



## Review Article

# The contribution of health behaviors to socioeconomic inequalities in health: A systematic review

Dusan Petrovic<sup>a,\*</sup>, Carlos de Mestral<sup>a</sup>, Murielle Bochud<sup>a</sup>, Mel Bartley<sup>b</sup>, Mika Kivimäki<sup>b</sup>, Paolo Vineis<sup>c</sup>, Johan Mackenbach<sup>d</sup>, Silvia Stringhini<sup>a</sup>

<sup>a</sup> Institute of Social and Preventive Medicine (IUMSP), Lausanne University Hospital, Route de la corniche 10, 1010 Lausanne, Switzerland

<sup>b</sup> University College London (UCL), 536, 1-19 Torrington Place, WC1E 7HB London, United Kingdom

<sup>c</sup> Imperial College London, 511, Medical School, St Mary's Campus, London, United Kingdom

<sup>d</sup> Erasmus MC, Department of Public Health, P.O. Box 2040, 3000, CA, Rotterdam, The Netherlands



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## ABSTRACT

Unhealthy behaviors and their social patterning have been frequently proposed as factors mediating socioeconomic differences in health. However, a clear quantification of the contribution of health behaviors to the socioeconomic gradient in health is lacking. This study systematically reviews the role of health behaviors in explaining socioeconomic inequalities in health.

Published studies were identified by a systematic review of PubMed, Embase and Web-of-Science. Four health behaviors were considered: smoking, alcohol consumption, physical activity and diet. We restricted health outcomes to cardiometabolic disorders and mortality. To allow comparison between studies, the contribution of health behaviors, or the part of the socioeconomic gradient in health that is explained by health behaviors, was recalculated in all studies according to the absolute scale difference method.

We identified 114 articles on socioeconomic position, health behaviors and cardiometabolic disorders or mortality from electronic databases and articles reference lists. Lower socioeconomic position was associated with an increased risk of all-cause mortality and cardiometabolic disorders, this gradient was explained by health behaviors to varying degrees (minimum contribution –43%; maximum contribution 261%).

Health behaviors explained a larger proportion of the SEP-health gradient in studies conducted in North America and Northern Europe, in studies examining all-cause mortality and cardiovascular disease, among men, in younger individuals, and in longitudinal studies, when compared to other settings. Of the four behaviors examined, smoking contributed the most to social inequalities in health, with a median contribution of 19%.

Health behaviors contribute to the socioeconomic gradient in cardiometabolic disease and mortality, but this contribution varies according to population and study characteristics. Nevertheless, our results should encourage the implementation of interventions targeting health behaviors, as they may reduce socioeconomic inequalities in health and increase population health.

## 1. Introduction

The existence of a stepwise association between socioeconomic position (SEP) and health related outcomes (Antonovsky, 1967; Krieger et al., 1997; Miranda et al., 2008; Bartley, 2004), also referred as the socioeconomic gradient in health, constitutes one of the most consistent findings of epidemiologic research. Individuals with a lower socioeconomic position, as measured by occupational position, educational attainment, income, or composite indexes, are more likely to die earlier and have a higher incidence of cardiovascular events, diabetes, obesity, and other diseases than their more advantaged counterparts (Bartley,

2004; Adler et al., 1993). As eliminating socioeconomic disadvantage from society is difficult, quantifying modifiable intermediate factors and targeting them could have important public health benefits. Epidemiologic research has long investigated potential mediating factors of the association between socioeconomic position and health outcomes, with health behaviors, environmental exposures or psychosocial factors having been identified as major mechanisms in the link between low SEP and increased disease risk (Supplementary Fig. 1) (Matthews et al., 2010; Stringhini et al., 2011a; Stringhini et al., 2012a; Robertson et al., 2015a; Næss et al., 2007; van Oort et al., 2005).

Health behaviors such as smoking, alcohol consumption, diet and

\* Corresponding author.

E-mail address: [dusan.petrovic@chuv.ch](mailto:dusan.petrovic@chuv.ch) (D. Petrovic).

physical activity (PA) are major risk or protective factors for chronic diseases (Who and Consultation, 2003; Centers for Disease C, Prevention, 2008; Klatsky et al., 1992) and are also strongly socially patterned, with detrimental behaviors being more prevalent in lower SEP groups when compared to higher SEP groups (Nocon et al., 2007; Macintyre, 2000; Wardle and Steptoe, 2003). Yet, despite extensive investigations, a clear understanding of the role of health behaviors in social inequalities in health is still lacking, a major challenge being that their estimated contribution to the socioeconomic gradient in health varies greatly across studies, ranging from 12% to 72% (van Oort et al., 2005; Stringhini et al., 2011b; Laaksonen et al., 2008; Lantz et al., 1998; Schrijvers et al., 1999; Skalická et al., 2009; Stringhini et al., 2010).

The reasons for the differential contribution of health behaviors to social inequalities in health are numerous and include cultural differences between countries (Stringhini et al., 2011b), demographic characteristics of the participants included in the studies (Tseng and Lin, 2008), between-studies differences in the SEP measures, health behaviors and health outcomes examined, and methodological differences in the calculation of the contribution of health behaviors (Stringhini et al., 2010; Bartley, 2016). Another potential explanation may be related to the stage of the epidemiologic transition, which designates the changes in the prevalence of diseases, disease risk factors, and the changes in the adherence to health behaviors over time and in different socio-demographic contexts (Mackenbach et al., 1997). However, there is currently no attempt in the literature to synthesize the wealth of research on this topic and provide a more comprehensive assessment of health behaviors as mechanisms underlying the association between SEP and health. However, this is a crucial step for identifying targets for policies aimed at reducing socioeconomic differences in health as well as improving health at the population level.

In this study, we conducted a systematic review and synthesis of the literature on the contribution of smoking, alcohol intake, physical activity and dietary patterns to socioeconomic inequalities in all-cause mortality and risk of cardiometabolic disorders, two health outcomes showing a particularly consistent socioeconomic gradient across studies (Avendano et al., 2006a; Suadcani et al., 2001; Stringhini et al., 2013a; Mackenbach et al., 2008). The overarching purpose of this review was to examine all previously published studies investigating the contribution of health behaviors to socioeconomic inequalities in health, and to provide a complete and comprehensive analysis regarding the sources of heterogeneity of this contribution, with a particular focus on methodological, sociodemographic and cultural factors.

## 2. Methods

### 2.1. Search strategy and inclusion criteria

In this systematic review, we aimed to retrieve and analyze all articles that examined the contribution of health behaviors to the socioeconomic gradient in all-cause mortality and cardiometabolic disorders. We used four main groups of search terms: terms related to SEP, terms related to health behaviors, terms related to health outcomes, and terms related to “contribution”, “role”, or “mediation” (Supplementary Material – search strategy). Article search was performed from August 2015 to December 2016 by searching PubMed, Embase and Web-of-Science electronic databases following the PRISMA-Equity guidelines (Welch et al., 2012). No publication date restrictions were imposed. Articles in English and French were considered. Two reviewers (DP, CdM) independently examined the titles and abstracts of the papers identified in the databases search, removed papers that did not meet the inclusion criteria and selected eligible papers for full-text review. The reference lists of reviewed papers were also searched for additional articles of interest that were not identified by the electronic search.

In this review, we included four health behaviors that had been previously strongly related to SEP, but also to all-cause mortality and

cardiometabolic disorders: smoking, alcohol consumption, physical activity, and dietary patterns (Who and Consultation, 2003; Centers for Disease C, Prevention, 2008; Klatsky et al., 1992; Jarvis and Wardle, 2005; Stringhini et al., 2013b; Trichopoulou and Lagiou, 1997; Mäki et al., 2014; Paffenbarger Jr et al., 1986). We also considered papers that performed analyses adjusted for multiple health behaviors simultaneously (i.e. smoking and alcohol). We searched for papers that reported SEP as measured by education, occupation, income, wealth, area-based indicators, childhood SEP indicators, partner's SEP as well as composite SEP scores (i.e. education and occupation). We included both cross-sectional and longitudinal observational studies investigating the contribution of the four health behaviors to socioeconomic inequalities in all-cause mortality and cardiometabolic outcomes (defined as cardiovascular disease, hypertension, coronary heart disease, stroke, diabetes, impaired glucose tolerance, metabolic syndrome, allostatic load, obesity). Despite the fact that some studies used BMI as a proxy for diet or a risk factor for other diseases, in the present review we considered it as a health outcome.

The main inclusion criterion in selected articles was the presence of a quantification of the contribution of health behaviors to the SEP gradient in health, or the possibility to estimate this from the data according to the difference method, which compares the coefficients from the SEP-health association model that is unadjusted for health behaviors, with the coefficients from a model additionally adjusted for health behaviors (Stringhini et al., 2010). Experimental studies (i.e. health education programs, randomized control trials), articles published in non-peer-reviewed journals, non-original research papers (i.e. reviews, commentaries), duplicate publications and articles limited to an abstract (i.e. congress proceedings) were excluded. After removing non-eligible papers, CdM and DP examined the papers to be included in the systematic review. For the title and abstract screening process, the level of agreement between the two reviewers was > 90%, while for full-text screening, the level of agreement between the two reviewers was > 95%. Whenever a conflict was encountered, the two reviewers discussed the article in question to decide whether to include it or not.

### 2.2. Data extraction

For each study, the following data were extracted: title, last name of first author, study region or country, cohort name, study period, study design, sample size, characteristics of participants, SEP indicator(s) (exposure), health outcome(s) (outcome) and health behavior(s) (mediating factor) along with their measurement methods (i.e. self-administered questionnaires, medical records, death registries), and two regression coefficients for SEP ( $\beta$ , hazard ratio (HR), odds ratio (OR), risk ratio (RR)) with 95% confidence intervals (CI); the first coefficient from the unadjusted regression model: SEP  $\rightarrow$  health outcome (Model 1), and the second coefficient from the regression model additionally adjusted for health behavior(s) or mediator(s): SEP  $\rightarrow$  health behavior(s)  $\rightarrow$  health outcome (Model 2).

While the majority of the included papers did not provide any direct assessment of the contribution of health behaviors to socioeconomic differences in all-cause mortality and risk of cardiometabolic disorders, in 31 studies this contribution was calculated according to the absolute ( $n = 13$ ) (Stringhini et al., 2011a; Stringhini et al., 2010; Suadcani et al., 2001; Stamler et al., 2003; László et al., 2008; Marmot et al., 2008; Kavanagh et al., 2010; Hagger-Johnson et al., 2012; Stringhini et al., 2012b; Woodside et al., 2012; Giesinger et al., 2013; Stringhini et al., 2014; Stringhini et al., 2016) or relative scale difference methods ( $n = 18$ ) (van Oort et al., 2005; Laaksonen et al., 2008; Schrijvers et al., 1999; Skalická et al., 2009; Lynch et al., 1996; Van Lenthe et al., 2002; Agardh et al., 2004; Strand and Tverdal, 2004; van Oort et al., 2004; Khang and Kim, 2005; Silva et al., 2008; Singh-Manoux et al., 2008; Khang et al., 2009; Beauchamp et al., 2010; Chapman et al., 2010; Nandi et al., 2014; Bihan et al., 2016; Bonaccio et al., 2016) which compare the beta coefficient for SEP from the unadjusted regression

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