 28 days after of first myocardial infarction (FMI); association with gender, educational level and country of birth was analyzed. Nationwide cohort study of 331,748 men and 186,755 women aged 30–84, living in Sweden, and diagnosed with first myocardial infarction (FMI).	Men had a higher risk of SMI than women (HR 1.14, 95% CI 1.12–1.55) with a downward trend over time, regardless of country of birth (p-trend<0.0001). Low educational level increased the HR of SMI irrespective of gender or country of birth. Foreign-born men and women had a slightly higher HR than those born in Sweden. Foreign-born men and women who had lived in Sweden for less than 35 years had a higher risk than those that had lived there for 35 years or longer.
Fischbacher et al. (2014)	2001	Scotland	To link self-reported socioeconomic position (SEP) and ethnicity data on 4.65 million individuals from the 2001 Scottish Census to hospital admission and mortality data for cardiovascular disease (CVD) in 10 ethnic groups. **Poisson regression** with robust variance was used to calculate CVD incidence rate ratios.	Wide socioeconomic variation between groups. Multiple SEP adjustment had little effect on relative risk of CVD for most groups. Where it did, the effect varied in direction and magnitude. Across groups, SEP measures were inconsistently associated with CVD hospitalization or death.

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Fiska et al. (2015)	1994–2003	Norway	130,066 participants were examined. A subgroup (n = 84,631) had additional life course socioeconomic data. **Using Cox proportional hazard analyses**, the authors calculated hazard ratios (HR) for coronary heart disease (CHD) mortality, assessed by linkages to the Norwegian Cause of Death Registry. For subgroup analyses, the authors created an index of life course socioeconomic position.	For men, myocardial infarction (MI) in parents and siblings was a risk factor for CHD mortality after adjusting for established risk factors and socioeconomic conditions; the highest risk was with MI in siblings (HR: 1.44 [1.19–1.75]). For women, self-reported family history (FH) constituted significant risk after similar adjustment only for those with MI in parents plus siblings (HR: 1.78 [1.16–2.73]). Adjusting for life course socioeconomic conditions marginally lowered the estimates, and those with FH did not have a worse life course socioeconomic position than those without.
Galobardes et al. (2006)	2004	Several countries	**Systematic review** in order to evaluate evidence of an association between socioeconomic circumstances during childhood and specific CVD subtypes, independent of adult socioeconomic position (MEDLINE, EMBASE and ISI Web of Science).	Of the 40 studies located, 31 found a robust inverse association between childhood circumstances and CVD risk, although findings varied among specific outcomes, socioeconomic measures and sex. The association was stronger for stroke (in particular for hemorrhagic stroke) than for CHD.
Gebreab et al. (2015)	2000–2004	United States	Data from the Jackson Heart Study (JHS) are used to examine the associations between multiple measures of life course socioeconomic position (SEP) and cardiovascular disease (CVD) events in a large cohort of African Americans. During a median of 7.2-year follow-up, 362 new or recurrent CVD events occurred in a sample of 5301 participants aged 21 to 94. Childhood SEP was assessed by mother's education, parental home ownership and childhood amenities. Adult SEP was assessed by education, income, wealth and public assistance.	Adult SEP was more associated with CVD risk in women than in men: age-adjusted hazard ratios for low versus high income (95% CIs), 2.46 (1.19 to 5.09) in women and 1.50 (0.87 to 2.58) in men, *P* for interaction=0.1244, and hazard ratio for low versus high wealth, 2.14 (1.39 to 3.29) in women and 1.06 (0.62 to 1.81) in men, *P* for interaction=0.0224. After adjustment for all adult SEP measures, wealth remained a significant predictor of CVD events in women (HR=1.73 [1.04, 2.85] for low versus high). Education and public assistance were less associated with CVD. Adult SEP was a stronger predictor of CVD events in younger than in older participants (HR for high versus low summary adult SEP score 3.28 [1.43, 7.53] for participants ≤50 years, and 1.90 (1.36 to 2.66) for participants >50 years, *P* for interaction 0.0846). Childhood SEP was not associated with CVD risk in women or men.
Kavanagh et el. (2010)	1999–2000	Australia	**Multilevel linear regression model** to study the associations between socioeconomic position (education and household income) and biomarkers of diabetes and cardiovascular disease (CVD).	**Low socioeconomic position** is more consistently associated with a worse profile of biomarkers for CVD and diabetes for women. Lower levels of **education** were associated with higher glucose

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				tolerance (some high school: 0.08, 95% CI 0.05–0.12 and no high school: 0.17, 95% CI 0.06–0.27); lower levels of education had higher systolic blood pressure (some high school: 1.94 mmHg, 95% CI 0.91–2.97 whereas lower 4.47 mmHg, 95% CI 1.58–7.36).
Laba et al. (2013)	1996–2012	Several countries	**Systematic review** to determine the effects of strategies to improve adherence to cardiovascular disease (CVD)-related medications in socioeconomically disadvantaged groups.	Strategies to improve adherence in general population have been shown to have had moderate effectiveness and cost-effectiveness. There is evidence that among socioeconomically disadvantaged groups, strategies that simultaneously target patients and physicians are highly effective.
Lawlor (2005a)	1999–2001	United Kingdom	**Multilevel logistic regression models** are used to assess the association between area-level socioeconomic characteristics and coronary heart disease.	All measurements of **socioeconomic position** were associated with increased prevalence (1.11 (95% confidence interval: 1.06–1.16)) and incident (7.9%–23.8%).
Lawlor (2005b)	1999–2001	United Kingdom	**Cox proportional hazards regression models** are used to analyze the association between father's social class and coronary heart disease.	Odds of coronary heart disease were 27% greater among those living in wards with a **deprivation score** above the median than among those living in a ward with a deprivation score equal to or below the median (odds ratio=1.27; 95% confidence interval=1.02–1.57).
Lawlor (2006)	2000–2002	United Kingdom	**ANOVA, chi-square statistic and multiple linear regression models** are used to examine the relation between childhood and adulthood socioeconomic position and the prevalence of subclinical atherosclerosis.	The gender-adjusted hazard ratio of experiencing coronary heart disease or stroke comparing the manual and nonmanual **social class categories** was 1.52 (95% confidence interval=1.14–2.02).
Li et al. (2008)	1990–2000	Sweden	**Cox regression model** was used to assess the associations between socioeconomic position and stroke incidence, subtype, recurrence and case fatality.	The incidence of stroke increased with decreasing annual **income** [women (relative risk: 1.75, 95% CI: 1.36 to 2.25); men (relative risk: 1.29, 95% CI: 1.06 to 1.58)].
Ljung and Hallqvist (2006)	1992–1994	Sweden	**Case-control study** of risk factors for incident myocardial infarction. Every year in manual work was added to calculate a proportion of the whole life course spent in adverse socioeconomic position.	With increasing proportion of life spent in adverse **socioeconomic position**, an increasing risk of myocardial infarction is found. The relative risk of myocardial infarction was 2.36 (95% confidence interval (CI) = 1.79 to 3.11) for men and 2.54 (95% CI = 1.70 to 3.78) for women who, over the entire life course, had always been in adverse socioeconomic position compared with those who had never been in adversity. They also found a strong increase in risk from being in adversity for only a few years, which showed an important

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				selection process.
Loucks et al. (2009)	1971–2003	United States	**Cox proportional hazards analyses** to determine whether cumulative life course socioeconomic position is associated with coronary heart disease incidence.	Cumulative **socioeconomic position** is found to be associated with incident coronary heart disease (CHD) after adjustment for age and sex (hazard ratio = 1.82, 95% confidence interval: 1.17, 2.85 for low vs. high cumulative socioeconomic position score). Adjustment for CHD risk factors reduced that magnitude of association (hazard ratio = 1.29, 95% confidence interval: 0.78, 2.13).
Malki et al. (2014)	1987–2010	Sweden	**Flexible parametric survival models** adjusted for calendar year, attained age, sex and birth country to study incidence rates of myocardial infarction and ischemic stroke and incidence rate ratios comparing levels of socioeconomic position.	Overall incidences of myocardial infarction and ischemic stroke decreased over time among men, but were stable among women. As regards ischemic stroke incidence, **socioeconomic inequality** increased over time in the age group 55 to 59. The incidence rate ratios for low manual compared to high nonmanual workers increased from 1.3 (95% CI: 1.2–1.4) in 1997 to 1.5 (1.4–1.7) in 2010 among men, and from 1.4 (1.3–1.6) in 1997 to 2.1 (1.8–2.5) in 2010 among women. The socioeconomic inequality in the incidence of myocardial infarction was stable over time for both.
Nordhal et al. (2014)	**7 existing population-based cohort studies (14 years until 2001)**	Denmark	**Additive hazards models** to study the combined effect and interaction between socioeconomic position, smoking and hypertension on ischemic and hemorrhagic stroke incidence.	It was found that the combined effect of **socioeconomic position** and smoking exceeded the sum of their separate absolute effect on risk of ischemic stroke, particularly among men (134 (95% confidence interval, 49–219)). They found evidence of an interaction between smoking and hypertension on risk of both ischemic and hemorrhagic stroke.
Roberts et al. (2010)	**1987–1989; 2000–2001**	United States	**Cox proportional hazards regression** to study the influence of life course socioeconomic position on incident heart failure (in blacks and whites).	Broadly, a graded linear association was observed between the incidence rate of heart failure and summary early-life **socioeconomic position** in both blacks and whites (for blacks, hazard ratio (HR) = 1.39, 95% confidence interval (CI): 1.00, 1.95; for whites, HR = 1.32, 95% CI: 1.06, 1.64).
Sposato and Saposnik (2012)	**2000–2011**	Several countries	Authors developed a systematic review and selected population-based studies reporting incident stroke risk and/or 30-day case fatality. They use three macro-socioeconomic status indicators: per capita gross domestic product adjusted for purchasing power parity; total health expenditure per capita at purchasing power	Age-adjusted incident risk of stroke was associated with lower **per capita gross domestic product** (p=0.661, P=0.027, R2=0.32) and total **health expenditure per capita** (p=0.623, P=0.040, R2=0.26). Thirty-day case fatality rates and proportion of hemorrhagic strokes were also related to lower per capita gross domestic product

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			parity; and unemployment rate. They examine the correlation of each indicator with incident risk of stroke.	and total health expenditure per capita. Moreover, stroke occurred at a younger age in populations with low per capita gross domestic product and total health expenditure per capita. There was no correlation between unemployment rates and outcome measures.
Thurston et al. (2005)	1971–1993	United States	The authors examined the association between socioeconomic position and health in the First National Health and Nutrition Examination Survey (retrospective cohort study). Relative risks of incident coronary heart disease were estimated in **multivariate Cox proportional hazards regression.**	Low **education** was associated with greater social and psychological risks for women than men. Cox proportional hazards models showed that education and **income** were inversely associated with incident coronary heart disease in age-only and multivariate models. Risk associated with education varied by gender (p = 0.01), with less than high school education associated with stronger risk of coronary heart disease in women (relative risk = 2.15, 95% confidence interval: 1.46–3.17) than in men (relative risk = 1.58, 95% confidence interval: 1.18–2.12) in age-adjusted models.

Cancer

We found 15 studies that presented evidence on SES and cancer outcomes. Most of them refer to lung cancer and breast cancer. Two of the revised articles consider gastric cancer and one study considers all-site cancer mortality.

The risks of mortality due to cancer by individual birth country, sex and socioeconomic position was examined by Abdoli et al. (2014) in the total Swedish population and in subgroups of the foreign-born population. They used data from the Migration and Health Cohort (1961–2009) and a *Poisson* regression model to calculate *Cancer Mortality Rate Ratio* and *Age-Standardized Rates*. Their main finding is that all-site cancer mortality decreased with increasing level of education irrespective of sex and country of birth. The risk was more prominent among foreign-born than Sweden-born men, but in women, it was more noticeable among Sweden-born women with low versus high education level.

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Sidorchuk et al. (2009) investigated the association between socioeconomic indicators and lung cancer incidence through a systematic revision and meta-analysis from 1966 to 2007. The inclusion terms were "socioeconomic position," "socioeconomic status," "social class," "occupational category," "occupational classification," "educational level" and "income" versus "lung cancer," "lung neoplasm," "lung cancer incidence" and "lung neoplasm incidence." To be included in the meta-analysis, studies had to give original data using a case-control or cohort methodology, consider as an outcome lung cancer incidence and provide risk estimates with 95% confidence intervals. The authors identified 64 studies eligible for inclusion out of the 3288 articles obtained from the search of the PubMed and EMBASE databases. The information on country was classified by geographical area and country's income level. The results confirmed a significant increase in the risk of lung cancer among the lowest socioeconomic categories for the socioeconomic indicators considered (education attainment, occupational categories and income). The results were particularly relevant for the educational attainment indicator. The results are consistent when the associations are adjusted for smoking.

Continuing with the analysis of the relationship between SES and lung cancer, Dalton et al. (2011) considered a sample of 25,648 people born between 1920 and 1982 that were diagnosed with a lung cancer between 2001 and 2008. The database analyzed was the Danish Lung Cancer Registry. Among people with a medium to high level of education, more men than women were diagnosed with lung cancer. Odds ratios for patients with lung cancer in an advanced stage are lower for those who have higher education, are higher for people who live alone and are decreasing average, which increases the associated morbidity. Men and older people have higher odds ratios in relation to the detection of lung cancer in an advanced state.

Another study was conducted by Dalton et al. (2015) based on the same database. In this article the authors identified 13,045 patients with lung cancer diagnosed between 2004 and 2010. They considered information about the different stages, histology, functional status and treatment. This information was completed with educational data and income. They analyzed associations between the previous socioeconomic indicators and the possibilities of receiving an initial treatment. Odds ratios in the detection of lung cancer, both in the advanced stages

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and in the early stages, are lower in patients with a low level of education and low income. Patients who live alone have a lower probability of lung cancer being detected at an early stage, and the same goes for individuals with low income levels, who have a lower probability of detection than those with higher incomes.

Nkosi et al. (2012), after conducting an analysis of the Canadian case, highlighted the importance of adjusting for several dimensions of smoking behavior in order to draw correct inferences about the relationship between low socioeconomic position and lung cancer. Ibfelt et al. (2013), using Cox regression models, studied the associations between socioeconomic indicators (education, income and cohabitation status) and mortality by all causes. The paper found that all mortality cause was higher in women with shorter rather than longer education, among those with lower rather than higher income and among women aged <60 years without a partner rather than those who cohabited. It is also shown that socioeconomic differences in relation to survival were partly explained by cancer stage and less by comorbidity or smoking.

Social factors explaining ethnic or racial inequalities in breast cancer survival are analyzed by McKenzie and Jeffreys (2009). The authors developed a systematic review of literature to identify studies that investigate the influence of socioeconomic position, along with other variables such as smoking, alcohol consumption and body mass index, on breast cancer survival. The study reviewed published studies from 1996 to 2008 including 16 studies from the 673 papers identified initially. The majority of papers included analysis of the effect of socioeconomic position on breast cancer survival using census-derived measures. To investigate the effect of socioeconomic position on ethnic inequalities in relation to survival, the percentage of change in the minority versus majority survival disparity was estimated. General results indicate that socioeconomic position would explain approximately half of the inequality in breast cancer survival (all causes) between ethnic groups. Nevertheless, the results indicate that socioeconomic position is not a determinant explicative variable once clinical factors have been accounted for.

Mortality after breast cancer was also analyzed by Larsen et al. (2015) in a study developed for Denmark. The article considers the influence of metabolic indicators, such as smoking,

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alcohol consumption and socioeconomic position, on breast cancer survival. The results from Cox proportional hazard models demonstrated that these considered factors could explain some (but not all) of the social inequality in relation to survival, and that improvement of lifestyle would improve survival among women with low socioeconomic position.

Schliching et al. (2012) analyzed the association between the county-level percentage of persons below the poverty level and breast cancer-specific survival (BCS) for cases diagnosed from 1990 to 2008. The information was obtained from the Surveillance, Epidemiology, and End Results (SEER) database linked to census-derived county attributes in the USA. Residing in a lower SEP, nonmetro county significantly worsens BCS survival for non-IBC in multivariate proportional hazards models. African American cases appear to have worse survival rates than non-Hispanic whites regardless of inflammatory status, stage, county-level SEP, tumor or treatment characteristics.

Evidence backing up the existence of differences in breast cancer prognostic factors between ethnic and socioeconomic groups is reported by McKenzie et al. (2008) for New Zealand. Other authors find differences in the incidence of cancer in relation to environmental characteristics such as neighborhood of residence. In this sense, Meijer et al. (2013) evaluated the influence of neighborhood characteristics on breast, prostate and lung cancer incidence in Denmark. Their results indicated that in addition to individual socioeconomic status, higher breast cancer incidence appears in areas with the highest population densities. Furthermore, increased prostate cancer incidence was found in areas with higher socioeconomic status. In addition, higher lung cancer incidence was associated with high population density and low socioeconomic status on the area level. In the same way, Olsen et al. (2015) demonstrated for Denmark that advanced stage at diagnosis was more prevalent for patients with low income and for men living alone.

Socioeconomic position and incidence of gastric cancer were analyzed by Uthman et al. (2012) by means of a systematic review and meta-analysis from 1966 to 2013. They used socioeconomic determinants in the search such as “socioeconomic position,” “socioeconomic status,” “social class,” “occupational category,” “occupational classification,” “educational level” and “income.” The population for the study consisted of patients with diagnosed gastric cancer in case-control or cohort studies. With these criteria, authors included 64 studies in a

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qualitative synthesis and 36 studies in the meta-analysis. The results indicate a negative social gradient with all studies socioeconomic position analyzed. The risk of gastric cancer increased among individuals with low levels of educational attainment, income, occupation and combined socioeconomic position. These results were consistent for most of the pooled estimations.

Later, Uthman et al. (2013) investigated the associations between gastric cancer incidence and education, occupation and income as indicators of socioeconomic position. The authors observed an increased risk of gastric cancer among the lowest socioeconomic position categories in education, occupation and combined socioeconomic position, compared with the highest categories. Although the association between the incidence of gastric cancer and the level of income was evident, it did not reach a statistically significant level.

Table 3. Summary of results for socioeconomic inequalities and cancer

CANCER				
STUDY	**YEAR**	**COUNTRY**	**METHODOLOGY**	**RESULTS (COMPARATIVE RISKS)**
Abdoli et al (2014)	1961-2009	Sweden	**Poisson regression models** to calculate cancer mortality rate ratio (MRR) and age-standardized rates (ASRs).	All-site cancer mortality decreased with increasing level of **education** irrespective of sex and country of birth. The risk was more prominent among foreign-born than Sweden-born men (foreign-born: MRR=1.42; Sweden-born: MRR= 1.28), but in women, it was more noticeable among Sweden-born (Sweden-born: MRR=1.39; foreign-born: MRR= 1.28) low versus high education level. Age-specific analysis revealed a lower cancer mortality risk among foreign-born women in all age strata whereas the increased mortality among foreign-born men was limited to those aged between 50

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				and 70 years.
Dalton et al. (2011)	2001-2008	Denmark	**Logistic regression models** were used to examine the simultaneous influence of all socioeconomic and demographic factors of interest on the likelihood of receiving a diagnosis of advanced-stage lung cancer.	The adjusted OR (odds ratio) for advanced-stage lung cancer was reduced among persons with higher **education** (OR, 0.92; 95% confidence interval (CI), 0.84–0.99). Higher education was associated with a reduced OR for 428 days between referral and diagnosis as was high **income** in early-stage patients. Male gender, age and severe comorbidity were associated with increased ORs in advanced-stage patients.
Dalton et al. (2015)	2004-2010	Denmark	Associations between SEP and receipt of first-line treatment for lung cancer were analyzed in **multivariate logistic regression models** and those with overall mortality in **Cox regression models** with stepwise inclusion of possible mediators.	For both low- and high-stage lung cancer, adjusted ORs for first-line treatment were reduced in patients with short **education** and low **income**, although the OR for education did not reach statistical significance in men with high-stage disease. The socioeconomic difference in overall survival was partly explained by differences in stage, treatment and comorbidity, although some differences remained after adjustment. Among patients with high-stage disease, the hazard ratio (HR) for death of those with low income was 1.12 (95% CI 1.05–1.19) in comparison with those with high income. The differences in risk of death by SEP were greatest in the first six months after diagnosis. Socioeconomic differences in survival after lung cancer are partly explained by social inequality in stage, first-line treatment and comorbidity.
Frederiksen et al. (2012)	2000-2008	Denmark	A **registry-based cohort study** links clinical data on prognostic factors and treatment from the National Lymphoma Database to individual socioeconomic information in Statistics Denmark including 6234 patients diagnosed with non-Hodgkin lymphoma (NHL).	All-cause mortality was 40% higher in NHL patients with short vs higher education diagnosed in 2000–2004 (hazard ratio (HR)=1.40

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				(1.27–1.54)), and 63% higher in 2005–2008 (HR=1.63 (1.40–1.90)). Mortality was increased in unemployed and disabled pensioners, those with low income and singles. Clinical prognostic factors attenuated, but did not eliminate, the association between education and mortality. Radiotherapy was less frequently given to those with short education (odds ratio (OR)=0.84 (0.77–0.92)), low income (OR=0.80 (0.70–0.91)), and less frequently to singles (OR=0.79 (0.64–0.96)). Patients living alone were less likely to receive all treatment modalities.
Ibfelt et al. (2012)	2005-2009	Denmark	**Logistic regression models** were used to analyze the relations between socioeconomic factors and cancer stage in a four-step model, with stepwise inclusion of mediators. A total of 1651 cervical cancer cases from the Danish Gynecological Cancer Database were analyzed. Date of diagnosis, clinical cancer stage, tumor histology and treating hospital were retrieved.	The risk of advanced- (stage II–IV) compared with early-stage cancer (stage I) was higher for women with short and medium education (OR = 2.40; 1.67–3.45 and 1.76; 1.44–2.16), women living without a partner (OR = 1.31; 1.10–1.55) and older women (OR = 1.07; 1.06–1.08 increase per year). Relations between socioeconomic factors and cancer stage were partly mediated by time since last Pap smear test and to a lesser extent by comorbidity.
Ibfelt et al. (2013)	2005-2010	Denmark	Associations between socioeconomic indicators (education, income and cohabitation status) and mortality by all causes were analyzed in **Cox regression models** with the inclusion of possible mediators. A total of 1961 cases of cervical cancer were diagnosed in the Danish Gynecological Cancer Database, with information on prognostic factors, treatment and lifestyle. Age, vital status, comorbidity and socioeconomic data were obtained from nationwide administrative registers.	All mortality cause was higher in women with shorter rather than longer education (hazard ratio (HR), 1.46; 1.20–1.77), among those with lower rather than higher income (HR, 1.32; 1.07–1.63) and among women aged <60 years without a partner rather than those who cohabited (HR, 1.60; 1.29–1.98). Socioeconomic differences in survival were partly explained by cancer stage and less by comorbidity or smoking (stage- and comorbidity-

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				adjusted HRs being 1.07; 0.96–1.19 for education and 1.15; 0.86–1.52 for income).
Larsen et al. (2015)	1993-1997	Denmark	**Cox proportional hazard models** are used to study the influence of metabolic indicators, smoking, alcohol consumption and socioeconomic position on mortality after breast cancer.	The age-stratified hazard ratio (HR) for women with basic or high school **education** was 1.40 (95% CI 1.05–1.86) compared to those with higher education. As for **income**, there was no significant trend in death from all causes between the income quartiles and adjustments only had minor effects on the estimates, although a significantly increased HR of 1.32 (95% CI 1.02–1.72) was observed among those with 2nd–3rd quartile income.
McKenzie et al. (2008)	1994-2004	New Zealand	**Logistic regressions** are used to study differences in breast cancer prognostic factors between ethnic and socioeconomic groups.	Results confirm that Maori, Pacific and low **socioeconomic** women present with poor-prognosis breast tumors. To be specific, women living in more deprived areas (NZDep 9–10 OR 1.22, 95% CI 1.10–1.35) were more likely to have nonlocal-stage breast tumors than those living in less deprived areas.
McKenzie and Jeffreys (2009)	1966-2008	Several Countries	**Systematic review** of studies indexed in MEDLINE to identify studies that investigated the explanatory power of ethnic/racial inequalities, among them socioeconomic position (SEP) on ethnic inequalities on breast cancer survival.	In the systematic review, authors found that **SEP** explains part of the ethnic inequality in survival from all causes but this finding was not evident for breast cancer-specific survival. The role of SEP appears to be smaller in the papers analyzed more recently. SEP explains more of the disparities for African American versus white women in the United States compared with other ethnic comparisons.
Meijer et al. (2013)	2004-2008	Denmark	Hazard rates (HR) using shared frailty models which are **multilevel random effect models** for survival data, accounting for a latent multiplicative effect on the hazard function, the 'frailty' were used to evaluate the influence of neighborhood characteristics on breast, prostate and lung cancer incidence.	Lower HR of breast cancer was found in areas with low population density (HR¼0.93; CI 0.88 to 0.99), while neighborhood **unemployment** had no effect. Inhabitants of lower unemployment

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				areas had a higher risk of prostate cancer (HR¼1.14; CI 1.08 to 1.21) than those in higher unemployment areas, whereas population density had no effect. Risk of lung cancer was lower in areas with the lowest population densities (HR¼0.80; CI 0.74 to 0.85) and lowest in areas with the lowest unemployment (HR¼0.88; CI 0.84 to 0.92).
Newmann and Garner (2005)	1990-2005	United States	**Structured review** for US-based research on cervical cancer and social inequities (Medline).	Despite overlap with other social domains of inequality, such as race/ethnicity, age, literacy and insurance status, socioeconomic deprivation was frequently found to be a strong predictor of screening diagnosis, treatment and survival differentials regardless of other social domains.
Nkosi et al. (2012)	1996-2002	Canada	**Logistic regression** to study associations between socioeconomic position and lung cancer when adjusting for smoking.	For comparisons of the highest to lowest categories of census-based **income**, the OR for lung cancer was 0.58 (95% CI = 0.32–1.05) when adjusting only for smoking status, but 0.97 (0.51–1.86) when adjusting for smoking status, cigarette years and time since cessation. As regards comparisons of highest to lowest levels of **education**, the ORs for lung cancer were 0.50 (0.38–0.65) and 0.76 (0.57–1.02), when making the least and most comprehensive adjustments for smoking, respectively. Comparing highly skilled with unskilled manual workers, the ORs were 0.78 (0.54–1.12) and 1.00 (0.68–1.47), respectively.
Schlichting et al. (2012)	1990-2008	United States	A retrospective cohort study to examine the association between county-level percentage of persons below the poverty level and BC-specific (BCS) survival for cases diagnosed from 1990 to 2008. **Kaplan–Meier estimator** was used to compare survival curves by county-level SEP variables, with	Residing in a lower SEP, nonmetro county significantly worsens BCS survival for non-IBC in multivariate proportional hazards models. African

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			the **log-rank test** used to detect differences between the survival curves.	American cases appear to have worse survival than non-Hispanic whites regardless of inflammatory status, stage, county-level SEP, tumor or treatment characteristics. Relationship between county-level percentage of persons below the poverty level, breast cancer type, stage and the hazard of breast cancer death (HR): Model 1: stage III IBC: (1.13 (0.97–1.32)). Model 2: stage III non-IBC: (1.13 (1.05–1.22)) Model 3: stage IV IBC: (1.05 (0.79–1.39)) Model 4: stage IV non-IBC: (1.12 (1.03–1.21)) (IBC: inflammatory breast cancer)
Sidorchuk et al. (2009)	1966-2007	Several countries	**Systematic review** and **meta-analysis** to investigate the associations between various socioeconomic indicators and lung cancer incidence. The authors systematically searched PubMed and EMBASE databases for articles published in English-speaking peer review journals.	Results indicate an overall increased risk in lung cancer incidence among people with low **educational** socioeconomic position (SEP), low **occupational** SEP and low **income-based** SEP. Lung cancer incidence was inversely associated with educational, occupational and income-based socioeconomic position (SEP) regardless of smoking adjustment.
Uthman et al. (2013)	1966-2013	Several countries	Residing in a lower SEP, nonmetro county significantly worsens BCS survival for non-IBC in **multivariate proportional hazards models**. African American cases appear to have worse survival than non-Hispanic whites regardless of inflammatory status, stage, county-level SEP, tumor or treatment characteristics. A **random-effect model** was used to pool the risk estimates from the individual studies.	Authors observed an increased risk of gastric cancer among the lowest SEP categories in **education** (RII=2.97; 95% CI 1.923 to 4.58), **occupation** (RII=4.33; 95% CI 2.57 to 7.29) and **combined SEP** (RII=2.64; 95% CI 1.05 to 6.63) compared with the highest SEP categories. Although the association between the incidence of gastric cancer and the level of **income** is evident, it did not reach a statistically significant level (RII=1.25; 95% CI 0.93 to 1.68).

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Diabetes

Among the studies that performed reviews of literature that analyzes the relationship between inequalities and non-communicable diseases, Tamayo et al. (2010) carried out two systematic reviews that included longitudinal, population- or community-based studies if they contained data on psychosocial factors in childhood and either diabetes incidence or obesity risk. Searches were limited to studies published between 1995 and 2010. Eight of the considered studies indicated that low parental status was associated with type 2 diabetes incidence or the development of metabolic anomalies. For obesity, the 11 studies included observed an independent association of low childhood SES with the risk for overweight and obesity later in life. Although the authors underline the limited comparability among the included studies, they provide evidence of the association between childhood SES and type 2 diabetes and obesity in later life. In this sense, psychosocial discrepancies in childhood seem to have an unfavorable impact on future type 2 diabetes incidence. Adjustment for adult SES and BMI attenuated this association.

Agardh et al. (2011) also conducted a systematic review and meta-analysis between 1966 and 2010 in order to identify published evidence of associations between type 2 diabetes incidence and socioeconomic position (SES) measured by educational level, occupation and income. The countries considered in the article were subdivided into high-, middle- and low-income countries. Twenty-three studies, including 41 measures of association, were considered relevant. The results suggest an overall increased risk of type 2 diabetes in low socioeconomic groups, measured by educational level, occupation or income. This association is consistent in high-income countries, although the available data are limited in middle- and low-income countries.

If we consider the studies that analyze the relationship between SES and diabetes at national level, Dalsgaard et al. (2014) studied the incidence of type 2 diabetes for a sample of 1533 people from the Addition Study Denmark, during the period 2000–2006. In the study the levels of HbA1c, cholesterol, blood pressure and muscle mass are virtually identical regardless of the level of education, level of income and occupational or state civil status. A greater proportion of people with lower levels of income level or a lower level of education have

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greater attention in the intensive care unit than people with higher levels of income and education. In general, is checked that the ability to meet the goals of treatment for HbA1c, cholesterol and blood pressure was not changed by the socioeconomic characteristics. The study noted that type 2 diabetes does not depend on socioeconomic characteristics.

In a later research, Dalsgaard et al. (2015) used a cohort of the Danish population between 40 and 69 years of age, all of them without a history of diabetes between the years 2001 and 2006. The authors estimate the mortality rate by level of education, income and coexistence between people with and without type 2 diabetes in Denmark. The age-standardized mortality rate decreases to improve the socioeconomic indicators. Together the effects of type 2 diabetes and socioeconomic indicators have a strong impact on the death rate. The combined effects yield multiplicative increased rates of mortality. In this sense, people with type 2 diabetes and low socioeconomic indicators (low education, low income level or living alone) have a death rate more than twice that of many people with high socioeconomic indicators (higher educational level, high incomes and living with others).

Different country-level studies have been developed in recent years. Hussen et al. (2013) followed a nationwide cohort, aged 0–30 years, in Sweden and found that age-standardized rates of type 1 diabetes mellitus increased among children younger than 15, but not among young adults (15–30 years). Demakokos et al. (2012) explored the association between the socioeconomic situation of children and adults and the incidence of diabetes in a sample of 7432 individuals aged 50 years or older from the English Longitudinal Study of Ageing (ELSA). The article indicated that psychosocial factors in women, and unhealthy behaviors and obesity in both women and men, partially explain the relationship between the socioeconomic status of adults and children (education, type of occupation, income, health and subjective social status) and the incidence of diabetes. The type of occupation, income and subjective social status are not significant in relation to the incidence of diabetes, once adjusted for psychosocial factors, obesity or unhealthy behaviours. However, the level of health (measured in degrees) is significant in relation to the incidence of diabetes, what happens when analyzing the incidence of education and socioeconomic position. In men the subjective social status and health are only statistical have effect on diabetes.

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Smith et al. (2011) investigated associations between cumulative socioeconomic position and the incidence of T2D in the Framingham Offspring Study in Canada. Analyses demonstrated that age-adjusted cumulative socioeconomic position was associated with T2D in women. Age-adjusted analyses for young-adulthood SEP, active professional life socioeconomic position and social-mobility frameworks all demonstrated associations between low socioeconomic position and T2D incidence in women. No association was observed between childhood SEP and T2D in women for father's education. In men, there was little evidence of associations between life course socioeconomic position and T2D incidence.

Spadea et al. (2010) analyzed the associations between cumulative low socioeconomic position and the incidence of type 2 diabetes mellitus T2D in the Framingham Offspring Study in Italy. Analyses demonstrated that age-adjusted cumulative socioeconomic position was associated with T2D in women. Age-adjusted analyses for young-adulthood socioeconomic position, active professional life SEP and social-mobility frameworks all demonstrated associations between low SEP and T2D incidence in women. No association was observed between childhood SEP and T2D in women for father's. In men, there was little evidence of associations between life course SEP and T2D incidence. These findings suggest that cumulative SEP is inversely associated with incidence of T2D in women, and that this association may be primarily due to women's educational levels and occupations.

Maty, James and Kaplan (2010) analyzed associations between several life course socioeconomic position measures and diabetes incidence in a sample of 5422 diabetes-free black and white participants in the Alameda County Study (US). Their results confirmed the important role of life course socioeconomic position measures in determining risk of diabetes.

Other authors have carried out more in-depth analysis of the influence of socioeconomic status on the care of diabetes. In this context, Brow et al. (2005) found the existence of differences in the care of diabetes due to socioeconomic or racial/ethnic disparities. The source of information is the Translating Research into Action for Diabetes (TRIAD) study. Compared with white patients, African Americans have lower indicators for A1C and LDL, a lower rate of vaccination against flu and lower blood pressure and lipid controls. In almost all cases, racial/ethnic minorities or blood pressure problems or lipid controls received similar or

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more intensified regarding care patients from whites or those with better socioeconomic indicators.

Table 4. Summary of results for socioeconomic inequalities and diabetes

DIABETES				
STUDY	**YEAR**	**COUNTRY**	**METHODOLOGY**	**RESULTS (COMPARATIVE RISKS)**
Agardh et al. (2011)	1966-2010	Several countries	Authors conducted a **systematic review** and **meta-analysis** of associations between type 2 diabetes incidence and socioeconomic position (SEP) measured by educational level, occupation and income.	Out of 5120 citations, 23 studies, including 41 measures of association, were found to be relevant. Compared with high **educational level**, **occupation** and **income**, low levels of these determinants were associated with an overall increased risk of type 2 diabetes [relative risk (RR)=1.41, 95% confidence interval (CI): 1.28–1.51], (RR=1.31, 95% CI: 1.09–1.57) and (RR=1.40, 95% CI: 1.04–1.88), respectively. The increased risks were independent of the income levels of countries, although based on limited data in middle- and low-income countries. The risk of getting type 2 diabetes was associated with low **SEP** in high-, middle- and low-income countries and overall. The strength of the associations was consistent in high-income countries, whereas there is a strong need for further investigation in middle- and low-income countries.
Dalsgaard et al. (2014)	2001-2006	Denmark	The authors examined the associations between socioeconomic position with change in cardiovascular risk factor and meeting targets for cardiovascular risk factor among people with detected type 2 DM six year. Baseline characteristics were described using means (SDs) and compared using an Anova test for normally distributed variables, by the median and Kruskal–Wallis one-way analysis of variance for non-normally distributed variables, and the chi-squared test was applied for categorical variables.	The changes in HbA1c, cholesterol, blood pressure and BMI were virtually the same across **educational level**, **income level**, **occupational status** and cohabiting status. Overall, the ability to meet treatment targets for HbA1c, cholesterol and blood pressure was not modified by the socioeconomic position group. A higher proportion of people with lower educational level or lower income level in the intensive care unit redeemed anti-hypertensive treatment compared to people with higher educational or income levels. Early detection and treatment did not introduce socioeconomic inequality in metabolic control in patients with screen-detected type 2 DM at six-year follow-up.

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Dalsgaard et al. (2015)	2001-2006	Denmark	The study population was characterized using the chi-square test and the t-test. The authors tested the interaction between socioeconomic variables (educational level, income level and cohabitation status) for women and men for groups (without diabetes and diabetes). The authors suggest three models: i) adjusted for age, duration of diabetes, calendar time; ii) further adjusted for history of cardiovascular disease (CVD) and cancer before study start; and iii) further adjusted for CVD and cancer before study start and CVD, cancer and number of other diseases according to the Charlson Comorbidity Index during follow-up.	People with type 2 diabetes and the lowest SEP (lowest educational level, lowest income level or living alone) had a more than twofold higher mortality rate ratio than people without diabetes and the highest SEP (highest educational level, high income level or cohabiting). In model 1 the MRRs for all-cause mortality among people with and without diabetes are higher in the group with lower education level (1.7 without diabetes and 2.8 with diabetes), in the group with lower income level (1.7 without diabetes and 2.8 with diabetes) for women. For men, the MRRs are less for education (1.5 and 2.4, respectively) and low income level (1.8 and 2.9, respectively). Similar results are obtained for models 2 and 3.
Demakakos et al. (2012)	2002-2003	United Kingdom	The authors examined the associations between childhood and adult socioeconomic position (SEP) and incident diabetes in 7432 individuals aged 50 or older from the English Longitudinal Study of Ageing (ELSA). **Cox proportional hazards regression models** were used to assess the adjusted associations between each of the six SEP measures and incidence of self-reported doctor-diagnosed type 2 diabetes. The authors suggest	On all models to lower educational level, lower hazard ratios are obtained. In model 1, for instance, in the group with lower than secondary education/no qualifications the hazard ratio is 2.9, while for the group of higher education it is 1.00 for women. For men they are 1.08 and 1.0, respectively. For occupational class intermediate occupations has a lower hazard ratio (0.82) than semi-routine/routine occupations (1.48) for women and 0.73 and 1.27, respectively, for men. Whereas for income, the highest tertile has a lower hazard ratio (1.00) than the lowest tertile (1.63) for women, for men the hazard ratios are similar between the lowest tertile (0.96) and highest tertile (1.00).

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			one model with variables such as age, age squared, marital status, whether still at work and number of cardiovascular and noncardiovascular comorbidities. It also presents variations of this model including psychosocial factors, wealth behaviors, body mass index and tertiles of total net household wealth.	
Hussen et al. (2013)	1969-2008	Sweden	The authors followed a nationwide cohort of 4,469,714 males and 4 ,231,680 females aged 0–30 years. Incidence rate ratios (IRRs) with 95% confidence intervals (CIs) for type 1 diabetes mellitus (T1DM) were calculated using **Poisson regression models**. They further calculated age-standardized rates (ASRs) of T1DM, using the world population as standard.	The ASR of T1DM increased among children younger than 15, but not among young adults (15–30 years). Compared with Swedish-born children, male and female immigrant children had 44 and 42 % lower IRR of TIDM, respectively. Among offspring of immigrants, corresponding decreases in IRRs were 27 and 24 %. Compared with children of parents with high education, male children of parents with low education had a 10% decreased IRR of T1DM, while no effect was observed among females. The IRR of T1DM increased with increasing age and calendar time of follow-up in both sexes (p-for trend <0.0001). In young adults, the IRR among immigrants decreased by 32% in males and 22% in females, while reductions in IRRs were less in offspring of immigrants.
Insaf et al. (2014)	1989,1994 and 2002	United States	**A generalized estimating equations approach** was used with a sample of 3497 adults from the Americans' Changing Lives study. Sex-specific models were calculated to compute prevalence ratios (PR) for associations of race and SEP with self-reported diagnoses of diabetes.	For men, childhood and adult SEP were unrelated to diabetes, and adjustment for life course SEP had little effect on the excess diabetes in blacks (PR=1.56, 95% CI 1.11 to 2.21). Adjustment for measures of life course SEP reduced the PR for the association between race and diabetes in women from 1.96 (95% CI 1.52 to 2.54) to 1.40 (95% CI 1.04 to 1.87), with the respondent's education responsible for most of the reduction in the association. Diabetes was also inversely associated with father's education, and low SEP throughout the life course was associated with a nearly threefold increase in diabetes (PR=2.89, 95% CI 2.10 to 3.99).
Leal et al.	1985-2009	Several countries	**Qualitative**	Low area socioeconomic level was generally

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(2011)			**systematic review** of the literature on geographic life environments and cardiometabolic risk factors (CMRFs), such as obesity, hypertension, type 2 diabetes, syslipidemias and metabolic syndrome in industrialized countries.	significantly associated with an increased risk of CMRFs (in 42 of the 56 studies on obesity, 8 of the 12 studies on hypertension, 3 of the 4 studies on diabetes and dyslipidemia and both of the 2 studies on metabolic syndrome).
Maty et al. (2010)	1965–1999	United States	**Cox proportional hazards analyses** to study associations between several life course socioeconomic position measures and diabetes incidence.	**Income** was protective for whites, but not related to incidence among blacks. Low **education** and blue-collar occupation were protective for blacks, but increased risk for whites. Among white participants, diabetes incidence was significantly associated with low childhood **SEP**, education (≤12 years versus >12) and income, as well as high blood pressure, excess body mass and former or current smoking status (HR range 1.6–6.4 and 95% CI range 1.1–9.3); low education and blue-collar occupation were protective against diabetes (low education HR=0.5, 95% CI=0.3–1.0; blue-collar occupation HR=0.7, 95% CI=0.4–1.4).
Smith et al. (2011)	1971–2001	Canada	**Pooled logistic regression analyses** are used to investigate associations between cumulative SEP and the incidence of T2D in the Framingham Offspring Study.	The authors demonstrated that age-adjusted cumulative **SEP** was associated with T2D in women (for low vs. high cumulative SEP, odds ratio (OR) = 1.92, 95% confidence interval (CI): 1.08–3.42). Age-adjusted analyses for young-adulthood SEP (7.85 for _12 vs. >16 years of education, OR = 2.84, 95% CI: 1.03–7.85), active professional life SEP (for laborer vs. professional/executive/supervisory/technical occupations, OR = 2.40, 95% CI: 1.05–5.47), and social-mobility frameworks (for declining life course SEP, OR = 2.99, 95% CI: 1.39–6.44; for stable low vs. stable high life course SEP, OR = 1.85, 95% CI: 1.02 - 3.35) all demonstrated associations between low SEP and T2D incidence in women. No association was observed between childhood SEP and T2D in women for father's education (some high school or less vs. any postsecondary education, OR = 1.26, 95% CI: 0.72–2.22). In men, there was little evidence of associations between life course SEP and T2D incidence.
Spadea et al. (2010)	1971-2001	Italy	The authors' objectives were to investigate associations between cumulative low socioeconomic position SEP and the incidence of type 2 diabetes mellitus T2D in the *Framingham*	Pooled logistic regression analyses demonstrated that age-adjusted cumulative SEP was associated with T2D in women (for low vs. high cumulative SEP, odds ratio (OR) = 1.92, 95% confidence interval (CI): 1.08, 3.42). Age-adjusted analyses for young-adulthood SEP (7.85 for ≤12 vs. >16 years of education, OR = 2.84, 95% CI: 1.03), active professional life SEP (for laborer vs. professional/executive/supervisory/technical occupations, OR = 2.40, 95% CI: 1.05–5.47),

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			Offspring Study. Multivariable pooled logistic regression adjusted for time-dependent covariates was used to estimate adjusted odds ratios.	and social-mobility frameworks (for declining life course SEP, OR = 2.99, 95% CI: 1.39–6.44; for stable low vs. stable high life course SEP, OR = 1.85, 95% CI: 1.02–3.35) all demonstrated associations between low SEP and T2D incidence in women. No association was observed between childhood SEP and T2D in women for father's education (some high school or less vs. any postsecondary education, OR = 1.26, 95% CI: 0.72–2.22). In men, there was little evidence of associations between life course SEP and T2D incidence. These findings suggest that cumulative SEP is inversely associated with incidence of T2D in women, and that this association may be primarily due to women's educational levels and occupations.
Tamayo et al. (2010)	1994–2010	Several countries	**Two systematic reviews** were carried out by the authors. They included longitudinal, population- or community-based studies if they contained data on psychosocial factors in childhood and either diabetes incidence or obesity risk.	The search strategy yielded a total of 19,504 results. Fourteen publications for obesity and 10 for diabetes mellitus were included in the final reviews. Psychosocial discrepancies in childhood seem to have an unfavorable impact on future type 2 diabetes incidence. Adjustment for adult **SES** and BMI attenuated these associations considerably. This finding raises the question of whether a favorable life course may be beneficial for the participants' metabolic status. The authors found family **income** and father´s **occupation** of relevance for overweight and obesity. Surprisingly, in contrast to their findings on diabetes incidence, parental education seemed to have less impact on future obesity risk. However, lower parental **education** was linked to an earlier age at onset of obesity in one study.

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4 DISCUSSION

This systematic review summarizes the methods and findings of studied associations between socioeconomic status (SES) and NCDs, published between 2005 and 2015. SES is proxied with different indicators, mainly education attainment, occupational categories and income. Different NCDs are considered, but most of the literature reviewed refers to CVDs, cancer and diabetes. Overall the evidence suggests that having low SES increased the risk of developing CVDs, lung and breast cancer and type 2 diabetes. Socioeconomic position is also associated with multiple NCD risk factors such as smoking and physical inactivity.

Published literature on inequalities, health and NCDs is characterized by a large number of heterogeneous papers, which determine the complexity of this kind of relationship. Improving this information is crucial for capturing fully the value of the socioeconomic measures, and for indicating the most relevant determinants of health and non-communicable diseases.

Several types of analysis produce very different results regarding the role of health determinants. The differences are particularly relevant when the results are presented in terms of effectiveness in health policies and welfare. Although the determinants of health identified in individual studies are important variables in an aggregate analysis, there are specific factors that influence social groups. Each individual factor measures different components and the selection of indicators is frequently influenced by the availability of data.

Socioeconomic circumstances during childhood appear to be relevant in terms of influencing to influence CVD in adulthood. Among adults with diabetes, a high prevalence of CVD is associated with a lower socioeconomic position. Socioeconomic status also presents a negative relationship with the incidence, recurrence and mortality of stroke, according to most of the literature revised. From a macroeconomic perspective, risk of stroke was associated with lower per capita GDP and health expenditure per capita. Most of the analyzed studies find that the increased prevalence of coronary heart disease varies across the social class distribution, showing that education and income are inversely associated with coronary heart disease.

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Literature that examines the association between cancer incidence or prevalence and SES is based mainly on lung, breast and gastric cancers. The results suggest that low SES is correlated with an increased risk of cancer incidence and mortality in the type of cancer referred to. Socioeconomic differences in survival after cancer detection are explained, partly, by the social inequality in the stage of detection, in the early stages of the treatment and the comorbidity. According to the results of the revised literature, efforts are recommended to improve early diagnosis and follow-up of the recommendations in the first stage of treatment in patients with cancer with low socioeconomic indicators. Evidence indicates that patients with lower socioeconomic indicators receive a less intense first treatment than those with higher indicators.

In relation to studies that analyze the relationship between SES and diabetes, most of the results suggest an overall increased risk of type 2 diabetes in low socioeconomic groups, measured by educational level, occupation or income. The results also find a direct relationship between the age-standardized mortality rate and SES that decreases to improve the socioeconomic indicators. In this sense, the effects of type 2 diabetes and socioeconomic indicators have a strong impact on the death rate.

In conclusion, according to the literature, social and economic disadvantage appears to have a significant consistent impact on mortality and morbidity caused by NCDs. Low socioeconomic status is associated with health inequalities in terms of access to care, increased incident risk of NCDs and early death. These findings point to the need for public health strategies and research to address socioeconomic status disparity among individuals. Strategies aimed at reducing socioeconomic inequalities in NCD should be investigated in relation to the disparities in risk, diagnosis and effective intervention among the highest-prevalence groups. The global burden of diseases and individual habits are changing because of globalization, urbanization and economic development. In this sense, it would be relevant to consider the potential of individual studies for analyzing the hypothesis of a more detailed relationship between socioeconomic status, health and NCDs.

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