FRESHER
FORESIGHT AND MODELLING FOR EUROPEAN HEALTH POLICY AND REGULATION

5.1
A systematic review of socioeconomic status, health and non-communicable diseases

DRAFT

Report - Summary

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INTRODUCTION TO THE FRESHER PROJECT

FRESHER is a collaborative research project that aims to detect emerging health scenarios to test and assess future policy options to tackle the burden of chronic non-communicable diseases (NCDs) in Europe. As one of the largest threats to public health globally, the exponential growth of NCDs in Europe has a serious negative impact on human development, reduces productivity, contributes to poverty and creates a significant burden on health systems. Therefore, one of the main goals of FRESHER is to identify core determinants that could be targeted to lessen the impact of NCDs, focusing on a set of chronic diseases which currently constitute the bulk of the mortality rate in Europe: cardiovascular diseases, cancers, diabetes, and chronic lung disease.

Rather than just extrapolating past health trends, the project consortium will use a variety of foresight techniques that account for the interdependencies of structural long term trends in demographic, gender relations, technological, economic, environmental, and societal factors for European countries. Supported by a mapping of determinants of NCDs in Europe, the developed model will capture the complex set of inter-relationships between individuals' history of engagement in risk-taking behaviors, exposure to environmental risks and the resulting distribution of health, social and economic consequences across gender and across social groups. All of these efforts will fuse to elaborate and produce inputs for the empirically-based dynamic micro-simulation tool capable of quantifying the current and future health and economic impacts of risk factors as well as potential new policies and policy combinations.

HORIZON SCANNING AND FORESIGHT

Recent health related Foresights and Forecasts show widespread use of visions, scenarios and forecasts with demographic shifts, rising healthcare costs, and emerging technologies predominating. Scenarios are ubiquitous in health Foresights and Forecasts. Many combine statistical forecasting with perceived trends to develop future scenarios that could form the basis for discussions for future policy formulations and options. Many also commence from a vision normatively determined on previous trends and future expectations to foresight and forecast future requirements in research, policy development, resources prioritization and interactive stakeholder engagement. Visions, scenarios, forecasts are in all regards preoccupied with issues of demographic trends, rising healthcare costs in order to finance those shifts, the inadequacies of healthcare structures in high and low income countries in delivering services often through lack of skilled personnel combined with the serendipitous effects of climate change, the widening epidemiology of chronic and infectious diseases and perceived changes in social attitudes to caring in communities.

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1 BACKGROUND

From a broad point of view, an individual's health is considered not only as an absence of disease, but as a fundamental human right (WHO, 1986). A comprehensive approach to health highlights its close relationship with social and economic conditions, physical environment and individual lifestyle. According to the Commission on Social Determinants of Health, we can consider health inequalities to be the result of the cumulative impact of decades of exposure to health risks of those who live in socioeconomically less advantaged circumstances (Commission on Social Determinants of Health, 2008).

If we focus on all the socioeconomic variables, the relationship between income (understood as a measure of socioeconomic status) and health is probably the most complicated (Fuchs, 2004). The correlation coefficient, obtained from the crudest associations, can range from highly positive to slightly negative, depending on the context and the aggregation level. Even when the positive correlation is strong and stable, causal interpretations may include income influencing health, health influencing income and/or "third variables" affecting both indicators in the same direction and at the same time. For this reason, Gross Domestic Product (GDP) is related to some health-outcomes indicators (Kanavos and Mossialos, 1996). However, there are exceptions. For example, some southern countries of the European Union that are relatively poor have a life expectancy indicator greater than that of the rich countries of northern Europe. Also, we can observe that the United States, one of the world's richest countries in terms of GDP per capita, has infant mortality rates similar to those of poorer countries (Starfield, 2000).

In addition, there is a large and growing body of literature in which the effects of income on health are examined because of the importance of these effects in the development of appropriate economic policies (Gravelle et al., 2002). Many studies have shown a negative association between income and mortality (Lutter and Morrall, 1994; McCarron et al., 1994; Viscusi, 1994; Sing and Siahpush, 2002; Shaw et al., 2005; Pearce and Dorling, 2006; Leyland et al., 2007; Singh and Kogan, 2007; Ezzati et al., 2008; Thomas et al., 2010). These empirical findings suggest that individual health is a function of individual income – *the absolute income hypothesis*. In relation to income inequality, the *relative income–health hypothesis* suggests that income inequality has a detrimental effect on population health because it is an individual's relative, rather than absolute, income that is important for health (Marmot et al., 1991; Wilkinson, 1997 and 1998; Wildman, 2001 and 2003; Borrell et al., 2002; Lopez Casasnovas and Rivera, 2002; Gravelle et al., 2002 and 2003; Eberstadt and Satel, 2004). Income inequality may therefore be a health risk (Le Grand, 1987; Wilkinson, 1992 and 1996). Similar results have been shown by Waldmann (1992) and Kawachi et al. (1996), using different measures of inequality. Thus, life expectancy and population mortality have been used as key indicators of economic and social development (Van Doorslaer and Koolman, 2002; Cantarero et al., 2005; Dierk and Nunnenkap, 2015).

Although previous empirical literature presents different interpretations of the evidence, most analyses report that average health is worse in more unequal societies. However, this relationship is not perfect, since there are several determinants that can influence it. In addition, previous empirical studies have shown that countries with lower per capita income levels have lower mortality rates (Preston, 1975). This fact could be explained by arguing that while it is true that some factors (food and housing) are positively associated with a level of income above a certain minimum, there may be others (alcohol, tobacco or drug consumption) that have the opposite effect.

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There is clear evidence indicating that a nonlinear, typically concave, relationship between health and income at an individual level will generate an aggregate relationship in which average health will depend negatively on the degree of inequality in the income distribution (Duleep, 1995; Wilkinson, 1996; Mackenbach et al., 2005; Mackenbach, 2012).

Hence, income redistribution from the rich to disadvantaged groups may improve some health indicators (Kawachi and Kennedy, 1999). Also, some authors have suggested the existence of conceptual difficulties in studying the relationship between income and individual health when aggregated data are used, because revenues have a diminishing marginal effect on health (Deaton and Muellbauer, 1980). This is because if income inequality increases, it tends to reduce average health but improve the health of "the rich", although this latter effect is less significant than the reduction in overall health.

The remainder of the paper is structured as follows. Section 2 provides an overview of the literature and methodology and the data we used. Section 3 discusses the results. The final section concludes.

2 METHODS

A systematic literature search was performed in PubMed, Cochrane Library and Web of Science (until 17 December 2015) to identify the most relevant published evidence regarding the relationship between income and health. In all databases, terms related to "health", "income" and "inequalities" were combined (for full search queries see Table 1). The searches were confined to papers published in the English language since 2010, to limit the scope of this review to the most recent data and the state of the art. In other words, we considered a 5-year retrospective horizon to be enough.

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

#	Search term
	PubMed
#1.	Health [Title/Abstract]
#2.	Income [Title/Abstract]
#3.	Inequality [Title/Abstract]
#4.	Limit to: journal article; year of publication >= 2010; English and Spanish; Humans subjects, free-full text.
	Cochrane Library
#1.	Health [Title/Abstract]
#2.	Income [Title/Abstract]
#3.	Inequality [Title/Abstract]
#4	Limit to: year of publication >= 2010.
	Web of Science
#1.	Health [Topic]; [Title]
#2.	Income [Topic]; [Title]
#3.	Inequality [Topic]; [Title]
#4.	Limit to: journal article; year of publication >= 2010; English and Spanish; Public Environmental Occupational Health “or” Social Issues “or” Health Care Sciences Services.

After finding publications in the electronic searches, duplicate records were removed. The selection of papers was ultimately based on the following eligibility criterion: an applied study with a focus on one or more OECD countries (included the European Union and other developed countries). Additionally, the results of “hand searching” are also included in the following pages, where a wider horizon is considered. Figure 1 is a diagram of the paper selection process following PRISMA (www.prisma-statement.org).

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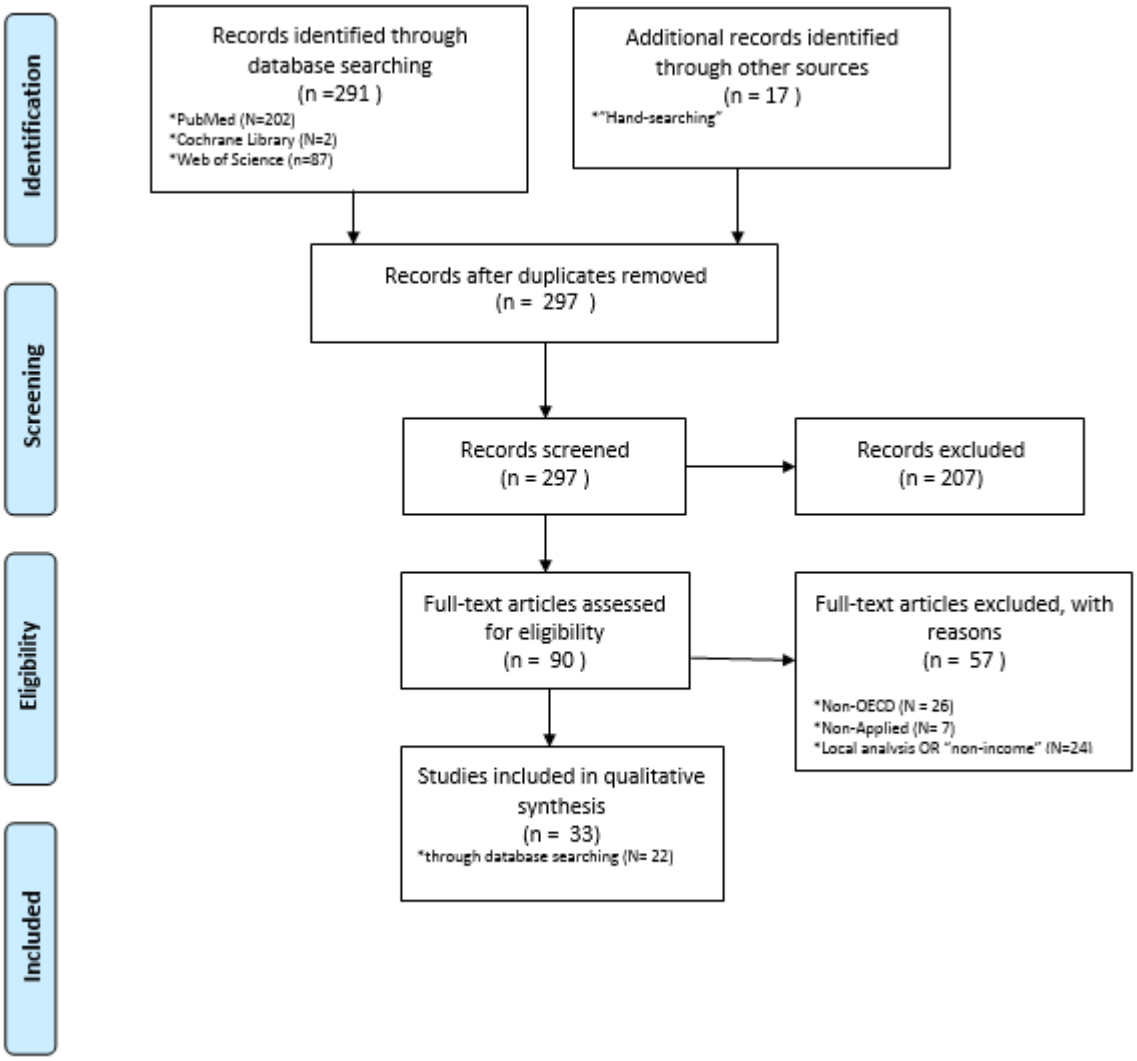
FIGURE 1
Flow diagram of paper selection process



The literature search located 291 publications in the databases under consideration, and 17 papers published between 2010 and 2015 were identified through "hand searching". A total of 11 duplicates were removed, resulting in 297 "unique papers". After screening the titles against the eligibility criteria, 90 papers were selected. Of these, 57 articles were excluded as they did not fit with the previous criteria. So, a final set of 33 selected studies have been taken into account in this review. In any case, further papers are finally considered to have a robust overview. The following Table 2 focuses on the 22 papers found through the database search.

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TABLE 2.
Characteristics of the studies included in the review (omitting those found by "hand searching")

STUDY	YEAR	COUNTRY	METHODOLOGY	MAIN RESULT
Allanson et al. (2010)	1991-1999	England	Index of "income-related health mobility".	There has been a fall in income-related health inequality.
Elgar (2010)	2005-2008	33 countries	2-level linear model with variances.	Income inequality might contribute to short life expectancy and adult mortality in part because of societal differences in trust.
Huijts et al. (2010)	2002, 2004, 2006	Denmark, Finland, Norway and Sweden	Binomial logistic regression models.	Income gradient. People reported significantly better health and were less likely to suffer from long-running illnesses if they had a higher income.
Idrovo et al. (2010)	2002-2004	110 countries	Path analysis of cross-sectional ecological data.	Income inequality and social capital have direct effects on life expectancy at birth.
Islam et al. (2010)	1980-1981, 1988-1989, 1996-1997	Sweden	Concentration Index, by fixed effect model.	Conventional unstandardized and standardized (by age and gender) CIs (Concentration Indexes) increase over time.

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TABLE 2 (continued)

Characteristics of the studies included in the review (omitting those found by "hand searching")

Karlsson et al. (2010)	2006	21 countries	Ordered probit model.	There is evidence of a negative relationship between income inequality and individual health in high-income countries.
Oshio and Kobayashi (2010)	2001, 2004, 2009; 2000, 2003, 2006.	Japan	ANOVA and ordered bivariate probit models.	Individuals who live in areas of high inequality tend to report themselves as both unhappy and unhealthy.
Petrie et al. (2011)	1999-2004	Scotland, England and Wales	Decomposition method in order to account explicitly for mortality in the longitudinal analysis of income-related health inequalities.	Accounting for deaths in the decomposition analysis shows that the relative health changes for both regions and genders between 1999 and 2004 were significantly regressive, such that initially poor people experienced a greater share of health losses compared to their initial state of health.
Chen and Crawford (2012)	2000	United States	Multilevel regression models.	Income inequalities measured at different geographic scales have different interpretations and relate to societal factors at different levels. A rejection of the IIH (Income Inequality Hypothesis) at one geographic level cannot negate positive evidence at another level.

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TABLE 2 (continued)

Characteristics of the studies included in the review (omitting those found by "hand searching")

Hosseinpoor et al. (2012)	2002-2004	48 countries	Bivariate and count data models.	Prevalence of non-communicable disease risk factors demonstrates different patterns for varying degrees of socioeconomic inequality across low- and middle-income settings.
Karlsdotter et al. (2012)	2007	Spain	Logit model.	Support for the absolute income hypothesis: "a higher level of personal income is correlated with a lower probability of negative health outcomes".
Martinson (2012)	1999-2006; 2003-2006	United States and England	Weighted prevalence rates and risk ratios by income level for different health risk factors or conditions (obesity, hypertension, diabetes, low high-density lipoprotein cholesterol, high cholesterol ratio, heart attack or angina, stroke, and asthma).	Income gradients in health are very similar across age, gender, and numerous health conditions, and are robust to adjustments for race/ethnicity, health behaviours, body mass index, and health insurance.

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TABLE 2 (continued)

Characteristics of the studies included in the review (omitting those found by "hand searching")

Allanson and Petrie (2013)	1999-2004	Great Britain	Dynamic health function modelling framework (two-part model). Changes in IRHI (Income Related Health Inequality) through both morbidity changes and mortality. Quality Adjusted Life Years (QALYs) as health measure.	Major driver of the no equalising effects of mortality is the positive association between age and poverty, with other significant contributors including initial health status, advanced levels of educational attainment, gender and smoking.
Ásgeirsdóttir and Ragnarsdóttir (2014)	2007, 2009	Iceland	Health concentration index.	Cyclical income-related health distributions.
Siegel, Mielck and Maier (2014)	2002, 2006	Germany	Semiparametric extension of Wagstaff's corrected concentration index.	The degree of deprivation-specific income-related inequality in the three health outcomes exhibits only small variations across different levels of multiple deprivation for both sexes.
Siegel, Vogt and Sundmacher (2014)	1994-2011	Germany	Health concentration index.	Income-related health inequalities have roughly doubled over time, to the disadvantage of the economically deprived.

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TABLE 2 (continued)

Characteristics of the studies included in the review (omitting those found by "hand searching")

Vallejo-Torres et al. (2014)	2006-2010	England	Health concentration index.	Inequalities occur across the life-course but for some health issues there may be a period of equalisation in late adolescence and early adulthood.
Torre and Myrskylä (2014)	1975-2006	21 developed countries	Time series.	Income inequality is positively associated with mortality of males and females between the ages of 1 and 14 years and 15 and 49 years, and with mortality of females between the ages of 65 and 89, albeit less strongly than for younger age groups.
Chauvel and Leist (2015)	2005, 2011	18 countries	Multilevel models.	Linear health gradients increase. Intergenerational transmission of status gains in importance in countries with higher income inequality.
Jutz (2015)	2008-2009	42 European countries	Two-step hierarchical estimation approach.	Income inequality has more impact on health inequalities than do social policies.
Lillard et al. (2015)	1913-2009, 1984-2009	United States	Ordered probit models.	Exposure to income inequality in early life is related to worse health in later life.
Rambotti (2015)	1999	United States (and international)	Bivariate and cross-sectional associations.	Poverty has a significant and adverse effect.

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We also reviewed the works obtained from "hand searching", where the results are almost all based on economic criteria. Specifically, we can highlight that there is also a large amount of evidence about the influence of income on health status for different socioeconomic groups. References are listed at the end of this article, and we have included references in journals and cited books.

3 DISCUSSION

Among countries with more of a tradition of this type of study, we can find Great Britain and its "Black Report" (Black et al., 1980), which was updated with another report called "The Health Divide" (Whitehead, 1992). Furthermore, the "Achenson Report" is a continuation of previous studies, from the perspective of the wide differences in the United Kingdom between those at the low and those at the high end of the social scale (Achenson et al., 1998). These differences were observed in periods of prosperity and, at the same time, periods when there were reductions in the mortality rate across the country, considered at an aggregated level. In the "Achenson Report", a conceptual framework is presented that defines the determinants of health in a socioeconomic model. The distributions of income, education, housing, employment, smoking, alcohol intake and diet are considered as determinants of health. From this, the report specifies 39 recommendations, or priority policy directions, for reducing health inequalities. This advice is based on increasing the income of the poorest in order to improve their lifestyle and nutrition and the basic facilities at their disposal, in order to give them better health.

Among the most recent studies, there is also an interest in solving the apparent paradox that income appears to be related to health within countries but not between them. The explanation relies on the fact that in developed countries, which have already achieved a certain standard of living, increases in per capita GDP make little difference to the levels of health because of the *epidemiological transition*. (Mc Keown, 2009) that describes changing patterns of population age distributions, mortality, fertility, life expectancy, and causes of death. However, within countries, differences in living standards establish a social order in the population.

The epidemiological transition implies that absolute deprivation loses its relevance and comes to be replaced by relative deprivation (Wilkinson, 1996). This explains why, after a given time, income and health are inversely associated in developing countries but lose this relationship in developed countries.

Among the papers that raise the issue of income distribution as a possible reason for inequalities in individuals' health, that published by Deaton in 1999 is notable. Deaton proposes a model in which individual health is affected by the relative income of each individual with respect to the average income of the members of a reference group. The author shows that if the level of health does not depend on income, but if we consider income relative to the income of the members of the reference group, then the relationship between income and health becomes dependent on the relative size of the inequality inter and intra group. The model is subsequently extended to allow income inequalities to have a direct influence on health status. However, the empirical evidence that has been developed shows no relationship between mortality and income

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inequality.

Furthermore, Deaton and Paxson (2001) develop a similar analysis in order to examine the relationship between income inequality and mortality. Education, represented by years of schooling as a control variable, is included. The analysis is performed for the United States and Great Britain. The results show that neither the trends in the level of income nor the inequalities in income explain the adjusted mortality rates by age. Besides, Wagstaff and Van Doorslaer (2000) review a large body of literature on the effects of income inequality on population health. The authors conclude that only individual level studies are relevant for discriminating between the hypotheses that were advanced, and that aggregate level studies are not able to do this. The literature review shows that the individual level studies considered to be relevant provide strong support for the absolute income hypothesis, no support for the relative income hypothesis and little or no support for the income inequality hypothesis.

In relation to this we can think about the countries of eastern Europe, where, despite their egalitarian distribution of income, there are high mortality rates. Contoyannis and Foster (1999) found that it is absolute income that has a significant effect on health, and not relative income. Their results highlight the idea that, under certain conditions such as income growth, it is possible to increase both the average health of the population and inequalities in the same proportion. These increases would be independent of the income distribution. Along the same lines, we can point to the paper of Van Doorslaer et al. (1997), whose results support the idea that health inequalities cannot be definitively attributed to income inequalities. A possible explanation for it could be the characteristics of health system in each country. This study was conducted for nine industrialized countries, with the measure of health being a self-assessment by individuals.

Table 2 focuses on the 22 papers obtained from the database search. The first group of studies explore the fact that people who live in areas of high inequalities tend to report themselves as both unhappy and unhealthy (having a shorter life expectancy and high adult mortality), and that this tendency increases over time (Allanson et al., 2010; Elgar, 2010; Huijts et al., 2010; Idrovo et al., 2010; Islam et al., 2010; Karlsson et al., 2010; Oshio and Kobayashi, 2010; Petrie et al., 2011).

Moreover, the following group of studies developed various econometric approaches (multilevel regression, bivariate and count data or logit models) in order to consider geographic, socioeconomic and poverty-related issues (Chen and Crawford, 2012; Hosseinpoor et al., 2012; Karlsdotter et al., 2012; Martinson, 2012; Allanson and Petrie, 2013; Ásgeirsdóttir and Ragnarsdóttir, 2014).

The health concentration index and its corrections have been employed in recent studies (Siegel, Mielck and Maier, 2014; Siegel, Vogt and Sundmacher, 2014; Vallejo-Torres et al., 2014). As is described in Table 2 and Figure 2, the relative income–health hypothesis is also analysed by Torre and Myrskylä (2014) using panel data for 21 developed countries over 30 years. Income inequality is measured by the Gini index, and mortality rates for age intervals and gender are used. The results suggest that income inequality is positively associated with mortality rates, mainly in the younger age groups.

Hu and Van Lenthe (2005) assess the relationship between income inequality and mortality in 43 European countries between 1987 and 2008. Data on income inequality are expressed using the Gini index based on household income. A significant association between income inequality and

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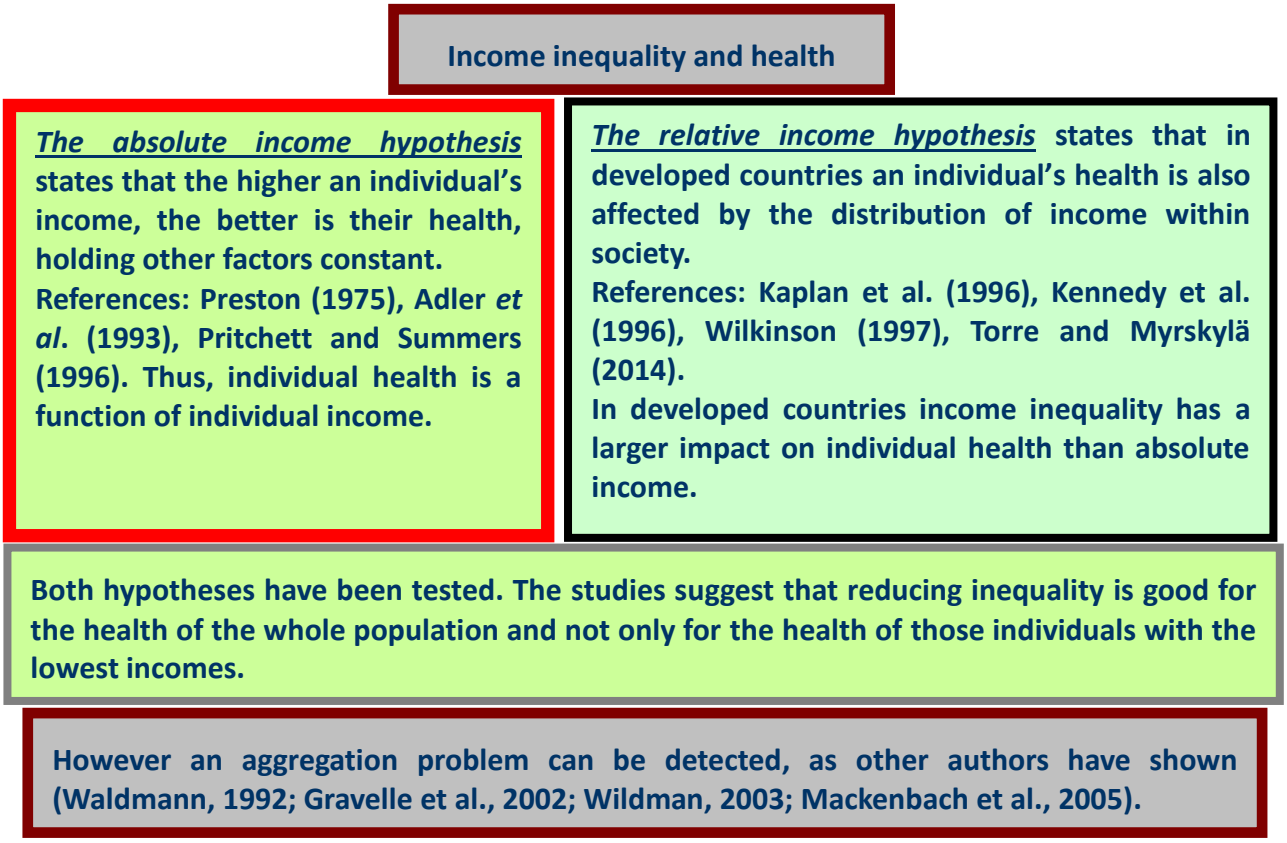
mortality indicators was found in pooled cross-sectional analysis. These results indicate higher mortality rates in countries with larger income inequalities. Nevertheless, when the country fixed effects are added, most of the previous associations become insignificant. The authors conclude that in European countries income inequality does not have an independent effect on mortality.

FIGURE 2
Relative and absolute income–health hypotheses



Moreover, it seems logical that there would be a difference between rich and poor countries in how income distribution would affect health status. In relation to this, Waldmann (1992) suggests that there is a social effect of income inequality in the richest countries and in the poorest countries too. Rodgers (1979) found, for 56 countries with different levels of wealth, that life expectancy is related to both per capita income and its distribution.

Following this line of argument, Deaton (2001a) discusses the connection between income inequality and health in a sample of rich and poor countries. He considers factors such as the nonlinear effects of income, credit restriction, nutrition, and the provision of public goods. The paper concludes that there is no direct relationship between health and income inequality. Other variables, such as the racial composition of the population, are also taken into account in studies such as those of Lubotsky and Deaton (2001) and Deaton (2001b).

Shibuya et al. (2002) analyse the effects on self-assessed health of individual income and income distribution in the prefectures of Japan, using a cross-sectional analysis. The main health measure

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was the self-assessed health of each respondent in a survey of people's living conditions, health and welfare. Income inequality at the prefectural level was measured by the Gini coefficient. The results show that individual income was more strongly associated with self-assessed health than was income inequality. Median income was inversely related to self-assessed health when regional effects were included in the analysis.

Wilkinson and Pickett (2006) performed a review of the literature analysing the association between income distribution and the health of the population. They identified 155 studies published between 1974 and 2005. They divided the studies into three categories according to their findings: "wholly supportive" if they reported only statistically significant associations between greater income inequality and poorer population health; "unsupportive" if they found no statistically significant positive associations; and "partially supportive" or "mixed" if there were some positive associations. The authors emphasized the use of different methodologies in the revised studies to test the hypothesis that greater inequality is associated with poorer population health. The main differences were the different sizes of the analysed areas, and the control variables considered in the models. The general conclusion of the review is that income distribution is related to health where it represents a measure of the differences in social class in the society.

Among the studies that conduct their analysis on individual data, Ettner's study (1996) estimates the effects of income on a set of individual health proxies. Nonlinear models and cross-sectional data were used, and the study takes into account the possibility of causality between the variables when using instruments. The results show a strong positive effect of income on health.

Dahl et al. (2006) analyse the degree to which contextual income inequality affects the health of Norwegian regions, above the effects of mean regional income and individual-level confounders. The study analyses men and women born between 1927 and 1968 who were registered as being alive at the end of 1993. The results differ from previous studies in suggesting that in Norway a comparatively egalitarian income distribution interferes with the emergence of regional-level income inequality effects on mortality. This would mean that comprehensive welfare institutions do not have a positive effect on health status.

From another point of view, a study developed in Spain (Regidor et al., 2014) evaluates the relationship between income and mortality for the period 1970-2010 at a provincial level. The indicator used for average provincial income was the gross domestic product per capita in the province, for each of the 50 Spanish provinces. The empirical results show that inequality in the distribution of provincial income declined during the four decades covered by the study. Moreover, the difference in the mortality rate between the poorest and richest provinces declined for infant mortality and increased for all-cause mortality. In this study, provincial income inequality decreased, but income became more powerful as a predictor of premature mortality.

More recently, Pickett and Wilkinson (2015) have conducted a new review of the literature on the subject. Their work uses an epidemiological causal framework in order to infer the likelihood of a causal relationship between income inequality and health. They find a strong causal connection between income inequality and health, according to the exhaustive body of literature reviewed. IN the minority of studies that found no association, the following factors can be identified as problems: an inappropriate scale used to measure income inequality; the inclusion of mediating variables as controls; the use of subjective measures of health; and time periods that were too

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short. The authors also highlight that the effect of income inequality is to increase the gap between social classes or to widen differences in status.

Hosseinpoor et al. (2012) quantify the prevalence of disability among older adults of low- and middle-income countries in order to establish socio-demographic patterns of distribution. They use World Health Survey data from 2002-2004 that includes 53,447 adults aged 50 or older from 48 countries. A multivariate Poisson regression model is used. Disability was measured with a binary variable derived from self-assessed functional difficulties. Household economic status was used as a socio-demographic variable, together with other variables such as sex, age, marital status, living area and education level. The results show that one out of five in the richest quintile, and two out of five in the poorest quintile, reported a disability and that the likelihood of a disability increased with decreasing household economic status, after controlling for confounders.

Multilevel and ordered probit models and a two-step hierarchical estimation approach are employed by Chauvel and Leist (2015), Lillard et al. (2015), Jutz (2015) and Rambotti (2015). In these studies income inequality has more impact on health inequality than social policies, and is related to worse health in later life.

Nevertheless, the real nature of the relationship between health and income is still not clearly defined, because of methodological issues. The literature that we have analysed raises a variety of questions about this relationship and shows the sensitivity in the different studies to the methodology used. The results depend to a great extent on the type of indicator used to measure health, the level of data aggregation and the causal effects among the variables.

As Table 3 shows in relation to *health indicators*, measuring the health status of a population is problematic because there is no complete and comparable health index among countries or regions. The indicators commonly used, which are available for a large number of countries, are mortality rates (infant and adult) and life expectancy. However, these indicators are not sensitive to improvements in quality of life, a fundamental aspect in developed countries where high levels of health have already been achieved (Parkin et al., 1987). Despite these disadvantages, mortality is an indicator widely used in studies linking income and health, as the data are more readily available when making international comparisons.

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TABLE 3

Health indicators, Data aggregation and Causality of variables (income and health)

Health indicators	There is no complete and comparable health index for all countries. The indicators commonly used are mortality rates (infant and adult) and life expectancy. However, these indicators are not sensitive to improvements in quality of life (Parkin et al., 1987). Data at the individual level are recommended (Wagstaff and Van Doorslaer, 2000).
Data aggregation	This presents problems from a methodological point of view. The availability of comparable data for long periods of time is a problem, and individual conditions of linearity are required, while the evidence suggests that relationships in this regard are configured in a nonlinear way (Preston, 1975; Rodgers, 1979; Duleep, 1995; Ettner, 1996; Gravelle et al., 1998; Deaton, 2001a and 2001b; Mackenbach et al., 2005).
Causality of the variables	Population health would also help explain differences in income levels among individuals and countries. The effect could bias results and make any inferences about the structural effect of income on health difficult (Fuchs, 1973 and 2004; Ettner, 1996).

Databases such as health surveys collect a variety of indicators that provide a broader view of health, since they ask about individuals' perceptions of their own health status, their health behaviour and their use of health services. If individual data are available, it is possible to make comparisons between different socioeconomic groups. The main problem stems from the fact that these health surveys do not usually present a longitudinal follow-up, but are cross-sectional studies. Another problem that is attributed to them is that they are based on respondents' memory, and the questions are usually limited to a short time period. Moreover, these types of survey are unrepresentative for certain high-risk groups or marginalized parts of the population. Nevertheless, these individual-level data are recommended by various authors when the objective is to analyse the most advanced and compelling hypotheses about the relationships between income and health (Wagstaff and Van Doorslaer, 2000).

Data aggregation, used in numerous studies examining the health status of the population in different countries and its relationship to the level of income, can also present problems from a methodological point of view. A first problem is the availability of comparable data for long periods of time. The observations are often measures at national or regional level, in contrast to individual panel data for which there are a large number of observations of cross-sectional measurements at very few points in time. Therefore, the problems differ depending on the observation unit adopted: the individual or an aggregate geographical area.

Moreover, a new problem when using aggregate-level data to analyse individual-level hypotheses arises if individual conditions of linearity are required. The reason for this is that empirical evidence suggests that relationships in this area are configured in a nonlinear way (Preston, 1975; Rodgers, 1979); Duleep, 1995 and Ettner, 1996; suggested a single nonlinear relationship between income level and health).These nonlinear methods are based on the idea that income has a strong positive effect on mortality for low levels of income, but that this effect is limited at higher income

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levels. This means that the results of studies that attempt to compare average income levels and mortality rates can be misleading.

Gravelle et al. (1998) discuss the possible inconsistency of aggregate studies that use the functional specifications of individual data, or incorrect data. Their study takes into account the absolute income level and its distribution. They develop functional forms and methods of alternative modelling including epidemiological transition. The importance of income in individual-level studies and its low significance in aggregate-level studies is also pointed out by Deaton (2001a and 2001b).

Mackenbach et al. (2005) examine the shape of the relationship between household equivalent income and self-assessed health in seven European countries. The authors found that a higher household equivalent income was associated with better self-assessed health, particularly in the middle-income range. This relationship was generally curvilinear in higher income ranges, implying less improvement in self-assessed health per unit of rising income. These results support the idea of decreasing marginal health returns per unit increase in income at the higher income ranges.

Causality of the variables that are considered in the analysis of the relationship between income and health is another methodological aspect that is particularly relevant (Fuchs, 2004). Although numerous studies indicate a positive relationship between health and income, few of them analyse the causality of this association. The stability of income inequality over time in most countries makes this causality difficult to test (Babones, 2008). This author points out that although there exists a "strong, consistent and statistically significant correlation between national income inequality and population health", there is also evidence indicating that this correlation is causal.

However, population health would also help to explain differences in income levels between individuals and between countries. The importance of investment in health has been re-emphasized by the theories of human capital. Improvements in health diminish productivity losses caused by disease in the workforce, reducing disability, weakness and the number of days off work. Also, they increase assistance to schools and the learning capacity of school children. One could also point to the decline of family disruption and other undesirable social issues as well as the reduction of negative externalities, for example in the case of caring for the sick.

The effects of productivity gains in workers are particularly great for countries with a low level of development. Poor people have a higher risk of illness and their income depends exclusively on their physical work. Investment in health would therefore be a productive investment, since it would increase income. It would be an important part of development and would help to reduce the income gap between rich and poor countries. Testing this relationship may lead to inconsistencies because of the causality between the two variables. This reverse causality could bias the results and make it difficult to draw inferences about the structural effect of income on health.

Fuchs (1973) conducted a study with individual data for the United States. The study did not show the expected negative relationship between income and mortality. He suggested that this reflects a causal link that moves in the direction of health to income and not in the opposite direction. According to the author, poor health before death could reduce income, rather than income affecting health and mortality. These problems with the updated correlations between

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socioeconomic variables and health were pointed out again by the author in 2004.

In addition, Ettner (1996) established an effect of reverse causation between health, approximated through individual and subjective measures of health, and family income. She found, by developing instrumental variables estimations, that income and health are determined simultaneously.

Also, as Table 4 describes, the trajectories of social mobility over the life course (U-shaped) and the variations in patterns of social mobility mean that it is very important to study inequalities in health and socioeconomic status because they are present early in life (Currie and Madrian, 1999; Bengtsson and Mineau, 2009; Almond and Currie, 2011a and 2011b; De Ree and Alessie, 2011; Lundborg et al., 2014).

TABLE 4
Social mobility over the life course: some findings

Recent papers	Currie and Madrian (1999), Bengtsson and Mineau (2009), Almond and Currie (2011a and 2011b), De Ree and Alessie (2011), Lundborg et al. (2014), Flores et al. (2015).
Some empirical findings	- Inequalities in health and socioeconomic status are present early in life. - Childhood circumstances have direct and indirect impacts (through mediating determinants) on health in later life and on outcomes related to socioeconomic status (mainly understood as employment (or educational level) and wages). - The most efficient way (universal vs. group-specific interventions) to solve life cycle inequalities in health and socioeconomic status is an open question. - Alternative specifications should be used for the model, or long panels should be used to follow the same individuals over a period of time, as their age could help to understand the impact of health on socioeconomic status and to predict future health and the expenditure required.

Furthermore, it would be interesting to take into account the existing links between parental socioeconomic status (measured by education, income or labour status) and child health, and therefore between the health of a child today and his or her health and status in the future (its derived results in education, income, and/or adult occupation). In relation to this, Currie (2009), among others, highlights the importance that health could have in the intergenerational transmission of socioeconomic status.

It has also been shown that maternal disadvantage leads to worse health at birth through poor health behaviour, exposure to harmful environmental factors, worse access to medical care, and underlying maternal health (Aizer and Currie, 2014; Fletcher, 2014).

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Finally, these are relevant issues and, as Flores and Kalwij (2014) and Flores et al. (2015) show, childhood circumstances have direct and indirect impacts (through mediating determinants) on health in later life and outcomes related to socioeconomic status (mainly understood as employment (or educational level) and wages). The direct impacts can be large and can remain latent until old age because of the difficulty in disentangling age-period cohort effects (e.g. before/after retirement). In order to give a solution to it, alternative specifications for modelling this problem should be used, or long panels to follow the same individuals over a period of time as they age could help to measure the impact of health on socioeconomic status, the reverse impact of the social hierarchy on health, and to forecast future health and the expenditure involved.

4 CONCLUSIONS

The published health economics literature on socioeconomic status, health and non-communicable diseases is characterized by a large number of papers that show the complexity of those relationships. Improving this information is crucial if we are to capture the value of socioeconomic measures fully, and to discover the most relevant determinants of health and non-communicable diseases.

What is true is that different types of analysis produce very different results on the role of health determinants. Thus, the individual conception of health provides a different framework of research from a social analysis. The differences are relevant when the results are presented in terms of effectiveness in health policies and welfare (Wildman, 2003). Although the determinants of health identified in individual studies are important variables in an aggregate analysis, there are specific factors that influence social groups. In this sense, for example, a better health status derived from a greater level of education may be the result of an education variable directly influencing the individual's health or may be because of an improvement in social class due to a better education.

Lastly, further research is necessary to investigate the role of income level, its composition and its distribution on health status and the labour market. To help with this, perhaps we can highlight the greater potential of individual studies, with the new databases available, for analysing hypotheses about a more detailed relationship between socioeconomic status, health and non-communicable diseases.

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18. Journal of Economic Review
19. Journal of Epidemiology and Community Health
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