An intersectional approach in social epidemiology: Understanding health heterogeneity

Wemrell, Maria

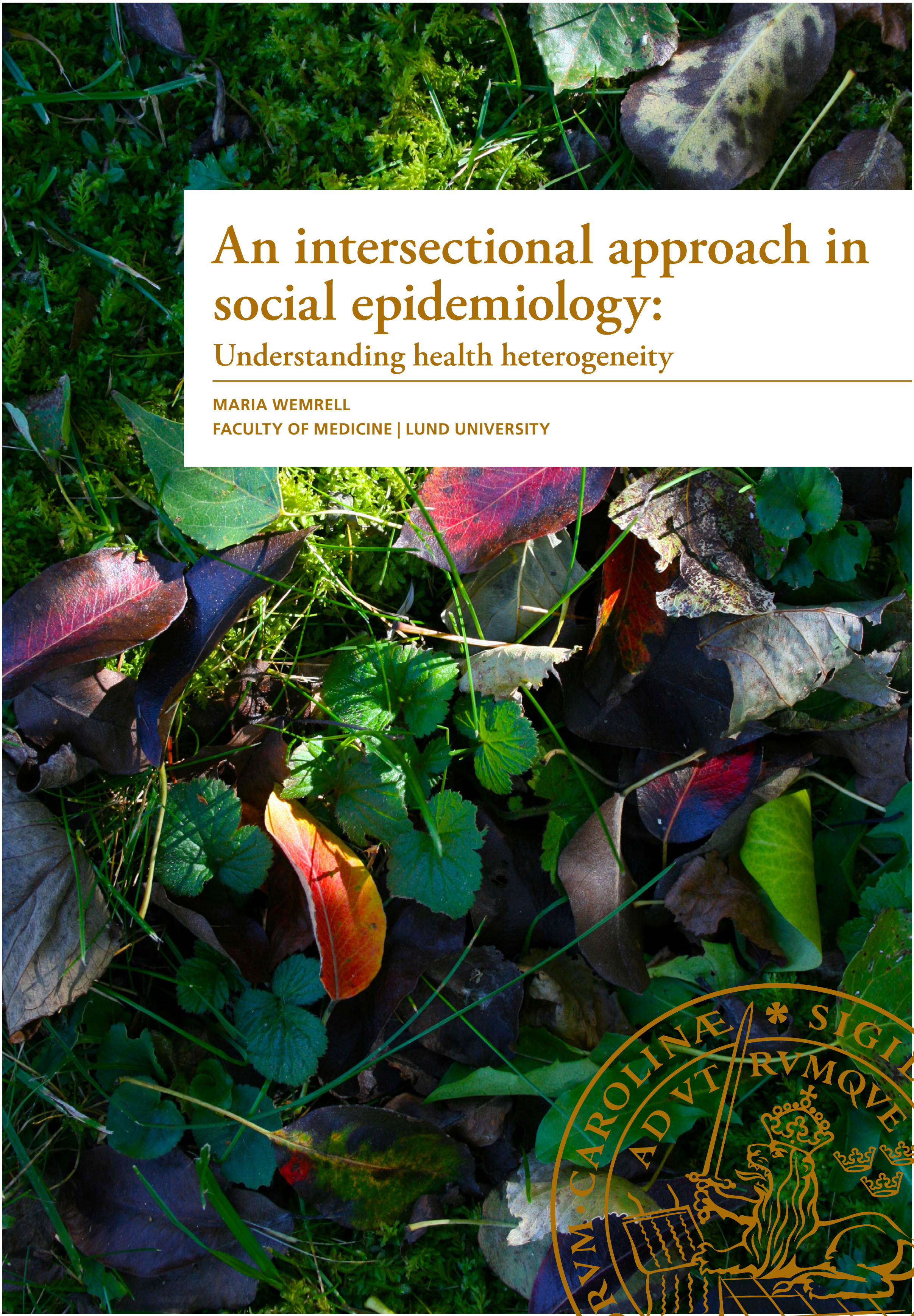
2017

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
Wemrell, M. (2017). *An intersectional approach in social epidemiology: Understanding health heterogeneity*. [Doctoral Thesis (compilation), Department of Clinical Sciences, Malmö]. Lund University: Faculty of Medicine.

Total number of authors:
1



An intersectional approach in social epidemiology:

Understanding health heterogeneity

MARIA WEMRELL

FACULTY OF MEDICINE | LUND UNIVERSITY

An intersectional approach in social epidemiology

An intersectional approach in social epidemiology:

Understanding health heterogeneity

Maria Wemrell

LUND
UNIVERSITY

DOCTORAL DISSERTATION
by due permission of the Faculty of Medicine, Lund University, Sweden.
To be defended at Kvinnokliniken, SUS, Malmö. Nov 27th 2017, 13.00.

Faculty opponent:
Karien Stronks, Prof., PhD., University of Amsterdam, Netherlands

Supervisor:
Juan Merlo, Prof., PhD., MD., Lund University
Assistant supervisors:
Shai Mulinari, PhD., Lund University
Anne-Christine Hornborg, Prof., PhD., Lund University

Organization:
LUND UNIVERSITY

Faculty of Medicine,
Department of Clinical Sciences Malmö,
Unit of Social Epidemiology

Author(s): Maria Wemrell

Document name:
DOCTORAL DISSERTATION

Date of issue:
Nov 6th 2017

Sponsoring organization

Title and subtitle:
An intersectional approach in social epidemiology: Understanding health heterogeneity

Abstract:

Critical debates within the science of (social) epidemiology concern the relative lack of social theory in epidemiological research and the low discriminatory accuracy (DA) of much epidemiological knowledge on factors and markers of risk for disease. Against this background, this thesis integrates intersectionality theory into epidemiological study. The purposes are to improve the understanding of heterogeneities in population groups and thus increase DA, and to incorporate a theoretical framework that directs attention toward power dynamics driving the production of health disparities as well as toward their measurement. An intersectionality perspective is incorporated into empirical study of risk for ischemic heart disease in Sweden, and of influenza vaccination uptake in the US. A categorical intersectionality perspective is operationalized through assessment of difference in average risk between intersectional strata. The measurement of the DA of the social and racial/ethnic categorizations used is aligned to an anti-categorical intersectionality perspective, as this DA is found to be low due to heterogeneities within and/or overlaps between groups.

Despite the integration of intersectionality theory, the DA of the social and racial/ethnic categories under study remains low. Such measurements of low DA point to a current limitation in knowledge about causation mechanisms and individual heterogeneity in (social) epidemiology. This project has therefore been partially driven by an interest in other possible ontological ways of understanding health, risk and prevention of disease, found in complementary or alternative forms of medicine (CAM). The thesis includes a pilot study measuring the use of, and attitudes towards, CAM and conventional medicine in Skåne, the southernmost province of Sweden.

Key words: Social Epidemiology; Intersectionality; Discriminatory Accuracy; Social determinants of health; Complementary and Alternative Medicine

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language

ISSN: 1652-8220 Key title: Doctoral Dissertation Series 2017:126

ISBN: 978-91-7619-509-3

Recipient's notes

Number of pages 116

Price

Security classification

Signature Maria Wemrell Date Oct 20th 2017

An intersectional approach in social epidemiology:

Understanding health heterogeneity

Maria Wemrell

LUND
UNIVERSITY

Cover photo by Karolina Holm Diebate

Department of Clinical Sciences Malmö

Lund University, Faculty of Medicine
Doctoral Dissertation Series 2017:126

ISBN 978-91-7619-509-3
ISSN 1652-8220

Printed in Sweden by Media-Tryck, Lund University
Lund 2017

To my Father

Content

Abbreviations

AR	Absolute risk
ACE	Average causal effect
AUC	Area under the ROC curve (also AU-ROC)
CAM	Complementary or alternative medicine
CDC	US Centers for Disease Control and Prevention
CVD	Cardiovascular disease
CI	Confidence interval
FPF	False positive fraction
ICC	Intra-class correlation coefficient
ICE	Individual causal effect
IHD	Ischemic heart disease
MAIH	Multilevel analysis of individual heterogeneity
MED	Conventional medicine
NHFS	National 2009 H1N1 Flu Survey
OR	Odds ratio
PAF	Population attributable fraction
RCT	Randomized clinical trial
ROC	Receiver operating characteristic curve
STS	Science and technology studies
TNS Sifo	Taylor Nelson Sofres and Svenska institutet för opinionsundersökningar (The Swedish Institute for Opinion Surveys)
TPF	True positive fraction
VPC	Variance partition coefficient

List of tables and figures

Tables

Figures

List of papers

I. **Wemrell M**, Merlo J, Mulinari S, Hornborg A-C: Contemporary epidemiology: A review of critical discussions within the discipline and a call for further dialogue with social theory. *Sociology Compass* 2016, 10(2): 153–171.

II. **Wemrell M**, Mulinari S, Merlo J: Intersectionality and risk for ischemic heart disease in Sweden: Categorical and anti-categorical approaches. *Social Science & Medicine* 2017, 177: 213-222.

III. **Wemrell M**, Mulinari S, Merlo J: An intersectional approach to multilevel analysis of individual heterogeneity (MAIH) and discriminatory accuracy. *Social Science & Medicine* 2017, 178: 217-219.

IV. Mulinari S, **Wemrell M**, Rönnerstrand B, Subramanian S, Merlo J: Categorical and anti-categorical approaches to US racial/ethnic groupings: Revisiting the National 2009 H1N1 Flu Survey (NHFS). *Critical Public Health* 2017, Online publication April 27.

V. **Wemrell M**, Merlo J, Mulinari S, Hornborg A-C: Two-thirds of survey respondents in Sweden used complementary or alternative medicine (CAM) in 2015. *Complementary Medicine Research* 2017, Online publication May 23.

Study I has been reprinted with permission from Wiley.
Study II-III have been reprinted with permission from Elsevier.
Study IV has been reprinted with permission from Taylor & Francis.
Study V has been reprinted with permission from Karger.

Related publications

Research articles

Merlo J, Mulinari S, **Wemrell M**, Subramanian S, Hedblad B: The tyranny of the averages and the indiscriminate use of risk factors in public health: The case of coronary heart disease. *Social Science & Medicine Population Health* 2017, 3: 684-698.

Wemrell M, Merlo J: Kategorier av risk: Om epidemiologi och intersektionalitets-teori. *Socialmedicinsk Tidskrift* 2016, 93(3): 306-319.

Popular scientific publication

Wemrell M, Mulinari S, Merlo J: Intersektionalitet och risk för ischemisk hjärtsjukdom i Sverige. *BestPractice Diabetes/Hjärtkärlsjukdom* 2017, 7(22): 24-28.

Research report

Wemrell M, Mulinari S, Merlo J, Hornborg A-C: Användning av alternativ och komplementär medicin (AKM) i Skåne: Pilotstudie 2016. Rapport 1. Lunds Universitet: Enheten för Socialepidemiologi, Medicinska Fakulteten; 2016. http://www.med.lu.se/english/klinvetmalmo/unit_for_social_epidemiology/information_to_society

Forthcoming

Wemrell M: Hearts at risk. Notions of heart and prevention of heart disease in biomedical and Chinese medical training in contemporary Scandinavia.

Abstract

Critical debates within the science of (social) epidemiology concern the relative lack of social theory in epidemiological research and the low discriminatory accuracy (DA) of much epidemiological knowledge on factors and markers of risk for disease. Against this background, this thesis integrates intersectionality theory into epidemiological study. The purposes are to improve the understanding of heterogeneities in population groups and thus increase DA, and to incorporate a theoretical framework that directs attention toward power dynamics driving the production of health disparities as well as toward their measurement. An intersectionality perspective is incorporated into empirical study of risk for ischemic heart disease in Sweden, and of influenza vaccination uptake in the US. A categorical intersectionality perspective is operationalized through assessment of difference in average risk between intersectional strata. The measurement of the DA of the social and racial/ethnic categorizations used is aligned to an anti-categorical intersectionality perspective, as this DA is found to be low due to heterogeneities within and/or overlaps between groups.

Despite the integration of intersectionality theory, the DA of the social and racial/ethnic categories under study remains low. Such measurements of low DA point to a current limitation in knowledge about causation mechanisms and individual heterogeneity in (social) epidemiology. This project has therefore been partially driven by an interest in other possible ontological ways of understanding health, risk and prevention of disease, found in complementary or alternative forms of medicine (CAM). The thesis includes a pilot study measuring the use of, and attitudes towards, CAM and conventional medicine in Skåne, the southernmost province of Sweden.

1. Introduction

In contemporary critical discussion within modern epidemiology, one line of debate, largely maintained by Merlo et al. [1-5], concerns the ability of groups and categorizations to properly classify individuals with or without a certain health outcome. Starting in the research field of neighborhoods and health, Merlo et al. [6-9] have stressed the necessity of evaluating the validity of geographical categorizations such as neighborhoods by not only measuring differences between neighborhood averages (i.e., specific contextual effects), but also assessing the variance around those averages through variance partition coefficients (VPCs) or intra-class correlation coefficients (ICCs) (i.e., general contextual effects). A corresponding approach can be applied to non-geographical groupings, and besides geographical categorizations [10-13], the analogous concept of discriminatory accuracy (DA) has been used by Merlo et al. to measure the predictive validity of biological [14-16] and socioeconomic or ethnic categorizations [2, 17-19].

Another line of argument within and about modern epidemiology, pursued by various researchers since the 1990s [20-23], addresses the need for increased integration of social theory [24] in epidemiological research, for the purposes of furthering understanding of how structures and relationships of power affect causation and distribution of disease at the population level [20, 22]. Inquiry into these critical debates contributes one article (Study I) [25] to this thesis.

Interest in increased DA corresponds with efforts toward improved understanding of heterogeneities in population groups, sought through the current focus on personalized medicine [26] as well as through efforts towards a furthered understanding of socioeconomic differences in health. Intersectionality theory has, based on its focus on interactions, heterogeneities and specificities of categories and categorizations of people, been pointed out as being likely to be fruitful in the latter context [27-29]. Importantly, intersectionality adds a theoretical framework through which interest is aimed toward power dynamics fuelling the production of health inequalities, as well as toward the measurement of such disparities.

The major part of the thesis (Part A) consists of an effort towards integration of intersectionality theory into epidemiological study. The purposes are to improve the understanding of heterogeneities in population groups and thus increase the DA of the categorizations used, and to incorporate a theoretical framework which enables the direction of attention towards power dynamics driving the production of health disparities. An intersectionality perspective is applied to study of risk for ischemic heart disease in Sweden (Study II) [30], and of influenza vaccination uptake in the US (Study IV) [31]. The former discusses the use of socioeconomic classifications while the latter focuses on the use of racial/ethnic categories, in relation to the outcomes under study. A categorical [32] intersectionality perspective is operationalized through the assessment of differences in average risk between intersectional strata. Measurement of the DA of the categorizations used is aligned with an anti-categorical [32] intersectionality perspective, as this DA is found to be low due to heterogeneities within and/or overlaps between groups.

A response (Study III) [33] to a commentary [29] on Study II [30] develops the discussion and briefly outlines future and ongoing efforts toward integrating intersectionality theory into multilevel analyses of individual heterogeneity [3].

Despite the incorporation of intersectionality theory, and corroborating other studies made by members of the research group [1-5, 12, 18, 19] and others [15, 34, 35], the DA measured in the present studies remains low. Such measurements of low DA reveal a current limitation in knowledge regarding causation mechanisms and individual heterogeneity in epidemiology. This project has therefore been partially driven by an interest in exploring other possible ontological ways of understanding health, risk and prevention of disease, found in complementary or alternative forms of medicine (CAM) (Part B). Qualitative studies of notions of risk and prevention of heart disease communicated in conventional and Chinese medical training in contemporary Scandinavia have been pursued, and will be developed through additional future research. Consequently, the thesis includes a pilot study (Study V) [36] measuring the use of, and attitudes towards, CAM and conventional medicine in Skåne, the southernmost province of Sweden.

This thesis forms part of a wider research project, led by Juan Merlo and supported by the Swedish Scientific Council, centered on multilevel analysis of individual heterogeneity.

For an overview of the studies included in the thesis, see Table 1 and Figure 1.

Table 1. Summary of the studies included in the thesis

Study	Study design and method	Aim	Data	Status
I	Non-systematic literature review and theoretical discussion	To provide an overview of critical debates within risk factor epidemiology	Literature review/ theoretical argument	Article published
II	Prospective cohort study with 1-year follow-up; logistic regression models	To measure IHD risk and DA, using intersectional variables and integrating intersectionality theory	Register data; 3.6 million adults in Sweden	Article published
III	Response to commentary	To develop the approach used in Article II	Conceptual argument/ literature study	Article published
IV	Survey-based study; logistic regression models	To measure influenza vaccination uptake and DA, using intersectional variables and integrating intersectionality theory	Survey data; 56.434 adults in the US	Article published
V	Survey-based study; logistic regression models	To measure the use of, and attitudes towards, CAM in Skåne (southern Sweden)	Survey data; 1.534 adults in Skåne	Article published

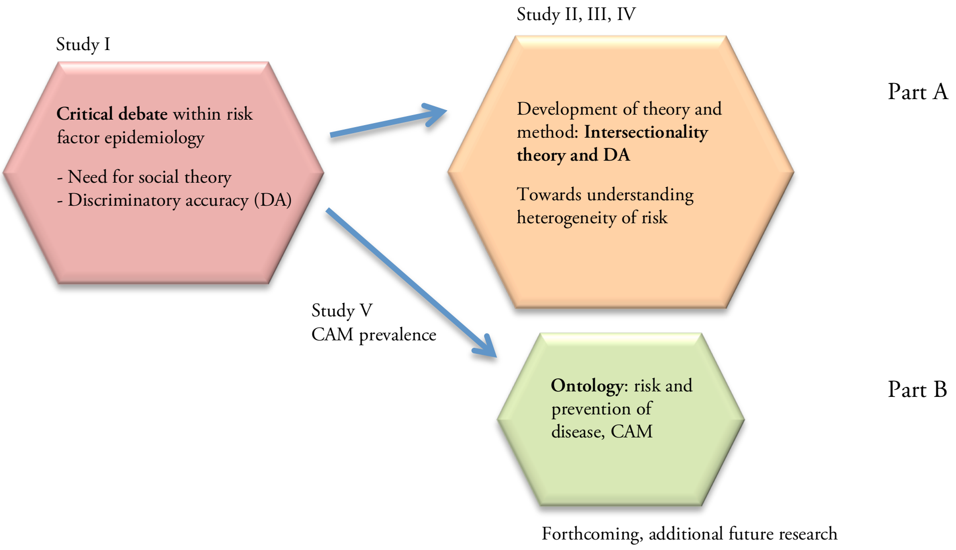


Figure 1. Overview of research project

2. Background

Health inequities and social theory in epidemiology

During the past few decades, many researchers have argued that epidemiology needs to give increased attention to structural forces and relationships of power in the study of causes and distribution of disease at the population level [21, 22, 25, 37]. Health inequalities have been a major topic of epidemiological study from at least since the UK Department of Health and Social Security's so-called Black Report was published in 1980 as one of the foundational works in the area [38], pointing toward widening health inequalities and arguing that health is largely shaped by socioeconomic factors such as income, education and working conditions. Over time, a growing and now very large amount of epidemiological research has documented and replicated evidence of health disparities and socioeconomic factors as determinants of disease [39-41]. These days, it would probably be difficult to find an epidemiologist claiming that social factors are not relevant to disease causation [42]. Nonetheless, epidemiological knowledge has limitations in terms of its ability to provide adequate tools for addressing existing health disparities [22].

A critique reiterated at least since the 1990s concerns epidemiology's relative focus on the individual as its unit of observation, analysis and intervention. Numerous authors have observed that despite its interest in the population level, epidemiology has tended to direct attention towards the body, lifestyle, behavior, sex/gender, race/ethnicity and perhaps the personality, emotional state or socioeconomic status of the individual [21, 43-45], rather than on the social structures or relationships that encompass individuals. Krieger [20] notes that, although the epidemiological study of chronic diseases, at least in principle, invites investigation of social factors and structures, attention has tended to go toward the causative factors deemed 'closest' to the disease outcome, typically biological agents or lifestyle factors relating to bodies and behaviors of individuals. Lofters and O'Campo [46] observe that such framing of health inequities as individual-level issues, resolvable through individual-level intervention or behavioral change, can result in practices of blaming the victim [47] rather than any actual amelioration of existing disparities. Along similar lines, Shim [48-50] argues that in mainstream epidemiology, population categories tend to be construed in terms of risk factors on the individual level, rather than as functions of structural dynamics between individuals or groups, and that this, in turn, may perpetuate or even have detrimental effects on health disparities [25, 30].

Correspondingly, a large proportion of social epidemiological studies of health disparities have consisted of identification of inequalities and connections between these and various risk factors. While these studies have indeed underpinned efforts to address health disparities, such knowledge about risk factors provides an insufficient basis for effective action toward equity [22]. Epidemiologists have demonstrated strong relationships between socioeconomic factors and health, but the identification of concrete mechanisms and pathways linking socioeconomic status to health has proven more challenging, to the detriment of the ability to design effective policy interventions [51]. Accordingly, Galea and Link [42] point to the need for increased focus on biological causation mechanisms in epidemiology, while Muntaner [52] argues for further investigation of social mechanisms. We do not only need studies of unequal average distribution of health and disease between groups defined according to race, gender or class, Ng and Muntaner note [23], but also analyses of relational mechanisms such as sexism and racism. Productive analytic attention toward structural dynamics of power needs to be further developed.

Studies of relational mechanisms and social dynamics are buttressed by social theory. Attendance to such theory has, however, been relatively weak, although long called for, in epidemiology [21-23]. Social theory provides conceptual frameworks for empirical research, through providing basic concepts and ontological assumptions about society and the nature of human interaction, and establishing analytical tools and categories necessary for inference from observed phenomena to generalized concepts. Theory and empirical research should thus be seen as mutually interdependent processes, as theory provides a framework for the generation of concepts, problematics and hypotheses that guide empirical research, as well as the standards for its evaluation [51]. Absence of explicit theory in epidemiological study thus does not equate to the non-existence of underlying assumptions or values, but merely means that these are not made entirely clear [21, 53, 54]. With reference to the dominance of implicit, rather than explicit, use of theory to inform epidemiological research, Krieger [21] notes that this typically rests on ontologies and epistemologies tied to biomedical and so-called lifestyle approaches. Central traits in both are individualism and reductionism, as primary causes of disease at both the individual and population levels are typically assumed, as noted, to be genes or risk factors to which exposure is largely determined by the characteristics or behaviors of the individual. This is despite the fact that epidemiology has long distinguished between causes of disease at individual and population levels [55].

Meanwhile, considerable efforts have been made to further integrate social parameters and theories [24] into epidemiology, for example through ecosocial theory [56-58], theorization of psychosocial determinants of health and disease [59-61], fundamental cause theory [62, 63], Latin American Social Medicine [64], complex systems frameworks [65, 66], critical realism [22, 23, 67], the concept of social conflict [52], and approaches inspired by Deleuze and Guattarí [51, 68]. Much of this work has drawn on medical sociology, a main objective of which is to document the patterning of health and disease according to socioeconomic conditions and to explain the relationship between the two [69]. Another theoretical framework, with roots in legal and gender studies, which has been advocated and increasingly integrated into population health research [28] is intersectionality theory, to which we will return below.

Discriminatory accuracy

As summarized elsewhere [1, 3, 4], the concept of discriminatory accuracy (DA) relates to a line of debate within epidemiology concerning problematics arising from the translation of aggregate-level risk, as in probabilistic concepts based on measurements in populations (average causal effects, ACE), into risk estimates regarding individuals (individual causal effects, ICE).

Epidemiological knowledge on risk typically builds on investigation of difference between average risk estimates computed for different population groups, categorized along various biological (e.g., blood pressure), social (e.g., socioeconomic status) or geographical (e.g., neighborhood) variables, calculated through measures such as relative risk (RR) or odds ratio (OR). It is well known that such probabilistic measures are not typically directly translatable to individuals, as averages can obscure major differences between people within the same group, and/or substantial overlaps between people in different groups. In other words, average measures of association do not represent the heterogeneity of individual effects [55]. The application of average measures on individuals, which has been called "tyranny of the means" [70] or the "mean-centric approach" [71], has therefore been criticized, already by Claude Bernard (1813–1878) [72], later by Lancelot Hogben (1895–1975) [73] and in recent times by epidemiologists favoring "n-of-1" design (studies made on single individuals) [74] or personalized medicine [26, 75]. Similar critique has been expressed in social science [71, 76] and biology [77, 78]. In epidemiology corresponding ideas, voiced by Rockhill [35] and Smith [79], have been developed theoretically and empirically by Merlo et al. [1-11].

Currently, average risk remains a major basis for the assessment of individual-level risk in much clinical and preventive practice, not least in relation to cardiovascular disease (CVD) [80]. As a model example of the current risk factors approach to disease prevention, in clinical practice established risk factors for CVD are evaluated, typically within a risk score algorithm such as SCORE or QRISK [81, 82], and individuals are then treated according to their predicted level of risk. Risk assessment through the measurement of risk factors is thus closely linked to preventive intervention, as the former aims to discriminate which individuals are, or are not, candidates for different forms of preventive treatment [35]. As such assessment rests on measures of average risk, consideration of individual heterogeneity has not been fully addressed [1].

Measurement of DA [1, 3, 4] offers a means to assess the presence of individual heterogeneity. DA gauges the ability of a certain diagnostic tool, marker or category to correctly discriminate between people with or without the outcome of interest [3, 15], often used to evaluate predictive validity [83] in epidemiology and other medical sciences [3, 15]. The basic principle expressed through the concept of DA is that, in order to be suitable for individual-level diagnostic or prognostic inference, most exposure categories, whether social, geographic or biological, must be robust in their capacity to discriminate between individuals who do and do not demonstrate the outcome at hand [3, 4]. Measures of DA are therefore highly relevant for public health. However, in the epidemiological study of risk factors, whether social or biological, inclusion and interpretation of DA has so far been relatively rare [2-4, 18].

In the research field of neighborhoods and health, Merlo et al. [6-9] have pursued the evaluation of geographical categorizations like neighborhoods by not only assessing differences between neighborhood averages, but also by measuring the variance around those averages through variance partition coefficients (VPCs) or intra-class correlation coefficients (ICCs). The analogous concept of DA has further been used by Merlo et al. to measure the predictive validity of biological [14-16], socioeconomic or ethnic [2, 17-19] as well as geographic categorizations [10-13]. DA corresponds with the concept of variance explained (r^2) [84], measured through linear regression models and used to evaluate the general strength of findings in research fields including ecology [85] as well as epidemiology [4, 34].

While measures of association alone are, as mentioned, inappropriate for assessing the DA of statistical models [15, 86-90], it should be emphasized that DA can be low even in the presence of large differences in average risk. In fact, what is generally considered to be a very strong association between an exposure and an outcome (e.g., expressed as an OR of 10) might actually be related to a rather weak capacity of the exposure to discriminate between cases and non-cases in the population [15, 91]. Crucially, different exposure-outcome associations may display similar average causal effects, but diverge in terms of DA. As an example, Figure 2 [4] illustrates two instances (A and B) of comparison between two categories (red and blue). In the case of A, the DA is strong, as internal heterogeneity within the categories and overlap between them is very limited. In the case of B the DA is weak, due to heterogeneities within and overlap between the categories. Nonetheless, the differences in average risk (D_A and D_B) are in principle the same.

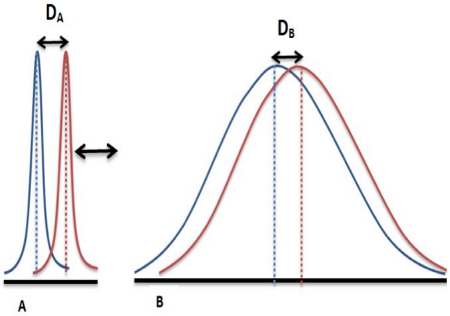


Figure 2: Discriminatory accuracy: an example

In Case A and B, two categories (red and blue) are compared. While the differences in average risk (D_A and D_B) are in principle the same, the DA is not. In the case of A the DA is strong, as the groups are internally relatively homogenous and there is not much overlap between them. In the case of B the DA is weak, due to considerable heterogeneities within and overlap between the groups [4].

DA can be measured through the construction of a receiver operating characteristic curve, or ROC curve, which plots the true positive fraction (TPF) against the false positive fraction (FPF) [5]. In the context of measuring the DA of a risk factor, the TPF conveys the probability of having been exposed to the risk factor if the outcome occurs (TPF=number of exposed cases/number of cases). That is, the TPF measures specificity through elucidating the share of disease cases in which exposure to the risk factor was present. The FPF, in turn, expresses the probability of having been exposed to the risk factor when the outcome does not occur (FPF=number of exposed controls/number of controls). In other words, the FPF indicates specificity through conveying the share of subjects undiagnosed with the disease who were exposed to the risk factor. The ROC curve plots the TPF against the FPF at a range of threshold levels. The area under the ROC curve (AUC), or C statistic, quantifies discrimination [15, 86, 92] as the ability of the risk factor to correctly classify those with and without the disease. The AUC ranges from 0.5 to 1.0. An AUC=0.5 means that the DA of the risk factor or biomarker corresponds to that obtained by flipping an unbiased coin. That is to say, a risk factor with an AUC=0.5 is of very limited use for predictive purposes [15]. An AUC=1.0 means complete accuracy. AUC values can be categorized, arbitrarily, as excellent (0.90-1.00), good (0.80-0.90), fair (0.70-0.80), poor (0.60-0.70) or inadequate (0.50-0.60) [1]. It may be noted here that according to a calculation from Pepe et al. [15], a DA corresponding with a TPF=90% and a FPF=5% requires an OR=171 (See Fig. 3).

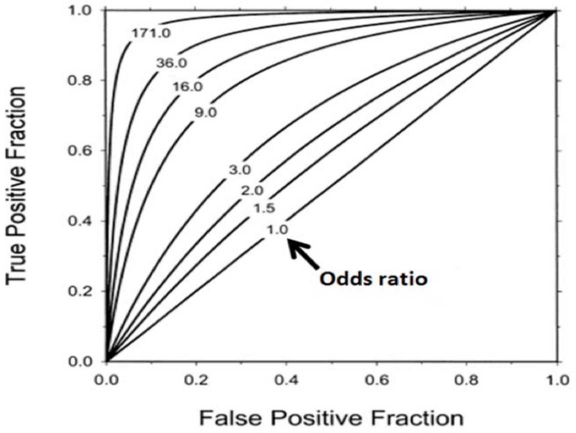


Figure 3: ROC: TPF, FPF, OR and DA
Correnspondence between the true positive fraction (TPF) and the false positive fraction (FPF) of a binary risk factor, and the associated odds ratios (ORs). In this figure, adapted from Pepe et al. [1, 15], a TPF=90% and a FPF=5% correlates with an OR=171.

In correspondence with measures of clustering, such as ICCs produced in multilevel analyses [6, 8, 93, 94], assessment of DA discerns which part of the total individual variance that can be explained by reference to a certain categorization [95]. The individual variance of a certain outcome can thus be understood as the continuous distribution of individual differences around the mean of the population. This total individual variance can be decomposed at different levels or through different categorizations, the relevance of which increases with the share of the total individual variance that relates to that specific level or categorization [3]. For most observable continuous variables, such decomposition of total individual variance is a straightforward matter. For discrete, dichotomous variables, this calculation requires special statistical techniques [96] but the substantive interpretation is similar [3]. In either case, a low DA suggests that outcome heterogeneities within categories, and/or overlaps of individual values between categories, are so large that the explanatory capacity of the categorizations' average values is very limited at the individual level. The stronger the DA, the more relevant the exposure category (e.g., risk factor, neighborhood, social group) is for public health [2, 6, 8, 11]. In cases where the DA is low, however, conclusions based on group averages may lead to under- or over-diagnosis and ineffective treatment, and may have a stereotyping or stigmatizing effect through representing population groups as being more homogenous, and different from others, than they actually are [2].

It is noteworthy that measures of population attributable fraction (PAF), which aim to quantify the share of a disease burden in a population that is attributable to a certain risk factor and that is therefore potentially preventable through elimination of that exposure [4, 97], may exaggerate the relevance of risk factors by not considering people exposed to the factor who do not develop disease [1, 5]. That is, although it is often used to quantify risk [98, 99], the PAF does not take the FPF into account. When the ratio between the prevalence of a risk factor and the prevalence of the disease is high, both the TPF and the FPF tend to be large. Therefore, a highly prevalent risk factor for an uncommon disease produces a high PAF but simultaneously has low DA. In other words, the PAF disregards DA [1, 5].

While interpretation of DA is, as mentioned, uncommon in the epidemiological study of risk, existing measurements show that many risk factors, social as well as biological, provide fairly blunt instruments for discrimination of individuals who will or will not become ill, and who should therefore be, or not be, the object of treatment or targeted intervention [2-5, 14, 15, 18, 35, 100]. This applies, for example, to risk factors for cardiovascular disease [5, 35, 79]. Rockhill [35] refers to studies according to which cardiovascular risk factors were almost as prevalent among people with and without cardiovascular disease. Merlo et al. [1, 5] stress that, in comparison to risk assessment based only on age and gender, neither newly identified biomarkers nor established risk factors such as hypertension add much to the ability to predict who will actually contract coronary heart disease. Along similar lines, Glymour and Rudolph [34] observe that disease predictors not only explored in genetic but also in social epidemiology actually have very limited ability to explain variance (r^2) in health outcomes. Smith's [79] response to this "Gloomy Prospect" of epidemiology is an acknowledgement that, while ORs and other corresponding average measures of associations provide insufficient bases for individual-level prediction, such probabilistic, or even stochastic, models of prediction should be used for population-level inferences. Concluding that probabilistic or stochastic measures are the best we have, Smith writes (p 556):

> Chance leads to averages being the only tractable variables in many situations, and this is why epidemiology makes sense as a science. We should embrace the effects of chance, rather than pretend to be able to discipline them [79].

Rockhill [35] similarly poses group averages against mechanisms determining individual events, emphasizing that the former cannot elucidate the latter. Again, individual risk is assumed to be a stochastic phenomenon that cannot be determined at the individual level but that is best estimated through population averages [3]. Merlo et al. [3, 6, 8, 9] argue, in contrast, that epidemiology needs to be developed beyond consideration of population-average risk, through expansion of knowledge about individual responses in different contexts, via analyses of individual heterogeneity and measurement of DA.

While DA is a descriptive tool that does not offer actual explanations for within-group heterogeneity [29], measures of DA provide information that reaches beyond the current focus on probabilistic knowledge in epidemiology [3, 4]. Mechanistic approaches, in epidemiology, seek to establish casual hypotheses by explaining how something works [101]. While this stance relates comfortably, in principle, to biomedical visions of specific etiology [102], and propels the drive towards causal inference, the rise of multifactorial webs of causation and the concomitant focus on risk, evaluated by means of difference between group averages and expressed in measures such as ORs, has brought probabilistic approaches to the center of epidemiology [103]. Measures of probability establish the extent to which an event is likely to occur, rather than the dynamics through which such events are brought about, and the resultant lack of attention paid to mechanism has been a major cause of criticism against probabilistic risk factor or "black-box" epidemiology [23, 104]. Thus, many have argued that epidemiologists must pay more attention to the biological [42] and social [23] mechanisms of disease causation. Measures of DA, in combination with theorization and hypotheses-testing informed by intersectionality theory, may yield valuable contributions to knowledge concerning social mechanisms of disease causation.

Intersectionality theory

Against the background of the relative lack of social theory in epidemiology, and the need for further understanding of population heterogeneity, intersectionality is a concept and a theory which may have much to offer population health science. While categorization along lines of race/ethnicity, sex/gender and class/socioeconomic status are central to epidemiological study of health disparities, as well as to conceptualization of exposures or factors of risk, the basic feature of intersectionality theory is the understanding of such categories not as separate, but rather as interacting. Power structures are set in the center of analysis; focus is directed to what social categories and their interactions disclose about power, and social change is an explicit and overarching goal [32, 105, 106]. Key concepts are inequality, relationality, power, social context, complexity and social justice [106]. Intersectionality functions, write Lutz et al. [107], as "an instrument that helps us grasp the complex interplay between disadvantage and privilege" (p 8).

An intersectionality perspective has been advocated and, to a certain degree, integrated in studies of population health and risk during the past few decades [27-29, 105, 108-113]. Intersectionality offers a theoretical framework, note Kapilashrami et al. [109], which can help epidemiologists look toward social dynamics rather than social categories and thus investigate structural motors for inequalities rather than individual-level behaviors and risk factors. Bauer [27] notes that intersectionality perspectives can contribute to epidemiology through increased specificity in mappings of health disparities, and added knowledge concerning variability within, and overlaps between, social categories.

While the concept of intersectionality was coined and developed by Kimberlé Williams Crenshaw, in her analysis of the legal positioning of colored women [114], it has a long pre-history consisting of efforts toward understanding interlocking social structures or systems of oppression such as racism and sexism [115, 116]. This pre-history extends into 19th century writings of, for example, Indian social reformer Savitribai Phule and US former slave and activist Sojourner Truth [106], through the 1970s Combahee River Collective [117] and through social movement activism in the 1960s to early 1980s. Collins and Bilge [106] emphasize the importance of this prehistory while stressing that intersectionality is not only an area of critical research, but also of critical praxis, as its primary purpose is to be used as a tool for empowering people. In recent times, the concept of intersectionality has been called a “theory whose time has come” (p 193) [115], as it has gained immense popularity among scholars, policy advocates and activists around the world [106]. In Sweden, intersectionality theory has been introduced and developed by scholars such as Paulina de los Reyes and Diana Mulinari [118], Irene Molina [119, 120] and Nina Lykke [121]. By now, argues Yuval-Davis [122], intersectionality should be accepted in contemporary sociology as the most valid theoretical approach to social stratification.

Although intersectionality has strong roots in legal and gender studies, the concept has spread to a range of academic disciplines including history, sociology, philosophy and anthropology [123]. While it rests on the core insight that socioeconomic and political conditions are not shaped by any one factor or any one axis of social division, but rather by many such axes in interaction, scholars and other actors understand and use the term intersectionality in differing ways [106, 115, 124]. McCall [32] famously distinguishes between categorical (or inter-categorical) and anti-categorical orientations toward intersectionality. Categorical analysis aims to elucidate how interlocking systems of oppression, such as racism and sexism, interact to produce inequalities between social groups in society, expressed, for example, in the distribution of income, education and health outcomes. Here, traditional social categories such as ethnicity and gender can be used in analyses of patterns of interaction, dominance and subordination. Anti-categorical inquiry, on the other hand, directs critique toward categorization itself. Emphasis is placed on the inherent fluidity and malleability of social categories, as these are socially contingent constructions rather than mirrorings of fixed realities. It is here argued that categorization per se can lead to the creation, perpetuation or essentialization of differences and inequalities between groups. Power-implicated categorizations of gender and race, for example, should therefore be carefully used or deconstructed as a central part of social change.

There are no given intersectionality methods that can be readily applied to any research field, but rather scholars take up different facets of intersectionality in ways that relate to their specific concerns. In different contexts, Marx Feree [125] writes, researchers and other actors attempt to adapt or "bend" the meaning and application of intersectionality to fit it with their own interests, agendas or needs. Davis [124] argues that the open-endedness of the intersectionality concept, which awards its broad appeal and invites further elaboration and use, is, in fact, one of the keys to its success. Carbado et al. [126] note that intersectional analyses are always in-process, "necessarily particularized and therefore provisional and incomplete" (p 2). However, Collins and Bilge [106] emphasize the importance of maintaining discussion of whether and how research approaches are in fact intersectional. They warn, in particular, against the loss of the critical and essentially political character of intersectionality and encourage consideration of how the chosen approach retains a critical focus. Along similar lines, Cho, Crenshaw and McCall [123] encourage reflection on what, in specific instances, intersectional analyses do [116]. Intersectionality should not be applied in absence of systematic critique or a social justice ethos [106, 107, 127].

Thus far, intersectionality research has largely been pursued through qualitative research methods, and it has been noted that intersectionality perspectives are perhaps not entirely compatible with quantitative methods [28, 128, 129]. A way in which intersectionality research stands at potential odds with quantitative approaches is through its core emphasis on the fluidity and heterogeneity of population categories, and on the relationship between such population categories and the power structures of which they form part. A central aspect of intersectionality research is thus the effort to move beyond a positivist understanding of population categories as static, reified or naturally inevitable. Lykke [130] promotes use of the term categorization instead of category, as she associates category with something static, congealed or reified while categorization is more amenable to the capture of social and communicative processes. Marx Ferree [125] observes that inequality should not be understood or studied in terms of fixed points of interaction between set categories, but rather as being located in dynamic and mutually constituted relationships. Intersections between categories should be approached as "organizational fields" (p 56), in which various forms of inequality are experienced, contested and perpetuated through processes by which, for example, race takes on multiple gendered meanings. Accordingly, Soiland critiques studies in which "the relations go and the categories come" (quoted in Lutz, p 8) [107], as intersectionality is reduced to the metaphor of a crossroads between categories and relations of power are neglected. Bhavnani prefers the concept of configurations to that of intersection, as the former emphasizes what Yuval-Davis [122] calls the "flowing and interweaving threads" (p 156) that constitute interlocking systems of oppression. In summary, analytic attention to the complexities of categorizations as dynamic, historical and social processes does not necessarily align with ways in which categories are construed and used in quantitative analysis. As Seng [131] notes, the more qualitative, historical, interpretive or subjective dimensions of identities or social categorizations, which may have effects on health outcomes, are not easily captured in statistical models.

A related challenge for quantitative intersectionality research lies in the available data. In existing survey or register data, questions and scales may not have been developed in accordance with an intersectional perspective [28, 132]. Even if researchers recognize the limitations of such data, we often need to work with what we have. While an intersectionality perspective may thus be brought to the analysis, unproblematized use of categories of, for example, race and gender, found in such data runs the risk of being deemed an "incorrect operationalization of intersectionality's core insight" (p 21) [115]. Furthermore, in the active gathering of data, queries of how to ask questions about intersecting and mutually constitutive aspects of experience and identity, without trying to separate those aspects into isolated phenomena or using an additive approach, do not necessarily have easy answers [129].

A further point of difference between intersectionality research and quantitative population health research, in general, lies in the former's attendance to interrelatedness and to dynamics of inequality encompassing privileged as well as disadvantaged [118, 133, 134] and "hybrid" [135] intersectional positions. This interest contrasts with the relative focus on populations at risk that is typical in quantitative health science.

Consequently, researchers have argued that qualitative methods should be used for intersectionality research [128, 129], and integration of qualitative study into epidemiology informed by intersectionality has been advocated [27]. This said, McCall [32] notes that categorical intersectionality is compatible with quantitative research investigating demographic characteristics as proxies for structural inequality, and such work has indeed been done.

Quantitative population health studies have modeled combinations of demographic variables such as race and gender [110, 136], and measured interaction effects alongside main effects [132, 137] in multivariate analysis, to measure structural inequality along intersectional lines. Intersectionality has also been integrated into analysis of life course trajectories [138]. More implicitly, intersectionality has been incorporated into epidemiology through analyses of outcome heterogeneity within and between social categories [12, 14, 18]. In efforts to bring identity and experiences of discrimination into the analysis, Longman Marcellin et al. quantify interactions between racism and transphobia [139], while Seng et al. [131] operationalize intersectionality on three levels; interpersonal (experiences of discrimination), contextual (e.g., high crime neighborhood) and structural (low education and poverty). In recent years, intersectional approaches have begun to be integrated into multilevel analysis [29, 140-142].

However, in epidemiological research intersectionality perspectives are still relatively uncommon. Intersectionality remains absent, for example, in handbooks on measurement of inequality and socioeconomic position [143]. Researchers working to integrate intersectional perspective in quantitative study [105, 131], or reviewing this area of research [28, 109, 144], acknowledge that statistical operationalizations of intersectionality perspectives are, as yet, not fully developed. Sen et al. [136] remark on the existence of a knowledge gap, and of a paucity of research, which at least partially stem from current limitations in quantitative methods used to study intersectionality. Empirical, quantitative evidence of how intersections between, for example, race, gender and class affect health inequalities has thus remained sparse.

The present studies

Three studies included in this thesis (Study II, III, IV) contribute to the integration of intersectionality perspectives in epidemiology through juxtaposing a categorical approach, as outlined by McCall [32], with the calculation of differences in average risk between intersectional strata, and aligning an anti-categorical approach [32] with measurement of DA.

Bauer [27] observes, as mentioned, that potential contributions of intersectional analysis to epidemiology include increased specificity in mappings of health disparities. A word of caution should be issued, however, that intersectionality theory is not adequately applied through mere efforts toward fractioning the population into smaller taxonomic units through the combination of more than one major axis of social differentiation. To intersectionality research on health disparities, the object of interest is how interacting systems of power drive incidence of, and disparities in, disease. A second potential contribution noted by Bauer [27] is added knowledge about variability within, and overlaps between, social categories. In the present studies, intersectional analysis is integrated for both these purposes.

With reference to the first potential contribution observed by Bauer [27], categorical intersectionality can potentially fulfill the capacity to increase understanding of power dynamics through mappings of health disparities, by lending itself to conventional statistical measurement of between-group differences in average risk using intersectional strata or groups of social relationships [145]. Second, efforts toward increasing knowledge validity through attendance to outcome variability within, and overlap between, social groups [27] relate more readily to anti-categorical approaches. A novelty of the present studies lies in the argument that anti-categorical intersectionality, aiming to demonstrate intra-group heterogeneity of, and overlap between, social categories with regards to distribution of risk, can be operationalized in quantitative study through measurement of DA. Such anti-categorical intersectionality can pose something of a challenge to epidemiology, through urging researchers to make explicit the variability within, and overlap between, socially defined groups. Attendance to such variability prompts consideration of what implications such heterogeneity may have for the usefulness of social categories in the design of public health policies.

Bauer [27] does not mention any potential tension between the two ways in which she sees intersectionality potentially contributing to epidemiology. Similarly, Lofters and O'Campo [46] ask epidemiologists to use quantitative intersectional methodologies to "highlight the most vulnerable subgroups where action is most urgently needed and ensure the best use of resources for ameliorating inequities" (p 105) and to consider heterogeneity within socially defined groups to avoid the pursuit of misguided individual-level interventions, but without discussing any potential conflict between these two aspects of intersectionality. Tensions may exist, however, between differences in average causal effects on the one hand and measures of individual heterogeneity or DA on the other. Such potential tension are seldom teased out in epidemiology.

Ischemic heart disease and Influenza vaccination uptake

Ischemic heart disease

Cardiovascular disease (CVD) has been a major focus of epidemiological research ever since the rise of chronic illnesses such as lung cancer and CVD prompted the discipline to expand its attention beyond infectious disease. Early large-scale studies of CVD and its risk factors, such as the Framingham Study, provided seminal contributions to current multifactorial models of causality, to contemporary notions of risk factors and populations at risk [103], and thus to modern epidemiology [146]. Since the 1960s, CVD has declined in the so-called developed world, but, according to the WHO, it is still the number one cause of death globally [147]. In the USA, CVD affected around 15,4 million people in 2013 [148], and in Europe it causes over 4 million deaths each year [149]. In Sweden, it is the primary cause of death [150].

Average differences in cardiovascular risk along categorizations of socioeconomic status and race/ethnicity are well documented [151-154]. Heavier disease burdens carried by less privileged people can also be seen on the global level, as CVD declines in wealthier nations while being on the rise in the global South [155].

CVD is of further interest in the context of calculation, assessment and management of risk, as epidemiologists, alongside sociologists and anthropologists, point to tendencies to the placing of responsibility if not blame on the individual, rather than on socioeconomic living conditions, for cardiovascular disease or risk [21, 22, 46, 48-50, 156-158]. Meanwhile, measurement of DA shows that risk factors for CVD do not discriminate very well between individuals who will or will not contract the disease [1, 5, 35, 79]. For these reasons, the first object chosen for empirical study (Study II) [30] was risk of ischemic heart disease (IHD) in Sweden.

Influenza vaccination uptake

The second empirical object of study (Study IV) [31] is non-receipt of seasonal influenza vaccine in the US, with regards to differences along categories of race/ethnicity. A number of studies have investigated disparities in influenza vaccine uptake in the US, as being related to race/ethnicity [159-162] and other socioeconomic and demographic factors such as income, education, age and gender [163-165]. The US Centers for Disease Control and Prevention (CDC) regularly publish influenza vaccination rates classified according to a four-group race/ethnicity standard: Hispanic (any race); non-Hispanic White only; non-Hispanic Black only; and non-Hispanic, all other races or multiple races [166]. Over recent decades, higher influenza vaccination coverage has consistently been documented among non-Hispanic White adults than among non-Hispanic Black adults or Hispanic adults [159-161], and this is assumed to translate to differences in flu-associated morbidity and mortality [167]. The well-established and persistent racial/ethnic disparities found in prior studies, together with the importance of other socioeconomic and demographic factors, provide an interesting empirical setting for the intersectional approach explored in this thesis.

A further reason for selecting influenza vaccination uptake as an object of empirical study lies in on-going discussions about policies deemed appropriate for reduction of racial/ethnic disparities [168, 169]. The majority of the suggested policies are broad, including, for example, increasing vaccine availability, decreasing patient 'out of pocket' costs, making the offering of vaccines in health care and other settings into a routine practice, offering education about the risks and benefits of vaccines, and using patient reminder systems [160, 161]. A shared feature of such policies is that they do not target individuals based on racial or ethnic identification, and that they may be beneficial across racial/ethnic groups while simultaneously reducing differences between racial/ethnic groups. Offering free or low-cost vaccination, for example, may increase vaccination rates across groups, in particular among low-income individuals, but may simultaneously reduce differences because of disproportionately high poverty rates in some racial/ethnic groups.

In addition to such broad interventions, however, policies targeting specific racial/ethnic groups have been proposed [170-172]. It has been suggested, for example, that Black and Hispanic adults should be targeted by a text message campaign encouraging them to consult their doctors about vaccination, in order to address knowledge gaps and dispel misconceptions [171]. Such racially or ethnically tailored interventions rest on the translation of group-level rates or average causal effects into individual causal effects, which, as noted, is questionable due to potential outcome variability within and overlap between groups [3, 12, 173]. Leaving concerns about stigmatization [174] aside, suggestions to implement racially or ethnically tailored policies raise questions about the value of racial/ethnic identification as a predictor of vaccination status, and about its predictive value, compared to and above other relevant social categorizations such as those based on age, income, education, or gender, or on a combination of social categorizations.

Complementary and alternative medicine (CAM)

The low discriminatory accuracy of many risk factors for disease, which reveals some uncertainty about chronic disease causation mechanisms, motivates explorative interest in other possible ways of conceptualizing and practicing disease prevention. Among the factors pulling [175] people to the use of complementary and alternative medicine (CAM), one appears to be understandings of body, health, disease and disease prevention found, or thought to be found, within CAM [176-184].

According to the US National Institutes of Health (NIH), CAM is "a group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine" [185]. Complementary medicine refers to therapy used in combination with conventional medicine, while alternative medicine is a term for medicine used instead of it. The NIH divide CAM into five groups [185, 186]: alternative medical systems (e.g., homeopathy, Chinese medicine, and Ayurvedic medicine), mind-body interventions (e.g., meditation, mental training, and art therapy), biologically based therapies (e.g., herbs and nutritional supplements), manipulation therapies (e.g., chiropractic and massage), and energy therapies (e.g., healing).

Salamonsen and Ahlzén [178] relate people's widespread use of CAM to a need for a phenomenologically and socially based understanding of health and illness. Pointing towards ways of understanding unhealth in terms of disease (the biomedical perspective), illness (the phenomenological perspective), and sickness (the social perspective) respectively, they argue that public health care systems aiming at involving patients in treatment processes, while defining and reaching goals of treatment and compliance, may have much to benefit from acknowledging the coexistence of these differing epistemologies. Salamonsen and Ahlzén thus suggest that increased understanding of how disease and disease prevention is conceptualized within CAM can be of value to public health care provision.

CAM has often been framed in terms of a more holistic or less reductionist alternative to, and reaction against, the ontological dualism [187] that has tended to characterize biomedicine in the modern era, as the latter rests on Cartesian division between body and mind, biological and social, culture and nature, and a range of other interrelated dichotomies [188, 189]. One way in which biomedicine acts to reinforce the mind/body or reason/nature divide, is by construing the ill person as an essentially non-contextualized and individualized pathological body [187]. While many have observed that simple opposition between reductionist, dualist biomedicine and holistic, non-dualistic CAM does not hold up to scrutiny [176], such oppositional categories can still be relevant as active agents in the construction of medical knowledge, practice and identity [190]. Extending historical roots into vitalistic and romantic movements of previous eras [191], and having developed alongside academic endeavors such as feminist and postcolonial studies [187], varieties of CAM share motivations also found within sociology, anthropology and Science and Technology Studies (STS) to reach beyond Cartesian dualism in order to find alternative conceptualizations of the body, not least in analyses of health and illness [68, 192-198]. At the same time, CAM has been critiqued for not offering alternatives to, but rather aligning itself with, individualistic and reductionist if not capitalist or neo-liberal agendas [199-201].

Additional future research explores the question of how heart disease and heart disease prevention are conceptualized along holistic and/or reductionist lines, in contemporary Scandinavian conventional medical and Chinese medical training, respectively. Included in the thesis (Study V) is a prevalence study of CAM usage in southern Sweden.

CAM prevalence

Many research results suggest that a large and possibly growing number of people now use CAM [36, 202]. CAM prevalence research [203-205] from, for example, the USA [206], UK [207], Canada [208] and Australia [209], suggests that a large part of the studied populations make use of CAM, which has been said to be subject to "exponential growth" around the world (p 75) [210]. A range of studies have found high rates of CAM use among people with diverse diseases such as cancer [211], cardiovascular disease [212], asthma [213], and others [214-216]. Studies have further looked at reasons for, or factors associated with, the use of CAM [217-220].

A range of studies have pointed to a higher prevalence of CAM use among women than among men [221-223]. Researchers have looked at CAM consumption in different age groups [224-226], and in populations defined by race/ethnicity [227, 228]. Shippee [229] found, for example, that Black Americans who had experienced racial discrimination were more likely to use CAM. With reference to studies of CAM use in various population groups [230-233], Cant and Watts [234] comment on the existence of intersectional effects of gender, ethnicity, class and culture, related to CAM consumption. Correspondingly, Keshet and Simchai [235] call for an intersectionality perspective in future studies of CAM use.

Scandinavian research [236, 237] includes a study estimating, in 2005, that 45% of the Danish population and 34% of the Norwegian population had used CAM [238]. In Sweden, analogous studies are few. An investigation conducted in the 1980s [239] found that 22% of the population had used CAM, while 40% were open to trying CAM in the future. Skåne, the southernmost region of the country, included the area (Malmöhus) where CAM usage was at its lowest (14%). According to a 2001 study measuring CAM use among inhabitants of Stockholm [240], 49% of the population had used CAM in the previous year. Alongside these more overarching prevalence studies, research has looked at the use of nutritional supplements, herbal medicine, and/or natural remedies [241-243], patient groups with certain diseases [244-246], and CAM use in a small municipality [247].

Overall, despite research conducted, up-to-date and adequate knowledge of CAM use in Sweden, as in other countries, is lacking. This is due not only to a paucity of large studies but also to high levels of incertitude and low comparability of the existing studies [203, 248]. Studies differ, for instance, regarding the definitions of CAM and the included study populations and timeframes [249, 250]. Questions of how prevalent CAM consumption is, and of how it is distributed between population groups, are thereby largely left unanswered [36, 186, 202].

3. Aims

Aims

Part A

1. To review critical debates within risk factor epidemiology concerning low DA and lack of social theory (Study I).

2. To, against the background of critical debates within risk factor epidemiology concerning low DA and lack of social theory, integrate intersectionality theory into epidemiological study (Study II, III, IV).

3. To measure increases in DA acquired through integration of intersectionality theory into epidemiological study (Study II, III, IV).

Part B

4. To, against the background of low DA expressing limitations in epidemiological knowledge of risk and prevention of disease, investigate use of and attitudes towards complementary and alternative medicine (CAM) in a Swedish population (Study V).

5. To, against the background of low DA expressing limitations in epidemiological knowledge of risk and prevention of disease, explore ontological understandings of health, risk and prevention of disease found in conventional and Chinese medical training in contemporary Scandinavia (Additional future research).

Research questions

Part A

1. What are the central features of critical debates pursued within the discipline of epidemiology, regarding DA and lack of social theory? (Study I)

2. How can intersectionality theory contribute to addressing the problematic aspects of epidemiological study identified in such critical debates? (Study II, III, IV)

3. Does intersectionality theory serve to increase DA, in empirical studies? (Study II, IV)

Part B

4. What is the current prevalence of, and attitude toward, CAM in a Swedish population? (Study V)

5. How do ontological understandings of health, risk and prevention of disease found in Chinese medical training in contemporary Scandinavia differ from those found in conventional medical training? (Additional future research)

6. If epidemiological knowledge about risk and prevention of disease is insufficient, might this be one reason behind the interest in forms of complementary or alternative medicine in the general population? (Additional future research)

Aims of individual studies

The aim of Study I is to:

(i) review critical debates within risk factor epidemiology concerning low DA and lack of social theory

The aims of Study II are to:

(i) replicate previous studies of social stratification of risk for IHD
(ii) use an alternative modeling of population groups informed by categorical intersectionality
(iii) establish whether intersectional groupings lead to improvement of DA regarding prediction of IHD in Sweden

(iv) further conceptual and methodological debate regarding categorical and anti-categorical intersectionality and DA

The aim of Study III is to:

(i) further conceptual and methodological discussion regarding intersectionality, DA and multilevel analysis

The aims of Study IV are to:

(i) investigate average associations between social categorizations and non-receipt of seasonal influenza vaccine, in accordance with conventional mappings of health disparities
(ii) explore outcome heterogeneity related to standard racial/ethnic categories through stratifying racial/ethnic groups by gender and education, in accordance with a categorical intersectionality perspective
(iii) investigate how well racial/ethnic categories predict non-receipt of influenza vaccine, compared to other relevant social categorizations
(iv) further conceptual and methodological debate regarding categorical and anti-categorical intersectionality and DA

The aims of Study V are to:

(i) measure use of CAM and conventional medicine in Skåne
(ii) measure attitudes towards CAM and conventional medicine in Skåne
(iii) contribute toward development of a measurement tool for CAM prevalence study (I-CAM-Q) [251]

4. Methods and Populations

Study I

Study I [25] consists of a literature review, based on extensive literature studies using the search engines PubMed, Web of Science and Google Scholar.

The subject matter of the review is extensive, and the article makes no claims to being in any way exhaustive. It is intended as an introductory overview of debates relevant to social theorists interested in epidemiological knowledge production, as well as to epidemiologists drawn to social theory or self-reflexive inquiry.

Study II

Study II [30] explores an intersectionality approach to the study of risk for ischemic heart disease (IHD) in Sweden.

Population and data

The study population includes all individuals aged 45–80 by Dec 31st 2010, residing in Sweden since at least 5 years, and consists of approximately 3.6 million people. The study rests on register data from Statistics Sweden (SCB) and the National Board of Health and Welfare (Socialstyrelsen). The construction of the database was approved by the Regional Ethics Committee of Lund, Sweden (Dnr 2014/856), by the Data Safety Committee at Statistics Sweden and by the National Board of Health and Welfare.

Variables

The outcome variable is hospitalization due to IHD (ICD-10-codes I20–I25) in 2011–2013 (yes versus no). Explanatory variables are based on socio-demographic data included in the registers, regarding age, gender, time as a registered inhabitant of Sweden, income, civil status and prescription of psychotropic medication, used as a proxy variable for psychological ill health.

The age variable was divided into seven groups (45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–80 years). Gender was defined as male or female. While from an intersectionality perspective binary classification of gender is a limitation, an "other" category was not permitted by the register data. Although gendered aspects of symptoms, treatment and prevalence of cardiovascular disease are indeed interesting [252, 253], their complexity in combination with the overall higher (documented) prevalence of cardiovascular disease among males caused us to stratify the data along gender and thus conduct separate analyses for males and females. Regarding categories of race/ethnicity, much of the research on cardiovascular risk has focused on broad "racial" and ethnic categories, notably White, Black and Hispanic citizens of the US [152]. In Sweden, while many forms of racism and racialization co-exist [254], immigration is of strong importance to racialized relationships. Here, race/ethnicity was operationalized in terms of time as a registered inhabitant of Sweden. The variable was dichotomized as having been a registered inhabitant of the country for less than 10 years or for 10 years or more. As all individuals in the cohort had resided in Sweden for at least 5 years, in effect members of the recently immigrated group became residents of Sweden 5–10 years prior to 2010. Class or socioeconomic status was measured in terms of individualized disposable household income, categorized as low, medium or high, based on the division of the whole adult population (18–80 years) into tertiles. Marital or civil status, which was assumed to be associated with differences in distribution of normativity and resources in society, have also been shown to correlate with cardiovascular risk [255]. Civil status was here dichotomized as cohabiting or living in a single-person household. Prescription of psychotropic medication was used as a proxy variable for psychological ill health. Mental ill health is a documented risk factor for cardiovascular disease [256], potentially interacting with social categorizations. The variable measures prescriptions from 2006 to 2010, according to the Anatomic Therapeutic Chemical categorization system (ATC N05A, N05B, N05C or N06A; yes versus no).

Intersectional strata, or groups of social relationships [145], were formulated through 24 combinations of the mentioned variables, stratified by gender, on the basis of their positionings (i.e., 1. Males who had been registered inhabitants of Sweden for at least 10 years, had high income, cohabited and had not been prescribed psychotropic medication. 2. Males who had been registered inhabitants of Sweden for at least 10 years, had high income, cohabited and had been prescribed psychotropic medication … 25. Females who had been registered inhabitants of Sweden for at least 10 years, had high income, cohabited and had not been prescribed psychotropic medication … 48.) These intersectional variables were intended to be understood as proxies for interacting relationships of power driving distribution of IHD incidence.

Statistical analysis

Associations between IHD and explanatory variables were calculated by means of gender stratified logistic regressions, estimating odds ratios (ORs) and 95% confidence intervals (CIs). Absolute risk (AR) was also measured, as average risk within the category (i.e., incidence) rather than in terms of comparison with the reference group.

Three different regression models were developed. The first model (age only) included only age, entered as a categorical variable. The second model (conventional social) includes, alongside age, the other variables noted above; time as a registered inhabitant of Sweden, income, civil status and psychological ill health as measured through prescription of psychotropic medication. This model replicates, in principle, previous studies of social stratification of risk for cardiovascular disease. In the third model (intersectional) the data was approached from a categorical intersectionality perspective, through the formulation of the abovementioned groups of social relationships. This model was adjusted for age, entered as a continuous variable with a quadratic term used to accommodate the non-monotone association between age and IHD observed in the first model. The reference values of the variables in models 2 and 3 were the more privileged or normative positions: cohabiting people with high income, who have lived in Sweden for a long time and who have not been prescribed psychotropic medication.

The DA of the logistic regression models was measured by means of the area under the receiver-operating characteristic curve (AUC or AU-ROC), or C statistic, which is a well-established way of measuring DA [3, 15, 257]. As mentioned above, ROC curves are created by plotting sensitivity, or the true positive fraction (TPF), vs. 1-specificity, or the false positive fraction (FPF), at various threshold settings of predicted risk obtained from the logistic regression models. Here, the AUC can be interpreted as the probability that a randomly selected individual with IHD will have a higher predicted risk of IHD than a randomly selected individual without IHD. For example, an AUC=0.6 means that if we randomly select one person without IHD and one individual with IHD, the probability of having a higher predicted risk of IHD for the diseased individual is 60%. If the AUC=1, every individual with IHD would have a higher predicted risk of IHD than every person without IHD.

The AUC was calculated for the first model (age only) and the results were used as a reference for comparison with the AUC of the second (conventional social) and third (intersectional) models. In this way, we measured the incremental value of the second and third models, in terms of the increased ability to discriminate IHD cases from non-cases, compared to the model based only on age. Increased AUC would suggest better understanding of the distribution of IHD risk in the population.

As age is a major determinant of IHD risk, in a secondary analysis we again measured the AUC of the three models, but in strata of age (i.e., 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–80 years). This was done to minimize the influence of age on the overall DA and to provide a better understanding of heterogeneity.

The statistical analyses were performed using SPSS Version 22.0 (SPSS Inc., Chicago. Illinois. USA).

Study III

Study III [33], which is a response to a commentary [29] on Study II, rests on literature study and discussion. It consists of methodological and conceptual discussion regarding intersectionality, DA and multilevel analysis.

Study IV

Study IV [31] applies an intersectionality perspective to study of influenza vaccination uptake in the US.

Population and data

The study was based on the National 2009 H1N1 Flu Survey (NHFS). The NHFS [163] is a one-time telephone survey conducted from October 2009 to June 2010 on behalf of the US Centers for Disease Control and Prevention (CDC), aiming to monitor and evaluate the 2009–2010 vaccination campaign [258]. The survey gathered data on the uptake of the pandemic pH1N1 as well as usual trivalent seasonal influenza vaccines among adults and children. Among the contacted adults, 56.656 (45.2%) provided complete responses.

Variables

The outcome variable was receipt of seasonal flu vaccination (yes or no). 'Yes' indicated that the person had received at least one seasonal influenza vaccination since August 2009. 202 individuals (0.4%) with missing values on this variable were excluded from the analysis.

As for explanatory variables, we used socio-demographic variables defined in the NHFS. Categorization of 'race and ethnicity' was based on self-reported classification into four groups: Hispanic (any race), non-Hispanic White, non-Hispanic Black, and non-Hispanic, other races or multiple races. This four-level variable was derived from answers to two questions in the NHFS. Consistent with the revised Office of Management and Budget [259] standards for classification of race and ethnicity, the first question was 'Are you of Hispanic or Latino origin?' The interviewer was instructed to offer the following alternatives: ‘Mexican/Mexicano, Mexican-American, Central American, South American, Puerto Rican, Cuban/Cuban American, or other Spanish-Caribbean’. This was followed by a second question: ‘(In addition to being Hispanic or Latino,) are you White, Black or African-American, American Indian, Alaska Native, Asian, Native Hawaiian or other Pacific Islander?’ The race/ethnicity variable presented in the NHFS is, however, compressed into the four groups described above. The ‘other races or multiple races’ group includes Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, and other races, as well as any non-Hispanic respondent selecting more than one race. Gender was defined as either male or female. While from an intersectionality perspective, binary classification of gender is a limitation, as in the study of IHD risk (Study I), an ‘other’ category was not permitted by the survey data. The age variable was divided into five groups (18–34, 35–44, 45–54, 55–64, and 65 or more years). We assessed socioeconomic position using the poverty status of the person’s household and the participant’s self-reported level of education (college graduate, some college, 12 years, <12 years, missing or unknown). Household poverty categories (>=$75.000/year, above the poverty threshold but <$75.000/year, below the poverty threshold, poverty status unknown) were based on the number of adults and children reported in the household, the reported household income, and the 2008 Census poverty thresholds [258].

The explanatory variables were combined into intersectional group variables. Here, intersectional groupings can be used to assess whether the average risk of vaccination non-receipt is similar in intersectional subgroups defined by different race/ethnicity (e.g., Black women vs. White men), or whether divergences exist within the same racial/ethnic group (e.g., White men vs. White women). If this is found to be the case, the results point toward important heterogeneities of effects within and between standard racial/ethnic categorizations. In addition to the existing variables used in the NHFS, we therefore created two intersectional variables by stratifying the categories of race and ethnicity, first by gender and second by gender and education. We used education rather than household poverty as a proxy for socioeconomic position, in this combined variable, because fewer values were missing for the former (5% vs. 17%).

Individual-level and household-level socio-demographic information was requested from the survey respondents. For some variables (race/ethnicity, gender, age), missing values were imputed. The NHFS used a sequential hot-deck method to assign imputed values, which involves replacing missing values for a non-respondent with observed values from a respondent that is similar to the non-respondent with respect to characteristics observed by both cases [258]. There is no information in the NHFS on the amount of imputed values but, according to the CDC, the amount was very small (personal communication).

Statistical analysis

Logistic regressions were used to measure associations between the potentially explanatory variables and non-receipt of seasonal influenza vaccine. We developed a series of analyses that modeled one variable at a time, followed by more elaborate models that adjusted for age, household poverty and level of education. We then conducted separate analyses using the two intersectional group variables mentioned above, created with the aim of investigating heterogeneity of effects within and between racial/ethnic groups. In all the analyses, we used the provided survey weights, calculating a number of socioeconomic and demographic variables including age, gender and race/ethnicity [258]. Associations were expressed by means of ORs and 95% CIs. The reference groups in the analyses were those presenting the highest vaccination rates.

As with the study on risk for IHD (Study II), we measured the DA of the logistic regression models through receiver operating characteristic (ROC) curve analysis. In an initial series of simple logistic regression models, we calculated the AUCs (or AU-ROCs) with 95% CIs of models including age alone or age plus one or more other variables. The incremental discriminatory value of a model was assessed through calculation of the increase in AUC. The AUC of age was used as the baseline from which to assess the incremental discriminatory value of other models, as age is a major determinant of influenza vaccine receipt and also a confounder of the association between race/ethnicity and influenza vaccination receipt [159-161]. In a second series of logistic regression models, we calculated the AUCs with 95% CIs of models including age and the variable race and ethnicity together with gender, or with gender, household poverty status, and educational level. This second series of modeling was done to assess the incremental discriminatory value of more elaborate models. Finally, we calculated the AUCs with 95% CIs of models including age and the two intersectional variables, with the aim of testing whether the use of intersectional sub-groupings lead to improvement of DA as compared to models that included race/ethnicity, gender and education as separate terms.

The statistical analyses were performed using SPSS Version 22.0 (SPSS Inc., Chicago, Illinois, USA) and STATA (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

Study V

Study V [36] measured the use of, and attitudes towards, CAM and conventional medicine, in Skåne during 2015.

Population and data

The survey study was conducted in collaboration with the market research company TNS Sifo[1] (*www.tns-sifo.se*), between January 22 and February 4, 2016. The questionnaire was completed by 1.534 adults (18–79 years) living in the region of Skåne, the inhabitants of which (1.25 million) make up 13% of Sweden's total population.

Respondents were randomly selected from TNS Sifo's web panel, which consists of approximately 120.000 people recruited through previous survey studies. The web panel is representative, with regard to categories of age and gender, of the part of the Swedish population that has regular access to the Internet. Population groups with lower income and shorter period of education are somewhat underrepresented. For the present study, the sample was non-proportional in order to cover the population according to age and gender, and to compensate for lower response rates among younger respondents. The sample was shown to be sufficiently representative of the population regarding those categories of gender and age. Each person could only respond once, and only fully completed surveys were included in the data.

The overall response rate was 31%. Web panel surveys performed by TNS Sifo have an average response rate of around 40%, and the lower rate in this case is likely due to the relatively large number of questions included in the survey. The response rate was higher in the older age groups than in the younger ones (48% for age 65–79 years, 35% for age 30–49 years, 20% for age 30–49 years, and 19% for age 18–29 years). This uneven distribution was, as mentioned, compensated for by allocation of a larger number of surveys to respondents of younger age.

Survey questionnaire

The questionnaire was based on the model I-CAM-Q [251], which has been developed by an international expert group, on the initiative of the National Research Center in Complementary and Alternative Medicine (NAFKAM) in Norway, with the aim of functioning as a standardized measurement instrument for the study of CAM prevalence in the EU. The questionnaire includes questions about visits to CAM providers, reception of complementary treatment in or through conventional health care, use of natural remedies such as nutritional supplements and herbal

---

[1] Taylor Nelson Sofres and Svenska institutet för opinionsundersökningar (The Swedish Institute for Opinion Surveys)

medicine, and use of self-help practices such as yoga or relaxation exercises, in the last 12 months. This survey model has been adapted, validated and used in a selection of European countries [249, 250, 260].

The I-CAM-Q was adapted to Swedish conditions, for example through adjustment of the complementary treatments available within conventional health care or through referral. It was also modified according to experiences and critiques of previous users [249, 250], through simplification of the survey layout, reduction of some questions (primarily regarding the regularity of CAM use), and the addition of questions on the use of conventional medicine. The latter was done to increase the face validity among non-CAM users and to enable comparison between types of health care consumption. In addition, background questions regarding demographic variables and health condition as well as questions regarding attitudes towards CAM and conventional medicine were added. Most of these questions had been validated and used in the Public Health Survey of the Skåne Region [261] or in a previous study of CAM use in Stockholm [240].

The parts of the questionnaire adapted from the I-CAM-Q format were translated into Swedish by a professional translator, and the developed version was assessed by four experts in the field[2]. An initial pilot study, including open questions about the types of CAM used and queries on the clarity of the questionnaire, was sent via e-mail to 100 randomly selected students at Lund University. The validation process was based on Sousa and Rojjanasrirat's [262] description of appropriate measures in translation, adaptation and validation of surveys on health.

The respondents received e-mails including a brief introductory text about the survey and a reference to more information on a website belonging to the Unit of Social Epidemiology, Lund University, together with a personal link to the survey. Respondents then completed the survey via computer or mobile phone. In questions about types of health care use, the order of response options was randomized to avoid any skewing of the results due to the sequence of alternatives.

After completion, TNS Sifo delivered the anonymized raw data to the research group.

The study has been approved by the Regional Board of Ethics (Dnr 2015/289). It is to be regarded as a pilot study, aimed towards possible future Regional Council (Region Skåne) surveys.

---

[2] Jenny-Ann Brodin Danell, PhD., Umeå University, Researcher in CAM; Åsa Trulsson, PhD., Linneaus University, Researcher in CAM; Anne-Christine Hornborg, PhD., Prof., Lund University, Researcher in CAM; Mona Lundström, BSc., CAM practitioner.

Variables

The survey measured use of CAM and conventional medicine, overall and along demographic variables of gender, age, education, income and self-rated social status, as well as health status. Information on age and gender was gathered from the respondents' background data. The level of education was categorized as basic, secondary, or tertiary, while in the analysis it was dichotomized as tertiary or not. Civil status was, in the analysis, dichotomized as cohabiting or living alone. Social status was self-rated [263] on a scale from 1 to 10, which in the analysis was divided into three levels: low (1–3), medium (4–7), and high (8–10). The respondents were further asked about their self-rated health, any long-term health problems or injuries, experiences of everyday stress, exercise habits, and their following of any particular diet. The questions on long-term health problems and diet were of a yes/no character. The other questions were multiple-choice questions, responses to which were later dichotomized into yes/no or good/bad.

The survey also measured attitudes towards CAM and conventional medicine.

Statistical analysis

Simple descriptive statistics were performed, alongside multiple logistic regressions modeling associations between the use of CAM versus conventional medicine and the variables described above, estimating ORs and 95% CIs. The results were not weighted.

We did not perform any analyses based on intersectionality perspectives, primarily due to the small sample size.

The statistical analyses were performed using SPSS Version 22.0 (SPSS Inc., Chicago, IL, USA).

5. Results

Study I

Study I [25] offers an overview of critical debates within epidemiology, parts of which were discussed in the Background section. A main point concerns mainstream epidemiology's focus on the individual as its unit of observation, analysis and intervention, and its relative lack of theorization of, and provision of bases for the effective amelioration of, social structures and dynamics driving the production of health disparities. Furthermore, the study discusses the concept of DA, and the low DA of many social and biological risk factors.

The review points to three partially overlapping areas where social theory, including intersectionality theory, has been called upon to contribute to epidemiological inquiry. The first consists of the analysis of macro-social determinants of health and disease, for example through the study of how political systems and priorities affect population health and health disparities [264] and through the development of an epidemiology informed by critical realism [22, 23, 52, 265]. The latter should aim to identify context-mechanism-outcome patterns and thus provide explanations of how macro-social determinants and population health are causally linked, for example through "relational mechanisms" (p 265) [266] such as racism and sexism as well as division of labor and historical trajectories of exploitation. The second area in which social theory should be increasingly employed is critical inquiry into how population categories used in epidemiological research are construed and handled, as these can themselves be considered to be part of power structures [48-50, 267-269]. The third area is embodiment, meaning analysis of continuities and pathways between macro-social conditions and societal relationships on the one hand, and health status on the other. In response to the question of how patterns of disease distribution can be understood as "biological expressions of social relations" (p 672) [56], the concept of embodiment offers a means to conceptualization of how social structures, relationships and experiences become biologically incorporated and manifested in bodies [21, 57, 270-276]. Finally, Study I includes a call for analytic openings toward explorative study of alternative models of explanation and treatment of risk and disease sought in CAM around the world.

Pertaining to the thesis, study of macro-social determinants of health and disease, and of use of categories of human difference, is pursued through integration of intersectionality theory. The concept of embodiment will be picked up in additional future research.

Study II

In the study of risk for IHD in Sweden [30], the second logistic regression model (conventional social) confirmed the existence of social stratification of risk (Table 2a,b). Increased risk of IHD was shown along all categorizations; men and women with low income, who lived in single-person households, had lived in Sweden for 10 years or less and had been prescribed psychotropic medication ran a higher risk of IHD than people with high income who had not been prescribed psychotropic medicine, who cohabited and had lived in the country for more than 10 years. Compared to the group with high income, low income was associated with a substantial increase in risk; OR=1.69 for men (95% CI 1.65–1.73) and OR=2.19 for women (95% CI 2.11–2.28). Prescription of psychotropic medication also correlated with increased risk; OR=1.73 for men (95% CI 1.71–1.75) and OR=1.87 for women (95% CI 1.83–1.90).

The third model (intersectional) showed a further increase in risk for certain intersectional groups of social relationships, indicative of power dynamics adversely affecting some groups more than others (Table 3a,b). IHD risk was notably high for men with medium income who had been registered inhabitants of Sweden for 10 years or less and had been prescribed psychotropic medication, whether cohabiting (OR=4.03, 95% CI 3.25–5.01) or living in single-person households (OR=3.70, 95% CI 3.36–5.80), in comparison to cohabiting men with high income, who had lived in Sweden for a long time and who had not been prescribed psychotropic medication. Risk was also higher for groups of women with low income who had been registered inhabitants of Sweden for 10 years or less and who had been prescribed psychotropic medication, whether they were living in single-person households (OR=4.81, 95% CI 3.93–5.89) or cohabiting (OR=4.37, 95% CI 3.47–5.50). Further, IHD risk was markedly higher among women with medium income, who cohabited, had lived in Sweden for 10 years or less and had been prescribed psychotropic medication (OR=4.76, 95% CI 3.26–6.96), and among women with low income who had lived in Sweden for 10 years or more and had been prescribed psychotropic medication, whether cohabiting (OR=3.97, 95% CI 3.75–4.20) or living alone (OR=3.82, 95% CI 3.64–4.01). From a categorical perspective, operationalized through calculation of average, between-group risk, we can conclude that combined patterns of domination and subordination contribute towards unequal distribution of IHD incidence in the population, as some groups of social relations in Sweden carry risk burdens of substantially larger weight than others.

Table 2a. IHD risk for men (45–80 years)

Odds ratios (ORs) and 95% confidence intervals (CIs) quantifying the association between individual characteristics and risk for ischemic heart disease (IHD) in the 1.800.364 men aged 45–80 residing in Sweden in 2010.

Individual characteristics		Percentage of the population (number)	**Model 1** (age-only)	**Model 2** (conventional social)	Absolute risk
			OR (95% CI)	OR (95% CI)	
Age (years)	45–49	17.5 (315.055)	Ref.	Ref.	0.97%
	50–54	16.0 (287.535)	1.95 (1.86–2.04)	1.91 (1.83–2.00)	1.87%
	55–59	15.6 (281.519)	3.27 (3.13–3.40)	3.13 (3.00–3.27)	3.10%
	60–64	16.8 (302.211)	5.16 (4.96–5.37)	4.81 (4.63–5.01)	4.81%
	65–69	15.0 (269.531)	7.63 (7.34–7.93)	6.78 (6.52–7.05)	6.95%
	70–74	10.3 (185.368)	12.00 (11.55–12.47)	9.85 (9.47–10.24)	10.52%
	75–80	8.8 (159.145)	17.94 (17.27–18.64)	13.66 (13.14–14.21)	14.95%
Time in Sweden (years)	<=10	1.2 (21.225)		1.08 (1.00–1.16)	4.12%
	>10	98.8 (1.779.139)		Ref.	5.22%
Income	High	35.5 (638.471)		Ref.	2.81%
	Middle	36.6 (658.910)		1.35 (1.32–1.37)	5.64%
	Low	27.9 (502.983)		1.69 (1.65–1.73)	7.68%
Civil status	Single	41.7 (750.364)		1.16 (1.14–1.18)	4.89%
	Cohabiting	58.3 (1.050.000)		Ref.	5.43%
Psychotropic medication	No	74.8 (1.346.117)		Ref.	4.20%
	Yes	25.2 (454.247)		1.73 (1.71–1.75)	8.20%

Table 2b. IHD risk for women (45–80 years)

Odds ratios (ORs) and 95% confidence intervals (CIs) quantifying the association between individual characteristics and risk for ischemic heart disease (IHD) in the 1.845.489 women aged 45–80 residing in Sweden in 2010.

Individual characteristics		Percentage of the population (number)	**Model 1** (age-only)	**Model 2** (conventional social)	Absolute risk
			OR (95% CI)	OR (95% CI)	
Age (years)	45–49	16.5 (305.332)	Ref.	Ref.	0.38%
	50–54	15.3 (282.665)	1.82 (1.69–1.96)	1.74 (1.62–1.88)	0.69%
	55–59	15.2 (280.583)	2.97 (2.78–3.18)	2.72 (2.54–2.91)	1.11%
	60–64	16.5 (304.845)	4.90 (4.60–5.22)	4.25 (3.99–4.53)	1.82%
	65–69	14.8 (272.758)	8.09 (7.60–8.61)	6.43 (6.04–6.85)	2.98%
	70–74	10.9 (201.441)	14.43 (13.58–15.34)	10.29 (9.67–10.96)	5.19%
	75–80	10.7 (197.865)	24.35 (22.93–25.85)	15.83 (14.88–16.83)	8.46%
Time in Sweden (years)	<=10	1.2 (21.317)		1.11 (1.00–1.23)	1.83%
	>10	98.8 (1.824.172)		Ref.	2.56%
Income	High	30.8 (568.157)		Ref.	0.85%
	Medium	34.6 (638.234)		1.50 (1.44–1.55)	2.17%
	Low	34.6 (639.098)		2.19 (2.11–2.28)	4.44%
Civil status	Single	45.7 (843.838)		1.11 (1.08–1.13)	3.02%
	Cohabiting	54.3 (1.001.651)		Ref.	2.16%
Psychotropic medication	No	60.0 (1.106.956)		Ref.	1.68%
	Yes	40.0 (738.533)		1.87 (1.83–1.90)	3.85%

Table 3a. IHD risk for men (45–80 years), intersectional strata

Odds ratios (ORs), 95% confidence intervals (CIs) and absolute risk (AR) quantifying the association between intersectional strata and risk for ischemic heart disease (IHD) in the 1.800.364 men aged 45–80 residing in Sweden in 2010 (Model 3).

	Time in Sweden		Income			Civil status		Psychotropic medication				
	<=10 years	>10 years	High	Medium	Low	Cohabiting	Single	No	Yes	Percentage of the population (number)	OR (95% CI)	AR
1		🟩	🟩			🟩		🟩		23.7 (427.028)	Ref.	0.62%
2		🟩	🟩				🟩		🟩	1.2 (21.229)	1.53 (1.41–1.65)	3.54%
3		🟩	🟩				🟩	🟩		5.1 (91.374)	0.95 (0.90–1.01)	1.75%
4		🟩	🟩			🟩			🟩	5.3 (95.391)	1.69 (1.63–1.75)	4.98%
5		🟩		🟩			🟩	🟩		10.6 (191.166)	1.11 (1.07–1.15)	2.57%
6		🟩		🟩			🟩		🟩	3.1 (55.377)	1.90 (1.82–1.99)	4.90%
7		🟩		🟩		🟩		🟩		16.8 (302.580)	1.35 (1.31–1.38)	6.04%
8		🟩		🟩		🟩			🟩	5.8 (103.529)	2.34 (2.27–2.41)	10.67%
9		🟩			🟩		🟩	🟩		13.6 (244.149)	1.48 (1.43–1.51)	5.64%
10		🟩			🟩		🟩		🟩	7.8 (139.838)	2.51 (2.45–2.58)	9.04%
11		🟩			🟩	🟩		🟩		4.1 (74.467)	1.60 (1.55–1.66)	9.05%
12		🟩			🟩	🟩			🟩	1.8 (33.011)	2.83 (2.73–2.94)	14.88%
13	🟩		🟩				🟩	🟩		0.0 (371)	0.97 (0.40–2.36)	1.35%
14	🟩		🟩				🟩		🟩	0.0 (133)	2.07 (0.76–5.65)	3.01%
15	🟩		🟩			🟩		🟩		0.1 (2.308)	1.20 (0.88–1.65)	1.73%
16	🟩		🟩			🟩			🟩	0.0 (637)	3.20 (2.22–4.62)	4.87%
17	🟩			🟩			🟩	🟩		0.1 (951)	1.23 (0.76–1.99)	1.79%
18	🟩			🟩			🟩		🟩	0.0 (344)	3.70 (3.36–5.80)	6.10%
19	🟩			🟩		🟩		🟩		0.2 (3.570)	1.55 (1.25–1.92)	2.44%
20	🟩			🟩		🟩			🟩	0.1 (1.393)	4.03 (3.25–5.01)	6.60%
21	🟩				🟩		🟩	🟩		0.2 (3.683)	1.35 (1.12–1.63)	3.18%
22	🟩				🟩		🟩		🟩	0.1 (1.749)	3.40 (2.85–4.06)	8.00%
23	🟩				🟩	🟩		🟩		0.3 (4.470)	1.34 (1.15–1.56)	4.05%
24	🟩				🟩	🟩			🟩	0.1 (1.616)	2.97 (2.48–3.55)	8.66%

Table 3b. IHD risk for women (45–80 years), intersectional strata

Odds ratios (ORs), 95% confidence intervals (CIs) and absolute risk (AR) quantifying the association between intersectional groups and risk for ischemic heart disease (IHD) in the 1.845.489 women aged 45–80 residing in Sweden in 2010 (Model 3).

	Time in Sweden		Income			Civil status		Psychotropic medication				
	<=10 years	>10 years	High	Medium	Low	Cohabiting	Single	No	Yes	Percentage of the population (number)	OR (95% CI)	AR
1		🟩	🟩			🟩		🟩		17.8 (328.368)	Ref.	0.62%
2		🟩	🟩				🟩		🟩	1.6 (28.773)	1.97 (1.77–2.20)	1.33%
3		🟩	🟩				🟩	🟩		3.5 (63.648)	1.12 (1.00–1.26)	0.54%
4		🟩	🟩			🟩			🟩	7.8 (144.304)	1.92 (1.81–2.05)	1.41%
5		🟩		🟩			🟩	🟩		7.9 (145.569)	1.31 (1.22–1.41)	0.89%
6		🟩		🟩			🟩		🟩	4.8 (89.374)	2.31 (2.16–2.47)	1.79%
7		🟩		🟩		🟩		🟩		13.1 (241.214)	1.60 (1.51–1.68)	1.99%
8		🟩		🟩		🟩			🟩	8.5 (156.453)	2.95 (2.80–3.11)	3.91%
9		🟩			🟩		🟩	🟩		13.5 (248.206)	2.02 (1.92–2.13)	2.93%
10		🟩			🟩		🟩		🟩	14.1 (259.557)	3.82 (3.64–4.01)	5.54%
11		🟩			🟩	🟩		🟩		3.6 (66.891)	2.25 (2.12–2.39)	4.07%
12		🟩			🟩	🟩			🟩	2.8 (51.815)	3.97 (3.75–4.20)	7.12%
13	🟩		🟩				🟩	🟩		0.0 (223)	1.56 (0.22–11.14)	0.45%
14	🟩		🟩				🟩		🟩	0.0 (132)	-	0.00%
15	🟩		🟩			🟩		🟩		0.1 (1.899)	1.55 (0.83–2.90)	0.53%
16	🟩		🟩			🟩			🟩	0.0 (810)	2.40 (1.14–5.07)	0.86%
17	🟩			🟩			🟩	🟩		0.1 (858)	0.65 (0.16–2.61)	0.23%
18	🟩			🟩			🟩		🟩	0.0 (647)	3.10 (1.53–6.25)	1.24%
19	🟩			🟩		🟩		🟩		0.1 (2.645)	1.24 (0.70–2.19)	0.45%
20	🟩			🟩		🟩			🟩	0.1 (1.474)	4.76 (3.26–6.96)	1.90%
21	🟩				🟩		🟩	🟩		0.2 (3.804)	2.45 (1.92–3.13)	1.81%
22	🟩				🟩		🟩		🟩	0.2 (3.047)	4.81 (3.93–5.89)	3.48%
23	🟩				🟩	🟩		🟩		0.2 (3.631)	2.16 (1.69–2.77)	1.85%
24	🟩				🟩	🟩			🟩	0.1 (2.417)	4.37 (3.47–5.50)	3.77%

Despite these substantial differences in average risk, however, the DA of the explanatory variables was quite low (Table 4; Fig. 4). While the overall AUC was relatively high, 0.743 for men and 0.779 for women, it was almost entirely accounted for by age alone. The AUC for Model 1 (age only) was 0.725 for men (95% CI 0.723–0.727) and 0.755 for women (95% CI 0.753–0.757). When social categories were included, in Model 2 (conventional social), AUC increased only slightly (+0.016 for men and +0.022 for women). The further DA added in Model 3 (intersectional), in comparison to Model 2 (conventional social), was small (+0.002 for men and +0.002 for women). The incremental value of social categories used in the second and third models was thus limited, in terms of increased DA. Compared with predictions solely based on age, then, none of the social variables or intersectional groupings, based on income, time in Sweden, civil status or psychological ill-health, gave large contributions to assessment of individual risk of IHD in men or women, compared with prediction only based on age.

We finally sought to de-emphasize the relevance of age, which is a major determinant of IHD, by making age-stratified analyses (45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–80 years) (Table 4). Here, the influence of age on AUC was expected to decrease, as age-related differences in risk were calculated within 5- or 6-year intervals instead of along the entire 45–80 year spectrum. As assumed, the AUC of Model 1 (age only) was very low (i.e., between 0.531 and 0.569), while the incremental value of Model 2 (conventional social) was higher than in the previous models where age was included as a categorical (Model 1 (age only), Model 2 (conventional social)) or continuous (Model 3 (intersectional)) variable. In this age-stratified analysis AUC increased with between 0.04 and 0.11 units. Model 3 (intersectional) yielded very minor increment, however, as AUC increased with between 0.00 and + 0.07 units. That is to say, while age is a strong determinant of IHD in the general population, age-stratified analysis reveals that conventional social characteristics (income, time in Sweden, civil status) and psychological health improve prediction of IHD incidence. As in the previous non-stratified analysis, the major part of the AUC increment pertained to conventional social categorization, as the DA added by the intersectional groupings was minor, despite substantially higher ORs calculated for some intersectional groupings (Model 3), as compared to the size of the ORs for conventional social categorizations (Model 2). From an anti-categorical perspective, operationalized through the measurement of DA, we can conclude that the intersectional groups of social relationships under study appear to be of limited relevance for the assessment of individual risk for IHD in Sweden.

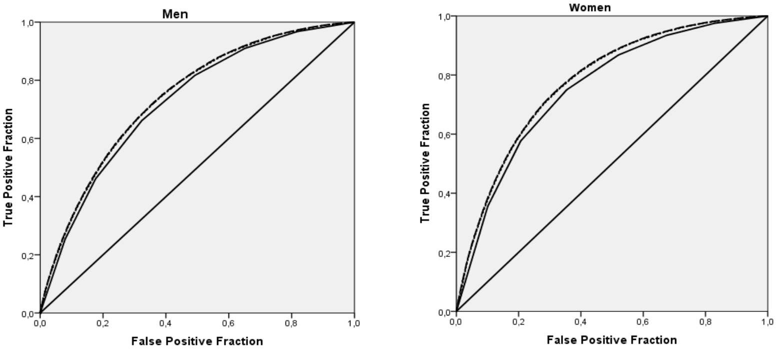
Table 4. DA of IHD risk models: AUC

Area under the receiver-operating characteristic curve (AUC) with 95% confidence intervals (CIs) and increments (Δ), using Model 1 (age-only) as reference, for the 3,645,853 men and women aged 45–80 residing in Sweden in 2010. The AUC is computed for the whole population (overall) and for age strata.

		Model 1 (age-only)	**Model 2** (conventional social)		**Model 3** (intersectional)	
		AUC (95% CI)	AUC (95% CI)	Δ	AUC (95% CI)	Δ
	Overall	**0.725 (0.723–0.727)**	**0.741 (0.740–0.743)**	**0.016**	**0.743 (0.742–0.745)**	**0.018**
Males	45–49	0.569 (0.559–0.579)	0.646 (0.636–0.656)	0.077	0.649 (0.639–0.659)	0.080
	50–54	0.547 (0.540–0.555)	0.617 (0.610–0.625)	0.070	0.620 (0.612–0.628)	0.073
	55–59	0.539 (0.533–0.545)	0.611 (0.605–0.617)	0.072	0.613 (0.606–0.619)	0.074
	60–64	0.531 (0.526–0.536)	0.596 (0.591–0.601)	0.065	0.597 (0.592–0.601)	0.066
	65–69	0.540 (0.535–0.544)	0.594 (0.590–0.598)	0.054	0.594 (0.590–0.599)	0.054
	70–74	0.533 (0.528–0.537)	0.585 (0.581–0.590)	0.052	0.586 (0.581–0.590)	0.053
	75–80	0.538(0.534–0.542)	0.579 (0.575–0.583)	0.041	0.580 (0.576–0.584)	0.042
	Overall	**0.755 (0.753–0.757)**	**0.777 (0.775–0.778)**	**0.022**	**0.779 (0.777–0.781)**	**0.024**
Females	45–49	0.553 (0.537–0.570)	0.664 (0.648–0.680)	0.111	0.671 (0.655–0.687)	0.118
	50–54	0.548 (0.535–0.560)	0.660 (0.648–0.673)	0.112	0.664 (0.652–0.677)	0.116
	55–59	0.544 (0.534–0.555)	0.653 (0.644–0.663)	0.109	0.655 (0.645–0.664)	0.111
	60–64	0.545 (0.537–0.552)	0.640 (0.632–0.647)	0.095	0.641 (0.634–0.648)	0.096
	65–69	0.550 (0.544–0.556)	0.632 (0.626–0.638)	0.085	0.633 (0.627–0.639)	0.086
	70–74	0.537 (0.531–0.542)	0.606 (0.600–0.611)	0.069	0.606 (0.601–0.612)	0.069
	75–80	0.541 (0.537–0.546)	0.593 (0.588–0.597)	0.052	0.593 (0.589–0.598)	0.052

Figure 4: DA of IHD risk models: ROC

The diagonal reference line illustrates the receiver-operating characteristic (ROC) curve for a risk factor that is, in principle, useless for prediction and corresponds with an area under the receiver-operating characteristic curve (AUC) equal to 0.5. The solid black line represents the ROC curve for Model 1, i.e., for prediction of IHD based only on age. The corresponding AUC equals 0.725 for men 0.755 for women. The dotted line illustrates the ROC curve for Model 2, i.e., for prediction of IHD based on age as well as income, time in Sweden, civil status and psychological health as separate variables. The corresponding AUC equals 0.741 for men and 0.777 for women. The dashed line shows the ROC curve for Model 3, i.e., for age and intersectional groups of social relationships. The corresponding AUC equals 0.743 for men and 0.779 in women. The two latter lines overlap.



Study III

Study III [33], which is a response to a commentary [29] on Study II, proposes a research framework of multilevel analysis of individual heterogeneity (MAIH) [3] informed by intersectionality theory. Arguments put forth in the article are considered in the Background and Discussion sections.

Study IV

The study of influenza vaccination uptake in the US [31] found the overall non-receipt of seasonal influenza vaccine to be 53.3%, in the sample. According to the raw data, and as can be seen in Table 5, coverage was higher for individuals identified as non-Hispanic White, compared to each of the other racial/ethnic groups, as well as in women compared to men. Our results thereby confirm previous findings that adult seasonal influenza vaccination coverage is higher among non-Hispanic White adults than among non-Hispanic Black adults or Hispanic adults [160-162, 167]. Vaccination coverage also generally increased with increasing age, household income, and educational level.

The analyses revealed that, compared to the non-Hispanic White group, rates of non-vaccination receipt were significantly higher among non-Hispanic Blacks (OR=1.72, CI 95% 1.52–1.94), Hispanics (OR=1.88, CI 95% 1.63–2.17), and people self-identified as being of other or multiple races (OR=1.19, CI 95% 1.04–1.37) (Table 6). The associations remained conclusive for non-Hispanic Blacks and Hispanics after adjustment for age, but the strength of the associations decreased for both groups and especially for Hispanics (OR=1.35, CI 95% 1.18–1.56). Additional adjustment for educational level and household poverty status further weakened associations but they remained statistically conclusive (Table 6). Moreover, men had a higher rate of non-receipt of seasonal influenza vaccine than women, and there were conclusive differences across age groups, as well as across household poverty and educational level categories (Table 6).

The eight intersectional subgroups, consisting of combinations of the race/ethnicity and gender variables, showed that in comparison to non-Hispanic White women, all other subgroups except women identified as being of ‘other or multiple races’ had higher rates of non-vaccination receipt (Table 7). However, ORs were similar for non-Hispanic White men (OR=1.20, CI 95% 1.11–1.30) and Hispanic women (OR=1.41, CI 95% 1.19–1.67), which shows that the risk of non-vaccination receipt is heterogeneously distributed within and between racial/ethnic categories. Combining race/ethnicity, gender, and education variables to create 40 different intersectional subgroups resulted in an even more complex picture: we observed substantial heterogeneity of effects within and between groups defined by race/ethnicity (Table 7).

Table 5. Influenza vaccination uptake: Characteristics of sample

	Total (n)	Total (%)	Non-receipt of seasonal influenza vaccine (%)
All	56.434	100	53.3
Racial/ethnic category			
Non-Hispanic White	44.909	79.6	51.0
Non-Hispanic Black	4.553	8.1	63.5
Hispanic	3.651	6.5	66.7
Non-Hispanic, other or multiple races	3.321	5.9	57.0
Gender			
Female	33.458	59.3	50.5
Male	22.976	40.7	57.5
Age			
18–34	11.022	19.5	71.0
35–44	8.244	14.6	63.6
45–54	11.077	19.6	60.3
55–64	11.699	20.7	48.8
>=65	14.392	25.5	32.3
Education			
College graduate	21.390	37.9	48.6
Some college	14.882	26.4	54.9
12 years	12.164	21.6	54.7
<12 years	5.020	8.9	60.3
Missing or unknown	2.978	5.3	62.2
Poverty status of household			
>=$75,000	14.398	25.5	49.9
<$75,000, above poverty threshold	26.994	47.8	52.1
Below poverty threshold	5.587	9.9	64.5
Missing or unknown	9.455	16.8	55.5

Table 6. Influenza vaccination uptake and social categorizations

Odds ratios (ORs) and 95% confidence intervals (CIs) quantifying the association between social categories and non-receipt of seasonal influenza vaccination, in the sample of 56.656 US adults.

	Unadjusted		Age-adjusted		Adjusted for age, educational level and household poverty status	
	OR	CI 95%	OR	CI 95%	OR	CI 95%
Racial/ethnic category						
Non-Hispanic White	1		1		1	
Non-Hispanic Black	1.72	1.52–1.94	1.57	1.38–1.78	1.40	1.23–1.60
Hispanic	1.88	1.63–2.17	1.35	1.18–1.56	1.18	1.02–1.36
Non-Hispanic, other or multiple races	1.19	1.04–1.37	0.97	0.84–1.13	0.93	0.80–1.08
Gender						
Female	1		1		1	
Male	1.27	1.19–1.35	1.19	1.11–1.27	1.23	1.14–1.32
Age						
18–34	4.98	4.48–5.54				
35–44	3.24	3.45–4.04				
45–54	3.14	2.84–3.47				
55–64	1.92	1.74–2.16				
>=65	1					
Education						
College graduate	1		1			
Some college	1.24	1.14–1.34	1.25	1.15–1.37		
12 years	1.29	1.18–1.41	1.48	1.35–1.63		
<12 years	1.60	1.41–1.80	1.92	1.69–2.18		
Missing or unknown	1.81	1.56–2.10	1.60	1.37–1.87		
Poverty status of household						
>=$75,000	1		1			
<$75,000, above poverty threshold	1.12	1.04–1.22	1.43	1.32–1.56		
Below poverty threshold	1.73	1.53–1.96	1.86	1.64–2.10		
Missing or unknown	1.31	1.18–1.45	1.76	1.58–1.96		

Table 7. Influenza vaccination uptake and intersectional subgroups
Odds ratios (ORs) and 95% confidence intervals (CIs) quantifying age-adjusted measures of association between intersectional subgroups and non-receipt of seasonal influenza vaccine, in the sample of 56.656 US adults.

				Educational level									
				College Graduate		Some college		12 years		<12 years		Missing or unknown	
Racial/ ethnic category	**Gender**	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Non-Hispanic White	*Female*	1		1		1.22	1.08–1.37	1.36	1.19–1.56	1.81	1.47–2.22	1.99	1.57–2.53
	Male	1.20	1.11–1.30	1.14	1.01–1.29	1.62	1.38–1.88	1.87	1.60–2.19	2.07	1.60–2.69	1.58	1.23–2.02
Non-Hispanic Black	*Female*	1.64	1.41–1.91	1.43	1.07–1.94	2.00	1.55–2.57	2.14	1.58–2.90	3.34	2.38–4.69	1.58	0.76–3.32
	Male	1.79	1.43–2.26	2.70	1.88–3.87	1.26	0.78–2.04	2.65	1.87–3.76	3.58	2.24–5.72	1.84	0.89–3.81
Hispanic	*Female*	1.41	1.19–1.67	1.57	1.11–2.22	1.38	0.97–1.86	2.47	1.69–3.62	1.68	1.23–2.29	1.75	0.99–3.10
	Male	1.53	1.21–1.93	0.89	0.54–1.49	1.68	1.01–2.78	2.92	2.00–4.26	2.50	1.77–3.54	2.82	1.56–5.10
Non-Hispanic, other or multiple races	*Female*	0.91	0.74–1.12	1.14	0.83–1.55	0.98	0.66–1.45	1.12	0.67–1.90	1.55	0.87–2.77	0.81	0.33–1.94
	Male	1.26	1.03–1.55	1.31	0.95–1.82	1.52	1.00–2.32	1.45	0.96–2.18	3.32	1.71–6.44	1.65	0.91–3.02

Table 8. DA of vaccination uptake models: AUC
Area under the receiver-operating characteristic curve (AUC) evaluating the DA of different models for non-receipt of seasonal influenza vaccine, in the sample of 56.656 US adults. The grey shading indicates which variables are included in Models 1–9. For example, Model 1 only included the variable age.

Variables in model	Model No.								
NHFS original variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Age	▨	▨	▨	▨	▨	▨	▨	▨	▨
Racial/ethnic category		▨		▨		▨	▨		
Gender			▨	▨			▨		
Education					▨	▨	▨		
Poverty status of household					▨	▨	▨		▨
Intersectional variables									
Racial/ethnic category stratified by gender								▨	
Racial/ethnic category stratified by gender and education									▨
AUC[1]	0.658	0.663	0.664	0.668	0.678	0.679	0.681	0.669	0.682
ΔAUC	Ref.	0.005	0.006	0.010	0.020	0.021	0.023	0.011	0.024

[1] 95% confidence intervals are ± 0.005 or 0.004

Despite these statistically significant associations, the DA of the categories studied was very low. Table 8 shows the AUCs of models that included age alone or age together with one or more of the explanatory variables. The AUC for age alone was 0.658 (Model 1) and it increased only slightly (+0.005) when information on race/ethnicity was included (Model 2). Similarly, information on gender did little to improve the DA above the model that included age (+0.006) (Model 3) or age and race (+0.004) (Model 4, compared to Model 2). Household poverty status and educational level were the most informative variables beyond age (each +0.014, not shown), but the model including age, household poverty status, and educational level still reached only an AUC=0.678 (+0.020) (Model 5). Notably, including race/ethnicity only added +0.001 (Model 6), which is consistent with a strong relationship between class and race/ethnicity. We observed the highest DA (AUC=0.681) for the model that included all explanatory variables (Model 7). However, this higher DA compared to the model including age only (+0.022) was primarily due to the socioeconomic variables. In the final analysis, we tested whether the composite intersectional variables improved the DA compared with the models where the race and ethnicity, gender and educational level variables were kept separate. The use of intersectional sub-groupings were found to do little to further improve DA (Models 4 vs. 8 and 7 vs. 9).

Study V

Use of CAM

The study of CAM use [36, 202] found that 71% of the respondents (78% of the women, 64% of the men) reported having used some form of CAM in the past year. Total CAM use here includes visits to CAM providers, the use of natural remedies such as nutritional supplements or herbal medicine, and the use of self-help methods such as yoga and breathing exercises (Table 9). This category of total CAM use does not include complementary forms of treatment given within conventional health care or through referral.

The most common types of CAM, reportedly used in the last year by 53% of the population sample, were natural remedies including herbal medicines and nutritional supplements. When nutritional supplements (such as vitamins, minerals, and oils) were excluded from the total CAM use, the user percentage decreased from 71% to 61% (70% among the women, 52% among the men).

Table 9. Types of CAM use

	Total % (n) (n=1.534)	Women % (n) (n=767)	Men % (n) (n=765)
Total CAM	71.0 (1.089)	78.1 (599)	63.9 (489)
Visits to CAM providers	32.9 (505)	36.9 (283)	28.9 (221)
Use of natural remedies	53.0 (813)	58.9 (452)	47.1 (360)
Use of self-help methods	31.7 (486)	42.8 (328)	20.5 (157)
Total CAM excl. nutritional supplements	60.6 (930)	69.5 (533)	51.8 (396)

CAM providers had been consulted by 33% of the respondents (37% of the women, 29% of the men) (Table 10). The large majority (53% of the mentioned 33%) of treatments consisted of massage, followed by chiropractic (17%), naprapathy (11%), acupuncture (6%), healing (3%), osteopathy (2%), reflexology (2%), homeopathy (1%), and other (7%). Massage was used frequently by both men (52%) and women (53%). More men visited chiropractors, while a larger share of women turned to healing and methods categorized as 'other'.

Natural remedies, herbal medicines, or nutritional supplements were, as mentioned, used by 53% of the respondents (59% of the women, 47% of the men) (Table 9). Of this consumption, 69% referred to nutritional supplements, while herbal medicine accounted for 25%, and other natural remedies for 6%.

Self-help methods were used by 32% of the respondents (43% of the women, 21% of the men) (Table 9). Breathing exercises (26%), yoga (20%), and relaxation exercises (17%) were most common. More men used meditation, while yoga was more frequently practiced among women.

A majority of the survey respondents (70%) reported the use of both CAM and conventional medicine. 1.4% of the sample reported the sole use of CAM.

Table 10. Types of CAM use: Subcategories

CAM providers	Total % (n) (n=505)[a]	Women % (n) (n=283)	Men % (n) (n=221)
Massage	52.5 (265)	52.7 (149)	52.0 (115)
Chiropractic	17.0 (86)	14.5 (41)	20.4 (45)
Naprapathy	11.3 (57)	11.0 (31)	11.8 (26)
Osteopathy	1.8 (9)	1.4 (4)	2.3 (5)
Acupuncture	5.5 (28)	6.0 (17)	5.0 (11)
Homeopathy	1.2 (6)	0.7 (2)	1.8 (4)
Reflexology	1.6 (8)	1.4 (4)	1.8 (4)
Healing	2.6 (13)	3.9 (11)	0.9 (2)
Other	6.5 (33)	8.5 (24)	4.1 (9)
Natural remedies	Total % (n) (n=813)[b]	Women % (n) (n=452)	Men % (n) (n=360)
Nutrition suppl.	68.5 (557)	67.5 (305)	69.7 (251)
Herbal medicine	25.3 (206)	26.1 (118)	24.4 (88)
Other remedies	6.2 (50)	6.4 (29)	5.8 (21)
Self-help practices	Total % (n) (n=485)[c]	Women % (n) (n=328)	Men % (n) (n=157)
Meditation	3.9 (19)	1.8 (6)	8.3 (13)
Yoga	20.2 (98)	23.2 (76)	13.4 (21)
Qi Gong/Tai Qi	1.6 (8)	2.4 (8)	0 (0)
Relaxation	16.5 (80)	14.3 (47)	21.0 (33)
Breathing exercises	26.3 (128)	29.0 (95)	21.0 (33)
Visualization	7.8 (38)	6.7 (22)	10.2 (16)
Prayer	7.6 (37)	6.7 (22)	9.6 (15)
Other	16.0 (78)	15.9 (52)	16.6 (26)

[a] Respondents who report visits to CAM providers, i.e., 33% of the study population.; [b] Respondents who report use of natural remedies, i.e., 53% of the study population.; [c] Respondents who report use of self-help practice, i.e., 32% of the study population.

Use of conventional medicine

Conventional medicine, reportedly used by 98% of the respondents (98% of the women, 97% of the men), here includes visits to conventional health care providers and the use of pharmaceutical drugs.

Of the respondents, 88% (90% of the women, 86% of the men) had seen a conventional health care provider in the last year. These include medical doctors, nurses, physiotherapists, psychologists, psychoanalysts, and dentists. Dentists were the most commonly visited type of providers. If this often routinely consulted provider is excluded, the level of use decreased to 31% (32% among the women, 29% among the men).

Pharmaceutical drugs were used by 91% of the population (94% of the women, 89% of the men) in the last year.

While 70% of the respondents, as mentioned in 'Use of CAM', reported the use of conventional medicine and CAM, 28% said they had used only conventional medicine.

Complementary treatment received within or via conventional health care

A total of 8% of the respondents (10% of the women, 6% of the men) reported having received some form of complementary treatment within a conventional health care setting or through referral. Types of treatment included acupuncture (22%), massage (21%), mindfulness (15%), chiropractic (5%), naprapathy (4%), natural remedies (2%), and others (32%). More women than men received acupuncture, while more men had treatment categorized as 'other'.

The relatively large share of reported treatments defined as 'other' suggests that the questionnaire, despite the validation process, did not cover the full range of complementary treatments available within conventional health care or through referral.

Gender, age, education, income, and social status

The self-reported information on the level of education, self-rated social status [263] and civil status of the respondents, along with information on age and gender gathered from their background data, can be seen in Table 11.

Table 11. Characteristics of CAM and conventional health care users

	CAM total[a] % (n)	MED total[b] % (n)	CAM only[c] % (n)	MED only[d] % (n)	CAM+MED[e] % (n)	No usage[f] % (n)
Total (n=1.534)	71.0 (1.089)	97.5 (1.495)	1.4 (21)	27.8 (427)	69.6 (1.068)	1.2 (18)
Women	55.0 (599)	50.3 (751)	42.9 (9)	37.8 (161)	55.3 (590)	38.9 (7)
Men	44.9 (489)	49.7 (742)	57.1 (12)	62.2 (265)	44.7 (477)	61.1 (11)
18–39 years	33.3 (363)	30.0 (448)	38.1 (8)	21.8 (93)	33.2 (355)	33.3 (6)
40–64 years	51.3 (559)	51.0 (763)	52.4 (11)	50.4 (215)	51.3 (548)	53.0 (9)
65–79 years	15.3 (167)	19.0 (284)	9.5 (2)	27.9 (119)	15.4 (165)	16.7 (3)
Basic education	5.5 (60)	6.5 (97)	9.5 (2)	9.1 (39)	5.4 (58)	25.0 (4)
Secondary education	33.3 (363)	34.4 (515)	42.9 (9)	37.7 (161)	33.1 (354)	43.8 (7)
Tertiary education	61.2 (666)	59.1 (883)	47.6 (10)	33.1 (354)	61.4 (656)	31.3 (5)
Low social status	35.3 (384)	8.5 (127)	14.3 (3)	9.8 (42)	8.0 (85)	0 (0)
Medium social status	48.3 (526)	75.0 (1.121)	72.2 (16)	73.8 (315)	75.5 (806)	66.7 (12)
High social status	15.5 (169)	15.4 (230)	9.5 (2)	14.8 (63)	15.6 (167)	33.3 (5)
Cohabiting	67.7 (737)	70.1 (1.030)	52.4 (11)	71.6 (303)	69.4 (727)	66.7 (10)
Living alone	30.4 (331)	29.9 (440)	47.6 (10)	28.4 (120)	30.6 (320)	33.3 (5)

[a]Respondents reporting visits to CAM providers, use of natural remedies, and/or use of self-help methods; [b]Respondents reporting visits to conventional health care providers and/or use of pharmaceutical drugs; [c]Respondents reporting use of CAM (visits to CAM providers, use of natural remedies, and/or use of self-help methods) and no use of conventional medicine; [d]Respondents reporting use of conventional health care (visits to conventional health care providers and/or use of pharmaceutical drugs) and no use of CAM; [e]Respondents reporting use of CAM and conventional medicine; [f]Respondents reporting no use of CAM or conventional medicine.

Logistic regression showed a higher prevalence of CAM use among women (OR=1.87, 95% CI 1.48–2.37), younger age groups (18–39 years and 40–64 years) (OR=2.33, 95% CI 1.66–3.26 and OR=1.68, 95% CI 1.26–2.25), and people with tertiary education (OR=1.29, 95% CI 1.01–1.65). No statistically significant association was found between CAM use and categories of social or civil status. The references used in the regressions were males, belonging to the oldest age group (65–75 years), living alone, with less than tertiary education, and low social status, respectively (Table 12).

The corresponding analysis of conventional medicine use showed no clear association with any of the mentioned factors (Table 12).

This analysis does not include users of complementary medicine in conventional health care settings or through referral.

Table 12. Associations between population characteristics and use of CAM and conventional medicine

Odds ratios (ORs) and 95% confidence intervals (CIs) expressing associations between CAM and conventional health care (MED) use and gender, age, education, social status, and civil status.

	CAM (total)[a]			MED (total)[b]	
	OR	95% CI		OR	95% CI
Women	1.87	(1.48–2.37)		1.49	(0.74–3.00)
Medium age[c]	2.33	(1.66–3.26)		0.52	(0.16–1.66)
Young age[d]	1.68	(1.26–2.25)		0.54	(0.18–1.62)
Tertiary education	1.29	(1.01–1.65)		2.00	(0.98–4.10)
High social status	1.03	(0.96–1.11)		0.94	(0.76–1.17)
Living alone	0.95	(0.73–1.24)		1.95	(0.96–3.93)

[a]Respondents reporting visits to CAM providers, use of natural remedies and/or use of self-help methods: [b]Respondents reporting visits to conventional health care providers and/or use of pharmaceutical drugs; [c]Age 40–64 years, compared to 65–79 years; [d]Age 18–39 years, compared to 65–79 years.

Health status

Respondents were asked about their self-rated health, any long-term health problems or injuries, experiences of everyday stress, exercise habits, and their following of any particular diet. The questions on long-term health problems and diet were of a yes/no character. The others were multiple-choice questions, responses to which were later dichotomized into yes/no or good/bad.

CAM consumption was associated with high levels of experienced stress (OR=1.64, 95% CI 1.16–2.32) and long-term health problems (OR=1.35, 95% CI 1.05–1.73), but not with bad self-rated health. Associations were also found with good exercise habits (OR=1.61, 95% CI 1.28–2.02) and the following of particular diets (OR=1.67, 95% CI 1.18–2.34). The references used in the regressions were persons with good self-rated health and no long-term health problems who experienced lower levels of stress, exercised less and did not follow a particular diet, respectively. The association between CAM use and exercise and adherence to a particular diets may suggest that CAM consumption correlates with an interest in lifestyle issues or health-promoting behavior.

Conventional medicine usage was strongly associated with long-term health problems (OR=7.26, 95% CI 2.12–24.86), but not with any of the other factors (Table 13).

This analysis does not include use of complementary medicine in conventional health care settings or through referral.

Table 13. Associations between health condition and use of CAM and conventional medicine

Odds ratios (ORs) and 95% confidence intervals (CIs) expressing associations between CAM and conventional health care (MED) use and health condition.

	CAM (total)[a]			MED (total)[b]	
	OR	95% CI		OR	95% CI
Bad self-rated health	1.10	(0.86–1.41)		0.90	(0.39–2.08)
Long-term health problems	1.35	(1.05–1.73)		7.26	(2.12–24.86)
High level of stress	1.64	(1.16–2.32)		1.87	(0.56–6.27)
Regular exercise	1.61	(1.28–2.02)		1.03	(0.52–2.04)
Following a diet	1.67	(1.18–2.34)		0.56	(0.25–1.26)

[a] Respondents reporting visits to CAM providers, use of natural remedies, and/or use of self-help methods

[b] Respondents reporting visits to conventional health care providers and/or use of pharmaceutical drugs

Purpose of health care use

In relation to each reported type of health care used, except for natural remedies and pharmaceutical drugs, the respondents were asked whether the purpose was treatment, disease prevention, diagnosis, well-being or other (Table 14). CAM providers were most commonly consulted for well-being (49%), treatment (35%), and prevention (22%). Visits to conventional caregivers, in turn, had the main purposes of diagnosis (68%), treatment (51%), and prevention (23%). When the category of dentists was excluded, the visits to conventional care for purposes of prevention dropped to 0%. Complementary care sought in or via a conventional medical setting had the purposes of treatment (57%), prevention (16%), and well-being (15%). Self-help methods, finally, were used for the purposes of well-being (75%), prevention (17%), and treatment (14%).

In summary, then, reported visits to CAM providers largely aimed at prevention and well-being, but also at disease treatment. Conventional medicine was primarily consulted for diagnosis and treatment. The larger emphasis on prevention found in reported CAM use supports the question of which role CAM plays, or might play, in actual disease prevention.

Table 14. Purpose of use of CAM and conventional medicine
Self-assessed purpose of CAM and conventional health care (MED) use

	Treatment % (n)	Prevention % (n)	Diagnosis % (n)	Well-being % (n)	Other % (n)
Visits to CAM providers	35.2 (178)	21.8 (110)	3.4 (17)	49.1 (248)	2.6 (13)
Visits to MED providers	50.7 (685)	23.1 (312)	68.1 (920)	9.9 (134)	9.1 (123)
Visits to MED excl. dentist	56.6 (267)	0 (0)	46.8 (221)	7.8 (37)	11.9 (56)
CAM in/via MED	56.1 (69)	16.3 (20)	6.5 (8)	14.6 (18)	7.3 (9)
Self-help methods	14.2 (69)	16.5 (80)	0.2 (1)	75.1 (365)	5.8 (28)

Perceived degree of helpfulness

The respondents were further asked about the perceived degree of helpfulness of each type of health care used, except for natural remedies and pharmaceutical drugs (Table 15). The types of health care most commonly rated as very helpful were visits to CAM providers (70%), followed by visits to conventional caregivers (61%), complementary care in or via a conventional setting (50%), conventional care excluding dentistry (49%), and self-help methods (29%).

Table 15. Perceived helpfulness of use of CAM and conventional medicine

Self-assessed degree of helpfulness of CAM and conventional health care (MED) use

	Very helpful % (n)	Helpful % (n)	Slightly helpful % (n)	Possibly helpful % (n)	Not helpful % (n)
Visits to CAM providers	69.9 (353)	27.7 (140)	5.1 (26)	1.6 (8)	1.0 (5)
Visits to MED providers	60.7 (819)	42.4 (572)	7.6 (103)	3.4 (46)	1.6 (22)
Visits to MED excl. dentist	48.7 (230)	31.8 (150)	8.3 (39)	4.2 (20)	1.5 (7)
CAM in/via MED	50.4 (62)	30.9 (38)	14.6 (18)	4.9 (6)	3.3 (4)
Self-help methods	29.0 (141)	48.6 (236)	26.3 (128)	14.6 (71)	3.7 (18)

Matters of opinion

Asked about the levels of trust, 59% of the respondents expressed confidence in CAM while 90% reported confidence in conventional medicine. While both genders expressed trust in conventional medicine, the level of trust in CAM was higher among the women (68%) than among the men (50%).

Regarding cooperation between conventional health care and CAM, a majority of the respondents (69%, 76% of the women and 63% of the men) expressed the opinion that it should increase, while 6% of the women and 15% of the men stated that collaboration should remain the same or decrease. 21% of the men and 18% of the women responded that they did not know.

Finally, the survey posed questions about opinions on background factors for disease and about attentiveness to studies and/or media reports on health risks. The data offer a very limited basis for comparison between types of health care users, due to the size of the population sample and the large and overlapping groups of health care users (CAM 71%, conventional medicine 98%, CAM and conventional medicine 70%). A minor tendency towards higher evaluation of the influence of an individual's own actions and lifestyle as well as of economic, social and political societal conditions on health can be seen among CAM users, as compared to users of conventional medicine. A small tendency towards a higher evaluation of one's own attentiveness towards studies and media reports on health risks, and of attempts towards changing one's own lifestyle accordingly, also appears among CAM users.

6. Conclusions and Discussion

Conclusions

Study I

Critical discussion on epidemiological knowledge production has, since the 1990s, called for further integration of social structures and relationships, reflection on handling of population categories, and inclusion of explicit social theory in epidemiological study. Intersectionality theory can contribute toward the fulfilling of such needs, based on its focus on population categories and their relationship to macro- and meso-level social structures of power [25].

Study II

The study of risk for IHD in Sweden [30] replicates and corroborates previous studies of social stratification of risk for IHD, confirming the existence of health inequities along all social and psychosocial categorizations used. A logistic regression model informed by categorical intersectionality showed further disparities in distribution of risk between intersectional strata or groups of relationships. From a categorical perspective, operationalized through calculation of average, between-group risk, we can conclude that combined patterns of domination and subordination contribute towards an unequal distribution of IHD incidence in the population. Measurement of AUC, made to establish whether the intersectional groupings lead to improvement of predictive validity, however, found DA to be low. While the overall AUC was relatively high, it was almost entirely accounted for by age. From an anti-categorical perspective, operationalized through measurement of DA, we can conclude that the intersectional groups of social relationships under study appear to be of limited relevance for assessment of individual risk for IHD in Sweden.

Study III

Study III [33] proposes a research framework of multilevel analysis of individual heterogeneity (MAIH) informed by intersectionality theory.

Study IV

The study on adult seasonal influenza vaccination uptake in the US [31] confirms that vaccination coverage is stronger among non-Hispanic White adults than among non-Hispanic Black adults or Hispanic adults. Stratification of racial/ethnic groups by gender and education, made in accordance with a categorical intersectionality perspective, revealed substantial outcome heterogeneity, however, as vaccination non-receipt was heterogeneously distributed within and between racial/ethnic categories. Furthermore, the DA of the categories studied was very low, and race/ethnicity only added a slight increase in AUC. In alignment with an anti-categorical perspective, the article therefore calls into question the use of racial/ethnic categories for prediction of vaccination uptake.

Study V

The CAM prevalence study [36] found that 71% of the survey respondents reported having used some form of CAM in the past year. CAM use was more common among women, in younger age groups, and among people with tertiary education. It was associated with high levels of experienced stress and long-term health problems and injuries, as well as with good exercise habits and adherence to particular diets. The stated purposes of CAM use were well-being and prevention and treatment of disease, and users reported having experienced a high level of helpfulness. The respondents expressed a lower level of trust in CAM than in conventional medicine. Nonetheless, the majority stated that cooperation between CAM and conventional medicine should increase.

Discussion

This thesis contributes to the integration of intersectionality perspectives in epidemiology through juxtaposing a categorical approach, as outlined by McCall [32], with average between-group risk calculations, and an anti-categorical approach [32] with the statistical concept of discriminatory accuracy (DA). This approach, applied in empirical study (Study II, IV), is intersectional [106] in the sense that it, in accordance with a categorical perspective, uses intersectional strata or groups of relationships in the study of health disparities. Furthermore, it proposes the measurement of DA as an addition to quantitative intersectionality toolkits, amenable to the study of the heterogeneity of social categorizations. Intersectionality theory prompts the direction of attention towards structures and dynamics of power, and, while the included studies do not encompass extended analyses of social structures driving production of health disparities, the intention has been to study social categorizations and intersectional strata as proxies for relationships of privilege and disadvantage. Moreover, intersectionality theory has also been used to express and inform understanding of a basic tension in modern epidemiology that has not been sufficiently addressed, namely that between probabilistic measurement of average between-group risk and measures of DA.

The merits of integrating intersectionality theory in epidemiology include, as noted [27], the adding of specificity to analyses of health disparities and the improvement of knowledge validity through attendance to heterogeneity within social categories. Accordingly, with reference to Cole [277], Williams et al. [278] note that intersectionality theory implores researchers to examine heterogeneity within social categories, and to highlight how membership in social categories structures inequalities and stigma in ways that shape opportunities and life chances. While neither Williams et al. [278], nor Bauer [27] or Lofters and O'Campo [46], mention any possible tension between these two aims in epidemiology, potentially reinforced by intersectionality theory, this thesis demonstrates two cases of such friction, with regards to socioeconomic and psychosocial factors associated with risk of IHD in Sweden and racial/ethnic categories associated with seasonal influenza vaccination uptake in the US. Such tension, between (categorical) measurement of average difference in distribution of risk and (anti-categorical) gauging of the predictive validity or DA of categorizations used, can bring light to two sides of the epidemiological coin at hand.

One such two-sidedness has previously been pointed out in the realm of genetics, where the use of racial/ethnic categories has been critiqued due to large genetic diversity within groups and overlap between groups that coincide with average between-group differences in allele frequencies [279-281]. Similar attentiveness towards the co-existence of average difference and heterogeneity should be awarded to analogous categorization in other areas of study. As Glymour and Rudolph [34] point out, not only genetic but also social epidemiology should be held to scrutiny regarding the ability to explain variance in disease outcomes. While a recognized problem with sub-group analysis is spurious associations [282], and aggregate data may conceal differences between groups [283], this thesis highlights that aggregating data can also conceal substantial outcome variability within groups and overlap between groups [284]. If this heterogeneity is considerable, references to between-group differences in average values, without reference to within-group variation and between-group overlap, risk overemphasizing the value of population categories as a means of predicting the health outcomes or health-related behaviors of individuals [12, 18]. This may result in ambiguous recommendations to researchers and policy-makers regarding the use and value of social categories.

One reason why concepts and theories of intersectionality are important in this epidemiological context is that the managing of such two-sidedness can be slippery, both politically and epistemologically. Knowledge regarding differences in average between-group risk, indicative of power relationships driving distribution of risk, can be crucial for the illumination and amelioration of health inequities. The same knowledge can contribute to stereotyping [173], stigmatization [174] or bio/medicalization [285, 286] of "risky" groups and individuals [144]. Measurement of low DA, on the other hand, highlights the importance of not treating identity categories, intersectional or not, as static and reified. It can be used to clarify that power-implicated social categorizations have low relevance, due to heterogeneity, in specific contexts. At the same time, low DA could also be used to downplay or dismiss social determinants of disease. The application of a theoretical framework of intersectionality demands sensitivity to, and discussion of, how epidemiological knowledge and categorization of population groups relate to power, in general as well as in specific cases of research and policy.

With reference to racial/ethnic categorizations, as studied in relation to influenza vaccination uptake in the US, it should be noted that the assertion of the limited value of such categorizations for individual-level prediction is not new [173, 287], and that its relevance extends beyond medicine and public health, for example to profiling by law enforcement and security personnel [288, 289]. The use of racial/ethnic categorizations in genetics has, as mentioned, been criticized due to the diversity within groups and overlap between groups that co-exists with average differences [280, 281], and a meta-analysis of racial differences in response to antihypertensive drugs found that despite average differences between US Whites and Blacks at the aggregate level, race had little value for prediction of responses to the drugs under study, due to overlaps between groups [290]. The novelty of the present study (Study IV) lies in the use of ROC curves as a measure of DA, employed to assess the overlap between racial/ethnic categories. Here, substantial overlaps in vaccination coverage are reflected in the low DA of the racial/ethnic categories used.

Such low DA counters the argument that, while not every individual within a racial/ethnic group possesses a particular characteristic, racial/ethnic categories function sufficiently well to predict which individuals possess it. As standard racial/ethnic categories do not function sufficiently well for individual-level prediction, reliance on racial/ethnic identification as a proxy in medical decision-making runs the risk of leading to inappropriate treatment based on stereotyping [173]. This does not preclude the possibility of other racial/ethnic categorizations having a higher DA, or that existing categorizations are more relevant for predicting other outcomes.

Regarding the use of racial/ethnic identification to predict vaccination uptake, an argument used in favor rests on reports of specific barriers to influenza vaccination in different racial/ethnic groups [170]. However, most of those barriers are not unique to any particular group [170]. While there may be issues of mistrust among African-Americans [162, 170] related to racism and social exclusion, mistrust is not a racially unique phenomenon [291], and is it not a racially unique reason for not receiving vaccination [170]. Social inequity in vaccination coverage and social patterning of trust are unlikely to be effectively addressed through racially tailored interventions. On the contrary, experiences with tailored social programs suggest that these tend to undermine social trust [292]. Interventions may be particularly misguided when aiming to alter the behavior of selected individuals, as opposed to changing macro- or meso-level factors that enable and constrain behaviors, as the targeting of individuals carries a higher risk of stigmatization [174]. To be clear, the aim here is not to question the importance of race/ethnicity as an identity, or to question the lived experience of people in a racialized society. The concern lies, rather, in the use of racial/ethnic categories for individual-level prediction and profiling. Such use would likely be reduced if measures of DA were routinely reported alongside measures of associations, in assessments of group level differences.

In general terms, and in alignment with categorical intersectionality research, co-existent difference in average between-group risk and low DA is better met by policies aimed at upstream macro- or meso-level factors than by interventions aiming to change the behaviors of individuals. Macro- or meso-level factors addressed by broad policies may not have high DA, but can be beneficial across groups [61, 264] and particularly enable underprivileged groups [293] while under the principle of primum non nocere (not doing any harm) avoiding the danger of misguided and potentially stigmatizing policies targeting individuals based on ethnic, gender or class identification [294]. At the same time, population-wide approaches based on principles outlined by Rose [55]; on moving the entire distribution of a certain risk factor in the right direction through population level strategies, is questionable [14, 295] in the presence of major heterogeneities identified through measurement of DA [3]. While Rose's ideas continue to be highly relevant, epidemiology needs to be further developed through the identification of the share of individual variation that can be accurately explained by reference to a certain categorization, in relation to the outcome of interest [6, 8, 10]. In principle, targeted intervention can be called for when population groups are identified with high DA. Again, however, intersectionality analysis draws attention back toward macro-level forces producing the disparities that negatively impact upon such population groups, for example racism, as being problems above and beyond bodies and behaviors of affected or "risky" individuals and populations.

It is worth noting here that the limitations of reliance on measurement of between-group averages also extend to information yielded by many randomized clinical trials (RCTs), as these generally investigate the average causal effects of treatments. As measures of average causal effects hide inter-individual heterogeneity of responses behind group averages, the ability to predict an individual's response (or the individual causal effect) on the basis of such average values alone is questionable [1, 296].

On categorical and anti-categorical approaches

Green et al. [29] note that emphasizing heterogeneity within, and overlaps between, social categorizations, and thus meriting the questioning of the relevance of such categorization for individual level prediction, may spur arguments for the adoption of an anti-categorical rather than categorical intersectional approach in epidemiology. However, that conclusion requires qualification. The aim here is not wholesale opposition to categorization per se, or delineation of an approach that is a priori anti-categorical. If the DA of a certain categorization is found to be low, the implication can indeed be anti-categorical in relation to the studied outcome. High DA would, on the other hand, confirm the relevance of the categorization in relation to that outcome, thus meriting an categorical approach. In any case, inquiry into the DA of categorizations should complement rather than replace measures of average between-group risk, in epidemiology and public health, while interpretation of tension between such measures can be informed by anti-categorical as well as categorical approaches. This ought to be a both-and, rather than either-or, approach. Interest should be focused toward the construction and definition of social categories, while the existing relationships of inequality represented by those categories are simultaneously acknowledged and investigated. Such relationships of inequality are indeed the object and raison d'être of social epidemiology as well as of intersectionality research, and the intention here is certainly to develop rather than de-prioritize their study.

Study IV, rather than arguing against categorization as such, poses the question of which ways of organizing attention to social differentiation in public health are the most valid, in relation to the vaccination uptake outcome. The results point to education and household poverty as being more relevant for uptake prediction than race/ethnicity, since the ROC curve analysis showed that education and household poverty status added +0.020 to the AUC, while race/ethnicity provided very little additional information (+0.001). However, while the CDC routinely publishes vaccination coverage data by race/ethnicity, in accordance with federal mandates requiring agencies under the Department of Health and Human Services to collect and report race/ethnicity-based statistics to monitor inequalities [268], and this has resulted in a proliferation of studies treating a set of racial/taxonomic categories as a standardized format of analysis [268], social class has received far less attention [287, 297]. While it is important to note that race/ethnicity and socioeconomic position are not independent, as the disadvantage suffered by members of some racial/ethnic minority groups will translate into lower average income and educational levels, polices that effectively address socioeconomic inequities are thus predicted to diminish, albeit not eliminate, racial/ethnic gaps. In other words, the deprioritization of socioeconomic inequalities may divert attention away from policies that could have a major impact on vaccination rates among minority group members while simultaneously benefitting the large group of deprived Whites. While not arguing against the value of social categorizations per se, then, but rather underpinning arguments for macro- or mesolevel intervention aiming to address socioeconomic inequities, the study suggests that splitting the population into increasingly smaller taxonomic units to "highlight the most vulnerable subgroups" [46] may not ensure the best use of resources for ameliorating inequalities because of the high degree of outcome variability within, and overlap between, social categories. This is due to the fact that, in this case, intersectional variables did little to improve the DA obtained by the models where the race and ethnicity, gender and educational level variables were kept separate. Further, the study points to the fact that decisions to focus on any particular set of social positions or intersection of positions will be guided by political, theoretical, and pragmatic choices and constraints. While measures of DA offer no escape from this situation, they provide an important means for evaluating the basis of such use. At the same time, measures of DA underscore the important point that social structures, such as racism, generate persistent patterns of inequality but not law-like regularities [52], and that there is a great deal of variance in health and health care seeking behavior that is not readily mapped onto social position [265].

As noted by many scholars [29, 109, 123, 298, 299], the integration of intersectionality in epidemiological study will be most effective when researchers do not lose sight of relationships and structures of power, or of social theory on production of health disparities, in the framing of study designs and results. It should be added that engagement of intersectionality in population health science would further benefit from remaining attentive to ongoing debates within intersectionality research at large, for example regarding distinctions between the study of categories of identity versus distribution of resources or power [106, 116, 118, 123, 300], regarding which categories should be included in intersectional analysis [115, 124], or regarding the importance of not only investigating interconnections, but also differences, between interlocking systems of oppression [118]. Gimenez [301] argues, for example, against the use of the term "classism", as class-based oppression differs from sexism and racism by consisting less of an ideology: "it denotes exploitative relations between people mediated by their relations to the means of production" (p 24). In other words, the inclusion of intersectionality theory in epidemiology should not only consist of the development of statistical models, but also of engagement with insights produced and complexities found within the field of intersectionality research.

Of interest here is discussion among intersectionality scholars concerning tension, potential or actual, between categorical and anti-categorical approaches [106, 107, 122, 125, 302]. Such tension can be related to that between structure and agency [302] or that between poststructuralist theory and critical theory on the effects of sexism, class and racism, such as standpoint theory. Lutz et al. [107] note that poststructuralist feminist theories, which can be denominated as anti-categorical, elaborate on the insight that categories cannot be understood in an essentialist way, while at the same time the power effects generated by such categories form the basis of hierarchization of groups and unequal social relations. Standpoint theory, which can, in turn, be related to categorical approaches, points to the individual's experiences, and thus her or his perspective, as being shaped by his or her social and political positioning. Intersectionality can offer reconciliation between these two strands of theory [122]. With reference to Spivak's notion of strategic essentialism [303], Lutz et al. [107] argue that political action must refer strategically to social categories. Marx Feree [125] comments that the agency of choosing one's struggles should shape the meaning of intersectionality in each specific context. Meanwhile, Collins and Bilge [106] observe that there is a difference between marginalized groups claiming an essentialized intersectional identity, for example as Black women, and authoritative agencies imposing agendas on historically disenfranchized categories of people, intersectional or not. While these discussions primarily concern identity and representation rather than concrete health outcomes or risk assessment, they can inform potentially complex [268] discussions of how categorical versus anti-categorical approaches in epidemiology and public health relate to power, in general as well as in specific cases of research and policy.

On epidemiological knowledge and its limitations

While the measurement of DA does not offer actual explanations for within-group heterogeneity [29], measures of DA do provide information that reaches beyond probabilistic knowledge of ACEs, typical in current epidemiology [1, 3, 4, 25]. Measures of DA, in combination with theorization and hypotheses-testing informed by intersectionality theory, can contribute to knowledge about social mechanisms of disease causation. At the same time, and as also noted by Green et al. [29], achieving high DA is likely often not feasible. In fact, the measurement of low DA lays bare and explicit a current lack of knowledge about causation mechanisms in epidemiology.

The limited predictive value of various biomarkers and risk factors has been discussed by several epidemiologists [81, 79, 304-307]. With reference to the typically low levels of variance explained (r^2), analogous to low DA, pertaining to predictors studied in social as well as genetic epidemiology, Glymour and Rudolph [34] comment that the "gaps in our understanding of what truly drives health are readily apparent" (p 263). In response, they recommend the inclusion of social theory and qualitative research in epidemiology, as well as open acknowledgement of the uncertainties of existing conceptual and statistical models.

While an attitude of openness and humility, with regards to knowledge gaps and low DA, is indeed appropriate, a noted way forward for the development of epidemiological method and theory lies in further multilevel analysis of individual heterogeneity (MAIH) [3, 33], and measurement of DA, ICC or analogous concepts [3, 6, 8, 9], informed by intersectionality theory. This said, within the present research project, the low DA of many risk factors of disease, or the "gaps in our understanding of what truly drives health" [34], motivates explorative analytic interest in other possible ways of conceptualizing and practicing disease prevention.

CAM prevalence

Among the reasons why people use complementary and alternative medicine (CAM), one appears to lie in the understanding of health, disease and disease prevention found, or thought to be found, in CAM [176-184]. While exploration of the nature of such understanding of health and disease prevention lies beyond the scope of this thesis, the included prevalence study confirms that a large share of the population of Skåne does indeed chose to use various forms of CAM.

While some have questioned the relevance of CAM prevalence research [308], others have emphasized its importance, both in terms of revealing the necessity of further investigation of CAM use and users, and of forming an essential part of wider projects of CAM research and development [210]. Knowledge relating to the prevalence of CAM use is important for answering questions such as which population or patient groups turn to different types of CAM, and why. How can or does CAM consumption affect population health, in positive [309] or negative [310] directions? What economic consequences does CAM use have? What needs for education, pertaining to conventional [311, 312] as well as CAM caregivers, can be identified? Do patients disclose their CAM use in clinical encounters with conventional health care [313, 314], and, if not, why? Is the field sufficiently regulated and researched [186]? Proper handling of such issues, on regional and national levels, requires current data on CAM usage.

In the face of the existing lack of knowledge about CAM use, nationally and regionally, and the often still marginal position of CAM in medical research and discussion, Study V motivates the posing of questions about the reasons and effects of

CAM use, while affirming the importance of further investigation and discussion of CAM consumption, policy, practice, and education. It also merits questions about ontological and epistemological understandings of body, health and disease prevention sought, and found, or not, in CAM.

Limitations

The studies included in this thesis have several limitations.

A limitation of Study I [25] lies in the relatively unstructured nature of the literature review, as the process of selecting sources was not strictly formalized. Due to the large volume of the gathered material and the marked consistence of themes discussed therein, alongside the article's nature as a theoretical and conceptual discussion, this does not, however, place the presented arguments in question.

Although the study of IHD risk (Study II) [30] was based on register data from 3.6 million individuals, one of the intersectional groupings included an insufficient number of people to yield a measurable result. For a few groupings, the 95% CIs measured were wide, which implies a substantial degree of uncertainty associated with the estimated level of risk. This underscores the fact and the potential problem that quantitative study of intersectional groupings requires large databases for sufficient statistical power, and future studies need to consider this. Furthermore, the analysis only included a small number of explanatory factors. Categorizations used, such as socioeconomic status based on income tertiles, or racialization based on time as registered inhabitants of Sweden, are simplistic. This makes findings of heterogeneity perhaps unsurprising. Analogous categorization is quite typical of social epidemiological research, however [18], which makes the identified heterogeneity all the more relevant. It is nonetheless arguable whether the study provides enough detail to underpin specific clinical or policy objectives. That is not the aim of this particular study, however, as its overall purpose is to contribute to conceptual and methodological discussion.

The study on vaccination uptake (Study IV) [31] is based on a cross-sectional telephone survey with a relatively low response rate (45.2%). This increases the risk of non-response bias, and recall error with regards to self-reported information. According to the CDC [166], the survey overestimates seasonal influenza vaccination coverage, in part likely due to misclassification of pandemic pH1N1 vaccine for seasonal influenza vaccine. To test whether the low DA of racial/ethnic categories was limited to seasonal influenza vaccination, we performed the analyses using 2009 pandemic pH1N1 vaccination status as the outcome, but conclusions were the same. Finally, the analysis does not consider the fact that vaccination levels changed over the duration of survey administration, and this could a have slight effect on vaccination coverage estimates.

Again with regards to Study IV, a body of literature discusses the strengths and weaknesses of different methods for assignment to racial/ethnic categories, including self-report, investigator-assignment, the use of administrative records, and the use of genetic markers. Study results can differ substantially depending on the method used [173]. In epidemiology, the ‘gold standard’ for racial/ethnic assignment is self-report, in accordance with the principle that people are who they say they are. However, the complexity and fluidity of individual identity makes it impossible to divide the population into non-overlapping racial/ethnic groups, or to validly and reliably allocate people to any given set of categories. Accordingly, research studies have found inconsistencies in the way that race and ethnicity are self-reported and recoded by investigators [173]. However, because the purpose of the study was to evaluate standard racial/ethnic categories used regularly by public health researchers and authorities, any limitations of the categories, although important to acknowledge, do not undermine our finding that standard racial/ethnic categories have low DA for the studied outcomes. A similar point can be made in relation to both Study IV and Study II with regards to the challenge, mentioned in the Introduction, of bringing an intersectional perspective to data that has not been developed in accordance with such a perspective [28, 115, 132]. While this is highly relevant to consider, again such limitations do not alter the conclusion that the social and racial/ethnic categories under study have low DA, in relation to the outcomes at hand.

As regards the CAM prevalence study (Study V) [36], a main weakness is the survey’s low response rate (31%), likely due to the relatively large number of questions included in the questionnaire. The result may overestimate CAM use, as people with a favorable attitude towards or interest in CAM might have been more likely to complete the survey than others without such an interest or attitude. It is also noteworthy that people with tertiary education, who, according to the present analysis are more likely to use CAM, are slightly overrepresented in the TNS Sifo web panel. On the other hand, such an overestimation may be counteracted by the lower response rates in younger age groups, among which CAM use appears to be more common. In any case, a survey completed by 1.534 individuals, with a response frequency of 31%, provides a limited base for drawing conclusions. Critique aimed towards much of the CAM prevalence research regarding low levels of certitude [203, 248, 249] thus also pertains to this study. However, while corroborating studies from Sweden and other countries, and in the face of a paucity of current research, this study confirms the relevance of further CAM research.

In summary

Eliminating health disparities along lines of race/ethnicity and other social categorizations is an important goal of public health policy. This thesis confirms the existence of differences in average risk for IHD in Sweden between intersectional groups defined by social and psychosocial characteristics, and for seasonal influenza vaccination non-receipt in the US between people categorized in racial/ethnic groups. Measurement of the DA of the categorizations used reveals, however, large degrees of heterogeneity within and overlaps between groups. This merits a questioning of the practical value of the categories used, for making inferences about IHD risk and vaccination behavior respectively, as the between-group differences or average causal effects (ACEs) do not represent the heterogeneity of individual effects. Consequently, the studies highlight the tension between average between-group risk and measures of DA, related to and understood by means of categorical and anti-categorical intersectionality.

While quantitative intersectionality research has often been of the categorical type, anti-categorical approaches have usually been furthered through qualitative research, often encompassing philosophical critique of social categorization as potentially leading to demarcation, exclusion and furthered inequality. Operationalized through the measurement of DA, anti-categorical approaches can also be investigated, expressed and developed within a quantitative framework.

The emphasis on DA, and on study of inter-individual heterogeneity around group means, as being of central relevance for understanding the effects of an exposure or risk factor on an outcome in a certain population is not only important because conclusions based on group averages may lead to under- or over-diagnosis, ineffective treatment or unnecessarily side effects and costs, but also because they can have a stereotyping effect through portraying and treating population groups as more homogenous, and different from others, than they actually are. This may also raise concern with regards to unwarranted medicalization [315], biomedicalization [286] or pharmaceuticalization [316], alongside potential stigmatization [174] of individuals exposed to risk, or included in ”risky” population groups. Measurement of average between-group risk should therefore routinely be complemented with gauging of its predictive validity in relation to clinical or preventive action, through investigation of outcome heterogeneity [2].

This said, low DA does not mitigate against broad macro- or meso-level policies, which under the principle of primum non nocere can be beneficial across groups and particularly enable underprivileged groups [293], while avoiding misguided policies targeting individuals based on social categorization [2, 18].

In essence and to summarize, categorical and anti-categorical perspectives can inform ways of thinking about tension between average-risk disparities and DA. Average between-group risk and DA both, and categorical and anti-categorical intersectional approaches both, should be carefully considered in relation to the specific outcome or question at hand, in future epidemiology and public health.

7. Future research

Intersectional approaches to multilevel analysis of individual heterogeneity (MAIH)

Additional and future research will be developed within the framework of multilevel analysis of individual heterogeneity (MAIH) [3, 33] informed, in this instance, by intersectionality theory.

As has been previously argued [2, 3, 6, 8, 11, 18], multilevel analysis represents a path beyond the dislocation of individual and population levels of analysis that is often found in epidemiology and public health. A multilevel approach does not separate individual variance from population (i.e., group or category) variance but considers the existence of a continuum of individual variance that can be decomposed at different levels of analysis, and thus enables simultaneous exploration of both between-population and within-population components of individual heterogeneity. Population effects are thereby appraised not merely through study of differences between population averages, but also through quantification of the share of the individual heterogeneity (i.e., variance) that exists at the population level [3, 6, 8, 11].

The idea of MAIH converges with the current movement of personalized medicine, or precision medicine [317] through its efforts toward understanding individual heterogeneity. Rather than only focusing on individual biomedical susceptibilities, however, MAIH aims to identify the components of individual heterogeneity in health that exist at the contextual level and across the life-course [3, 33].

Integrated into a multilevel framework, intersectionality offers a promising way forward for furthering the study of health inequities while integrating social theory in epidemiology.

Hearts at Risk: Risk and prevention of heart disease in Scandinavian conventional and Chinese medical training

The initial PhD project design included qualitative study of notions of risk and prevention of heart disease, as expressed by students and teachers of conventional and Chinese medical training, in contemporary Scandinavia. Ethics approval has been obtained (Dnr 2014/743), and participant observation has been pursued at parts of the Lund University Medical Faculty's medical training (200 hrs) as well as in four schools of Chinese medicine (460 hrs). A total of 30 semi-structured interviews, primarily with students, have been conducted. Field notes and interviews have been transcribed, and coded with the aid of the software program NVivo. Literature studies have been conducted. Initial analyses have been presented in seminars and conferences, and manuscripts are under development. In the interest of coherence, and in recognition that the original PhD project design was very broad, this work will be completed after the PhD dissertation.

CAM prevalence research

Further CAM prevalence research is planned.

Sammanfattning

(Summary in Swedish)

Kritisk debatt gällande epidemiologisk vetenskap pekar mot en relativ avsaknad av social teori inom epidemiologisk forskning samt mot låg prediktiv träffbarhet (discriminatory accuracy, DA) hos en stor andel av existerande epidemiologisk kunskap om risk faktorer och riskmarkörer för sjukdom. Mot denna bakgrund, vilken behandlas i avhandlingens första delarbete (Studie I), integrerar föreliggande avhandling intersektionalitetsteori i epidemiologiskt studium. Syftet härmed är dels att förbättra förståelsen för heterogeniteter i populationsgrupper samt därmed öka grupperingars DA, och dels att inkorporera ett teoretiskt ramverk som möjliggör analys av maktdynamik vilken driver produktion av ojämlik fördelning av hälsa, såväl som mätning av sådana ojämlikheter. Ett intersektionalitetsperspektiv appliceras i empiriskt studium av risk för ischemisk hjärtsjukdom (IHD) i Sverige (Studie II), samt av upptag av influensavaccin i USA (Studie IV). Ett kategoriskt intersektionalitetsperspektiv operationaliseras genom mätning av skillnader i genomsnittsrisk mellan intersektionella grupper. Beräkning av grupperingarnas DA relateras till anti-kategorisk intersektionalitet, då denna visar sig vara låg på grund av heterogeniteter inom och/eller överlappningar mellan grupper.

Undersökningen av risk för IHD (Studie II) består av en prospektiv kohortstudie med ett års uppföljning, baserad på registerdata från 3.6 miljoner personer (45-80 år) bosatta i Sverige år 2010. Associationer mellan insjuknande i IHD och ålder, genus, utbildning, tid som invånare i Sverige, civilstånd samt förskrivning av psykotropa läkemedel uttrycks genom odds ratior (OR) och 95-procentiga konfidensintervall (95% CI), framtagna genom logistiska regressionsmodeller. Studien replikerar tidigare undersökningar av social stratifiering av risk för IHD, då den bekräftar existensen av ojämlikheter i risk längs samliga grupperingskriterier. Logistisk regression informerad av ett kategoriskt intersektionalitetsperspektiv påvisar ytterligare ojämlikheter i riskdistribution mellan intersektionella grupper, vilket leder till slutsatsen att kombinerade mönster av social differentiering bidrar till fördelning av risk för IHD i populationen. Mätning av AUC, syftande till att visa om de intersektionella grupperingarna leder till förbättring av prediktiv träffbarhet, fann emellertid inga betydande ökningar. Medan den övergripande AUCn var relativt stor, härrörde sig denna huvudsakligen till ålder. Från ett anti-kategoriskt perspektiv, operationaliserat genom mätning av DA, ser de studerade intersektionella grupperingarna därmed ut att vara av begränsat värde för bedömning av risk för IHD på individnivå.

Studien av upptag av influensavaccination i USA (Studie IV) bygger på enkätdata från National 2009 H1N1 Flu Survey (NHFS) (n=56.656). Associationer mellan vaccinationsupptag och ras/etnicitiet samt ålder, genus, inkomst och utbildning analyserades genom logistiska regressioner, och uttrycks i odds ratior (OR) och 95%-procentiga konfidensintervall (95% CI). Studien påvisar ett större vaccinationsupptag bland personer självkategoriserade som vita, i jämförelse med övriga etnicitets- eller raskategoriseringar. Stratifiering utifrån genus och utbildning, gjord utifrån ett kategoriskt intersektionalitetsperspektiv, uppvisar emellertid en stor heterogenitet gällande fördelning av vaccinationsupptag inom och mellan ras- eller etnicitetsgrupperna. Därutöver är kategoriseringarnas DA låg, då ras/etnicitet endast bidrar med en mycket liten ökning av AUC. Utifrån ett anti-kategoriskt perspektiv ifrågasätter studien därför användning av kategoriseringar baserade på ras/etnicitet för prediktion av vaccinationsupptag.

Studie III utvecklar den konceptuella diskussion som förs i Studie II, och förordar inkorporering av intersektionalitetsteori i flernivåanalys av individuell heterogenitet (multilevel analysis of individual heterogeneity, MAIH).

Trots integration av intersektionalitetsteori förblir de studerade sociala och etniska kategoriernas DA låg. Denna låga DA påtalar en begränsning i vår nuvarande kunskap om kausala mekanismer och individuell heterogenitet inom (social)-epidemiologin. Föreliggande projekt har därför delvis motiverats av ett intresse för andra möjliga ontologiska sätt att förstå hälsa, risk och prevention av sjukdom, funna inom alternativ eller komplementär medicin (AKM). Kvalitativa studier av förhållningssätt till risk för och prevention av hjärtsjukdom, kommunicerade av lärare och studenter vid läkarutbildning samt vid skandinavisk utbildning i kinesisk medicin har genomförts, och kommer att utvecklas vidare. Avhandlingen innefattar en pilotstudie av användning av samt inställning till AKM och konventionell medicin i Skåne (Studie V).

Studien av AKM-användning (Studie V) baseras på enkätdata insamlade i samverkan med TNS Sifo (n=1.534), och analyserade genom logistisk regression. 71% av respondenterna uppgav sig ha använt någon form av AKM under det senaste året. AKM-användning var vanligare bland kvinnor, i yngre åldersgrupper samt bland personer med högre utbildning. Konsumtion av AKM var vidare associerad med höga nivårer av upplevd stress och långvariga hälsoproblem eller skador, samt med goda motionsvanor och följande av särskilda dieter. Självrapporterade syften med AKM-användningen var förebyggande samt behandling av sjukdom, och användare uppgav sig ha upplevt höga grader av hjälpsamhet. Respondenterna uttryckte en lägre nivå av förtroende för AKM än för konventionell medicin. Samtidigt uppgav en majoritet av dem att samarbete mellan AKM och konventionell medicin bör öka. Enkätens svarsfrekvens var 31%.

Avhandlingen visar sammanfattningsvis att kategoriska och anti-kategoriska intersektionalitetsperspektiv kan uttrycka samt öka förståelsen för spänning mellan, å ena sidan, genomsnittsrisk grupper emellan och, å andra sidan, grupperingarnas prediktiva träffbarhet. Mått på såväl DA som genomsnittsrisk, och kategoriska såväl som anti-kategoriska intersektionella perspektiv, bör beaktas i framtida epidemiologi och folkhälsovetenskap.

Acknowledgements

I want to express my sincere gratitude to those who, in various ways, have contributed to this thesis. In particular,

Juan Merlo, my supervisor. Thank you so much for all your endless support, guidance and enthusiasm, and for essentially giving me the opportunity to pursue this project. My gratitude is deep and wide. Thank you for everything!

Shai Mulinari, my assistant supervisor. Thank you for your stringency, for lots of intelligent discussion and valuable help, and for streetwise clues on the journey. You have been a gem!

Anne-Christine Hornborg, my assistant supervisor. While your guidance has primarily concerned the qualitative studies that will be completed after my dissertation, your support has been consistent and invaluable. Thank you so very much!

Raquel Perez Vicente, biostatistician. Thank you so much for important help with datasets and statistical analyses. Your contributions are very greatly appreciated!

Colleagues at the Unit of Social Epidemiology; Pernilla Bjerkeli, Sofia Zettermark, Sten Axelsson Fisk and others – thank you and all the best to you all!

And deep thanks, of course, to my children and loved ones.

Work toward this thesis was supported by the Swedish Scientific Council (#2013-2484, PI: Juan Merlo) and Risénstiftelsen.

References

1. Merlo J, Mulinari S, Wemrell M, Subramanian S, Hedblad B: The tyranny of the averages and the indiscriminate use of risk factors in public health: The case of coronary heart disease. *Soc Sci Med Pop Health* 2017, 3:684-698.
2. Merlo J, Mulinari S: Measures of discriminatory accuracy and categorizations in public health: a response to Allan Krasnik's editorial. *Eur J Public Health* 2015, 25(6):910.
3. Merlo J: Invited commentary: multilevel analysis of individual heterogeneity - a fundamental critique of the current probabilistic risk factor epidemiology. *Am J Epidemiol* 2014, 180(2):208-212.
4. Merlo J, Wagner P: The tyranny of the averages and the indiscriminate use of risk factors in public health: a call for revolution. *Eur J Epidemiol* 2013, 28(1):148.
5. Merlo J, Wagner P, Hedblad B: Discriminatory accuracy and population attributable fractions: the case of traditional risk factors and novel biomarkers for coronary heart disease. *Eur J Epidemiol* 2013, 28:S147.
6. Merlo J, Ohlsson H, Lynch KF, Chaix B, Subramanian SV: Individual and collective bodies: using measures of variance and association in contextual epidemiology. *J Epidemiol Community Health* 2009, 63(12):1043-1048.
7. Merlo J, Östergren P-O, Hagberg O, Lindström M, Lindgren A, Melander A, Råstam L, Berglund G: Diastolic blood pressure and area of residence: multilevel versus ecological analysis of social inequity. *J Epidemiol Community Health* 2001, 55(11):791-798.
8. Merlo J: Multilevel analytical approaches in social epidemiology: measures of health variation compared with traditional measures of association. *J Epidemiol Community Health* 2003, 57(8):550-552.
9. Merlo J, Chaix B, Yang M, Lynch J, Råstam L: A brief conceptual tutorial of multilevel analysis in social epidemiology: linking the statistical concept of clustering to the idea of contextual phenomenon. *J Epidemiol Community Health* 2005, 59(6):443-449.
10. Merlo J, Viciana-Fernández FJ, Ramiro-Fariñas D, Research Group of the Longitudinal Database of the Andalusian Population: Bringing the individual back to small-area variation studies: a multilevel analysis of all-cause mortality in Andalusia, Spain. *Soc Sci Med* 2012, 75(8):1477-1487.
11. Merlo J, Asplund K, Lynch J, Råstam L, Dobson A: Population effects on individual systolic blood pressure: a multilevel analysis of the World Health Organization MONICA Project. *Am J Epidemiol* 2004, 159(12):1168-1179.

12. Mulinari S, Juarez SP, Wagner P, Merlo J: Does maternal country of birth matter for understanding offspring's birthweight? A multilevel analysis of individual heterogeneity in Sweden. *PloS One* 2015, 10(5):e0129362.

13. Merlo J, Wagner P, Ghith N, Leckie G: An original stepwise multilevel logistic regression analysis of discriminatory accuracy: the case of neighbourhoods and health. *PloS One* 2016, 11(4):e0153778.

14. Juarez SP, Wagner P, Merlo J: Applying measures of discriminatory accuracy to revisit traditional risk factors for being small for gestational age in Sweden: a national cross-sectional study. *BMJ Open* 2014, 4(7):e005388.

15. Pepe MS, Janes H, Longton G, Leisenring W, Newcomb P: Limitations of the odds ratio in gauging the performance of a diagnostic, prognostic, or screening marker. *Am J Epidemiol* 2004, 159(9):882-890.

16. Rodriguez-Lopez M, Wagner P, Perez-Vicente R, Crispi F, Merlo J: Revisiting the discriminatory accuracy of traditional risk factors in preeclampsia screening. *PloS One* 2017, 12(5):e0178528.

17. Beckman A, Merlo J, Lynch J, Gerdtham U, Lindström M, Lithman T: Country of birth, socioeconomic position, and healthcare expenditure: a multilevel analysis of Malmö, Sweden. *J Epidemiol Community Health* 2004, 58(2):145-149.

18. Mulinari S, Bredstrom A, Merlo J: Questioning the discriminatory accuracy of broad migrant categories in public health: self-rated health in Sweden. *Eur J Public Health* 2015, 25(6):911-917.

19. Fisk SA, Merlo J: Absolute rather than relative income is a better socioeconomic predictor of chronic obstructive pulmonary disease in Swedish adults. *Int J Equity Health* 2017, 16(1):70.

20. Krieger N: Epidemiology and the web of causation - has anyone seen the spider? *Soc Sci Med* 1994, 39(7):887-903.

21. Krieger N: Epidemiology and the people's health: Theory and context. New York: Oxford University Press; 2011.

22. O'Campo P, Dunn JR: Rethinking social epidemiology: Towards a science of change. Dordrecht and New York: Springer; 2012.

23. Ng E, Muntaner C: A critical approach to macrosocial determinants of population health: engaging scientific realism and incorporating social conflict. *Curr Epidemiol Rep* 2014, 1:27-37.

24. Collyer F: The Palgrave handbook of social theory in health, illness and medicine. Basingstoke and New York: Springer; 2015.

25. Wemrell M, Merlo J, Mulinari S, Hornborg AC: Contemporary epidemiology: a review of critical discussions within the discipline and a call for further dialogue with social theory. *Sociol Compass* 2016, 10(2):153-171.

26. Lillie EO, Patay B, Diamant J, Issell B, Topol EJ, Schork NJ: The n-of-1 clinical trial: the ultimate strategy for individualizing medicine? *Prev Med* 2011, 8(2):161-173.

27. Bauer GR: Incorporating intersectionality theory into population health research methodology: challenges and the potential to advance health equity. *Soc Sci Med* 2014, 110:10-17.

28. Giritli K, Olofsson A: Intersectional approaches in health-risk research: a critical review. *Sociol Compass* 2014, 8(9):1112–1126.

29. Green MA, Evans CR, Subramanian SV: Can intersectionality theory enrich population health research? *Soc Sci Med* 2017, 178:214-216.

30. Wemrell M, Mulinari S, Merlo J: Intersectionality and risk for ischemic heart disease in Sweden: Categorical and anti-categorical approaches. *Soc Sci Med* 2017, 177:213-222.

31. Mulinari S, Wemrell M, Rönnerstrand B, Subramanian S, Merlo J: Categorical and anti-categorical approaches to US racial/ethnic groupings: revisiting the National 2009 H1N1 Flu Survey (NHFS). *Crit Public Health* 2017, Online publication 26 April.

32. McCall L: The complexity of intersectionality. *Signs* 2005, 30(3):1771-1800.

33. Wemrell M, Mulinari S, Merlo J: An intersectional approach to multilevel analysis of individual heterogeneity (MAIH) and discriminatory accuracy. *Soc Sci Med* 2017, 178:217-219.

34. Glymour MM, Rudolph KE: Causal inference challenges in social epidemiology: bias, specificity, and imagination. *Soc Sci Med* 2016, 166:258-265.

35. Rockhill B: Theorizing about causes at the individual level while estimating effects at the population level - Implications for prevention. *Epidemiology* 2005, 16(1):124-129.

36. Wemrell M, Merlo J, Mulinari S, Hornborg A-C: Two-thirds of survey respondents in Sweden used complementary or alternative medicine (CAM) in 2015. *Complement Med Res* 2017.

37. Susser M, Susser E: Choosing a future for epidemiology: II. From black box to Chinese boxes and eco-epidemiology. *Am J Public Health* 1996, 86(5):674-677.

38. Department of Health and Social Security: Inequalities in health. Report of a research working group. London: DHSS; 1980.

39. Commission on Social Determinants of Health: Closing the gap in a generation: health equity through action on the social determinants of health: final report of the commission on social determinants of health: World Health Organization; 2008.

40. Marmot M, Wilkinson R (eds.): Social determinants of health. Oxford: Oxford University Press; 1999.

41. Oakes M, Kaufman J: Methods in social epidemiology. Hoboken: John Wiley & Sons; 2006.

42. Galea S, Link BG: Six paths for the future of social epidemiology. *Am J Epidemiol* 2013, 178(6):843-849.

43. Susser M: Does risk factor epidemiology put epidemiology at risk? Peering into the future. *J Epidemiol Community Health* 1998, 52(10):608-611.

44. Syme L: To prevent disease. The need for a new approach. In: *Health and social organization: Towards a health policy for the 21st century.* Edited by Blane D, Brunner E, Wilkinson R. London and New York: Routledge; 1996: 21–31.

45. Camargo K, Ortega F, Coeli C: Modern epidemiology and its discontents. *Rev Saúde Pública* 2013, 47(5):984–991.

46. Lofters A, O'Campo P: Differences that matter. In: *Rethinking social epidemiology. Towards a science of change.* Edited by O'Campo P, Dunn J. Dordrecht: Springer; 2012: 93–109.

47. McKinlay JB: The promotion of health through planned sociopolitical change: challenges for research and policy. *Soc Sci Med* 1993, 36(2):109-117.

48. Shim JK: Heart-sick. The politics of risk, inequality, and heart disease. New York: New York University Press; 2014.

49. Shim JK: Understanding the routinised inclusion of race, socioeconomic status and sex in epidemiology: the utility of concepts from technoscience studies. *Sociol Health Illn* 2002, 24(2):129-150.

50. Shim JK: Constructing 'race' across the science-lay divide: Racial formation in the epidemiology and experience of cardiovascular disease. *Soc Stud Sci* 2005, 35(3):405-436.

51. Øversveen E, Rydland HT, Bambra C, Eikemo TA: Rethinking the relationship between socio-economic status and health: Making the case for sociological theory in health inequality research. *Scand J Public Health* 2017, 45(2):103-112.

52. Muntaner C: Invited commentary: On the future of social epidemiology – A case for scientific realism. *Am J Epidemiol* 2013, 128(6):852–857.

53. Pearce N: Traditional epidemiology, modern epidemiology, and public health. *Am J Public Health* 1996, 86(5):678-683.

54. McKinlay JB: Paradigmatic obstacles to improving the health of populations – Implications for health policy *Salud Publica Mex* 1998, 40(4):369–379.

55. Rose GA: The strategy of preventive medicine. Oxford England, New York: Oxford University Press; 1992.

56. Krieger N: Theories for social epidemiology in the 21st century: an ecosocial perspective. *Int J Epidemiol* 2001, 30(4):668-677.

57. Krieger N: Methods for the scientific study of discrimination and health: An ecosocial approach. *Am J Public Health* 2012, 102(5):936-945.

58. Buffardi A, Thomas K, Holmes K, Manhart L: Moving upstream: Ecosocial and psychosocial correlates of sexually transmitted infections among young adults in the United States. *Am J Public Health* 2008, 98:1128–1136.

59. Marmot M: The status syndrome: How social standing affects our health and longevity. New York: Times Books/Henry Holt; 2004.

60. McEwen B: Central effects of stress hormones in health and disease: Understanding the protective and damaging effects of stress and stress mediators. *Eur J Pharmacol* 2008, 582:174–185.

61. Wilkinson R, Pickett K: The spirit level: Why more equal societies almost always do better. London: Allen Lane, Penguin Books; 2009.

62. Link BG, Phelan J: Social conditions as fundamental causes of disease. *J Health Soc Behav* 1995:80-94.

63. Mackenbach JP, Kulhánová I, Bopp M, Deboosere P, Eikemo TA, Hoffmann R, Kulik MC, Leinsalu M, Martikainen P, Menvielle G: Variations in the relation between education and cause-specific mortality in 19 European populations: A test of the "fundamental causes" theory of social inequalities in health. *Soc Sci Med* 2015, 127:51-62.

64. Tajer D: Latin American social medicine: roots, development during the 1990s, and current challenges. *Am J Public Health* 2003, 93(12):2023-2027.

65. Roux AVD: Integrating social and biologic factors in health research: a systems view. *Ann Epidemiol* 2007, 17(7):569-574.

66. Jayasinghe S: Conceptualising population health: from mechanistic thinking to complexity science. *Emerg Themes Epidemiol* 2011, 8(1):2.

67. Scambler G, Scambler S: Theorizing health inequalities: The untapped potential of dialectical critical realism. *Soc Theor Health* 2015, 13(3-4):340-354.

68. Duff C: Assemblages of health. Rotterdam: Springer; 2014.

69. Collyer F, Scambler G: The Sociology of health, illness and medicine: Institutional progress and theoretical frameworks. In: *The Palgrave handbook of social theory in health, illness and medicine.* Edited by Collyer F. Basingstoke: Palgrave Macmillan; 2015.

70. Tabery J: Commentary: Hogben vs the Tyranny of averages. *Int J Epdemiol* 2011:dyr027.

71. Downs GW, Rocke DM: Interpreting heteroscedasticity. *Am J Polit Sci* 1979:816-828.

72. Bernard C: An introduction to the study of experimental medicine. New York: Schuman; 1949.

73. Hogben L, Sim M: The self-controlled and self-recorded clinical trial for low-grade morbidity. *Br J Prev Soc Med* 1953, 7(4):163.

74. Guyatt G, Sackett D, Taylor DW, Ghong J, Roberts R, Pugsley S: Determining optimal therapy – randomized trials in individual patients. *N Engl J Med* 1986, 314(14):889-892.

75. Larson EB: N-of-1 trials: a new future? *J Gen Intern Med* 2010, 25(9):891-892.

76. Braumoeller BF: Explaining variance; or, stuck in a moment we can't get out of. *Political Anal* 2006, 14(3):268-290.

77. Gould SJ: The mismeasure of man. New York: Norton; 1996.

78. Kaplan JM, Winther RG: Prisoners of abstraction? The theory and measure of genetic variation, and the very concept of "race". *Biol Theory* 2013, 7(4):401-412.

79. Smith GD: Epidemiology, epigenetics and the 'Gloomy Prospect': embracing randomness in population health research and practice. *Int J Epidemiol* 2011, 40(3):537-562.

80. Goff DC, Lloyd-Jones DM, Bennett G, Coady S, D'Agostino RB, Gibbons R, Greenland P, Lackland DT, Levy D, O'Donnell CJ: 2013 ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American College of

Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol* 2014, 63(25_PA).

81. Cooney MT, Dudina AL, Graham IM: Value and limitations of existing scores for the assessment of cardiovascular risk: a review for clinicians. *J Am Coll Cardiol* 2009, 54(14):1209-1227.
82. Greenland P, Knoll MD, Stamler J, Neaton JD, Dyer AR, Garside DB, Wilson PW: Major risk factors as antecedents of fatal and nonfatal coronary heart disease events. *JAMA* 2003, 290(7):891-897.
83. Page RM, Cole GE, Timmreck TC: Basic epidemiological methods and biostatistics: A practical guidebook. Boston: Jones & Bartlett; 1995.
84. DeMaris A: Explained variance in logistic regression: A Monte Carlo study of proposed measures. *Sociol Methods Res* 2002, 31(1):27-74.
85. Møller A, Jennions MD: How much variance can be explained by ecologists and evolutionary biologists? *Oecologia* 2002, 132(4):492-500.
86. Royston P, Altman DG: Visualizing and assessing discrimination in the logistic regression model. *Stat Med* 2010, 29(24):2508-2520.
87. Wald NJ, Morris JK: Assessing risk factors as potential screening tests: a simple assessment tool. *Arch Intern Med* 2011, 171(4):286-291.
88. Boyko EJ, Alderman BW: The use of risk factors in medical diagnosis: opportunities and cautions. *J Clin Epidemiol* 1990, 43(9):851-858.
89. Khoury MJ, Newill CA, Chase GA: Epidemiologic evaluation of screening for risk factors: application to genetic screening. *Am J Public Health* 1985, 75(10):1204-1208.
90. Ware JH: The limitations of risk factors as prognostic tools. *N Engl J Med* 2006, 355(25):2615-2617.
91. Wald N, Hackshaw A, Frost C: When can a risk factor be used as a worthwhile screening test? *BMJ* 1999, 319(7224):1562.
92. Pepe MS: The statistical evaluation of medical tests for classification and prediction. New York: Oxford University Press; 2003.
93. Merlo J, Yang M, Chaix B, Lynch J, Råstam L: A brief conceptual tutorial on multilevel analysis in social epidemiology: investigating contextual phenomena in different groups of people. *J Epidemiol Community Health* 2005, 59(9):729-736.
94. Merlo J, Chaix B, Ohlsson H, Beckman A, Johnell K, Hjerpe P, Råstam L, Larsen K: A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Health* 2006, 60(4):290-297.
95. Wagner P, Merlo J: Discriminatory accuracy of a random effect in multilevel logistic regression. *Int J Epidemiol* 2015, 44(suppl 1):i49-i50.
96. Goldstein H, Browne W, Rasbash J: Partitioning variation in multilevel models. *Understand Stat* 2002, 1(4):223-231.
97. Rockhill B, Newman B, Weinberg C: Use and misuse of population attributable fractions. *Am J Public Health* 1998, 88(1):15-19.

98. Björck L, Rosengren A, Bennett K, Lappas G, Capewell S: Modelling the decreasing coronary heart disease mortality in Sweden between 1986 and 2002. *Eur Heart J* 2009, 30 (9):1046-1056

99. Yusuf S, Hawken S, Ôunpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J: Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2004, 364(9438):937-952.

100. Ivert AK, Mulinari S, van Leeuwen W, Wagner P, Merlo J: Appropriate assessment of ethnic differences in adolescent use of psychotropic medication: multilevel analysis of discriminatory accuracy. *Ethn Health* 2016, 21(6):578-595.

101. Broadbent A: Inferring causation in epidemiology: mechanisms, black boxes, and contrasts. In: *Causality in the sciences.* Edited by Illari PM, Russo F, Williamson J: Oxford University Press; 2011: 45-69.

102. Mulinari S: The specificity triad: notions of disease and therapeutic specificity in biomedical reasoning. *Philos Ethics Humanit Med* 2014, 9(14).

103. Armstrong D: Clinical prediction and the idea of a population. *Soc Stud Sci* 2017, 47(2):288-299.

104. Susser M: Does risk factor epidemiology put epidemiology at risk? Peering into the future. *J Epidemiol Community Health* 1998, 52(10):608-611.

105. Hankivsky O: Women's health, men's health, and gender and health: Implications of intersectionality. *Soc Sci Med* 2012, 74(11):1712-1720.

106. Collins PH, Bilge S: Intersectionality. Cambridge: Polity; 2016.

107. Lutz H, Herrera Vivar MT, Supik L: Framing Intersectionality: An Introduction. In: *Framing intersectionality: debates on a multi-faceted concept in gender studies.* Edited by Lutz H, Herrera Vivar MT, Supik L. Farnham: Ashgate; 2011.

108. Collins PY, von Unger H, Armbrister A: Church ladies, good girls, and locas: Stigma and the intersection of gender, ethnicity, mental illness, and sexuality in relation to HIV risk. *Soc Sci Med* 2008, 67(3):389-397.

109. Kapilashrami A, Hill S, Meer N: What can health inequalities researchers learn from an intersectionality perspective? Understanding social dynamics with an inter-categorical approach? *Soc Theory Health* 2015, 13(3-4):288-307.

110. Iyer A, Sen G, Östlin P: The intersections of gender and class in health status and health care. *Glob Public Health* 2008, 3(S1):13-24.

111. Hankivsky O, Grace D, Hunting G, Giesbrecht M, Fridkin A, Rudrum S, Ferlatte O, Clark N: An intersectionality-based policy analysis framework: critical reflections on a methodology for advancing equity. *Int J Equity Health* 2014, 13(1):119.

112. Bowleg L: The problem with the phrase women and minorities: intersectionality – an important theoretical framework for public health. *Am J Public Health* 2012, 102(7):1267-1273.

113. Stronks K, Kunst AE: The complex interrelationship between ethnic and socio-economic inequalities in health. *J Public Health* 2009, 31(3):324-325.

114. Crenshaw K: Demarginalizing the intersection of race and sex: a Black feminist critique of antidiscriminiation doctrine, feminist theory and antiracist politics. In: *Sustainable energy choices for the 90s: Conference proceedings.* University of Chicago Legal Forum; 1989: 139–167.

115. Hancock A-M: Intersectionality: An intellectual history. New York: Oxford University Press; 2016.

116. Grzanka PR: Introduction: Intersectional objectivity. In: *Intersectionality: a foundations and frontiers reader.* Edited by Grzanka PR. Boulder: Westview; 2014.

117. Combahee River Collective: A Black Feminist Statement: na; 1977.

118. de los Reyes P, Mulinari D: Intersektionalitet: kritiska reflektioner över (o)jämlikhetens landskap. Malmö: Liber; 2010.

119. Molina I: Intersubjektivitet och intersektionalitet för en subversiv antirasistisk feminism. *Sociologisk Forskning* 2004, 41(3):19-24.

120. de los Reyes P, Molina I, Mulinari D (eds.): Maktens (o)lika förklädnader: Kön, klass och etnicitet i det postkoloniala Sverige. Stockholm: Atlas; 2002.

121. Lykke N: Intersektionalitet – ett användbart begrepp för genusforskningen. *TGV* 2003(1):sid 47-56.

122. Yuval-Davis N: Beyond the recognition and re-distribution dichotomy: Intersectionality and stratification. In: *Framing intersectionality: debates on a multi-faceted concept in gender studies.* Edited by Lutz H, Herrera Vivar MT, Supik L. Farnham: Ashgate; 2011.

123. Cho S, Crenshaw KW, McCall L: Toward a field of intersectionality studies: Theory, applications, and praxis. *Signs* 2013, 38(4):785-810.

124. Davis K: Intersectionality as buzzword: A sociology of science perspective on what makes a feminist theory successful. In: *Framing intersectionality: debates on a multi-faceted concept in gender studies.* Edited by Lutz HL, Herrera Vivar MT, Supik L. Farnham: Ashgate; 2011.

125. Marx Ferree M: The discursive politics of feminist intersectionality. In: *Framing intersectionality: debates on a multi-faceted concept in gender studies.* Edited by Lutz H, Herrera Vivar MT, Supik L. Farnham: Ashgate; 2011.

126. Carbado DW, Crenshaw KW, Mays VM, Tomlinson B: Intersectionality. *Du Bois Rev* 2013, 10(2):303-312.

127. Dill BT, Kohlman MH: Intersectionality: A transformative paradigm in feminist theory and social justice. In: *Handbook of feminist research: Theory and praxis.* Edited by Hesse-Biber SN. Thousand Oaks, CA: Sage Publications; 2012: 154-174.

128. Mullings L, Schulz AJ: Intersectionality and health: an introduction: San Francisco: Jossey-Bass; 2006.

129. Bowleg L: When Black+lesbian+woman≠Black lesbian woman: The methodological challenges of qualitative and quantitative intersectionality research. *Sex roles* 2008, 59(5-6):312-325.

130. Lykke N: Intersectional analysis: Black box or useful critical feminist thinking technology. In: *Framing intersectionality: debates on a multi-faceted concept in gender studies.* Edited by Lutz H, Herrera Vivar MT, Supik L. Farnham: Ashgate; 2011.
131. Seng JS, Lopez WD, Sperlich M, Hamama L, Meldrum CDR: Marginalized identities, discrimination burden, and mental health: Empirical exploration of an interpersonal-level approach to modeling intersectionality. *Soc Sci Med* 2012, 75(12):2437-2445.
132. Veenstra G: Race, gender, class, and sexual orientation: intersecting axes of inequality and self-rated health in Canada. *Int J Equity Health* 2011, 10:3.
133. Roberts D, Jesudason S: Movement intersectionality: The case of race, gender, disability, and genetic technologies. *Du Bois Rev* 2013, 10(2):313-328.
134. Case KA: Discovering the privilege of whiteness: White women's reflections on anti-racist identity and ally behavior. *J Soc Issues* 2012, 68(1):78-96.
135. Carastathis A: Intersectionality: Origins, contestations, horizons. Lincoln & London: University of Nebraska Press; 2016.
136. Sen G, Iyer A, Mukherjee C: A methodology to analyse the intersections of social inequalities in health. *J Hum Dev Capab* 2009, 10(3):397-415.
137. Hinze SW, Lin J, Andersson TE: Can we capture the intersections? Older black women, education, and health. *Women Health Iss* 2012, 22(1):E91-E98.
138. Warner DF, Brown TH: Understanding how race/ethnicity and gender define age-trajectories of disability: An intersectionality approach. *Soc Sci Med* 2011, 72(8):1236-1248.
139. Longman Marcellin R, R. Bauer G, I. Scheim A: Intersecting impacts of transphobia and racism on HIV risk among trans persons of colour in Ontario, Canada. *Ethn Inequal Health Soc Care* 2013, 6(4):97-107.
140. Evans C, Williams D, Onnela J-P, Subramanian SV: A multilevel approach to modeling health inequalities at the intersection of multiple social identities. In: *Annual Meeting of the Pacific Sociological Association.* Portland, OR; 2016.
141. Evans C: Innovative approaches to investigating social determinants of health – Social networks, environmental effects and intersectionality. Boston: Harvard University Press; 2015.
142. Jones K, Johnston R, Manley D: Uncovering interactions in multivariate contingency tables: a multi-level modelling exploratory approach. *Method Innov* 2016, 9:1–17.
143. Shaw M, Galobardes B, Lawlor D, Lynch J, Wheeler B, Davey-Smith G: The handbook of inequality and socioeconomic position: Conceptes and measures: Bristol: The Policy Press; 2007.
144. Olofsson A, Zinn JO, Griffin G, Giritli Nygren K, Cebulla A, Hannah-Moffat K: The mutual constitution of risk and inequalities: Intersectional risk theory. *Health Risk Soc* 2014, 16(5):417-430.
145. Walby S, Armstrong J, Strid S: Intersectionality: Multiple inequalities in social theory. *Sociology* 2012:46(2):224-240.

146. Rothstein W: Public health and the risk factor. New York and Suffolk: University of Rochester Press; 2003.

147. World Health Organization (WHO): Cardiovascular diseases (CVDs): Fact sheet, 2017. Retreived Aug 14, 2017, from http://www.who.int/mediacentre/factsheets/fs317/en/.

148. Lieb W, Vasan RS: Genetics of coronary artery disease. *Circulation* 2013, 128(10):1131-1138.

149. Lara-Pezzi E, Dopazo A, Manzanares M: Understanding cardiovascular disease: a journey through the genome (and what we found there). *Dis Model Mech* 2012, 5(4):434-443.

150. HjärtLungFonden: Hjärtrapporten 2016. En sammanfattning av hjärthälsoläget i Sverige. Stockholm: HjärtLungFonden; 2016.

151. Dalstra JA, Kunst AE, Borrell C, Breeze E, Cambois E, Costa G, Geurts JJ, Lahelma E, Van Oyen H, Rasmussen NK: Socioeconomic differences in the prevalence of common chronic diseases: an overview of eight European countries. *Int J Epidemiol* 2005, 34(2):316-326.

152. Kurian AK, Cardarelli KM: Racial and ethnic differences in cardiovascular disease risk factors: a systematic review. *Ethn Dis* 2007, 17(1):143.

153. Manrique-Garcia E, Sidorchuk A, Hallqvist J, Moradi T: Socioeconomic position and incidence of acute myocardial infarction: a meta-analysis. *J Epidemiol Community Health* 2011, 65(4):301-309.

154. Yang D, Dzayee DAM, Beiki O, de-Faire U, Alfredsson L, Moradi T: Incidence and case fatality after day 28 of first time myocardial infarction in Sweden 1987-2008. *Eur J Prev Cardiol* 2012:19(6):1304-1315.

155. Reddy KS: Cardiovascular disease in non-Western countries. *New Engl J Med* 2004, 350(24):2438-2440.

156. Wheatley EE: Bodies at risk: an ethnography of heart disease. London and New York: Routledge; 2006.

157. Sachs L: Is there a pathology of prevention? The implications of visualizing the invisible in screening programs. *Cult Med Psychiatry* 1995, 19(4):503-525.

158. Jovanovic M: Creating the 'dis-ease' of high cholesterol: A sociology of diagnosis reception analysis. *Soc Sci Med* 2014, 101:120-128.

159. Lu P-J, Singleton JA, Euler GL, Williams WW, Bridges CB: Seasonal influenza vaccination coverage among adult populations in the United States, 2005–2011. *Am J Epidemiol* 2013, 178(9):1478-1487.

160. Lu P-J, O'Halloran A, Bryan L, Kennedy ED, Ding H, Graitcer SB, Santibanez TA, Meghani A, Singleton JA: Trends in racial/ethnic disparities in influenza vaccination coverage among adults during the 2007-08 through 2011-12 seasons. *Am J Infect Control* 2014, 42(7):763-769.

161. Lu P-J, O'Halloran A, Williams WW, Lindley MC, Farrall S, Bridges CB: Racial and ethnic disparities in vaccination coverage among adult populations in the US. *Am J Prev Med* 2015, 49(6):S412-S425.

162. Quinn SC, Jamison A, Freimuth VS, An J, Hancock GR, Musa D: Exploring racial influences on flu vaccine attitudes and behavior: Results of a national survey of White and African American adults. *Vaccine* 2017, 35(8):1167-1174.

163. Ding H, Santibanez TA, Jamieson DJ, Weinbaum CM, Euler GL, Grohskopf LA, Lu P-J, Singleton JA: Influenza vaccination coverage among pregnant women – National 2009 H1N1 Flu Survey (NHFS). *Am J Obstet Gynecol* 2011, 204(6):S96-S106.

164. Linn ST, Guralnik JM, Patel KV: Disparities in influenza vaccine coverage in the United States, 2008. *J Am Geriatr Soc* 2010, 58(7):1333-1340.

165. Vlahov D, Bond KT, Jones KC, Ompad DC: Factors associated with differential uptake of seasonal influenza immunizations among underserved communities during the 2009–2010 influenza season. *J Community Health* 2012, 37(2):282-287.

166. Centers for Disease Control and Prevention (CDC): Final estimates for 2009–2010 seasonal influenza and influenza A (H1N1) 2009 monovalent vaccination coverage – United States, August 2009 through May, 2010. 2012. Retrieved May 26, 2016, from http://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm 2011.

167. Dee DL, Bensyl DM, Gindler J, Truman BI, Allen BG, D'Mello T, Pérez A, Kamimoto L, Biggerstaff M, Blanton L: Racial and ethnic disparities in hospitalizations and deaths associated with 2009 pandemic influenza A (H1N1) virus infections in the United States. *Ann Epidemiol* 2011, 21(8):623-630.

168. Fiscella K: Commentary – Anatomy of racial disparity in influenza vaccination. *Health Serv Res* 2005, 40(2):539-550.

169. Hutchins SS, Fiscella K, Levine RS, Ompad DC, McDonald M: Protection of racial/ethnic minority populations during an influenza pandemic. *Am J Public Health* 2009, 99(S2):S261-S270.

170. Chen JY, Fox SA, Cantrell CH, Stockdale SE, Kagawa-Singer M: Health disparities and prevention: racial/ethnic barriers to flu vaccinations. *J Community Health* 2007, 32(1):5-20.

171. Phillips AL, Kumar D, Patel S, Arya M: Using text messages to improve patient–doctor communication among racial and ethnic minority adults: An innovative solution to increase influenza vaccinations. *Prev Med* 2014, 69:117-119.

172. Wooten KG, Wortley PM, Singleton JA, Euler GL: Perceptions matter: beliefs about influenza vaccine and vaccination behavior among elderly white, black and Hispanic Americans. *Vaccine* 2012, 30(48):6927-6934.

173. Kaplan JB: The quality of data on "race" and "ethnicity": implications for health researchers, policy makers, and practitioners. *Race Soc Probl* 2014, 6(3):214-236.

174. Guttman N, Salmon CT: Guilt, fear, stigma and knowledge gaps: ethical issues in public health communication interventions. *Bioethics* 2004, 18(6):531-552.

175. Vincent C, Furnham A: Why do patients turn to complementary medicine? An empirical study. *Brit J Clin Psychol* 1996, 35:37-48.

176. Gale N: The sociology of traditional, complementary and alternative medicine. *Sociol Compass* 2014, 8(6):805-822.

177. Siahpush M: A critical review of the sociology of alternative medicine: research on users, practitioners and the orthodoxy. *Health:* 2000, 4(2):159-178.

178. Salamonsen A, Ahlzén R: Epistemological challenges in contemporary Western healthcare systems exemplified by people's widespread use of complementary and alternative medicine. *Health:* 2017:1363459317693408.

179. Johannessen H, Lázar H: Multiple Medical Realities. New York and Oxford: Berghahn Books; 2006.

180. McGuire M: Alternative therapies: the meaning of bodies in knowledge and practice. In: *Studies in Alternative Therapy 2: Body and Nature.* Edited by Johannesse H, Olesen G, Østergård S, Andersen J. Odense: INRAT & Odense University Press; 1995: 15-32.

181. Bullington J: En 'alternativ' syn på kroppen, inspirerad av Merleau-Pontys filosofi. In: *Perspektiv på komplementär medicin. Medicinsk pluralism i mångvetenskaplig belysning* Edited by Eklöf M. Lund: Studentlitteratur; 2004: 101-116.

182. Baarts C, Pedersen IK: Derivative benefits: exploring the body through complementary and alternative medicine. *Sociol Health Illn* 2009, 31(5):719-733.

183. O'Connor BB: Conceptions of the body in complementary and alternative medicine. In: *Complementary and alternative medicine. Challenge and change.* Edited by Kelner M, Wellman B, Pescosolido B, Saks M. London: Routledge; 2003.

184. Hess DJ: Medical modernisation, scientific research fields and the epistemic politics of health social movements. *Sociol Health Illn* 2004, 26(6):695-709.

185. NCCAM: What is complementary and alternative medicine (CAM)? Publication No D156. Bethesda, MD: National Institutes of Health; 2006.

186. Jensen I, Lekander M, Nord CE, Rane A, Ekenryd C: Complementary and alternative medicine (CAM): a systematic review of intervention research in Sweden. Stockholm: Swedish Council for Working Life and Social Research (FAS); 2007.

187. Scott A: Homoeopathy as a feminist form of medicine. *Sociol Health Illn* 1998, 20(2):191-214.

188. Scott AL: Paradoxes of holism: Some problems in developing an antioppressive medical practice. *Health:* 1999, 3(2):131-149.

189. Turner BS: Medical power and social knowledge. London: Sage Publications; 1995.

190. Pritzker S: Living translation: language and the search for resonance in U.S. Chinese medicine. New York: Berghahn; 2014.

191. Heelas P: Spiritualities of life: New Age romanticism and consumptive capitalism. Malden, MA: Blackwell Pub; 2008.

192. Mol A: The body multiple: ontology in medical practice. Durham: Duke University Press; 2002.

193. Ingold T: Being alive: essays on movement, knowledge and description. London and New York: Routledge; 2011.

194. Fox NJ: The ill-health assemblage: Beyond the body-with-organs. *Health Sociol Rev* 2011, 20(4):359-371.

195. Birke LI: Feminism and the biological body. New Brunswick, N.J: Rutgers University Press; 2000.

196. Lin WY, Law J: A correlative STS: Lessons from a Chinese medical practice. *Soc Stud Sci* 2014, 44(6):801-824.

197. Johnston J, Barcan R: Subtle transformations: Imagining the body in alternative health practices. *Int J Cult Stud* 2006, 9(1):25-44.

198. Tarr J: Habit and conscious control: Ethnography and embodiment in the Alexander Technique. *Ethnography* 2008, 9(4):477-497.

199. Carrette JR, King R: Selling spirituality: The silent takeover of religion. London: Routledge; 2005.

200. Possamai A: Alternative spiritualities and the cultural logic of late capitalism. *Cult Relig* 2003, 4(1):31-45.

201. Hornborg A-C: Healing or Dealing? Neospiritual therapies and coaching as individual meaning and social discipline in late modern Swedish society. In: *Religion in consumer society: Brands, consumers and markets.* Edited by Gauthier F, M. T. Farnham: Ashgate; 2013: 189-206.

202. Wemrell M, Mulinari S, Merlo J, Hornborg A-C: Användning av alternativ och komplementär medicin (AKM) i Skåne: Pilotstudie 2016. Rapport 1. Lunds Universitet: Enheten för Socialepidemiologi, Medicinska Fakulteten; 2016.

203. Eardley S, Bishop FL, Prescott P, Cardini F, Brinkhaus B, Santos-Rey K, Vas J, von Ammon K, Hegyi G, Dragan S: A systematic literature review of complementary and alternative medicine prevalence in EU. *Complement Med Res* 2012, 19(Suppl. 2):18-28.

204. Harris P, Cooper K, Relton C, Thomas K: Prevalence of complementary and alternative medicine (CAM) use by the general population: a systematic review and update. *Int J Clin Pract* 2012, 66(10):924-939.

205. Frass M, Strassl RP, Friehs H, Müllner M, Kundi M, Kaye AD: Use and acceptance of complementary and alternative medicine among the general population and medical personnel: a systematic review. *Ochsner J* 2012, 12(1):45-56.

206. Clarke TC, Black LI, Stussman BJ, Barnes PM, Nahin RL: Trends in the use of complementary health approaches among adults: United States, 2002–2012. *Natl Health S Report* 2015(79):1-16.

207. Hunt KJ, Coelho HF, Wider B, Perry R, Hung S, Terry R, Ernst E: Complementary and alternative medicine use in England: results from a national survey. *Int J Clin Pract* 2010, 64(11):1496-1502.

208. Metcalfe A, Williams J, McChesney J, Patten SB, Jetté N: Use of complementary and alternative medicine by those with a chronic disease and the general population-results of a national population based survey. *BMC Complement Altern Med* 2010, 10(1):1.

209. D'Onise K, Haren MT, Misan GM, McDermott RA: Who uses complementary and alternative therapies in regional South Australia? Evidence from the Whyalla Intergenerational Study of Health. *Aust Health Rev* 2013, 37(1):104-111.

210. Adams J: Restricting CAM consumption research: Denying insights for practice and policy. *Complement Ther Med* 2007, 15(2):75-76.

211. Horneber M, Bueschel G, Dennert G, Less D, Ritter E, Zwahlen M: How many cancer patients use complementary and alternative medicine: a systematic review and metaanalysis. *Integr Cancer Ther* 2012, 11:187-203.

212. Grant SJ, Bin YS, Kiat H, Chang DH-T: The use of complementary and alternative medicine by people with cardiovascular disease: a systematic review. *BMC Public Health* 2012, 12(1):1.

213. Shen J, Oraka E: Complementary and alternative medicine (CAM) use among children with current asthma. *Prev Med* 2012, 54(1):27-31.

214. Alaaeddine N, Okais J, Ballane L, Baddoura RM: Use of complementary and alternative therapy among patients with rheumatoid arthritis and osteoarthritis. *J Clin Nurs* 2012, 21:3198-3204.

215. Haliloğlu B, İşgüven P, Yıldız M, Arslanoğlu İ, Ergüven M: Complementary and alternative medicine in children with type 1 diabetes mellitus. *J Clin Res Pediatr Endocrinol* 2011, 3(3):139-143.

216. Fuhrmann T, Smith N, Tausk F: Use of complementary and alternative medicine among adults with skin disease: updated results from a national survey. *J Am Acad Dermatol* 2010, 63(6):1000-1005.

217. Arthur K, Belliard JC, Hardin SB, Knecht K, Chen C-S, Montgomery S: Practices, attitudes, and beliefs associated with complementary and alternative medicine (CAM) use among cancer patients. *Integr Cancer Ther* 2012, 11(3):232-242.

218. Thomson P, Jones J, Evans JM, Leslie SL: Factors influencing the use of complementary and alternative medicine and whether patients inform their primary care physician. *Complement Ther Med* 2012, 20(1):45-53.

219. Sirois FM: Motivations for consulting complementary and alternative medicine practitioners: a comparison of consumers from 1997–8 and 2005. *BMC Complement Altern Med* 2008, 8(1):1.

220. Richardson J: What patients expect from complementary therapy: a qualitative study. *Am J Public Health* 2004, 94(6):1049-1053.

221. Taylor S: Gendering in the holistic milieu: a critical realist analysis of homeopathic work. *Gend Work Organ* 2010, 17(4):454-474.

222. Hornborg A-C: Coaching och lekmannaterapi. En modern väckelse?: Dialogos Förlag; 2012.

223. Sointu E, Woodhead L: Spirituality, gender, and expressive selfhood. *J Sci Study Relig* 2008, 47(2):259-276.

224. Johnson PJ, Kozhimannil KB, Jou J, Ghildayal N, Rockwood TH: Complementary and alternative medicine use among women of reproductive age in the United States. *Women Health Iss* 2016, 26(1):40-47.

225. Wilson KM, Klein JD: Adolescents' use of complementary and alternative medicine. *Ambul Pediatr* 2002, 2(2):104-110.

226. Zuzak TJ, Boňková J, Careddu D, Garami M, Hadjipanayis A, Jazbec J, Merrick J, Miller J, Ozturk C, Persson IA: Use of complementary and alternative medicine by

children in Europe: published data and expert perspectives. *Complement Ther Med* 2013, 21:S34-S47.

227. Grzywacz JG, Suerken CK, Neiberg RH, Lang W, Bell RA, Quandt SA, Arcury TA: Age, ethnicity, and use of complementary and alternative medicine in health self-management. *J Health Soc Behav* 2007, 48(1):84-98.
228. Keith VM, Kronenfeld JJ, Rivers PA, Liang S-Y: Assessing the effects of race and ethnicity on use of complementary and alternative therapies in the USA. *Ethn Health* 2005, 10(1):19-32.
229. Shippee TP, Schafer MH, Ferraro KF: Beyond the barriers: Racial discrimination and use of complementary and alternative medicine among Black Americans. *Soc Sci Med* 2012, 74(8):1155-1162.
230. Broom A, Doron A, Tovey P: The inequalities of medical pluralism: hierarchies of health, the politics of tradition and the economies of care in Indian oncology. *Soc Sci Med* 2009, 69(5):698-706.
231. Furth C, Shu-yueh C: Chinese medicine and the anthropology of menstruation in contemporary Taiwan. *Med Anthropol Q* 1992, 6(1):27-48.
232. Michel JL, Mahady GB, Veliz M, Soejarto DD, Caceres A: Symptoms, attitudes and treatment choices surrounding menopause among the Q'eqchi Maya of Livingston, Guatemala. *Soc Sci Med* 2006, 63(3):732-742.
233. Green G, Bradby H, Chan A, Lee M: "We are not completely Westernised": Dual medical systems and pathways to health care among Chinese migrant women in England. *Soc Sci Med* 2006, 62(6):1498-1509.
234. Cant S, Watts P: Complementary and alternative medicine: Gender and marginality. In: *The Palgrave handbook of gender and healthcare.* Edited by Kuhlmann, E., Annandale, E. Springer; 2012: 488-504.
235. Keshet Y, Simchai D: The 'gender puzzle' of alternative medicine and holistic spirituality: A literature review. *Soc Sci Med* 2014, 113:77-86.
236. Steinsbekk A, Rise MB, Johnsen R: Changes among male and female visitors to practitioners of complementary and alternative medicine in a large adult Norwegian population from 1997 to 2008 (the HUNT studies). *BMC Complement Altern Med* 2011, 11(1):1.
237. Fønnebø V, Launsø L: High use of complementary and alternative medicine inside and outside of the government-funded health care system in Norway. *J Altern Complem Med* 2009, 15(10):1061-1066.
238. Hanssen B, Grimsgaard S, Launso L, Fønnebø V, Falkenberg T, Rasmussen NK: Use of complementary and alternative medicine in the Scandinavian countries. *Scand J Prim Health* 2005, 23(1):57-62.
239. Alternativmedicinkommittén: Fakta och röster om alternativ medicin: en delrapport från Alternativmedicinkommittén. Stockholm: Socialdepartementet; 1987.
240. Eklöf M, Tegern G: Stockholmare och den komplementära medicinen. Rapport 12. Stockholm: HSN, Stockholms läns landsting; 2001.

241. Messerer M, Johansson SE, Wolk A: Use of dietary supplements and natural remedies increased dramatically during the 1990s. *J Intern Med* 2001, 250(2):160-166.

242. Wallström P, Elmståhl S, Johansson U, Östergren PO, Hanson BS: Usage and users of natural remedies in a middle-aged population: Demographic and psychosocial characteristics. Results from the Malmö Diet and Cancer Study. *Pharmacoepidemiol Drug Saf* 1996, 5(5):303-314.

243. Nilsson M, Trehn G, Asplund K: Use of complementary and alternative medicine remedies in Sweden. A population-based longitudinal study within the northern Sweden MONICA Project. *J Intern Med* 2001, 250(3):225-233.

244. Lasse S, Peter HN: Investigating use of CAM treatments among members with multiple sclerosis in the Nordic MS societies. *Eur J Integr Med* 2012, 4:174.

245. Klingberg E, Wallerstedt SM, Torstenson T, Håwi G, Forsblad-d'Elia H: The use of complementary and alternative medicine in outpatients with inflammatory rheumatic diseases in Sweden. *Scand Journal Rheumatol* 2009, 38(6):472-480.

246. Hederos C-A: Vanligt med alternativ behandling av allergiskt sjuka barn. *Läkartidningen* 1988, 85:3580-3581.

247. Al-Windi A: Predictors of herbal medicine use in a Swedish health practice. *Pharmacoepidemiol Drug Saf* 2004, 13(7):489-496.

248. Ernst E: Prevalence surveys: to be taken with a pinch of salt. *Complement Ther Clin Pract* 2006, 12(4):272-275.

249. Eardley S, Bishop FL, Cardini F, Santos-Rey K, Jong MC, Ursoniu S, Dragan S, Hegyi G, Uehleke B, Vas J: A pilot feasibility study of a questionnaire to determine European Union-wide CAM use. *Complement Med Res* 2012, 19(6):302-310.

250. Re ML, Schmidt S, Güthlin C: Translation and adaptation of an international questionnaire to measure usage of complementary and alternative medicine (I-CAM-G). *BMC Complement Altern Med* 2012, 12:259.

251. Quandt SA, Verhoef MJ, Arcury TA, Lewith GT, Steinsbekk A, Kristoffersen AE, Wahner-Roedler DL, Fønnebø V: Development of an international questionnaire to measure use of complementary and alternative medicine (I-CAM-Q). *J Altern Complem Med* 2009, 15(4):331-339.

252. Mosca L, Barrett-Connor E, Wenger NK: Sex/gender differences in cardiovascular disease prevention: what a difference a decade makes. *Circulation* 2011, 124(19):2145-2154.

253. van der Meer MG, Cramer MJ, van der Graaf Y, Doevendans PA, Nathoe HM, SMART study group: Gender difference in long-term prognosis among patients with cardiovascular disease. *Eur J Prev Cardiol* 2014, 21(1):81-89.

254. Pred A: Even in Sweden: Racisms, racialized spaces, and the popular geographical imagination. Berkeley, Los Angeles and London: University of California Press; 2000.

255. Venters M, Jacobs DR, Pirie P, Luepker RV, Folsom AR, Gillum RF: Marital status and cardiovascular risk: the Minnesota heart survey and the Minnesota heart health program. *Prev Med* 1986, 15(6):591-605.

256. Barth J, Schumacher M, Herrmann-Lingen C: Depression as a risk factor for mortality in patients with coronary heart disease: a meta-analysis. *Psychosom Med* 2004, 66(6):802-813.

257. Gerds TA, Cai T, Schumacher M: The performance of risk prediction models. *Biom J* 2008, 50(4):457-479.

258. Centers for Disease Control and Prevention (CDC): Datasets and related documentation for the National 2009 H1N1 Flu Survey (NHFS). 2012. Retrieved May 26, 2016, from http://www.cdc.gov/nchs/nis/data_files_h1n1.htm.

259. Office of Management and Budget (OMB): Revisions to the standards for the classification of federal data on race and ethnicity. 1997. Retrieved Jan 11, 2017, from http://www.whitehouse.gov/omb/fedreg_1997standards.

260. Güthlin C, Re ML, Gerlach F, Schmidt S: Comprehensive validation of a questionnaire asking for CAM use (I-CAM-Q-Questionnaire) – Are results valid and is the questionnaire suitable for use in different languages? *Eur J Integr Med* 2010, 2(4):207-208.

261. Fridh M, Modén B, Lindström M, Grahn M, Rosvall M: Folkhälsorapport Skåne 2013. Malmö: Region Skåne; 2013.

262. Sousa VD, Rojjanasrirat W: Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: a clear and user-friendly guideline. *J Eval Clin Pract* 2011, 17(2):268-274.

263. Adler N, Stewart J: The MacArthur scale of subjective social status. In: *Psychosocial Notebook Psychosocial Working Group.* San Francisco; 2007.

264. Beckfield J, Krieger N: Epi+demos+cracy: linking political systems and priorities to the magnitude of health inequities – evidence, gaps, and a research agenda. *Epidemiol Rev* 2009, 31:152-177.

265. Dunn JR: “Explanation”, philosophy and theory in health inequalities research: Towards a critical realist approach. In: *Rethinking social epidemiology.* Edited by O’Campo P, Dunn JR. New York: Springer; 2012: 23-42.

266. Muntaner C, Ng E, Prins SJ, Bones-Rocha K, Espelt A, Chung H: Social class and mental health: Testing exploitation as a relational determinant of depression. *Int J Health Serv* 2015, 45(2):265-284.

267. Pollock A: Medicating race: Heart disease and durable preoccupations with difference. Durham and London: Duke University Press; 2012.

268. Epstein S: Inclusion: the politics of difference in medical research. Chicago: University of Chicago Press; 2007.

269. Epstein S: Bodily differences and collective identities: The politics of gender and race in biomedical research in the United States. *Body Soc* 2004, 10(2-3):183-203.

270. Krieger N: Embodiment: a conceptual glossary for epidemiology. *J Epidemiol Commun H* 2005, 59(5):350-355.

271. Krieger N: Embodying inequality: epidemiologic perspectives. Amityville, N.Y.: Baywood Pub.; 2005.

272. Gravlee CC: How race becomes biology: embodiment of social inequality. *Am J Phys Anthropol* 2009, 139(1):47-57.

273. Kuzawa CW, Sweet E: Epigenetics and the embodiment of race: developmental origins of US racial disparities in cardiovascular health. *Am J Hum Biol* 2009, 21(1):2-15.

274. Fausto-Sterling A: The bare bones of race. *Soc Stud Sci* 2008, 38(5):657-694.

275. Fausto-Sterling A, Coll CG, Lamarre M: Sexing the baby: Part 2 applying dynamic systems theory to the emergences of sex-related differences in infants and toddlers. *Soc Sci Med* 2012, 74(11):1693-1702.

276. Walters KL, Mohammed SA, Evans-Campbell T, Beltrán RE, Chae DH, Duran B: Bodies don't just tell stories, they tell histories: Embodiment of historical trauma among American Indians and Alaska Natives. *Du Bois Rev* 2011, 8(1):179-189.

277. Cole ER: Intersectionality and research in psychology. *Am Psychol* 2009, 64(3):170.

278. Williams DR, Kontos EZ, Viswanath K, Haas JS, Lathan CS, MacConaill LE, Chen J, Ayanian JZ: Integrating multiple social statuses in health disparities research: the case of lung cancer. *Health Serv Res* 2012, 47(3pt2):1255-1277.

279. Barbujani G, Ghirotto S, Tassi F: Nine things to remember about human genome diversity. *Tissue Antigens* 2013, 82(3):155-164.

280. Holsinger KE, Weir BS: Genetics in geographically structured populations: defining, estimating and interpreting FST. *Nat Rev Genet* 2009, 10(9):639-650.

281. Lewontin RC: The apportionment of human diversity. In: *Evolutionary biology.* Edited by Dobzhansky T, Hecht M, Steere W. Boston: Springer; 1972: 381-398.

282. Sun X, Ioannidis JP, Agoritsas T, Alba AC, Guyatt G: How to use a subgroup analysis: users' guide to the medical literature. *JAMA* 2014, 311(4):405-411.

283. Pande RP, Yazbeck AS: What's in a country average? Wealth, gender, and regional inequalities in immunization in India. *Soc Sci Med* 2003, 57(11):2075-2088.

284. Bleich SN, Thorpe RJ, Sharif-Harris H, Fesahazion R, LaVeist TA: Social context explains race disparities in obesity among women. *J Epidemiol Community Health* 2010, 64(5):465-469.

285. Aronowitz RA: The converged experience of risk and disease. *Milbank Q* 2009, 87(2):417-442.

286. Clarke AE, Shim J, Mamo L, Fosket JR, Fishman JR: Biomedicalization: technoscientific transformations of health, illness, and US biomedicine. *Am Sociol Rev* 2003, 68(2):161-194.

287. Kaplan JB, Bennett T: Use of race and ethnicity in biomedical publication. *JAMA* 2003, 289(20):2709-2716.

288. Engel RS: A critique of the "outcome test" in racial profiling research. *Justice Q* 2008, 25(1):1-36.

289. M'charek A: Silent witness, articulate collective: DNA evidence and the inference of visible traits. *Bioethics* 2008, 22(9):519-528.

290. Sehgal AR: Overlap between whites and blacks in response to antihypertensive drugs. *Hypertension* 2004, 43(3):566-572.

291. Boulware LE, Cooper LA, Ratner LE, LaVeist TA, Powe NR: Race and trust in the health care system. *Public Health Rep* 2016.

292. Kumlin S, Rothstein B: Making and breaking social capital: The impact of welfare-state institutions. *Comp Polit Stud* 2005, 38(4):339-365.

293. Sheldon TA, Parker H: Race and ethnicity in health research. *J Public Health* 1992, 14(2):104-110.

294. Bredström A: Sweden: HIV/AIDS policy and the 'crisis' of multiculturalism. *Race Cl* 2009, 50(4):57-74.

295. Razak F, Smith GD, Subramanian S: The idea of uniform change: is it time to revisit a central tenet of Rose's "Strategy of Preventive Medicine"? *Am J Clin Nutr* 2016, 104(6):1497-1507.

296. Poulson RS, Gadbury GL, Allison DB: Treatment heterogeneity and individual qualitative interaction. *Am Stat* 2012, 66(1):16-24.

297. Setse RW, Euler GL, Gonzalez-Feliciano AG, Bryan LN, Furlow C, Weinbaum CM, Singleton JA: Influenza vaccination coverage – United States, 2000–2010. *MMWR Suppl* 2011, 60(1):38-41.

298. Hankivsky O, Christoffersen A: Intersectionality and the determinants of health: a Canadian perspective. *Crit Public Health* 2008, 18(3):271-283.

299. Clarke AY, McCall L: Intersectionality and social explanation in social science research. *Du Bois Rev* 2013, 10(2):349-363.

300. Ehala M: Signs of identity: The anatomy of belonging. London and New York: Routledge; 2017.

301. Gimenez ME: Marxism, and class, gender, and race: Rethinking the trilogy. *Race, Gender & Class* 2001, 8:23-33.

302. Villa P-I: Embodiment is always more: Intersectionality, subjection and the body. In: *Framing intersectionality: debates on a multi-faceted concept in gender studies.* Edited by Lutz H, Herrera Vivar MT, Supik L. Farnham: Ashgate; 2011.

303. Spivak G: Subaltern studies: deconstructing historiography. In: *Selected works of Gayantri Chakravorty Spivak.* Edited by Landry D, MacLean G: London: Routledge; 1996: 203–235.

304. Wald NJ, Law MR: A strategy to reduce cardiovascular disease by more than 80%. *BMJ* 2003, 326(7404):1419.

305. Melander O, Newton-Cheh C, Almgren P, Hedblad B, Berglund G, Engström G, Persson M, Smith JG, Magnusson M, Christensson A: Novel and conventional biomarkers for prediction of incident cardiovascular events in the community. *JAMA* 2009, 302(1):49-57.

306. Zethelius B, Berglund L, Sundström J, Ingelsson E, Basu S, Larsson A, Venge P, Ärnlöv J: Use of multiple biomarkers to improve the prediction of death from cardiovascular causes. *New Engl J Med* 2008, 358(20):2107-2116.

307. Wald NJ, Simmonds M, Morris JK: Screening for future cardiovascular disease using age alone compared with multiple risk factors and age. *PloS One* 2011, 6(5):e18742.

308. Ernst E: Keynote comment: dumbing down of complementary medicine. *Lancet Oncol* 2005, 6(7):442-443.

309. Chan A, Tan H, Ching T, Tan H: Clinical outcomes for cancer patients using complementary and alternative medicine. *Altern Ther Health Med* 2012, 18:12-17.

310. Taylor DM, Walsham N, Taylor SE, Wong L: Potential interactions between prescription drugs and complementary and alternative medicines among patients in the emergency department. *Pharmacother* 2006, 26(5):634-640.

311. Gaylord SA, Mann JD: Rationales for CAM education in health professions training programs. *Acad Med* 2007, 82(10):927-933.

312. Wetzel MS, Eisenberg DM, Kaptchuk TJ: Courses involving complementary and alternative medicine at US medical schools. *JAMA* 1998, 280(9):784-787.

313. Berg E, McGregor J, Burkart M, Poulton C, Hogan S: What everybody is doing but no one is talking about: complementary and alternative medicine (CAM) prevalence in the ANCA SVV population. *Presse Med* 2013, 42(4):775.

314. Sidora-Arcoleo K, Yoos HL, Kitzman H, McMullen A, Anson E: Don't ask, don't tell: parental nondisclosure of complementary and alternative medicine and over-the-counter medication use in children's asthma management. *J Pediatr Health Care* 2008, 22(4):221-229.

315. Conrad P: The medicalization of society: On the transformation of human conditions into treatable disorders. Baltimore: John Hopkins University Press; 2008.

316. Abraham J: Pharmaceuticalization of society in context: Theoretical, empirical and health dimensions. *Sociology* 2010, 44(4):603-622.

317. Khoury MJ, Iademarco MF, Riley WT: Precision public health for the era of precision medicine. *Am J Prev Med* 2016, 50(3):398.

Study I

Sociology Compass 10/2 (2016), 153–171, 10.1111/soc4.12345

Contemporary Epidemiology: A Review of Critical Discussions Within the Discipline and A Call for Further Dialogue with Social Theory

Maria Wemrell[1]*, Juan Merlo[1], Shai Mulinari[1,2] and Anne-Christine Hornborg[3]
[1]*Unit of Social Epidemiology, Faculty of Medicine, Lund University*
[2]*Department of Sociology, Faculty of Social Sciences, Lund University*
[3]*Center for Theology and Religious Studies, Lund University*

Abstract

The discipline of epidemiology, which holds major influence on public health policy as well as on clinical medical practice, has in recent decades to a large extent been concerned with the identification of factors and markers of risk for disease. Much health information and intervention is thus informed by a wealth of studies on a variety of risk factors, of which the individual is encouraged to keep informed and to be responsible about. Meanwhile, risk factor epidemiology has been subject to intense debate, both within and outside the discipline. The following review offers an overview of critical intradisciplinary debates. It then opens discussion on three partially overlapping areas where social theory has been called upon to contribute to epidemiological inquiry, namely analysis of macro-social determinants of health and disease, of categories of human difference and of embodiment. The review ends with, and is motivated by, a plea for further integration of and dialogue between epidemiology and social theory.

Introduction

The discipline of epidemiology, which holds major influence on public health policy as well as on clinical medical practice, has in recent decades to a large extent been concerned with the identification of factors and markers of risk for disease. Much health information and intervention is thus informed by a wealth of studies on a variety of risk factors, of which the individual is encouraged to keep informed and to be responsible about. Meanwhile, risk factor epidemiology has been subject to intense debate, both within and outside the discipline. The following review offers an overview of critical intradisciplinary debates. It then opens discussion on three partially overlapping areas where social theory has been called upon to contribute to epidemiological inquiry. These are analysis of macro-social determinants of health and disease, of categories of human difference and of embodiment (i.e. how social structures 'get under the skin' and thus affect patterns of health – e.g. Ferraro and Shippee 2009). The review ends with, and is motivated by, a plea for further integration of and dialogue between epidemiology and social theory.

The subject matter of the review is extensive, and the article lays no claims on being in any way exhaustive. It is intended as an introductory overview of debates relevant to social theorists interested in epidemiological knowledge production, as well as to epidemiologists drawn to social theory and/or self-reflexive inquiry.

Epidemiological knowledge in question

Epidemiology, as defined by the WHO (2015), is 'the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems'. In Moon's words, epidemiologists strive to 'describe, explain, predict and control' disease (Moon et al. 2000, 5). As major causes of mortality in western countries shifted from infectious to chronic illnesses around the mid 20th century, modern epidemiology developed in conjunction with a multifactorial model of disease aetiology. Specific, often bacterial- or virus-oriented, models adhering to infectious diseases were thus supplanted with the assumption that a range of influences or risk factors, metaphorically envisioned as a web of causation, contributes to disease development. Early investigations like the Framingham and Seven Countries studies, largely focused on cardiovascular disease, laid the groundwork, and the discipline's continued trajectory has been supported by synchronic growth of information technology, rapidly growing amounts of data and increasingly sophisticated statistical methods. Today, clinical guidelines informed by epidemiological study, and abundant media reports on what risks should be avoided or considered in the interest of health, have become familiar parts of many contemporary settings.

Within social theory, researchers have framed risk factor epidemiology in various ways. Many have pointed to the central role of epidemiological knowledge in expansion of medical interest, reaching beyond disease to also include risk-of or risk-as disease. This expansion has been related to processes of medicalisation (e.g. Aronowitz 2009; Conrad 2007; Greene 2007; Kawachi and Conrad 1996; Klawiter 2002; Skolbekken 2008), pharmaceuticalisation (e.g. Abraham 2010; Dumit 2012; Pollock and Jones 2015; Williams et al. 2008) and biomedicalisation (e.g. Clarke et al. 2003, 2010). Others have used the Foucaultian concept of biopower (e.g. Dean 1999; Gottweis 2005; Hacking 1991; Helén 2004; Jackson 2003; Lemke 2011; Rose 2007; Shim 2014; Wheatley 2006) and other strands of social theory on risk (e.g. Beck 1992; Douglas 1984; Douglas and Wildavsky 1982; Giddens 1991; Lupton 1999; Lyng 1990) to grapple with epidemiological notions of risk. What is not always forefronted in such theorisation, nor for that matter in mainstream epidemiological literature, is the wealth of divergent views, often incorporating calls for social theory, which can be found within the discipline itself.

In many settings, epidemiological calculations still tend to have an air of impeccably standardised and neutral quantification. Still, Latour's (1987) description of the double-sided Janus face of science, where one side displays neat, hard facts and the other reveals the messiness of controversies and contingencies, is very apt here. Critical discussions abound, as in any living field of study, and waves of debate have at times run notably high. During the 1990s, Poole and Rothman referred to the 'epidemiology wars' (Poole and Rothman 1998), while McKinlay stated that 'business as usual simply cannot continue' (McKinlay 1993, 109), and Susser argued that epidemiologists 'need either to adopt a new paradigm or face a sort of eclipse' (Susser 1998, 609). As major threads of such debates can be traced into present times, our review begins there.

1990s: on subject matter, methodology and notions of paradigmatic change

Epidemiological writings from the 1990s can, as Camargo et al. (2013) observe, be divided into two major groups. The first offers an abundance of calculations on various risk factors for disease, while the second voices criticisms towards the former, in debates construed by Shy (1997) as a legal battle between a mainstream defendant and a critical prosecutor. As the topic of the present review is critical debate, focus here lies on arguments of the latter.

A reiterated critique concerned mainstream epidemiology's focus on the individual, as its unit of observation, analysis and intervention. Numerous authors observed that although epidemiology according to basic definition was to be regarded as population medicine, it still tended to focus on the body, lifestyle, behaviour, sex/gender, race/ethnicity and perhaps the personality, emotional state or socioeconomic status of the single person (e.g. Anonymous 1994; Dean and

Hunter 1996; McKinlay 1993; Poland et al. 1998; Susser 1989; Syme 1996). Consequently, Susser observed, epidemiology had 'little regard for the social structures and social dynamics that encompass [individuals]' (Susser 1998, 609). While a number of epidemiologists did pursue analyses of social determinants of disease (e.g. Kaplan 1999; Krieger et al. 1993; Lynch et al. 1997; Marmot and Wilkinson 1999; Marmot et al. 1991; Townsend and Davidson 1982), authors like Syme (1996) and Krieger (1992) noted that categories of socioeconomic status and/or class had generally been omitted or de-prioritised in epidemiological research, particularly in the United States. Meanwhile, only a minority of studies considered health effects of phenomena like racism, sexism or environmental destruction (e.g. Dean and Hunter 1996; Krieger and Sidney 1996; Krieger et al. 1998; McMichael 1995). As an example of how larger contextual phenomena were displaced from study, Wing (1994) brought up smoking, the establishment of which as a major risk factor was typically considered one of epidemiology's great successes. Wing observed that in epidemiological study, as in related prevention strategies, smoking was typically construed as a habit of individual consumers. Other parts of the scenario, like those involving tobacco industry, agribusiness or social circumstances conducive to smoking, did not provoke as much interest. As a result, smoking did indeed decrease in the western world, especially among the more privileged, while in poorer countries it increased. Despite the alleged success of epidemiology, then, many people still became ill due to smoking, while health disparities were exacerbated. Shy's (1997) prosecutor wrote, accordingly:

> It is one thing to identify the risk factors for lung cancer in individuals and another to understand what changes occurred in society to result in an epidemic of lung cancer in the 20th century [...] Academic epidemiology failed to study the underlying societal factors that are causes of disturbances in health at the population level (Shy 1997, 480f).

Such underlying questions should be addressed, many argued, through investigation of macro-level, socioeconomic and/or power-related societal parameters (e.g. McKinlay and Marceau 2000; McMichael 1995; Muntaner 1999; Pearce 1996; Poland et al. 1998).

For Shy's defendant, i.e. mainstream epidemiology, such phenomena were not considered part of epidemiological subject matter. Critics argued, however, that they should be (Shy 1997; Syme 1996), some by drawing attention to earlier periods in the history of the discipline, notably 19th century Europe where epidemiologists like Chadwick, Farr, Engels and Virchow agreed that issues of population disease were societal in nature (Krieger 1992; Wing 1994). While political motivations of both theorisations and prevention efforts may have differed, focus was directed towards the societal level. Over the 19th century this orientation was progressively overshadowed by germ theory, until by the mid-20th century mortality due to chronic illness rose to prominence together with the framework of multicausality. This model re-opened the case, at least in principle, for stronger inclusion of social parameters in analyses of disease causation. Such work was indeed done, not least within social epidemiology (i.e. the evolving sub-discipline concerned with social determinants of disease), but as argued by Krieger (1994), attention still tended to be directed towards the factors or strands of the web of causation deemed 'closest' to the disease outcome. These were typically biological agents or lifestyle factors relating to bodies and behaviours of individuals. McKinlay (1993) commented that epidemiology thereby supported tendencies towards blaming the victim of disease.

These discussions took place on several levels, involving questions of epistemology, ontology, knowledge application and the issue of whether knowledge could or should be neutral or value-free (e.g. Camargo et al. 2013). Regarding the point of neutrality, some explicitly argued for adherence to such ideals (Savitz et al. 1999; Stolley 1985). Others drew attention to the contingency of all knowledge (Brown 1993; Krieger 1994, 1999; Moon et al. 2000; Wing 1994).

While arguing against what they perceived as a general absence of social theory in epidemiology, authors like Krieger (1994), Pearce (1996) and McKinlay (1998) asserted that this absence did not equate to non-existence of underlying assumption or values but merely meant that these were not made visible, or conscious. Along similar lines, some pointed to limitations and/or values inherent in epidemiological research methodologies themselves. According to Schwartz and Carpenter (1999), these often tended towards 'providing the right answer for the wrong question', for example, by studying causation of homelessness through looking for traits differentiating homeless people from non-homeless ones, leaving other questions unasked and thus unanswered. To McKinlay's mind,

> [l]ike good servants, these epidemiological approaches and methods are always available, do whatever is asked of them, but seldom question the underlying reasons (McKinlay 1998, 370).

While McKinlay (1993) noted that the randomised controlled clinical trial, the 'gold standard' among epidemiological methods, did not lend itself to study of macro-level forces, Wing (1994) and McMichael (1995) observed that within the framework of mainstream epidemiology, efforts to investigate social context almost inevitably became fraught with issues of confounding, i.e. of ambivalent or mixed influences requiring disentanglement for the reliable measurement of individual factors:

> it is only by excluding the context and focusing on particular factors considered independently of historical conditions that science can produce objective knowledge (Wing 1994, 82).

Rather than actually achieving objectivity, however, Wing argued that mainstream epidemiology made a political commitment to the status quo by excluding socioeconomic, political and cultural issues from consideration (also Brown 1993; Krieger 1994).

Alongside these debates, a different set of discussions pointed to other problems or uncertainties involved in the production and interpretation of epidemiological knowledge. In an article based on interviews with leading epidemiologists, Taubes (1995) noted that these seemingly converged in the view that regardless of how carefully or with which mathematical techniques studies were done, epidemiological study almost invariably struggled with error and bias, largely because the vast majority of risk factors accounted for such subtle influences that their significance was difficult to measure. 'We're pushing the edge of what can be done with epidemiology', Rothman stated (quoted in Taubes 1995, 167). Meanwhile, debates surrounding the scientific underpinnings of more or less established risk factors, notably for cardiovascular disease, continued. The controversy surrounding cholesterol was a case in point (e.g. Thompson 2009). On a more general note, some epidemiologists argued that established risk factors could not adequately explain cardiovascular disease trends within and between populations (Kannel and Thom 1984; Nieto 1999; Syme 1996). It is 'somewhat striking', Nieto stated with reference to cardiovascular epidemiology, 'how little new substantive knowledge has been gained in this area in the last four decades' (Nieto 1999, 293). There had been no lack of potential candidates, he added, as already in 1981 Hopkins and Williams (1981) listed 250 possible cardiovascular risk factors, and the number continued to rise. In McKinlay and Marceau's words, then,

> Established epidemiology is analogous to a maze (in this case, a maze of risk factors) with no opening or exit in sight (McKinlay and Marceau 2000, 26).

As part and parcel of such debates, several epidemiologists argued for radical renewal of the discipline, and to many an increased inclusion of social parameters was an overarching goal.

Multilevel analyses encompassing collective as well as individual levels were recommended and developed (Diez-Roux 1988, 2000; Susser 1989, 1998), while some argued for incorporation of ethnographic methods and other forms of qualitative study (Anonymous 1994; Dean and Hunter 1996; McKinlay 1993). A few evoked notions of paradigmatic change. While discerning co-existing paradigms within epidemiology and public health, McKinlay (1998; McKinlay and Marceau 2000) argued for increased attention towards collective or macro-social dimensions of disease causation, within a framework primarily concerned with health rather than disease. Susser (1998; Susser and Susser 1996) proposed a new Eco-Epidemiology, aiming to reach beyond the present focus on risk factors towards inclusion of societal as well as individual and molecular levels, all conceptualised as nested within each other in mutual and interactive interrelationship. Going further, while calling for reengagement between epidemiology and social sciences in the 21st century, Krieger (2000, 2001) proposed an ecosocial framework. Within it, study should tend to multiple levels of organisation, be concerned with social as well as biological determinants of disease, investigate processes of embodiment and include social theory.

2000 and onwards: the debates go on

The discipline of epidemiology continues to develop and has, again tending towards polarisation, produced two major lines of study. One is the molecular, fuelled by investigation of genes, genomes and biomarkers, while the other is the social, continuing to grow out of the work of the 1990s (e.g. Galea and Link 2013).

As for the molecular, the Human Genome Project was introduced in Europe as an endeavour towards 'Predictive Medicine' (Rose 2000). Massive investments alongside powerfully communicated narratives of pending ability to predict all sorts of diseases (e.g. Collins and McKusick 2001; Zwart 2009) nurtured expectations of exciting new realms of risk factors. Some time down the track, however, a limited amount of epidemiologically useful information had so far been yielded (e.g. *The Lancet* Editorial 2010; Hayden 2010). In the case of cardiovascular disease, for example, despite the identification of relevant markers, the 'effect sizes per risk allele have been modest' (Lieb and Vasan 2013, 1134), only explaining an 'extremely small increase in risk' (Cappola and Margulies 2011, 90). On a methodological note, Lara-Pezzi et al. remark,

> analysis of common multifactorial diseases such as CVD [cardiovascular disease] is hindered by the interdependence of genetic and environmental factors and the difficulties that are inherent in separating the influence of individual factors (Lara-Pezzi et al. 2012, 434).

While recent efforts have included attempts towards development of new cholesterol-lowering drugs (PCSK- and CETP-inhibitors; Dorey 2015; Durrington 2012) and future breakthroughs are possible, to date, then, complexities encountered in fields of genetics, genomics and epigenetics have mitigated against the anticipated 'revolution' (Collins 2010) in (predictive) medicine. So far, molecular epidemiology has not made the study of social parameters redundant, in other words. On the contrary, Meloni (2014) speaks of a social turn in the life sciences, pointing to (epi)genetics as one of the areas of natural science research through which it has become increasingly difficult to separate the biological from the social or cultural. It is debatable, however, how traceable the implications of such a social turn are in epidemiology and related health sciences (e.g. Krieger 2011; Lock 2013).

Meanwhile, the sub-discipline of social epidemiology has grown. A wealth of studies focusing on health inequalities and/or including social factors in explanatory models of health and disease has evolved (e.g. Berkman and Kawachi 2000; Commission on Social Determinants of Health 2008; Cwikel 2006; Navarro 2007; O'Campo and Dunn 2012; Oakes and Kaufman 2006). According to Galea and Link (2013), it would nowadays be hard to find an epidemiologist claiming that social factors are not relevant to disease causation. Still, scholars argue that current (social) epidemiology has severe limitations, in terms of its faltering ability to provide adequate tools for addressing existing health disparities.

This failure to contribute to alleviation of health inequalities should be met, Harper and Strumpf (2012) argue, by increased focus on what they call answerable questions. They hereby refer to narrowly specified research questions that can be addressed by means of experimental or quasi-experimental methods, preferably randomised controlled trials, enabling epidemiological study to make itself useful to policy-making in concrete and direct ways. Meanwhile, other authors argue against such a narrowing of horizons. Scott-Samuel and Smith (2015) assert, for example, that the dominant 'policy paradigm' that, within the framework of neo-liberalism, prioritises economic growth as an overarching goal, renders it virtually impossible for policy-makers to effectively reduce health inequalities (see also Schrecker and Bambra 2015). Along similar lines, O'Campo and Dunn (2012) observe that the identification and description of health inequalities and their links with various risk factors, which has been a major concern of (social) epidemiology, provides insufficient knowledge on which to base effective solutions (also Muntaner 2013; O'Campo 2003). What is missing, they argue, is adequate inclusion of macro-level societal forces and structures in epidemiological inquiry. Echoing discussions from previous decades, O'Campo and Dunn (2012), like Bauer (2014), Ng and Muntaner (2014), Muntaner (2013), Galea and Link (2013) and Krieger (2011), note that macro-level structures are still largely absent from study, as is social theory. Perhaps confirming the latter, a citation study of the influential *American Journal of Epidemiology* found that the proportion of references to social science journals remained, during the 22-year study period, around 0.2 percent (Oakes 2005).

Commenting on the persisting 'dominance of implicit, rather than explicit, use of epidemiologic theory to inform epidemiologic research', Krieger (2011, 4) observes that this implicit theory typically continues to rest on the ontologies and epistemologies of biomedical and lifestyle approaches. A central feature of both, Krieger notes, is individualism, as the primary causes of disease both on individual and population levels are taken to be biophysical agents, genes and 'risk factors' to which exposure is largely determined by individual characteristics and behaviours. A second feature is reductionism, as explanatory models centred on molecular processes and other mechanisms occurring within biological organisms are typically assumed to sufficiently explicate disease occurrence and distribution at the population level. Accordingly, a web of causation for myocardial infarction printed in a 2004 epidemiology textbook attends to

> [i]ndividual-level risk factors identified by biomedical and lifestyle hypotheses and does so with scant attention to the larger societal and ecologic context in which these exposures are produced and distributed, let alone whether the depicted factors are sufficient to explain extant and changing population distribution of disease (Krieger 2011, 154).

Biomedical and lifestyle orientations thrive, Krieger (2011) concludes, in 21st century science. Meanwhile, efforts continue to be made towards further integration of social parameters and theories into epidemiology, for example, through development of Krieger's ecosocial theory (e.g. Buffardi et al. 2008; Krieger 2012; Leslie and Lentle 2006; Yamada and Palmer 2007), Latin American Social Medicine (e.g. de Almeida-Filho 2000; Granda 2008; Krieger 2011; Muntaner 2013; Tajer 2003), theorisation of psychosocial determinants of health and disease (e.g. Marmot 2004; McEwen 2008; Wilkinson and Pickett 2009) and complex systems frameworks (e.g. Diez-Roux 2007; Jayasinghe 2011).

Another line of debate, reminiscent of previously mentioned discussions on epidemiological method (Taubes 1995), concerns conflicts arising from translation of aggregate-level risk, as in probabilistic concepts based on measurements in populations (average causal effects), into risk estimates regarding individuals (individual causal effects). This may perhaps not appear as a point of real controversy, as basic, introductory books on epidemiology emphasise that such translations are indeed problematic (Gerstman 2003; Webb and Bain 2011). As elaborated in seminal work by Rose (1992), who was inspired by Durkheim, it is well known that population averages may obscure considerable heterogeneities of responses between individuals and groups. Imposition of average values on the individual, termed the 'tyranny of the means' by Tabery (2011), has long been criticised (Bernard 1957; Hogben and Sim 1953), not least by epidemiologists promoting 'n-of-1' design (i.e. studies made on single persons; Guyatt et al. 1986) and/or personalised medicine (Lillie et al. 2011). Similar critiques have been raised in political (Downs and Roche 1979) and biological sciences (Gould 1996a, 1996b; Kaplan and Gronfeldt Winther 2013). Nonetheless, average-level risk continues to be applied to the individual level in a wealth of ongoing clinical and public health practices. Some epidemiologists therefore argue that consideration of individual heterogeneity has not been sufficiently addressed or integrated. Merlo et al. (2013a, 2013b, 2014), Smith and Egger (1998), Pepe et al. (2004) and Levine (2001) emphasise that as tools for distinguishing between individuals who will become ill or not, and thus who should or should not be (pharmaceutically) treated, population-average risk factors are often quite blunt. Most risk factors (social as well as biological) have, in other words, low discriminatory accuracy (Merlo 2014). In the case of cardiovascular disease, Levine (2005) refers to studies where risk factors were found to be almost as prevalent among those non-diseased as among those diseased, while Merlo et al. (2013a, 2013b) stress that neither established risk factors like hypertension nor newly found biomarkers do much to improve cardiovascular disease prediction as compared with estimates based merely on age and sex. Merlo (2014) adds that measurements often used to quantify the burden of cardiovascular disease (population attributable fractions, e.g. Yusuf et al. 2004; Björck et al. 2009) and thereby motivate public health interventions tend to be misleading as they may exaggerate the relevance of risk factors by not considering people who are exposed to the factor but do not develop disease. The adequacy of many risk factors, as bases of prevention strategies and explanations of disease trajectories, is thereby called into serious question. Epidemiologists pursuing this line of argument have handled the question in different ways. Levine (2007) takes a step away from quantitative risk calculation, while Smith's (2011) solution to the 'Gloomy Prospect' of epidemiology is an acknowledgement that probabilistic, or even stochastic, models of prediction are all that remain. Merlo et al. (2003, 2004, 2005, 2009, 2012, 2014) assert, rather, that epidemiology should continue to develop beyond consideration of population-average risk, through multilevel analyses of individual heterogeneity, taking discriminatory accuracy into central account. This is important not least, Merlo argues (also Mulinari et al. 2015a, 2015b), as population averages may stigmatise certain groups by making them appear more homogenous, and different to others, than they are.

These discussions relate, finally, to coexistence of probabilistic and mechanistic forms of knowledge. In epidemiology, mechanistic approaches basically seek to establish casual hypotheses by explaining 'how something works' (Broadbent 2011, 49). While this stance relates comfortably, in principle, to biomedical visions of specific aetiology (Mulinari 2014), the rise of multifactorial webs of causation and concomitant focus on risk brought probabilistic approaches into the centre of epidemiology. Measures of probability establish the 'extent to which an event is likely to occur' (Oxford Dictionaries 2015), rather than dynamics through which such events are brought about, and resultant lack of attention to mechanism has been a major cause of criticism against probabilistic risk factor or 'black-box' epidemiology (Greenland et al. 2004; Ng and Muntaner 2014; Susser 1998). Galea and Link (2013) argue, thus, that epidemiologists must increase their focus on biological mechanisms of disease causation. Others (Lofters and O'Campo 2012; Ng and Muntaner 2014) promote attention to social mechanisms. Merlo et al. (2012, 2013a, b, 2014) emphasise that probabilistic and mechanistic approaches exist in a relationship of deep tension, expressed in mentioned frictions between population-level and individual-level risks, which has not been resolved or adequately confronted. Noting that much empirical work in (social) epidemiology continues to adopt a probabilistic stance (also Smith 2011), Merlo stresses that this approach remains unable to grasp heterogeneity around averages and that epidemiologists need to step up in investigation of mechanisms of disease causation while incorporating analyses of variance. Furthermore, Merlo continues, the fundamental contradiction between probabilistic and mechanistic approaches needs to be recognised as part of a current state of crisis in epidemiology, and doors should be opened towards alternative forms of medical knowledge.

Engaging social theory

Over the past decades, then, as epidemiologists have debated various aspects of their discipline, reiterated arguments have been made for further integration of macro-level determinants of health and disease and of social theory, as well as of consideration of environmental sustainability, in epidemiological study. The following will open brief discussion on three partially overlapping areas where social science has been called upon to enter into or deepen dialogues with epidemiology, for purposes of theorising structures and relationships of power. These are analyses of macro-level determinants of health and disease, of categories of human difference and of embodiment.

Macro-level determinants of health and disease: political epidemiology and critical realism

Among the many arguments made for increased attention towards macro-level determinants of health and disease in epidemiology (e.g. Commission on Social Determinants of Health 2008; Levins 2000; Theorell 2006), authors like Beckfield and Krieger (2009) and Muntaner (2013; Ng and Muntaner 2014) argue for the development of a political epidemiology informed by critical realism.

Under the heading 'Epi+demos+cracy', Beckfield and Krieger (2009) propose a research agenda under which social epidemiology and political sociology cooperate in study of how political systems and priorities affect population health and health disparities. Beckfield and Krieger note that while epidemiology has mainly been concerned with individual-level associations between social position and health, and social sciences have looked at how political and economic systems affect population well-being, or how categories used to study health inequalities are in themselves part of relations of power, these two bodies of research have rarely engaged in explicit dialogue. Pointing to resultant knowledge gaps in existing literature, Beckfield and Krieger argue that there is much to benefit from combining strengths of sociology with those of epidemiology. Although such inquiry might be sensitive, due to inevitable actualisation of values and ideologies, Beckfield and Krieger argue that it is needed, for the production of knowledge that is practically applicable in efforts towards reducing health disparities:

> Power, after all, is at the heart of the matter – and the science of health inequities can no more shy away from this question than can physicists ignore gravity or physicians ignore pain (Beckfield and Krieger 2009, 169).

Muntaner (2013; Ng and Muntaner 2014) similarly argues that furthered understanding of how social production of disease can be changed requires integration of economics, politics and sociology into epidemiology. Noting that most epidemiological study adopts a fundamentally uncritical position towards existing social structures, Muntaner argues for adoption of the sociological framework of social conflict. Based on a view of society as characterised by inequality, tension and conflicting interests, this framework enables investigation of how unequal power relations are causally linked to unequal distribution of resources and, in turn, to generation of health inequalities.

In response to calls for theory, Ng and Muntaner (2014), like O'Campo and Dunn (2012; Dunn 2012; Lofters and O'Campo 2012), promote integration of critical realism (also Collins et al. 2015; Scambler and Scambler 2015). A central feature of this theoretical approach, as emphasised by these authors, is its focus on mechanism. In contrast to familiar epidemiological efforts to demonstrate associations between various factors and data, realist epidemiology aims to identify context-mechanism-outcome patterns and thus provide explanations of how macro-social determinants and population health are causally linked. It thus aims to explore 'relational mechanisms such as sexism, racism, heterosexism, ableism, ageism, classism' (Ng and Muntaner 2014, 32) as well as transnational division of labour and historical trajectories of exploitation, while aiming to assist the development of a 'public health imagination' (Ng and Muntaner 2014, 32f) by which personal health problems are understood to be public and political in nature. Such realist focus on mechanism implies, Dunn (2012) adds, that increasing amounts of data and/or statistical precision are not to be taken as the main or only ways to furthered knowledge. Attention should also be paid to theoretically framed analyses of causal mechanisms, resting on qualitative as well as quantitative inquiry.

Categories of human difference

Efforts, as quoted above, to investigate 'relational mechanisms such as sexism, racism, heterosexism, ableism, ageism, classism' (Ng and Muntaner 2014, 32) ideally encompass critical inquiry into how the very categories used to define such relations, within the study of health inequalities (Beckfield and Krieger 2009), can themselves be considered part of power structures. Stratifications along lines of race/ethnicity, sex/gender and class/socioeconomic position are central to (social) epidemiology's study of health disparities, as well as to conceptualisation of exposures or factors of risk. In social theory, inquiry into how difference has been constructed and negotiated in medical science along these categories forms a field in itself (e.g. Birke 2000; Johanisson 2004; McClintock 1995; Merchant 1989; Stepan 1996), and corresponding analysis on epidemiological handling of such categorisation can enrich analyses of health disparities with methodological and theoretical as well as self-reflexive insight.

Pollock (2012) investigates how notions of race have been invoked and constructed in relation to heart disease through efforts like the Framingham study, while Epstein (2004, 2007) looks at recent inclusion of populations differentiated along categories of race/ethnicity and sex/gender in clinical trials, arguing that such inclusion does not in itself counteract health disparities rooted in social structure rather than biology. Shim (2000, 2002, 2005, 2010, 2014), on her part, analyses how categories of race/ethnicity, sex/gender and class are used in cardiovascular epidemiology. A wealth of studies point to cardiovascular health inequalities along these lines (e.g. AHA/ASA 2013; Dalstra et al. 2005; Kurian and Cardarelli 2007). Although epidemiologists may have differing understandings of why such disparities exist and how they should be addressed, Shim argues that in epidemiological practice they tend to be dealt with in uniform, routine or 'ritualised' ways. Shim hereby refers to standardisation, a basic way of avoiding error in epidemiological study by weighing results against a standard population. Variables like ethnicity or socioeconomic status are thus compared and adjusted against 'standard differences', with the aim of making results representative of larger populations and/or teasing out influences from different factors. This practice tends to render health disparities as given, Shim argues, by normalising them and smoothing over the very differences that should be the focus of research (also Lofters and O'Campo 2012). Furthermore, by constructing such categories as individual-level risk factors, as in attributes of individuals and groups rather than dynamics of relationships between individuals or groups, and by modelling public health interventions accordingly, Shim asserts that epidemiology may contribute to perpetuation or even production of social inequalities.

Shim evokes the theoretical frame of intersectionality, the concept brought forward by Crenshaw (1989) and developed by theorists like McCall (2005), Nash (2008) and Choo and Ferree (2010) as a means of thinking beyond categories like ethnicity, gender, class and sexuality as separate, but rather as interacting in multi-layered ways. Intersectionality has been proposed as a theoretical framework for epidemiology and public health (Bauer 2014; Dworkin 2005; Hankivsky 2011; Iyer et al. 2008) as well as for analyses of risk (Collins et al. 2008; Hannah-Moffat and O'Malley 2007; Olofsson et al. 2014). Kapilashrami et al. (2015) suggest, for example, that such a framework can help researchers look towards social dynamics rather than social categories and thus consider structural drivers of inequalities rather than individual-level behaviours. Studies looking at how intersectionality has actually been integrated in the fields of health and risk research find limitations, however (Girtli Nygren and Olofsson 2014; Hankivsky 2012; Kapilashrami et al. 2015; Olofsson et al. 2014). Efforts have been made to integrate intersectionality into quantitative study, explicitly (e.g. Bauer 2014; Hinze et al. 2012; Veenstra 2011) or more implicitly through analyses of heterogeneity within and between social categories (Merlo et al. 2004; Mulinari et al. 2015a, 2015b). It is sometimes argued, however, that qualitative study is more suited for intersectionality studies than quantitative (Girtli Nygren and Olofsson 2014; Schultz and Mullings 2006), and integration of qualitative methods into epidemiology has been promoted for that purpose (Bauer 2014).

Embodiment

As a means to conceptualise continuities and pathways between macro-social conditions and societal relationships on the one hand, and the health status of population groups on the other, Krieger (2001, 2005a, 2005b, 2011, 2012) puts forward the concept of embodiment. This notion needs to lie at the very core of (social) epidemiology, she argues, as an understanding of health disparities requires theorisation of how social structures and experiences become biologically incorporated and manifested in bodies. A central question is thus how patterns of disease distribution can be understood as 'biological expressions of social relations' (Krieger 2001, 672). Such investigation necessarily involves theory, Kreiger emphasises, and she refers to authors like Bourdieu (1984), Merleau-Ponty (1989) and Scheper-Hughes and Lock (1987).

Epidemiological interest in embodiment can be taken as synchronic with what Meloni (2014) calls the social turn in the life sciences, as well as with the vast increase of interest in the body seen within the social sciences over recent decades, springing from problematisation of previously held conceptions of the body as universally constant (e.g. Csordas 1990, 1993; Shilling 2013). While renegotiation of boundaries between the 'social' and the 'biological' may be disconcerting to natural and social scientists alike (e.g. Lock 2013; Meloni 2014), a range of scholarly efforts rise to the challenge (e.g. Ingold and Palsson 2013; Landecker and Panofsky 2013; Oyama 2000). Studies pertaining to embodiment of social determinants of health include the works of Gravlee (2009), Kuzawa and Sweet (2009) and Fausto-Sterling (2008), all looking at how social inequalities become embodied in racialised individuals and groups. The inquiry of

Fausto-Sterling et al. (2012) into social aspects of development of sex-related differences in small children also argues for applicability to studies on health disparities. Another example is the investigation by Walters et al. (2011) of the embodiment of historical trauma among Native Americans, proposing that 'bodies don't just tell stories, they tell histories' (Walters et al. 2011, 179; also Hornborg 2005, 2010). The concept of embodiment provides ways, then, of moving beyond notions of disease distribution as solely reliant on behaviours and characteristics of individuals, while emphasising bodily engagement between humans and with the biophysical world and tracing connections between inner and outer realities (Krieger 2011).

Conclusion

As critical debates go on, the discipline of epidemiology continues to provide scientific underpinnings for public health interventions and clinical practices around the world. While some epidemiologists point to basic limitations in the explanatory and predictive power of risk factors as they are currently often handled (Levine 2005; Merlo 2014), many comment on persistent insufficiencies of, and difficulties in, integration of social structure and power in epidemiological study (e.g. Bauer 2014; O'Campo and Dunn 2012). Social theorists interested in health disparities and/or epidemiological knowledge production thus have many invitations to respond to.

The many (possible) interfaces between social theory and epidemiology have not been given justice in this short review. For one thing, the briefly mentioned writings on medicalisation, biopower and other social theory on risk (e.g. Abraham 2010; Beck 1992; Clarke et al. 2010; Conrad 2007; Douglas 1984; Dumit 2012; Greene 2007; Klawiter 2002; Lemke 2011; Lupton 1999; Shim 2014) show that far from only being part of the subject matter of critically oriented epidemiology, relations and dynamics of culture and power can be seen as intrinsic to the discipline's very enactment. Here it should be noted that Shim's (2014) ethnographic study of epidemiological knowledge production, of practices and discourses of epidemiologists in action, is one of but a few in a field that ought to be further developed. Questions of how local and global cultures intersect in creation and use of epidemiological knowledge should also be addressed, through further study of varying ways in which epidemiological findings inform public health policy in different countries (e.g. Vallgårda 2008, 2010). Another area in which social theory can add to epidemiological fields of interest lies in exploration of alternative models of explanation and treatment of risk and disease sought in complementary or alternative medicines around the world (e.g. Diehl and Eisenberg 2000; Eardley et al. 2012; Fischer 2012; Hess 2004). Having said that, the areas mentioned above – analyses of macro-level determinants of health and disease, of categories of human and health difference and of embodiment – do represent arenas for potentially fruitful further collaboration and dialogue between epidemiology and social theory. In the interest of understanding and addressing health disparities in the world, we believe that such collaboration is key.

Acknowledgements

JM and MW are supported by the Swedish Research Council (grant 2013-2484). SM is supported by the Swedish Research Council [grant 2013-1695].

Short Biographies

Maria Wemrell, MA in History and Anthropology of Religion, is a PhD candidate in Public Health, oriented towards Medical Anthropology, at the Unit of Social Epidemiology at the Department of Clinical Sciences, Lund University in Sweden. Her research interests are located in anthropology, science and technology studies and public health. Taking critical debates within the discipline of epidemiology as a starting point, her work is concerned with biomedical and complementary or alternative medical forms of knowledge and practice.

Juan Merlo is a Professor of Public Health and Community Medicine and Senior Physician in Social Medicine. He directs the Unit for Social Epidemiology at the Faculty of Medicine, Lund University in Sweden. He has an intense scientific production in international medical and epidemiological journals. His research has long-standing support from the Swedish Research Council and focuses on the application and interpretation of multilevel analysis for the investigation of socio-economic, ethnical and geographical disparities in health and healthcare utilization. His current research offers a critical perspective to the indiscriminate use of risk factors and promotes the influence of humanistic science in medicine.

Shai Mulinari is a Multidisciplinary Researcher based at the Department of Sociology and the Unit of Social Epidemiology at the Department of Clinical Sciences, at Lund University in Sweden. He has also been a Visiting Research Fellow at the Department of Social Science, Health and Medicine, King's College, London. He started his career in the natural sciences and in 2008 received his PhD in Developmental Biology from Lund University for work on the genetic control of cell shape changes in the early embryo. His current research, however, is located at the intersection of sociology, science and technology studies, pharmaceutical policy and public health.

Anne-Christine Hornborg is a Professor in History of Religions at the Centre for Theology and Religious Studies, Lund University. Hornborg has written several publications concerning indigenous worldviews, ecology and religion, healing and cultural trauma based on extensive fieldwork on Cape Breton, Canada, among the Mi'kmaq First Nation, as well as in Tonga and Peru. Hornborg has also applied theories and methods from the interdisciplinary field of Ritual Studies and from Anthropology in her examination of new ritual practices in late modern Sweden. Her discussions on neospiritual laymen therapy and coaching as products of neoliberal cosmology and the market in contemporary Swedish society has also attracted attention in a wider public.

Note

* Correspondence address: Maria Wemrell, Unit of Social Epidemiology, Faculty of Medicine, Lund University, Malmö, Sweden. E-mail: maria.wemrell@med.lu.se

References

Abraham, John 2010. 'Pharmaceuticalization of Society in Context.' *Sociology* **44**(4): 603–22.

AHA/ASA. 2013. Women and Cardiovascular Diseases. [Online]. Accessed on 16 June 2015 from: http://www.heart.org/idc/groups/heartpublic/@wcm/@sop/@smd/documents/downloadable/ucm_319576.pdf>

Anonymous 1994. 'Editorial: Population Health Looking Upstream.' *The Lancet* **343**(8895): 429–30.

Aronowitz, Robert A. 2009. 'The Converged Experience of Risk and Disease.' *Milbank Quarterly* **87**(2): 417–42.

Bauer, Greta 2014. 'Incorporating Intersectionality Theory into Population Health Research Methodology: Challenges and the Potential to Advance Health Equity.' *Social Science and Medicine* **110**: 10–7.

Beck, Ulrich 1992. *Risk Society – Towards a New Modernity*. London: Sage Publications.

Beckfield, Jason and Nancy Krieger 2009. 'Epi+demos+cracy: Linking Political Systems and Priorities to the Magnitude of Health Inequalities – Evidence, Gaps, and a Research Agenda.' *Epidemiologic Reviews* **31**: 152–77.

Berkman, Lisa and Ichiro Kawachi 2000. *Social Epidemiology*. Oxford: Oxford University Press.

Bernard, Claude 1957. *An Introduction to the Study of Experimental Medicine*. New York: Dover Publications.

Birke, Lynda 2000. *Feminism and the Biological Body*. New Brunswick, N.J.: Rutgers University Press.

Björck, Lena, Annika Rosengren, Kathleen Bennett, George Lappas and Simon Capewell. 2009. 'Modelling the Decreasing Coronary Heart Disease Mortality in Sweden Between 1986 and 2002.' *European Heart Journal* **30**: 1046–56.

Bourdieu, Pierre 1984. *Distinction: A Social Critique of the Jugdgement of Taste*. Cambridge, Mass.: Harvard University Press.

Broadbent, Alex 2011. 'Inferring Causation in Epidemiology: Mechanisms, Black Boxes, and Contrasts.' Pp. 45–70 in *Causality in the Sciences*, edited by P. McKay Illari, F. Russo and J. Williamson. Oxford: Oxford University Press.

Brown, Phil. 1993. 'When the Public Knows Better: Popular Epidemiology Challenges the System.' *Environment* **35**(8): 16–41.

Buffardi, Anne L., Kathy K. Thomas, King K. Holmes and Lisa E. Manhart 2008. 'Moving Upstream: Ecosocial and Psychosocial Correlates of Sexually Transmitted Infections Among Young Adults in the United States.' *American Journal of Public Health* **98**: 1128–36.

Camargo, Kenneth Rochel, Francisco Ortega and Claudia Medina Coeli 2013. 'Modern Epidemiology and its Discontents.' *Revista de Saúde Pública* **47**(5): 984–91.

Cappola, Thomas P. and Kenneth B. Margulies 2011. 'Functional Genomics Applied to Cardiovascular Medicine.' *Circulation* **124**: 87–94.

Choo, Hae Yeon and Mayra Marx Ferree 2010. 'Practicing Intersectionality in Sociological Research: a Critical Analysis of Inclusions, Interactions and Institutions in the Study of Inequalities.' *Sociological Theory* **28**(2): 129–49.

Clarke, Adele, Laura Mamo, Jennifer R. Fosket, Jennifer R. Fishman and Janet K. Shim 2003. 'Biomedicalization: Technoscientific Transformations of Health, Illness, and U.S. Biomedicine.' *American Sociological Review* **68**(2): 161–94.

Clarke, Adele, Laura Mamo, Jennifer R. Fosket, Jennifer R. Fishman and Janet K. Shim 2010. 'The Stratified Biomedicalization of Heart Disease.' Pp. 218–41 in *Biomedicalization. Technoscience, Health, and Illness in the U.S.*, edited by Adele Clarke, et al. Durham: Duke University Press.

Collins, Francis 2010. 'Has the Revolution Arrived?' *Nature* **464**: 674–6.

Collins, Chik, Marjorie McCrory, Mhairi Mackenzie and Gerry McCartney 2015. 'Social Theory and Health Inequalities: Critical Realism and a Transformative Activist Stance?' *Social Theory & Health* **13**: 377–96. Published online 22 July 2015.

Collins, Francis and Victor McKusick 2001. 'Implications of the Human Genome Project for Medical Science.' *Chalmer* **285**: 540–4.

Collins, Pamela Y., Hella von Unger and Adria Armbrister 2008. 'Church Ladies, Good Girls, and Locas: Stigma and the Intersection of Gender, Ethnicity, Mental Illness and Sexuality to HIV Risk.' *Social Science and Medicine* **67**: 389–97.

Commission on Social Determinants of Health 2008. *Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health* (PDF). World Health Organization. [Online]. Accessed on 22 Sept 2015 from: http://whqlibdoc.who.int/publications/2008/9789241563703_eng.pdf

Conrad, Peter 2007. *The Medicalization of Society: On the Transformation of Human Conditions into Treatable Disorders*. Baltimore and London: The John Hopkins University Press.

Crenshaw, Kimberle 1989. Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscriminiation Doctrine, Feminist Theory and Antiracist Politics. *University of Chicago Legal Forum*, 139–67.

Csordas, Thomas J. 1990. 'Embodiment as a Paradigm for Anthropology.' *Ethos* **18**(1): 5–47.

Csordas, Thomas J. 1993. 'Somatic Modes of Attention.' *Cultural Anthropology* **8**(2): 135–56.

Cwikel, Julie 2006. *Social Epidemiology: Strategies for Public Health Activism*. New York: Columbia University Press.

Dalstra, J. A. A., et al. 2005. 'Socioeconomic Differences in the Prevalence of Common Chronic Diseases: An Overview of Eight European Countries.' *International Journal of Epidemiology* **34**(2): 316–26.

de Almeida-Filho, N. 2000. *La Ciencia Tímida: Ensayos de Deconstrucción de la Epidemiología*. Buenos Aires: Lugar Editorial.

Dean, Mitchell 1999. 'Risk, Calculable and Incalculable.' Pp. 131–59 in *Risk and Sociocultural Theory*, edited by D. Lupton. New York: Cambridge University Press.

Dean, Kathryn and David Hunter 1996. 'New Directions for Health: Towards a Knowledge Base for Public Health Action.' *Social Science and Medicine* **42**(5): 745–50.

Diehl, David L. and David M. Eisenberg 2000. 'Complementary and Alternative Medicine (CAM): Epidemiology and Implications for Research.' *Progress in Brain Research* **122**: 445–55.

Diez-Roux, Ana V. 1998. 'Bringing Context back into Epidemiology: Variables and Fallacies in Multilevel Analysis.' *American Journal of Public Health* **88**(2): 216–22.

Diez-Roux, Ana V. 2000. 'Multilevel Analysis in Public Health Research.' *Annual Review of Public Health* **21**: 171–92.

Diez-Roux, Ana V. 2007. 'Integrating Social and Biologic Factors in Health Research: A Systems View.' *Annals of Epidemiology* **17**: 569–74.

Dorey, Emma 2015. Cholesterol-Busting PCSK9 Drugs. *The Pharmaceutical Journal*, April 15. [Online]. Accessed on 2 June 2015 from: http://www.pharmaceutical-journal.com/news-and-analysis/features/pcsk9-inhibitors-the-next-cholesterol-lowering-blockbusters/20068181.article

Douglas, Mary 1984. *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo*. London: Ark.

Douglas, Mary and Aaron Wildavsky 1982. *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers*. Berkeley: University of California Press.

Downs, George W. and David M. Roche 1979. 'Interpreting Heteroscedasticity.' *American Journal of Political Science* **23**(4): 816–28.

Dumit, Joseph 2012. *Drugs for Life: How Pharmaceutical Companies Define Our Health*. Durham and London: Duke University Press.

Dunn, James R. 2012. 'Explanation, Philosophy and Theory in Health Inequalities Research: Towards a Critical Realist Approach.' Pp. 23–42 in *Rethinking Social Epidemiology. Towards a Science of Change*, edited by P. O'Campo and J. Dunn. Dordrecht: Springer.

Durrington, Paul N. 2012. 'Cholesteryl Ester Transfer Protein (CETP) Inhibitors.' *British Journal of Cardiology* **19**(3): 126–33.

Dworkin, Shari L. 2005. 'Who is Epidemiologically Fathomable in the HIV/AIDS Epidemic? Gender Sexuality and Intersectionality in Public Health.' *Culture, Health and Sexuality* **7**(6): 615–23.

Eardley, Susan et al. 2012. CAM Use in Europe – The patients' Perspective. Part I: A Systematic Literature Review of CAM Prevalence in the EU. Final Report of CAMbrella, Work Package 4. [Online]. Accessed on 24 June 2015 from: https://fedora.phaidra.univie.ac.at/fedora/get/o:292161/bdef:Content/get

Editorial 2010. 'The Human Genome Project: Ten Years Later.' *The Lancet* **375**: 2194.

Epstein, Steven 2004. 'Bodily Differences and Collective Identities: the Politics of Gender and Race in Biomedical Research in the United States.' *Body Society* **10**(2–3): 183–203.

Epstein, Steven 2007. *Inclusion: The Politics of Difference in Medical Research*. Chicago: University of Chicago Press.

Fausto-Sterling, Anne 2008. 'The Bare Bones of Race.' *Social Studies of Science* **38**(5): 657–94.

Fausto-Sterling, Anne, C. C. Garcia and M. Lamarre 2012. 'Sexing the Baby: Part 2 Applying Dynamic Systems Theory to the Emergences of Sex-Related Differences in Infants and Toddlers.' *Social Science and Medicine* **74**: 1693–702.

Ferraro, Kenneth F. and Tetyana Pylypiv Shippee 2009. 'Aging and Cumulative Inequality: How Does Inequality Get Under the Skin?' *The Gerontologist* **49**(3): 333–43.

Fischer, Felix H. 2012. 'Key Issues in Clinical and Epidemiological Research in Complementary and Alternative Medicine – a Systematic Literature Review.' *Forschende Komplementärmedizin* **19**(2): 51–60.

Galea, Sandro and Bruce G. Link 2013. 'Six Paths for the Future of Social Epidemiology.' *American Journal of Epidemiology* **178**(6): 843–9.

Gerstman, Burt B. 2003. *Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology*. Hoboken, N.J.: Wiley-Liss.

Giddens, Anthony 1991. *Modernity and Self-Identity*. Cambridge: Polity Press.

Girtli Nygren, Katarina and Anna Olofsson 2014. 'Intersectional Approaches in Health-Risk Research: A Critical Review.' *Sociology Compass* **8**(9): 1112–26.

Gottweis, Herbert 2005. 'Govering Genomics in the 21st Century: Between Risk and Uncertainty.' *New Genetics and Society* **24**(2): 175–94.

Gould, Stephen Jay 1996a. *The Mismeasure of Man*. New York: Norton.

Gould, Stephen Jay 1996b. *Full House: The Spread of Excellence from Plato to Darwin*. New York: Three Rivers Press.

Granda, Edmundo 2008. 'ALAMES Turns 24.' *Social Medicine* **3**: 165–72.

Gravlee, Clarence C. 2009. 'How Race Becomes Biology: Embodiment of Social Inequality.' *American Journal of Physical Anthropology* **139**: 47–57.

Greene, Jeremy A. 2007. *Prescribing by Numbers*. Baltimore: John Hopkins University Press.

Greenland, Sander, Manuela Gago-Dominguez and Jose Esteban Castelao 2004. 'The Value of Risk-Factor ("Black-Box") Epidemiology.' *Epidemiology* **15**(5): 529–35.

Guyatt, Gordon, David Sackett, Wayne D. Taylor, John Ghong, Robin Roberts and Stewart Pugsley 1986. 'Determining Optimal Therapy-Randomized Trials in Individual Patients.' *The New England Journal of Medicine* **314**(14): 889–92.

Hacking, Ian 1991. 'How Should We Do the History of Statistics?' Pp. 181–95 in *The Foucault Effect: Studies in Governmentality*, edited by G. Burchell, C. Gordon and P. Miller. London: Harvester Wheatsheaf.

Hankivsky, Olena (Ed.). 2011. *Health Inequities in Canada: Intersectional Frameworks and Practices*. Vancouver: University of British Columbia Press.

Hankivsky, Olena 2012. 'Women's Health, Men's Health, and Gender and Health: Implications of Intersectionality.' *Social Science and Medicine* **74**(11): 1712–20.

Hannah-Moffat, Kelly and Pat O'Malley (Eds.). 2007. *Gendered Risks*. London and New York: Routledge–Cavendish.

Harper, Sam and Erin Strumpf 2012. 'Commentary: Social Epidemiology: Questionable Answers and Answerable Questions.' *Epidemiology* **23**: 795–8.

Hayden, Erika C. 2010. 'Human Genome at Ten: Life is Complicated.' *Nature* **464**: 664–7.

Helén, Ilpo 2004. 'Technics Over Life: Risk, Ethics and the Existential Condition in High-Tech Antenatal Care.' *Economy and Society* **33**(1): 28–51.

Hess, David 2004. 'Medical Modernisation, Scientific Research Fields and the Epistemic Politics of Health Social Movements.' *Sociology of Health and Illness* **26**(6): 695–709.

Hinze, Susan W., J. Lin and T. E. Andersson 2012. 'Can We Capture the Intersections? Older Black Women, Education, and Health.' *Women's Health Issues* **22**(1): e91–8.

Hogben, Lancelot and M. Sim 1953. 'The Self-Controlled and Self-Recorded Clinical Trial for Low-Grade Morbidity.' *British Journal of Preventive and Social Medicine* **7**(4): 163–79.

Hopkins, Paul and Roger R. Williams 1981. 'A Survey of 246 Suggested Coronary Risk Factors.' *Atherosclerosis* **40**(1): 1–52.

Hornborg, Anne-Christine 2005. 'Eloquent Bodies: Rituals in the Contexts Of Alleviating Suffering.' *Numen* **52**(3): 356–94.

Hornborg, Anne-Christine 2010. 'Cultural Trauma, Ritual and Healing.' Pp. 103–19 in *Identity and Pluralism: Ethnicity, Religion and Values*, edited by G. Collste. Linköping: Center for Applied Ethics.

Ingold, Tim and Gisli Palsson 2013. *Biosocial Becomings: Integrating Social and Biological Anthropology*. Cambridge: Cambridge University Press.

Iyer, Aditi, G. Sen and Piroska Östlin 2008. 'The Intersections of Gender and Class in Health Status and Health Care.' *Global Public Health* **3**(S1): 13–24.

Jackson, Beth E. 2003. 'Situating Epidemiology.' *Advances in Gender Research* **7**: 11–58.

Jayasinghe, Saroj 2011. 'Conceptualising Population Health: From Mechanistic Thinking to Complexity Science.' *Emerging Themes in Epidemiology* **8**(2). [Online]. Accessed on 24 June 2015 from: http://www.ete-online.com/content/pdf/1742-7622-8-2.pdf

Johanisson, Karin 2004. *Den mörka kontinenten. Kvinnan, medicinen och fin-de-siécle*. Stockholm: ePan, Norstedt.

Kannel, William B. and Thomas T. Thom 1984. 'Declining Cardiovascular Mortality.' *Circulation* **70**: 335.

Kapilashrami, Anuj, Sarah Hill and Nasar Meer 2015. 'What can Health Inequalities Researchers Learn from an Intersectionality Perspective? Understanding Social Dynamics with an Inter-Categorical Approach?' *Social Theory & Health* **13**: 288–307. Published online 17 June 2015.

Kaplan, George A. 1999. 'What is the Role of the Social Environment in Understanding Inequalities in Health?' *Annals of the New York Academy of Sciences* **896**: 116–9.

Kaplan, Jonathan M. and Rasmus Gronfeldt Winther 2013. 'Prisoners of Abstraction? The Theory and Measure of Genetic Variation, and the Very Concept of 'Race'.' *Biological Theory* **7**: 401–12.

Kawachi, Ichiro and Peter Conrad 1996. 'Medicalization and the Pharmacological Treatment of Blood Pressure.' Pp. 26–41 in *Contested Ground. Public Purpose and Public Interest in the Regulation of Prescription Drugs*, edited by P. Davis. New York: Oxford University Press.

Klawiter, Maren 2002. 'Risk, Prevention and the Breast Cancer Continuum: the NCI, the FDA, Health Activism and the Pharmaceutical Industry.' *History and Technology* **18**(4): 309–53.

Krieger, Nancy 1992. 'The Making of Public Health Data: Paradigms, Politics, and Polity.' *Journal of Public Health Policy* **13**(4): 412–27.

Krieger, Nancy 1994. 'Epidemiology and the Web of Causation: Has Anyone Seen the Spider?' *Social Science and Medicine* **39**(7): 887–903.

Krieger, Nancy 1999. 'Questioning Epidemiology: Objectivity, Advocacy, and Socially Responsible Science.' *American Journal of Public Health* **89**(8): 1151–3.

Krieger, Nancy 2000. 'Epidemiology and Social Sciences: Towards a Critical Reengagement in the 21st Century.' *Epidemiologic Reviews* **22**(1): 155–63.

Krieger, Nancy 2001. 'Theories for Social Epidemiology in the 21st Century: An Ecosocial Perspective.' *International Journal of Epidemiology* **30**: 668–77.

Krieger, Nancy 2005a. 'Embodiment: A Conceptual Glossary for Epidemiology.' *Journal of Epidemiology and Community Health* **59**(5): 350–5.

Krieger, Nancy (Ed.). 2005b. *Embodying Inequality: Epidemiologic Perspectives.* Amityville, NY: Baywood Publishing Company.

Krieger, Nancy 2011. *Epidemiology and the People's Health: Theory and Context.* Oxford: Oxford University Press.

Krieger, Nancy 2012. 'Methods for the Scientific Study of Discrimination and Health: An Ecosocial Approach.' *American Journal of Public Health* **102**(5): 936–45.

Krieger, Nancy, Dianne L. Rowley, Allen A. Herman, Byllye Avery, et al. 1993. 'Racism, Sexism and Social Class: Implications for Studies of Health, Disease, and Well-Being.' *American Journal of Preventive Medicine* **9**(6): 82–122.

Krieger, Nancy and Stephen Sidney 1996. 'Racial Discrimination and Blood Pressure: The CARDIA Study of Young Black and White Adults.' *American Journal of Public Health* **86**(10): 1370–8.

Krieger, Nancy, Stephen Sidney and Eugenie Coakley 1998. 'Racial Discrimination and Skin Color in the CARDIA Study: Implications for Public Health Research. Coronary Artery Risk Development in Young Adults.' *American Journal of Public Health* **88**(9): 1308–13.

Kurian, Anita and Kathryn Cardarelli 2007. 'Racial and Ethnic Differences in Cardiovascular Disease Risk Factors: A Systematic Review.' *Ethnicity and Disease* **17**(1): 143–52.

Kuzawa, Christopher and Elizabeth Sweet 2009. 'Epigenetics and the Embodiment of Race: Developmental Origins of US Racial Disparities in Cardiovascular Health.' *American Journal of Human Biology* **21**(1): 2–15.

Landecker, Hannah and Aaron Panofsky 2013. 'From Social Structure to Gene Regulation, and Back: A Critical Introduction to Environmental Epigenetics for Sociology.' *Annual Review of Sociology* **39**: 18–25.

Lara-Pezzi, Enrique, Ana Dopazo and Miguel Manzanares 2012. 'Understanding Cardiovascular Disease: A Journey Through the Genome (and What We Found There).' *Disease Models and Mechanisms* **5**: 434–43.

Latour, Bruno 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, Mass: Harvard University Press.

Lemke, Thomas 2011. *Biopolitics. An Advanced Introduction*. New York and London: New York University Press.

Leslie, William D. and Brian Lentle 2006. 'Race/Ethnicity and Fracture Risk Assessment: An Issue That is More Than Skin Deep.' *Journal of Clinical Densitometry* **9**: 406–12.

Levine, Beverly Rockhill 2001. 'The Privatization of Risk.' *American Journal of Public Health* **91**: 365–8.

Levine, Beverly Rockhill 2005. 'Theorizing about Causes at the Individual Level While Estimating Effects at the Population Level.' *Epidemiology and Society* **16**(1): 124–9.

Levine, Beverly Rockhill 2007. 'Toward a Broader Notion of Community.' *Perspectives in Biology and Medicine* **50**(1): 124–35.

Levins, Richard 2000. 'Is Capitalism a Disease? The Crisis in U.S. Public Health.' *Monthly Review* **52**(4): 8–33.

Lieb, Wolfgang and Ramachandran Vasan 2013. 'Genetics of Coronary Artery Disease.' *Circulation* **128**: 1131–8.

Lillie, Elizabeth O., Bradley Patay, Joel Diamant, Brian Issell, Eric J. Topol and Nicholas J. Schork 2011. 'The n-of-1 Clinical Trial: The Ultimate Strategy for Individualizing Medicine?' *Perspectives in Medicine* **8**(2): 161–73.

Lock, Margaret 2013. 'The Epigenome and Nature/Nurture Reunification: A Challenge for Anthropology.' *Medical Anthropology* **32**: 291–308.

Lofters, Aisha and Patricia O'Campo 2012. 'Differences That Matter.' Pp. 93–109 in *Rethinking Social Epidemiology. Towards a Science of Change*, edited by P. O'Campo and J. Dunn. Dordrecht: Springer.

Lupton, Deborah 1999. *Risk*. London and New York: Routledge.

Lynch, John W., George A. Kaplan and Sarah J. Shema 1997. 'Cumulative Impact of Sustained Economic Hardship on Physical, Cognitive, Psychological, and Social Functioning.' *New England Journal of Medicine* **337**: 1889–95.

Lyng, Stephen 1990. 'Edgework: A Social Psychological Analysis of Voluntary Risk-taking.' *American Journal of Sociology* **95**(4): 851–86.

Marmot, Michael 2004. *The Status Syndrome: How Social Standing Affects our Health and Longevity*. New York: Times Books/Henry Holt.

Marmot, Michael and Richard Wilkinson (Eds.) 1999. *Social Determinants of Health*. Oxford: Oxford University Press.

Marmot, Michael, et al. 1991. 'Health Inequalities Among British Civil Servants: The Whitehall II Study.' *The Lancet* **337**(8754): 1387–93.

McCall, Leslie 2005. 'The Complexity of Intersectionality.' *Signs: Journal of Women in Culture and Society* **30**(3): 1771–880.

McClintock, Anne 1995. *Imperial Leather. Race, Gender and Sexuality in the Colonial Contest*. London: Routledge.

McEwen, Bruce S. 2008. 'Central Effects of Stress Hormones in Health and Disease: Understanding the Protective and Damaging Effects of Stress and Stress Mediators.' *European Journal of Pharmacology* **582**: 174–85.

McKinlay, John B. 1993. 'The Promotion of Health Through Planned Sociopolitical Change: Challenges for Research and Policy.' *Social Science and Medicine* **36**(2): 109–17.

McKinlay, J. B. 1998. 'Paradigmatic Obstacles to Improving the Health of Populations – Implications for Health Policy.' *Salud Pública de México* **40**(4): 369–79.

McKinlay, John B. and Lisa D. Marceau 2000. 'To Boldly Go….' *American Journal of Public Health* **90**(1): 25–33.

McMichael, Anthony J. 1995. 'The Health of Persons, Populations, and Planets: Epidemiology Comes Full Circle.' *Epidemiology* **6**(6): 633–6.

Meloni, Maurizio 2014. 'How Biology Became Social, and What it Means for Social Theory.' *The Sociological Review* **62**: 593–614.

Merchant, Carolyn 1989. *The Death of Nature: Women, Ecology, and the Scientific Revolution*. San Francisco: Harper & Row.

Merleau-Ponty, Maurice 1989. *Phenomenology of Perception*. London: Routledge.

Merlo, Juan 2003. 'Multilevel Analytical Approaches in Social Epidemiology: Measures of Health Variation Compared With Traditional Measures of Association.' *Journal of Epidemiology and Community Health* **57**: 550–2.

Merlo, Juan 2014. 'Invited Commentary: A Fundamental Critique of the Current (Multilevel) Risk Factor Epidemiology: The Multilevel Analysis of Individual Heterogeneity.' *American Journal of Epidemiology* **180**(2): 208–12.

Merlo, Juan, Kjell Asplund, John Lynch, Lennart Råstam and Annette Dobson 2004. 'Population Effects on Individual Systolic Blood Pressure: A Multilevel Analysis of the World Health Organization MONICA Project.' *American Journal of Epidemiology* **159**(12): 1168–79.

Merlo, Juan, Basile Chaix, Min Yang, John Lynch and Lennart Råstam 2005. 'A Brief Conceptual Tutorial of Multilevel Analysis in Social Epidemiology: Linking the Statistical Concept of Clustering to the Idea of Contextual Phenomenon.' *Journal of Epidemiology and Community Health* **59**(6): 443–9.

Merlo, Juan, Henrik Ohlsson, Kristian F. Lynch, Basile Chaix and S. V. Subramanian 2009. 'Individual and Collective Bodies: Using Measures of Variance and Association in Contextual Epidemiology.' *Journal of Epidemiology and Community Health* **63**(12): 1043–8.

Merlo, Juan and Philippe Wagner 2012. 'The Tyranny of the Averages and the Indiscriminate Use of Risk Factors in Public Health: A Call for Revolution.' *European Journal of Epidemiology* **28**(1, Supplement): 148.

Merlo, Juan, Philippe Wagner and Bo Hedblad 2013a. 'Discriminatory Accuracy and Population Attributable Fractions: The Case of Traditional Risk Factors and Novel Biomarkers for Coronary Heart Disease.' *European Journal of Epidemiology* **28**: S147.

Merlo, Juan and Philippe Wagner, Sol Juarez, Shai Mulinari and Bo Hedblad 2013b. The Tyranny of the Averages and the Indiscriminate use of Risk Factors and Population Attributable Fractions in Public Health: The Case of Coronary Heart Disease. Working paper version 2013-09-26. Unit for Social Epidemiology, Faculty of Medicine, Lund University.

Moon, Graham, et al. 2000. *Epidemiology: An Introduction*. Buckingham: Open University Press.

Mulinari, Shai 2014. 'The Specificity Triad: Notions of Disease and Therapeutic Specificity in Biomedical Reasoning.' *Philosophy, Ethics, and Humanities in Medicine* **9**: 14.

Mulinari, Shai, Anna Bredström and Juan Merlo 2015a. 'Questioning the Discriminatory Accuracy of Broad Migrant Categories in Public Health: Self-Rated Health in Sweden.' *The European Journal of Public Health* **25**(6): 911–7.

Mulinari, Shai, Sol Juarez, Phillippe Wagner and Juan Merlo 2015b. 'Does Maternal Country of Birth Matter for Understanding Offspring's Birthweight? A Multilevel Analysis of Individual Heterogeneity in Sweden.' *PloS One* **10**: 5 e0129362.

Muntaner, Carles 1999. 'Invited Commentary: Social Mechanisms, Race, and Social Epidemiology.' *American Journal of Epidemiology* **150**(2): 121–6.

Muntaner, Carles 2013. 'Invited Commentary: On the Future of Social Epidemiology–A Case for Scientific Realism.' *American Journal of Epidemiology* **178**(6): 852–7.

Nash, Jennifer 2008. 'Re-Thinking Intersectionality.' *Feminist Review* **89**: 1–15.

Navarro, Vicente (Ed.). 2007. *Neoliberalism, Globalization, and Inequalities: Consequences for Health and Quality of Life*. Amityville, NY: Baywood Publishing Company.

Ng, Edwin and Carles Muntaner 2014. 'A Critical Approach to Macrosocial Determinants of Population Health: Engaging Scientific Realism and Incorporating Social Conflict.' *Current Epidemiology Reports* **1**: 27–37.

Nieto, Javier. F. 1999. 'Cardiovascular Disease and Risk Factor Epidemiology: A Look Back at the Epidemic of the 20th Century.' *American Journal of Public Health* **89**(3): 292–4.

O'Campo, Patricia 2003. 'Invited Commentary: Advancing Theory and Methods for Multilevel Models of Residential Neighborhoods and Health.' *American Medical Journal* **157**(1): 9–13.

O'Campo, Patricia and James Dunn 2012. 'Introduction.' Pp. 1–22 in *Rethinking Social Epidemiology. Towards a Science of Change*, edited by P. O'Campo and J. Dunn. Dordrecht: Springer.

Oakes, Michael J. 2005. 'An Analysis of American Journal of Epidemiology Citations With Special Reference to Statistics and Social Science.' *American Journal of Epidemiology* **161**(5): 494–500.

Oakes, Michael J. and Jay S. Kaufman 2006. *Methods in Social Epidemiology*. San Francisco: Jossey-Bass.

Olofsson, Anna, Jens O. Zinn, Gabriele Griffin, Katarina Giritli Nygren, Andreas Cebulla and Kelly Hannah-Moffat 2014. 'The Mutual Constitution of Risk and Inequalities: Intersectional Risk Theory.' *Health, Risk and Society* **16**(5): 417–30.

Oxford Dictionaries. 2015. Probability. [Online]. Accessed on 24 June 2015 from: http://www.oxforddictionaries.com/definition/english/probability

Oyama, Susan 2000. *Evolution's Eye: A Systems View of the Biology-Culture Divide*. Durham, NC: Duke University Press.

Pearce, Neil 1996. 'Traditional Epidemiology, Modern Epidemiology, and Public Health.' *American Journal of Public Health* **86**(5): 678–83.

Pepe, Margaret S., Holly Janes, Gary Longton, Wendy Leisenring and Polly Newcomb 2004. 'Limitations of the Odds Ratio in Gauging the Performance of a Diagnostic, Prognostic, or Screening Marker.' *American Journal of Epidemiology* **159**: 882–90.

Poland, Blake, David Coburn, Ann Robertson and Joan Eakin 1998. 'Wealth, Equity and Health Care: A Critique of a 'Population Health' Perspective on the Determinants of Health.' *Social Science and Medicine* **46**(7): 785–98.

Pollock, Anne 2012. *Medicating Race: Heart Disease and Durable Preoccupations with Difference*. Durham and London: Duke University Press.

Pollock, Anne and David S. Jones 2015. 'Coronary Artery Disease and the Contours of Pharmaceuticalization.' *Social Science and Medicine* **131**: 221–7.

Poole, Charles and Kenneth J. Rothman 1998. 'Our Conscientious Objection to the Epidemiology Wars.' *Journal of Epidemiology and Community Health* **52**(10): 613–4.

Rose, Geoffrey 1992. *Individuals and Populations, The Strategy of Preventive Medicine*. Oxford: Oxford University Press.

Rose, Hilary 2000. 'Risk, Trust and Scepticism in the Age of the New Genetics.' Pp. 62–77 in *The Risk Society and Beyond: Critical Issues for Social Theory*, edited by B. Adam, U. Beck and J. van Loon. London: Sage Publications.

Rose, Nikolas 2007. *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*. Princeton: Princeton University Press.

Savitz, David A., Charles Poole and William C. Miller 1999. 'Reassessing the Role of Epidemiology in Public Health.' *American Journal of Public Health* **89**(8): 1158–61.

Scambler, Graham and Sasha Scambler 2015. 'Theorizing Health Inequalities: The Untapped Potential of Dialectical Critical Realism.' *Social Theory & Health* **13**: 340–54. Published online 24 June 2015.

Scheper-Hughes, Nancy and Margaret Lock 1987. 'The Mindful Body: A Prolegomenon to Future Studies in Medical Anthropology.' *Medical Anthropology Quarterly* **1**: 6–41.

Schrecker, Ted and Clare Bambra 2015. *How Politics Makes Us Sick. Neoliberal Epidemics*. Basingstoke: Palgrave Macmillan.

Schultz, Amy J. and Lee Mullings (Eds.) 2006. *Gender, Race, Class and Health: Intersectional Approaches*. San Francisco: Jossey Bass.

Schwartz, Sharon and Kenneth M. Carpenter 1999. 'The Right Answer for the Wrong Question: Consequences of Type III Error for Public Health Research.' *American Journal of Public Health* **89**(8): 1175–80.

Scott-Samuel, Alex and Katherine Elizabeth Smith 2015. 'Fantasy Paradigms of Health Inequalities: Utopian Thinking?' *Social Theory & Health* **13**: 418–36. Published online 1 July 2015.

Shilling, Chris 2013. *The Body and Social Theory*. London: Sage Publications.

Shim, Janet K. 2000. 'Bio-Power and Racial, Class, and Gender Formation in Biomedical Knowledge Production.' *Research In The Sociology Of Health Care* **17**: 173–95.

Shim, Janet K. 2002. 'Understanding the Routinised Inclusion of Race, Socioeconomic Status and Sex in Epidemiology: The Utility of Concepts from Technoscience Studies.' *Sociology of Health and Illness* **24**(2): 129–50.

Shim, Janet K. 2005. 'Constructing "Race" across the Science-Lay Divide: Racial Formation in the Epidemiology and Experience of Cardiovascular Disease.' *Social Studies of Science* **35**(3): 405–36.

Shim, Janet K. 2010. 'The Stratified Biomedicalization of Heart Disease.' Pp. 218–41 in *Biomedicalization. Technoscience, Health, and Illness in the U.S*, edited by A. Clarke, et al. Durham: Duke University Press.

Shim, Janet K. 2014. *Heart-Sick. The Politics of Risk, Inequality, and Heart Disease*. New York and London: New York University Press.

Shy, Carl M. 1997. 'The Failure of Academic Epidemiology: Witness for the Prosecution.' *American Journal of Epidemiology* **145**(6): 479–84.

Skolbekken, John-Arne 2008. 'Unlimited Medicalization? Risk and the Pathologization of Normality.' Pp. 16–29 in *Health, Risk and Vulnerability*, edited by A. Petersen and I. Wilkinson. New York: Routledge.

Smith, George D. 2011. 'Epidemiology, Epigenetics and the "Gloomy Prospect": Embracing Randomness in Population Health Research and Practice.' *International Journal of Epidemiology* **40**(3): 537–62.

Smith, George D. and M. Egger 1998. 'Incommunicable Knowledge? Interpreting and Applying the Results of Clinical Trials and Meta-Analyses.' *Journal of Clinical Epidemiology* **51**(4): 289–95.

Stepan, Nancy L. 1996. 'Race and Gender: The Role of Analogy in Science.' Pp. 121–36 in *Feminism and Science*, edited by E. Fox Keller and H. Longino. Oxford: Oxford University Press.

Stolley, Paul D. 1985. 'Faith, Evidence, and the Epidemiologist.' *Journal of Public Health Policy* **6**: 37–42.

Susser, Mervyn 1989. 'Epidemiology Today. "A Thought-Tormented World".' *International Journal of Epidemiology* **18**(3): 481–8.

Susser, Mervyn 1998. 'Does Risk Factor Epidemiology put Epidemiology at Risk? Peering into the Future.' *Journal of Epidemiology and Community Health* **52**: 608–11.

Susser, Mervyn and Ezra Susser 1996. 'Choosing a Future for Epidemiology: II. From Black Box to Chinese Boxes and Eco-Epidemiology.' *American Journal of Public Health* **86**(5): 674–7.

Syme, Leonard S. 1996. 'To Prevent Disease. The Need for a New Approach.' Pp. 21–31 in *Health and Social Organization: Towards a Health Policy for the 21st Century*, edited by D. Blane, E. Brunner and R. Wilkinson. London and New York: Routledge.

Tabery, James 2011. 'Commentary: Hogben vs the Tyranny of averages.' *International Journal of Epidemiology* **40**(6): 1454–8.

Tajer, Déborah 2003. 'Latin American Social Medicine: Roots, Developments During the 1990s, and Current Challenges.' *American Journal of Public Health* **93**: 2023–7.

Taubes, Gary 1995. 'Epidemiology Faces Its Limits.' *Science* **269**(5221): 164–5 +167–169.

Theorell, Töres 2006. *I spåren av 90-talet*. Stockholm: Karolinska Institutet University Press.

Thompson, G. R. 2009. 'History of the Cholesterol Controversy in Britain.' *QJM* **102**: 81–6.

Townsend, Peter and Nicholas Davidson (Eds.) 1982. *Inequalities in Health: The Black Report*. Harmondsworth, UK: Penguin Books.

Vallgårda, Signild 2008. 'Social Inequality in Health: Dichotomy or Gradient? A Comparative Study of Problematizations in National Public Health Programmes.' *Health Policy* **85**(1): 71–82.

Vallgårda, Signild 2010. 'Tackling Social Inequalities in Health in the Nordic Countries: Targeting a Residuum or the Whole Population?' *Journal of Epidemiology and Community Health* **64**(6): 495–6.

Veenstra, Gerry 2011. 'Race, Gender and Class and Sexual Orientation: Intersecting Axes of Inequality and Self Rated Health in Canada.' *International Journal for Equity and Health* **10**(3).

Walters, Karina L., Selina A. Mohammed, Teresa Evans-Campbell, Ramona E. Beltrán, David H. Chae and Bonnie Duran 2011. 'Bodies Don't Just Tell Stories, They Tell Histories. Embodiment of Historical Trauma Among American Indians and Alaska Natives.' *Du Bois Review: Social Science Research on Race* **8**(1): 179–89.

Webb, Penny and Chris Bain 2011. *Essential Epidemiology: An Introduction for Students and Health Professionals*. Cambridge: Cambridge University Press.

Wheatley, Elizabeth 2006. *Bodies at Risk. An Ethnography of Heart Disease*. Hampshire and Burlington: Ashgate.

WHO 2015. Epidemiology. [Online]. Accessed on 15 May 2015 from: http://www.who.int/topics/epidemiology/en/

Wilkinson, Richard and Kate Pickett 2009. *The Spirit Level: Why More Equal Societies Almost Always Do Better*. London: Allen Lane, Penguin Books.

Williams, Simon J., Clive Seale, Sharon Boden, Pam Lowe and Deborah L. Steinberg 2008. 'Waking Up to Sleepiness: Modafinil, the Media and the Pharmaceuticalisation of Everyday/Night Life.' *Sociology of Health and Illness* **30**(6): 839–55.

Wing, Steve 1994. 'Limits of Epidemiology.' *Medicine and Global Survival* **1**: 74–86.

Yamada, Seiji and W. Palmer 2007. 'An Ecosocial Approach to the Epidemic of Cholera in the Marshall Islands.' *Social Medicine* **2**: 79–88.

Yusuf, Salim, et al. 2004. 'Effect of Potentially Modifiable Risk Factors Associated With Myocardial Infarction in 52 Countries (the INTERHEART Study): Case–Control Study.' *The Lancet* **364**(9438): 909–1010.

Zwart, Hub 2009. 'The Adoration of a Map: Reflections on a Genome Metaphor.' *Genomics, Society and Policy* **5**(3): 29–43.

Study II

Social Science & Medicine 177 (2017) 213–222

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Intersectionality and risk for ischemic heart disease in Sweden: Categorical and anti-categorical approaches

Maria Wemrell [a, *], Shai Mulinari [a, b], Juan Merlo [a, c]

[a] Unit of Social Epidemiology, Faculty of Medicine, Lund University, Malmö, Sweden
[b] Department of Sociology, Faculty of Social Sciences, Lund University, Lund, Sweden
[c] Center for Primary Health Research, Region Skåne, Malmö, Sweden

ARTICLE INFO

Article history:
Received 10 November 2016
Received in revised form
17 January 2017
Accepted 23 January 2017
Available online 24 January 2017

Keywords:
Socioeconomic factors
Health inequalities
Cardiovascular disease
Sweden
Intersectionality
Categorical
Anti-Categorical
Discriminatory accuracy

ABSTRACT

Intersectionality theory can contribute to epidemiology and public health by furthering understanding of power dynamics driving production of health disparities, and increasing knowledge about heterogeneities within, and overlap between, social categories. Drawing on McCall, we relate the first of these potential contributions to categorical intersectionality and the second to anti-categorical intersectionality. Both approaches are used in study of risk of ischemic heart disease (IHD), based on register data on 3.6 million adults residing in Sweden by 2010, followed for three years. Categorical intersectionality is here coupled with between-group differences in average risk calculation, as we use intersectional categorizations while estimating odds ratios through logistic regressions. The anti-categorical approach is operationalized through measurement of discriminatory accuracy (DA), i.e., capacity to accurately categorize individuals with or without a certain outcome, through computation of the area under the curve (AUC). Our results show substantial differences in average risk between intersectional groupings. The DA of social categorizations is found to be low, however, due to outcome variability within and overlap between categories. We argue that measures of DA should be used for proper interpretation of differences in average risk between social (or any other) categories. Tension between average between-group risk and the DA of categorizations, which can be related to categorical and anti-categorical intersectional analyses, should be made explicit and discussed to a larger degree in epidemiology and public health.

1. Introduction

1.1. Background

At least since the 1990s, researchers have argued that epidemiology needs to give increased attention to social power dynamics and structural forces in the study of cause and distribution of disease on the population level (Krieger, 2011; O'Campo and Dunn, 2012; Susser and Susser, 1996; Wemrell et al., 2016). A growing and now gigantic amount of social epidemiological research looks toward socioeconomic risk factors as determinants of disease (Commission on Social Determinants of Health, 2008) not least regarding cardiovascular disease (Manrique-Garcia et al., 2011), and today it would likely be hard to find an epidemiologist claiming that social factors are not relevant to disease causation (Galea and Link, 2013). However, limitations remain. The majority of social epidemiological studies of health disparities have consisted of identification of inequalities and connections between these and various risk factors, and while such studies have underpinned efforts to address disparities, knowledge about risk factors provides an insufficient basis for effective action toward health equity (O'Campo and Dunn, 2012). Productive analytic attention toward structural dynamics of power needs to be developed further. In Ng and Muntaner's words (2014), we not only need studies of unequal average distribution of health and disease between groups defined according to race, gender or class, but also analyses of relational mechanisms like sexism and racism.

Study of relational mechanisms and social dynamics is buttressed by social theory. Attendance to theory has however been weak, although long called for, in epidemiology (Krieger, 1994; Ng and Muntaner, 2014; O'Campo and Dunn, 2012). Krieger (2011)

---

[*] Corresponding author. Clinical Research Center, Jan Waldenströms gata 35, 205 02 Malmö. Sweden.
E-mail address: maria.wemrell@med.lu.se (M. Wemrell).

http://dx.doi.org/10.1016/j.socscimed.2017.01.050
0277-9536/

notes that absence of explicit theory does not equate to non-existence of underlying assumptions or values, but merely means that these are not made visible, or fully conscious. With reference to dominance of implicit, rather than explicit, use of theory to inform epidemiologic research, Krieger notes that this typically rests on ontologies and epistemologies tied to biomedical and so-called lifestyle approaches. Central traits in both are individualism and reductionism, as primary causes of disease at both individual and population level are typically assumed to be genes or risk factors to which exposure is largely determined by the individual's characteristics or behaviors. This is despite the fact that epidemiology has long distinguished between causes of disease at individual and population levels (Rose, 1992).

The above applies no less to research on cardiovascular disease. Studies continually replicate affirmation of the relevance of socioeconomic factors to cardiovascular risk. Shim (2014) argues, however, that in cardiovascular epidemiology, handling of population categories such as race/ethnicity, sex/gender and class/socioeconomic position construe these in terms of risk factors on the individual level, rather than as functions of dynamics *between* individuals or groups (Krieger, 2011; O'Campo and Dunn, 2012). As public health interventions tend to be formed according to the same principle, Shim argues that epidemiological knowledge can contribute to reproduction or even creation of social differences and inequalities. Along similar lines, Lofters and O'Campo (2012) observe that the framing of health inequities as individual-level issues, resolvable through individual-level intervention or behavioral change, can result in practices of “blaming the victim” rather than actual amelioration of existing disparities.

Against this background, intersectionality is a concept and a theory which has been advocated and to a certain degree integrated by authors including Shim (2014) in studies of population health and risk during past decades (Girtli Nygren and Olofsson, 2014). The basic feature of intersectionality theory, which first gained influence through Crenshaw's (1989) analysis of positionings of colored women, is conceptualization of categories such as race/ethnicity, sex/gender, class and sexual orientation not as separate but as interacting. Power structures are set in the center of analysis; focus is directed to what social categories and their interactions disclose about power, and social change is an explicit and overarching goal (Hankivsky, 2012). Intersectionality thereby offers a theoretical framework, write Kapilashrami et al. (2015), which can help epidemiologists look toward social dynamics rather than social categories and thus investigate structural motors for inequalities rather than individual-level behaviors and risk factors.

Bauer (2014) observes that potential contributions of intersectional analysis to epidemiology include increased specificity in mappings of health disparities. We agree, while issuing a word of caution that intersectionality theory is not adequately applied through mere efforts toward fractioning the population into smaller taxonomic units through the combination of more than one major axis of social differentiation. To intersectionality research on health disparities, the object of interest is how interacting systems of power drive disease incidence. A second potential contribution noted by Bauer (2014) is added knowledge about variability within, and overlaps between, social categories. In the present study, we integrate intersectional analysis for both these purposes, in inquiry into risk of ischemic heart disease (IHD) in Sweden. Drawing on McCall (2005) we relate these two aims to two forms of intersectional analysis.

McCall (2005) famously distinguishes between categorical (or inter-categorical) and anti-categorical orientations toward intersectionality. Categorical analysis aims to analyze how interlocking systems of oppression, such as racism and sexism, interact to produce inequalities between social groups in society, expressed for example in distribution of income, education and health outcomes. Here, traditional social categories such as ethnicity and gender may be used in analyses of patterns of interaction, dominance and subordination. Anti-categorical inquiry, on the other hand, directs critique toward categorization itself. Emphasis is placed on the inherent fluidity and malleability of social categories, as these are socially contingent constructions rather than mirrorings of fixed realities. It is here argued that categorization *per se* can lead to creation, perpetuation or essentialization of differences and inequalities between groups. Power-implicated categorizations of gender and race, for example, should therefore be carefully used or deconstructed as a central part of social change.

While intersectionality research has to a large degree been pursued through use of qualitative methods, McCall (2005) notes that the categorical perspective is compatible with quantitative research. Intersectionality has been integrated in quantitative study explicitly (Hinze et al., 2012; Veenstra, 2011) and more implicitly through analysis of outcome heterogeneity within and between social categories (Mulinari et al., 2015a), but in epidemiological research this is still relatively uncommon. Intersectionality remains absent, for example, in handbooks on measurement of inequality and socioeconomic position (Shaw et al., 2007).

Categorical intersectionality can lend itself to integration into conventional statistical measurement of between-group differences in average risk, thus potentially fulfilling the capacity to increase understanding of power dynamics through mappings of health disparities. Efforts toward increasing knowledge validity through attendance to outcome variability within and overlap between social groups (Bauer, 2014) relates more readily to anti-categorical approaches. We argue that anti-categorical intersectionality, aiming to demonstrate intra-group heterogeneity of and overlap between social categories regarding individual risk, can be operationalized in quantitative study through measurement of discriminatory accuracy (DA).

1.2. Discriminatory accuracy

DA measures the ability of a certain diagnostic tool, marker or category to correctly discriminate between people with or without an outcome of interest, often used to evaluate predictive validity (Page et al., 1995) in epidemiology and other medical sciences (Merlo, 2014; Pepe et al., 2004). In principle, the tool, biomarker or category needs to have high DA to be deemed valid for diagnostic or prognostic assessment of individuals. In the epidemiological study of risk factors, whether social or biological, inclusion and especially interpretation of DA has, however, so far been relatively rare (Merlo, 2014; Merlo and Mulinari, 2015; Merlo and Wagner, 2012).

Epidemiological knowledge on risk typically builds on investigation of difference between average risk computed for different population groups, categorized along various biological (e.g., blood pressure), social (e.g., socioeconomic status) or geographical (e.g., neighborhood) variables. It is well known that such probabilistic measures are typically not directly translatable to individuals, as averages can obscure major differences between people within the same group, and/or substantial overlaps between people in different groups (Rose, 1992). Application of average measures on individuals, which has been called “tyranny of the means” (Tabery, 2011), has long been criticized (Bernard and Greene, 1957; Hogben and Sim, 1953) not least by epidemiologists favoring “n-of-1” design (studies made on single individuals) (Guyatt et al., 1986) or personalized medicine (Lillie et al., 2011). Similar critique has been voiced in social science (Downs and Rocke, 1979) and biology (Gould, 1996; Kaplan and Winther, 2013). Still, average risk remains a major basis for assessment of individual risk in much clinical and preventive practice, not least regarding cardiovascular disease (Goff et al., 2014).

It should be emphasized that DA can be low even in presence of large differences in average risk. What is generally considered to be a very strong association between an exposure and an outcome (e.g., expressed as an odds ratio [OR] of 10) might actually be related to a rather weak capacity of the exposure to discriminate between cases and non-cases. Adopting a multilevel perspective, we understand individual variance of a certain outcome as a continuous distribution of individual differences around the mean of the population. This total individual variance can be decomposed at different levels or through different categorizations, the relevance of which increases with the share of the total individual variance that relates to that specific level or categorization (Merlo, 2014). In correspondence with measures of clustering, such as the intra-class correlation coefficient used for operationalization of contextual phenomena (Merlo, 2003; Merlo et al., 2006, 2009, 2005), measures of DA discern which part of the total individual variance that can be explained by reference to a certain categorization (Wagner and Merlo, 2015). For most observable continuous variables, such decomposition of total individual variance is a straightforward matter. For discrete, dichotomous variables this calculation requires special statistical techniques (Goldstein et al., 2002) but the substantive interpretation is similar (Merlo, 2014). In either case, a low DA suggests that outcome heterogeneities within categories, and/or overlaps of individual values between categories, are so large that the explanatory capacity of the categorizations' averages values is very limited at the individual level.

This is an important question for population-health sciences, we argue (Merlo and Mulinari, 2015), not only because conclusions based on group averages may lead to under- or over-diagnosis and ineffective treatment, but also because they can have a stereotyping and stigmatizing effect through representing population groups as more homogenous, and different from others, than they are. We argue that measurement of average between-group risk should therefore routinely be complemented with gauging of its predictive validity in relation to clinical or preventive action, through investigation of outcome heterogeneity (Merlo and Mulinari, 2015).

In the research field of neighborhoods and health, Merlo et al. (2009) have stressed the necessity of evaluating the validity of geographical categorizations like neighborhoods by not only measuring differences between neighborhood averages (i.e., specific contextual effects) but also by assessing the variance around those averages through variance partition coefficients or intra-class correlations (i.e., general contextual effects). The analogous concept of DA can be used to measure the predictive validity of biological (Juarez et al., 2014; Pepe et al., 2004), socioeconomic or ethnic (Beckman et al., 2004; Merlo and Mulinari, 2015; Mulinari et al., 2015a) as well as geographical categorizations (Merlo et al., 2012, 2016; Mulinari et al., 2015b). DA also corresponds with the concept of variance explained (r^2) (Merlo et al., 2013b), measured through linear regression and used to evaluate the general strength of findings in research fields including ecology (Møller and Jennions, 2002) as well as epidemiology (Glymour and Rudolph, 2016).

While interpretation of DA is, as mentioned, uncommon in epidemiological study of risk, existing measurements show that many risk factors, social as well as biological, are fairly blunt instruments for discrimination of individuals who will or will not become ill, and who should therefore be, or not be, the object of treatment or targeted intervention (Ivert et al., 2016; Juarez et al., 2014; Merlo, 2014; Merlo and Mulinari, 2015; Merlo and Wagner, 2012; Merlo et al., 2013a; Mulinari et al., 2015a; Pepe et al., 2004; Rockhill, 2005). This also applies to risk factors for cardiovascular disease (Merlo et al., 2013a, 2013b; Rockhill, 2005; Smith, 2011). Rockhill (2005) refers to studies according to which cardiovascular risk factors were almost as prevalent among people with and without cardiovascular disease. It is noteworthy here that measures (population attributable fraction or PAF) often used to quantify cardiovascular risk (Björck et al., 2009; Yusuf et al., 2004) may exaggerate the relevance of risk factors by not considering people exposed to the factor who do not develop disease (Merlo et al., 2013a). Merlo et al. (2013a) also stress that in comparison to risk assessment based only on age and sex/gender, neither newly identified biomarkers nor established risk factors like hypertension add much to the ability to predict who will actually contract coronary heart disease. Along similar lines, Glymour and Rudolph (2016) observe that disease predictors explored not only in genetic but also social epidemiology actually have very limited ability to explain variance (r^2) in health outcomes. Smith's (2011) response to this "Gloomy Prospect" of epidemiology is acknowledgement that probabilistic, or even stochastic, models of prediction are all that remain. We assert, rather, that epidemiology needs to be developed beyond consideration of population-average risk, through multilevel analyses of individual heterogeneity and measurement of DA (Merlo, 2003, 2014; Merlo et al., 2009; Merlo et al., 2005).

In sum, when DA is shown to be low, and hence the predictive validity of the categorization in relation to the question or outcome at hand can be questioned, the approach can be related to, and become a tool for, anti-categorical intersectionality. DA thereby offers a means of applying anti-categorical approaches within a quantitative framework. Potential friction between measurement of average risk between intersectional groups and low DA of such groupings can be related to dynamic tension between categorical and anti-categorical intersectionality.

1.3. Intersectional categories of risk for IHD in Sweden

Differences in average IHD risk along categorization of socioeconomic status and race/ethnicity are well documented (Dalstra et al., 2005; Kurian and Cardarelli, 2007; Manrique-Garcia et al., 2011; Yang et al., 2011). From a categorical intersectionality perspective, we want to investigate the presence of such differences, understood as expressions of intersecting relationships of power, in recent Swedish data. We are also interested, from an anti-categorical perspective, in the extent to which social categories used in measurement of such differences are homogenous enough to be relevant for prediction of IHD in the study population (Wemrell and Merlo, 2016).

The aims of the present study are thus to (i) replicate previous studies of social stratification of risk for IHD, to then (ii) use an alternative modeling of population groups informed by categorical intersectionality and thereafter (iii) establish whether intersectional groupings lead to improvement of DA regarding prediction of IHD.

2. Population and methods

2.1. Study population

The study population includes all people aged 45–80 by Dec 31st, 2010, residing in Sweden since at least 5 years, and consists of approximately 3.6 million people. The study rests on register data from Statistics Sweden (SCB) and The National Board of Health and Welfare (Socialstyrelsen). The construction of the database was approved by the Regional Ethics Committee of Lund, Sweden (2014/856), by the Data Safety Committee at Statistics Sweden and by The National Board of Health and Welfare.

2.2. Variables

The outcome variable was hospitalization due to ischemic heart disease (IHD) (ICD-10-codes I20-I25) in 2011–2013 (yes versus no). Explanatory variables were based on socio-demographic data included in the registers, regarding age, gender, time as a registered inhabitant of Sweden, income, civil status and prescription of psychotropic medication, used as a proxy variable for psychological ill health.

The age variable was divided into seven groups (45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–80 years). Gender was defined as male or female. While from an intersectionality perspective binary classification of gender is a limitation, an "other" category was not permitted by the register data. Although gendered aspects of symptoms, treatment and prevalence of cardiovascular disease are indeed interesting (Mosca et al., 2011), their complexity in combination with the overall higher (documented) prevalence of cardiovascular disease among males caused us to stratify the data along gender and thus conduct separate analyses for males and females. Regarding categories of race/ethnicity, much research on cardiovascular risk has focused on broad "racial" and ethnic categories, notably White, Black and Hispanic citizens of the US (Kurian and Cardarelli, 2007). In Sweden, while many forms of racism and racialization co-exist (Pred, 2000), immigration is of major importance to racialized relationships. Here, race/ethnicity is operationalized in terms of time as a registered inhabitant of Sweden. The variable was dichotomized as having been a registered inhabitant of the country for less than 10 years or for 10 years or more. As all individuals in the cohort had resided in Sweden for at least 5 years, in effect members of the recently immigrated group became residents of Sweden 5–10 years ago. Class or socioeconomic status was measured in terms of individualized disposable household income categorized as low, medium or high, based on division of the whole adult population (18–80 years) into tertiles. Marital or civil status, which we assume to be associated with differences in distribution of normativity and resources in society, has also been shown to correlate with cardiovascular risk (Venters et al., 1986). Civil status was here dichotomized as cohabiting or living in a single person household. Prescription of psychotropic medication was used as a proxy variable for psychological ill health. Mental ill health is a documented risk factor for cardiovascular disease (Barth et al., 2004), potentially interacting with social categorizations. The variable measured prescriptions from 2006 to 2010, according to the Anatomic Therapeutic Chemical categorization system (ATC N05A, N05B, N05C or N06A; yes versus no).

Intersectional variables, or groups of social relationships (Walby et al., 2012), were formulated through 24 combinations of the mentioned variables, stratified by gender, on the basis of their positionings (i.e., 1. Males who had been registered inhabitants of Sweden for at least 10 years, had high income, cohabited and had not been prescribed psychotropic medication. 2. Males who had been registered inhabitants of Sweden for at least 10 years, had high income, cohabited and had been prescribed psychotropic medication … 25. Females who had been registered inhabitants of Sweden for at least 10 years, had high income, cohabited and had not been prescribed psychotropic medication … 48.) These intersectional variables were intended as proxies for interacting relationships of power driving distribution of IHD incidence.

2.3. Statistical analysis

We calculated associations between IHD and explanatory variables by means of gender stratified logistic regressions, estimating odds ratios (ORs) and 95% confidence intervals (CIs). Absolute risk (AR) was also measured, as average risk within the category (i.e., incidence) rather than in terms of comparison with the reference group.

We developed three different models. The first model *(age only)* included only age, entered as a categorical variable. The second model *(conventional social)* includes, alongside age, the other variables noted above; time as a registered inhabitant of Sweden, income, civil status and psychological ill health as measured through prescription of psychotropic medication. This model replicates, in principle, previous studies of social stratification of risk for cardiovascular disease. In the third model *(intersectional)* we approached the data from a categorical intersectionality perspective, through formulation of the mentioned groups of social relationships. This model adjusted for age, entered as a continuous variable with a quadratic term used to accommodate the non-monotone association between age and IHD observed in the first model. The reference values of the variables in models two and three were the more privileged or normative positions; cohabiting people with high income, who had lived in Sweden for a long time and who had not been prescribed psychotropic medication.

We measured the DA of the statistical models by means of area under the receiver-operating characteristic curve (AUC), which is a well-established way of measuring DA (Gerds et al., 2008; Merlo, 2014; Pepe et al., 2004). AUC assumes a value from 0.5 to 1; 1 equals perfect discrimination while 0.5 represents the same degree of predictive power as the flipping of a coin. We calculated the AUC for the first model *(age only)* and used the result as a reference for comparison with the AUC of the second *(conventional social)* and third *(intersectional)* models. In this way we measured the incremental value of the second and third models, in terms of increased ability to discriminate IHD cases from non-cases, compared to the model based only on age. Increased AUC would suggest better understanding of the distribution of IHD risk in the population.

As age is a major determinant of IHD risk, in a secondary analysis we again measured the AUC of the three models, but in strata of age (i.e., 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–80 years). This was done to minimize the influence of age on the overall DA and to provide a better understanding of heterogeneity.

We performed the statistical analyses using SPSS Version 22.0 (SPSS Inc., Chicago. Illinois. USA).

3. Results

Our results can be seen in Tables 1–3. Overall, IHD risk is higher for men than for women. The second model *(conventional social)* confirmed the existence of social stratification of risk for IHD in Sweden (Tables 1a and 1b). Increased risk was shown along all categorizations; men and women with low income, who lived in single person households, had lived in Sweden for ten years or less and had been prescribed psychotropic medication ran a higher risk of IHD than people with high income who had not been prescribed psychotropic medicine, who cohabited and had lived in the country for more than ten years. Compared to the group with high income, low income was associated with a substantial increase in risk – OR = 1.69 for men (95% CI 1.65–1.73) and OR = 2.19 for women (95% CI 2.11–2.28). Prescription of psychotropic medication also correlated with increased risk – OR = 1.73 for men (95% CI 1.71–1.75) and OR = 1.87 for women (95% CI 1.83–1.90).

The third model *(intersectional)* showed further increase in risk for certain groups of social relationships, indicative of power dynamics adversely affecting some groups more than others (Tables 2a and 2b). IHD risk was notably high for men with medium income who had been registered inhabitants of Sweden for 10 years or less and had been prescribed psychotropic medication, whether cohabiting (OR 4.03, 95% CI 3.25–5.01) or living in single person households (OR 3.70, 95% CI 3.36–5.80), in comparison to

Table 1a
Odds ratios (ORs) and 95% confidence intervals (CIs) quantifying the association between individual characteristics and risk for ischemic heart disease (IHD) in the 1.800.364 men aged 45–80 residing in Sweden in 2010.

Individual characteristics		Percentage of the population (number)	Model 1 (*age-only*) OR (95% CI)	Model 2 (*conventional social*) OR (95% CI)	Absolute risk
Age (years)	45–49	17.5 (315.055)	Ref.	Ref.	0.97%
	50–54	16.0 (287.535)	1.95 (1.86–2.04)	1.91 (1.83–2.00)	1.87%
	55–59	15.6 (281.519)	3.27 (3.13–3.40)	3.13 (3.00–3.27)	3.10%
	60–64	16.8 (302.211)	5.16 (4.96–5.37)	4.81 (4.63–5.01)	4.81%
	65–69	15.0 (269.531)	7.63 (7.34–7.93)	6.78 (6.52–7.05)	6.95%
	70–74	10.3 (185.368)	12.00 (11.55–12.47)	9.85 (9.47–10.24)	10.52%
	75–80	8.8 (159.145)	17.94 (17.27–18.64)	13.66 (13.14–14.21)	14.95%
Time in Sweden (years)	<= 10	1.2 (21.225)		1.08 (1.00–1.16)	4.12%
	>10	98.8 (1.779.139)		Ref.	5.22%
Income	High	35.5 (638.471)		Ref.	2.81%
	Middle	36.6 (658.910)		1.35 (1.32–1.37)	5.64%
	Low	27.9 (502.983)		1.69 (1.65–1.73)	7.68%
Civil status	Single	41.7 (750.364)		1.16 (1.14–1.18)	4.89%
	Cohabiting	58.3 (1.050.000)		Ref.	5.43%
Psychotropic medication	No	74.8 (1.346.117)		Ref.	4.20%
	Yes	25.2 (454.247)		1.73 (1.71–1.75)	8.20%

Table 1b
Odds ratios (ORs) and 95% confidence intervals (CIs) quantifying the association between individual characteristics and risk for ischemic heart disease (IHD) in the 1.845.489 women aged 45–80 residing in Sweden in 2010.

Individual characteristics		Percentage of the population (number)	Model 1 (*age-only*) OR (95% CI)	Model 2 (*conventional social*) OR (95% CI)	Absolute risk
Age (years)	45–49	16.5 (305.332)	Ref.	Ref.	0.38%
	50–54	15.3 (282.665)	1.82 (1.69–1.96)	1.74 (1.62–1.88)	0.69%
	55–59	15.2 (280.583)	2.97 (2.78–3.18)	2.72 (2.54–2.91)	1.11%
	60–64	16.5 (304.845)	4.90 (4.60–5.22)	4.25 (3.99–4.53)	1.82%
	65–69	14.8 (272.758)	8.09 (7.60–8.61)	6.43 (6.04–6.85)	2.98%
	70–74	10.9 (201.441)	14.43 (13.58–15.34)	10.29 (9.67–10.96)	5.19%
	75–80	10.7 (197.865)	24.35 (22.93–25.85)	15.83 (14.88–16.83)	8.46%
Time in Sweden (years)	<= 10	1.2 (21.317)		1.11 (1.00–1.23)	1.83%
	>10	98.8 (1.824.172)		Ref.	2.56%
Income	High	30.8 (568.157)		Ref.	0.85%
	Medium	34.6 (638.234)		1.50 (1.44–1.55)	2.17%
	Low	34.6 (639.098)		2.19 (2.11–2.28)	4.44%
Civil status	Single	45.7 (843.838)		1.11 (1.08–1.13)	3.02%
	Cohabiting	54.3 (1.001.651)		Ref.	2.16%
Psychotropic medication	No	60.0 (1.106.956)		Ref.	1.68%
	Yes	40.0 (738.533)		1.87 (1.83–1.90)	3.85%

cohabiting men with high income, who had lived in Sweden for a long time and who had not been prescribed psychotropic medication. Risk was also higher for groups of women with low income who had been registered inhabitants of Sweden for 10 years or less and who had been prescribed psychotropic medication, whether living in single person households (OR 4.81, 95% CI 3.93–5.89) or cohabiting (OR 4.37, 95% CI 3.47–5.50). IHD risk was also markedly higher among women with medium income, who cohabited, had lived in Sweden for 10 years or less and had been prescribed psychotropic medication (OR 4.76, 95% CI 3.26–6.96), and among women with low income who had lived in Sweden for 10 years or more and had been prescribed psychotropic medication, whether cohabiting (OR 3.97, 95% CI 3.75–4.20) or living alone (OR 3.82, 95% CI 3.64–4.01). From a categorical perspective, operationalized through calculation of average, between-group risk, we can thus conclude that combined patterns of domination and subordination contribute towards unequal distribution of IHD incidence in the population, as some groups of social relations in Sweden carry risk burdens of substantially higher weight than others.

Despite these differences in average risk, however, the DA of the explanatory variables was low. While the overall AUC was fairly high, 0.743 for men and 0.779 for women, it was almost entirely accounted for by age alone. The AUC for model one *(age only)* was 0.725 for men (95% CI 0.723–0.727) and 0.755 for women (95% CI 0.753–0.757) (Table 3, overall). When social categories were included, in model two *(conventional social)*, AUC increased only slightly (+0.016 for men and +0.022 for women). The further DA added in model three *(intersectional)*, in comparison to model two *(conventional social)*, was small (+0.002 for men and +0.002 for women) (Fig. 1). In other words, the incremental value of social categories used in the second and third models was limited, in terms of increased DA. Compared with prediction solely based on age, none of the social variables or groupings, based on income, time in Sweden, civil status or psychological ill-health, gave large contributions to assessment of individual risk of IHD in men or women, compared with prediction solely based on age.

We finally sought to de-emphasize the relevance of age, which is a major determinant of IHD, by making age-stratified analyses (45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–80 years) (Table 3). Here the influence of age on AUC was assumed to decrease, as age-related differences in risk were calculated within 5- or 6-year intervals instead of along the entire 45–80 year spectrum. As expected, the AUC value of model 1 (*age only*) was very low (i.e., between 0.531 and 0.569), while the incremental

Table 2a

Odds ratios (ORs), 95% confidence intervals (CIs) and absolute risk (AR) quantifying the association between intersectional groups and risk for ischemic heart disease (IHD) in the 1.800.364 men aged 45–80 residing in Sweden in 2010.

	Time in Sweden		Income			Civil status		Psychotropic medication				
	<=10 years	>10 years	High	Medium	Low	Cohabiting	Single	No	Yes	Percentage of the population (number)	OR (95% CI)	AR
1		🟩	🟩			🟩		🟩		23.7 (427.028)	Ref.	0.62%
2		🟩	🟩				🟩		🟩	1.2 (21.229)	1.53 (1.41–1.65)	3.54%
3		🟩	🟩				🟩	🟩		5.1 (91.374)	0.95 (0.90–1.01)	1.75%
4		🟩	🟩			🟩			🟩	5.3 (95.391)	1.69 (1.63–1.75)	4.98%
5		🟩		🟩			🟩	🟩		10.6 (191.166)	1.11 (1.07–1.15)	2.57%
6		🟩		🟩			🟩		🟩	3.1 (55.377)	1.90 (1.82–1.99)	4.90%
7		🟩		🟩		🟩		🟩		16.8 (302.580)	1.35 (1.31–1.38)	6.04%
8		🟩		🟩		🟩			🟩	5.8 (103.529)	2.34 (2.27–2.41)	10.67%
9		🟩			🟩		🟩	🟩		13.6 (244.149)	1.48 (1.43–1.51)	5.64%
10		🟩			🟩		🟩		🟩	7.8 (139.838)	2.51 (2.45–2.58)	9.04%
11		🟩			🟩	🟩		🟩		4.1 (74.467)	1.60 (1.55–1.66)	9.05%
12		🟩			🟩	🟩			🟩	1.8 (33.011)	2.83 (2.73–2.94)	14.88%
13	🟩		🟩				🟩	🟩		0.0 (371)	0.97 (0.40–2.36)	1.35%
14	🟩		🟩				🟩		🟩	0.0 (133)	2.07 (0.76–5.65)	3.01%
15	🟩		🟩			🟩		🟩		0.1 (2308)	1.20 (0.88–1.65)	1.73%
16	🟩		🟩			🟩			🟩	0.0 (637)	3.20 (2.22–4.62)	4.87%
17	🟩			🟩			🟩	🟩		0.1 (951)	1.23 (0.76–1.99)	1.79%
18	🟩			🟩			🟩		🟩	0.0 (344)	3.70 (3.36–5.80)	6.10%
19	🟩			🟩		🟩		🟩		0.2 (3570)	1.55 (1.25–1.92)	2.44%
20	🟩			🟩		🟩			🟩	0.1 (1393)	4.03 (3.25–5.01)	6.60%
21	🟩				🟩		🟩	🟩		0.2 (3683)	1.35 (1.12–1.63)	3.18%
22	🟩				🟩		🟩		🟩	0.1 (1749)	3.40 (2.85–4.06)	8.00%
23	🟩				🟩	🟩		🟩		0.3 (4470)	1.34 (1.15–1.56)	4.05%
24	🟩				🟩	🟩			🟩	0.1 (1616)	2.97 (2.48–3.55)	8.66%

value of model 2 (*conventional social*) was higher than in the previous models where age was included as a categorical (model 1 *[age only]*, model 2 *[conventional social]*) or continuous (model 3 *[intersectional]*) variable. In this age-stratified analysis AUC increased with between 0.04 and 0.11 units. Model 3 (*intersectional*) yielded very minor increment, however, as AUC increased with between 0.00 and + 0.07 units. That is, while age is a strong determinant of IHD in the general population, age-stratified analysis reveals that conventional social characteristics (income, time in Sweden, civil status) and psychological health improve prediction of IHD incidence. As in the previous non-stratified analysis, the major part of the AUC increment pertained to conventional social categorization, as the DA added by the intersectional groupings was minor, despite substantially higher ORs calculated for some intersectional groupings (model 3), as compared to the size of the ORs for conventional social categorizations (model 2). From an anti-categorical perspective, operationalized through measurement of DA, we can conclude that the intersectional groups of social relationships under study appear to be of limited relevance for assessment of individual risk for IHD in Sweden.

4. Conclusions and discussion

Critical discussion on epidemiological knowledge production has since the 1990s called for integration of social structures and relationships, reflection on handling of population categories, and inclusion of explicit social theory in epidemiological study. Intersectionality theory can contribute toward filling such needs, based on its focus on population categories and their relationship to societal structures of power.

Table 2b
Odds ratios (ORs), 95% confidence intervals (CIs) and absolute risk (AR) quantifying the association between intersectional groups and risk for ischemic heart disease (IHD) in the 1.845.489 women aged 45–80 residing in Sweden in 2010.

	Time in Sweden		Income			Civil status		Psychotropic medication				
	<=10 years	>10 years	High	Medium	Low	Cohabiting	Single	No	Yes	Percentage of the population (number)	OR (95% CI)	AR
1		🟩	🟩			🟩		🟩		17.8 (328.368)	Ref.	0.62%
2		🟩	🟩				🟩		🟩	1.6 (28.773)	1.97 (1.77–2.20)	1.33%
3		🟩	🟩				🟩	🟩		3.5 (63.648)	1.12 (1.00–1.26)	0.54%
4		🟩	🟩			🟩			🟩	7.8 (144.304)	1.92 (1.81–2.05)	1.41%
5		🟩		🟩			🟩	🟩		7.9 (145.569)	1.31 (1.22–1.41)	0.89%
6		🟩		🟩			🟩		🟩	4.8 (89.374)	2.31 (2.16–2.47)	1.79%
7		🟩		🟩		🟩		🟩		13.1 (241.214)	1.60 (1.51–1.68)	1.99%
8		🟩		🟩		🟩			🟩	8.5 (156.453)	2.95 (2.80–3.11)	3.91%
9		🟩			🟩		🟩	🟩		13.5 (248.206)	2.02 (1.92–2.13)	2.93%
10		🟩			🟩		🟩		🟩	14.1 (259.557)	3.82 (3.64–4.01)	5.54%
11		🟩			🟩	🟩		🟩		3.6 (66.891)	2.25 (2.12–2.39)	4.07%
12		🟩			🟩	🟩			🟩	2.8 (51.815)	3.97 (3.75–4.20)	7.12%
13	🟩		🟩				🟩	🟩		0.0 (223)	1.56 (0.22–11.14)	0.45%
14	🟩		🟩				🟩		🟩	0.0 (132)	-	0.00%
15	🟩		🟩			🟩		🟩		0.1 (1899)	1.55 (0.83–2.90)	0.53%
16	🟩		🟩			🟩			🟩	0.0 (810)	2.40 (1.14–5.07)	0.86%
17	🟩			🟩			🟩	🟩		0.1 (858)	0.65 (0.16–2.61)	0.23%
18	🟩			🟩			🟩		🟩	0.0 (647)	3.10 (1.53–6.25)	1.24%
19	🟩			🟩		🟩		🟩		0.1 (2645)	1.24 (0.70–2.19)	0.45%
20	🟩			🟩		🟩			🟩	0.1 (1474)	4.76 (3.26–6.96)	1.90%
21	🟩				🟩		🟩	🟩		0.2 (3804)	2.45 (1.92–3.13)	1.81%
22	🟩				🟩		🟩		🟩	0.2 (3047)	4.81 (3.93–5.89)	3.48%
23	🟩				🟩	🟩		🟩		0.2 (3631)	2.16 (1.69–2.77)	1.85%
24	🟩				🟩	🟩			🟩	0.1 (2417)	4.37 (3.47–5.50)	3.77%

When speaking about merits of integrating intersectionality theory in epidemiology, however; of adding specificity to analyses of health disparities and improving knowledge validity through attendance to heterogeneity, Bauer (2014) makes no mention of any possible tension between these two aims in epidemiology. Similarly, Lofters and O'Campo (2012) advocate use of quantitative intersectional approaches in epidemiology, to "highlight the most vulnerable subgroups where action is most urgently needed and ensure the best use of resources for ameliorating inequities" and to attend to heterogeneities within social categories, in order to avoid misguided individual-level interventions. They do not discuss potential friction between these two approaches. We demonstrate a case of such tension, in the case of socioeconomic and psychosocial factors associated with risk of IHD in Sweden. This friction, we argue, is indicative of a basic tension in modern epidemiology that has not been sufficiently addressed, namely that between probabilistic measurement of average between-group risk and mechanistic (Merlo, 2014) measures of DA. We argue that while measurement of average risk informed by categorical intersectionality can add valuable knowledge about forces driving distribution of risk, such knowledge ought to be complemented with anti-categorical gauging of the predictive validity of categorizations used, through measurement of DA. Such measures of average risk and DA can bring light to two sides of the coin at hand.

One such two-sided coin has been pointed to in the realm of genetics, where the use of racial/ethnic categories has been critiqued due to large genetic diversity within groups and overlap between groups that coincides with average between-group differences in allele frequencies (Barbujani et al., 2013; Holsinger and Weir, 2009). Similar attentiveness toward co-existence of average difference and heterogeneity should be awarded to analogous categorization in other areas of study. As Glymour and Rudolph

Table 3
Area under the receiver-operating characteristic curve (AUC) with 95% confidence intervals (CIs) and increments (Δ), using model 1 (*age-only*) as reference, for the 3,645,853 men and women aged 45–80 residing in Sweden in 2010. The AUC is computed for the whole population (overall) and for age strata.

		Model 1 (*age-only*)	Model 2 (*conventional social*)		Model 3 (*intersectional*)	
		AUC (95%CI)	AUC (95%CI)	Δ	AUC (95%CI)	Δ
Males	**Overall**	**0.725 (0.723–0.727)**	**0.741 (0.740–0.743)**	**0.016**	**0.743 (0.742–0.745)**	**0.018**
	45–49	0.569 (0.559–0.579)	0.646 (0.636–0.656)	0.077	0.649 (0.639–0.659)	0.080
	50–54	0.547 (0.540–0.555)	0.617 (0.610–0.625)	0.070	0.620 (0.612–0.628)	0.073
	55–59	0.539 (0.533–0.545)	0.611 (0.605–0.617)	0.072	0.613 (0.606–0.619)	0.074
	60–64	0.531 (0.526–0.536)	0.596 (0.591–0.601)	0.065	0.597 (0.592–0.601)	0.066
	65–69	0.540 (0.535–0.544)	0.594 (0.590–0.598)	0.054	0.594 (0.590–0.599)	0.054
	70–74	0.533 (0.528–0.537)	0.585 (0.581–0.590)	0.052	0.586 (0.581–0.590)	0.053
	75–80	0.538 (0.534–0.542)	0.579 (0.575–0.583)	0.041	0.580 (0.576–0.584)	0.042
Females	**Overall**	**0.755 (0.753–0.757)**	**0.777 (0.775–0.778)**	**0.022**	**0.779 (0.777–0.781)**	**0.024**
	45–49	0.553 (0.537–0.570)	0.664 (0.648–0.680)	0.111	0.671 (0.655–0.687)	0.118
	50–54	0.548 (0.535–0.560)	0.660 (0.648–0.673)	0.112	0.664 (0.652–0.677)	0.116
	55–59	0.544 (0.534–0.555)	0.653 (0.644–0.663)	0.109	0.655 (0.645–0.664)	0.111
	60–64	0.545 (0.537–0.552)	0.640 (0.632–0.647)	0.095	0.641 (0.634–0.648)	0.096
	65–69	0.550 (0.544–0.556)	0.632 (0.626–0.638)	0.085	0.633 (0.627–0.639)	0.086
	70–74	0.537 (0.531–0.542)	0.606 (0.600–0.611)	0.069	0.606 (0.601–0.612)	0.069
	75–80	0.541 (0.537–0.546)	0.593 (0.588–0.597)	0.052	0.593 (0.589–0.598)	0.052

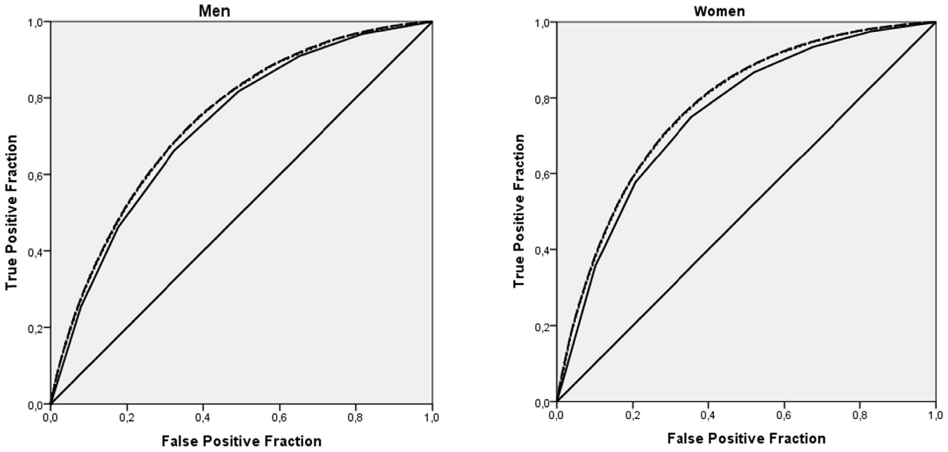


Fig. 1. The diagonal reference line illustrates the receiver-operating characteristic (ROC) curve for a risk factor that is, in principle, useless for prediction and corresponds with an area under the receiver-operating characteristic curve (AUC) equal to 0.5. The solid black line represents the ROC curve for model 1, i.e., for prediction of IHD based only on age. The corresponding AUC equals 0.725 for men 0.755 for women. The dotted line illustrates the ROC curve for model two, i.e., for prediction of IHD based on age as well as income, time in Sweden, civil status and psychological health as separate variables. The corresponding AUC equals 0.741 for men and 0.777 for women. The dashed line shows the ROC curve for model three, i.e., for age and intersectional groups of social relationships. The corresponding AUC equals 0.743 for men and 0.779 in women. The two latter lines overlap.

(2016) point out, not only genetic but also social epidemiology should be held up to scrutiny regarding ability to explain variance in disease outcomes. Measurement of DA is thus a critical although under-discussed issue in epidemiology, as well as a potential addition to anti-categorical intersectionality toolkits.

One reason why concepts and theories of intersectionality are important in this epidemiological context is that the managing of such two-sidedness can be slippery, politically as well as epistemologically. Knowledge about differences in average between-group risk, indicative of power relationships driving distribution of risk, can be crucial for illumination and amelioration of health inequities. The same knowledge can contribute to stereotypization, stigmatization (Guttman and Salmon, 2004) or bio/medicalization (Aronowitz, 2009; Clarke et al., 2003) of "risky" groups and individuals (Olofsson et al., 2014). Measurement of low DA, on the other hand, highlight the importance of not treating identity categories, intersectional or not, as static and reified. It can be used to clarify that power-implicated social categorizations have low relevance, due to heterogeneity, in specific contexts. At the same time, low DA could also be used to downplay or dismiss social determinants of disease. Application of a theoretical framework of intersectionality demands sensitivity to and discussion of how epidemiological knowledge and categorization of population groups relates to power, in general as well as in specific cases of research and policy.

The present study has its limitations. Although it is based on register data on 3.6 million individuals, one of the intersectional groupings included an insufficient number of people to yield a measurable result, and for a few groupings the 95% CIs measured were wide, implying a substantial degree of uncertainty associated with the estimated level of risk. This underscores the fact and the potential problem that quantitative study of intersectional groupings requires large databases for sufficient statistical power, and future studies need to consider that. Further, our analysis only included a small number of explanatory factors. Categorizations used, such as socioeconomic status based on income tertiles, or racialization based on time as registered inhabitants of Sweden, are simplistic. This makes findings of heterogeneity perhaps unsurprising. Analogous categorization is quite typical of social epidemiological research, however (Mulinari et al., 2015a), which makes the identified heterogeneity all the more relevant. It is nonetheless arguable whether the study provides enough detail to underpin specific clinical or policy objectives. That is not the aim of the study, however, as its overall purpose is to contribute to conceptual and methodological discussion.

On a general note, and in alignment with categorical intersectionality research, we do argue that co-existent difference in average between-group risk and low DA is better met by changing macro- or meso-level factors that enable or limit choices and behaviors, than by interventions aiming to change the behaviors of individuals. Macro- or meso-level factors addressed by broad policies may not have high DA, but can be beneficial across groups (Beckfield and Krieger, 2009; Wilkinson and Pickett, 2010) and particularly enable underprivileged groups (Sheldon and Parker, 1992) while under the principle of “primum non nocere” avoiding lures of misguided and potentially stigmatizing policies targeting individuals based on ethnic, gender or class identification (Bredström, 2009). Targeted intervention thus aimed towards individual-level behaviors or risk factors, typically based on biomedical or lifestyle approaches (Krieger, 2011), may lead to “blaming the victim” (Lofters & O'Campo, 2012) or even perpetuation or creation of disparities (Shim, 2014). At the same time, population-wide approaches based on principles outlined by Rose (1992); on moving the entire distribution of a certain risk factor in the right direction through population level strategies, is questionable (Merlo et al., 2004; Razak et al., 2016) in the presence of major heterogeneities identified through measurement of DA (Merlo, 2014). While Rose's ideas continue to be highly relevant, epidemiology needs to be developed further through identification of the share of individual variation that can be accurately explained by reference to a certain categorization, in relation to the outcome of interest (Merlo, 2003; Merlo et al., 2009, 2012). In other words, targeted intervention can be called for when population groups are identified with high DA. Again, however, intersectionality analysis points attention back toward macro-level forces producing the disparities that bear down on such population groups, e.g., racism, as being problems above and beyond bodies and behaviors of affected or “risky” individuals and populations.

In sum, while DA adds a valuable measure to intersectional research tools, categorical and anti-categorical intersectional approaches direct the epidemiological gaze toward interlocking systems of power driving health inequities, as well as toward heterogeneity of social categories. Categorical and anti-categorical perspectives can thus inform ways of thinking about tension between average-risk disparities and DA, which needs to be carefully teased out and given due consideration in epidemiology and public health.

Acknowledgements

This work was supported by the Swedish Research Council (JM&MW, grant 2013-2484; SM&MW, grant 2013-1695). We thank Raquel Pérez Vicente for help with the construction of the database and the statistical analysis.

References

Aronowitz, R.A., 2009. The converged experience of risk and disease. Milbank Q. 87, 417–442.
Barbujani, G., Ghirotto, S., Tassi, F., 2013. Nine things to remember about human genome diversity. Tissue antigens 82, 155–164.
Barth, J., Schumacher, M., Herrmann-Lingen, C., 2004. Depression as a risk factor for mortality in patients with coronary heart disease: a meta-analysis. Psychosom. Med. 66, 802–813.
Bauer, G.R., 2014. Incorporating intersectionality theory into population health research methodology: challenges and the potential to advance health equity. Soc. Sci. Med. 110, 10–17.
Beckfield, J., Krieger, N., 2009. Epi+ demos+ cracy: linking political systems and priorities to the magnitude of health inequities—evidence, gaps, and a research agenda. Epidemiol. Rev. 31, 152–177.
Beckman, A., Merlo, J., Lynch, J.W., Gerdtham, U.G., Lindstrom, M., Lithman, T., 2004. Country of birth, socioeconomic position, and healthcare expenditure: a multilevel analysis of Malmö, Sweden. J. Epidemiol. Community Health 58, 145–149.
Bernard, C., Greene, H.C., 1957. An Introduction to the Study of Experimental Medicine. Courier Corporation.
Björck, L., Rosengren, A., Bennett, K., Lappas, G., Capewell, S., 2009. Modelling the decreasing coronary heart disease mortality in Sweden between 1986 and 2002. Eur. Heart J. 30, 1046–1056.
Bredström, A., 2009. Sweden: HIV/AIDS policy and the 'crisis' of multiculturalism. Race Cl. 50, 57–74.
Clarke, A.E., Shim, J., Mamo, L., Fosket, J.R., Fishman, J.R., 2003. Biomedicalization: technoscientific transformations of health, illness, and US biomedicine. Am. Sociol. Rev. 68, 161–194.
Commission on Social Determinants of Health, 2008. Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health: Final Report of the Commission on Social Determinants of Health. World Health Organization.
Crenshaw, K., 1989. Demarginalizing the intersection of race and sex: a Black feminist critique of antidiscriminiation doctrine, feminist theory and antiracist politics. In: Sustainable Energy Choices for the 90s: Conference Proceedings. University of Chicago Legal Forum, pp. 139–167.
Dalstra, J.A., Kunst, A.E., Borrell, C., Breeze, E., Cambois, E., Costa, G., et al., 2005. Socioeconomic differences in the prevalence of common chronic diseases: an overview of eight European countries. Int. J. Epidemiol. 34, 316–326.
Downs, G.W., Rocke, D.M., 1979. Interpreting heteroscedasticity. Am. J. Polit. Sci. 23, 816–828.
Galea, S., Link, B.G., 2013. Six paths for the future of social epidemiology. Am. J. Epidemiol. 178, 843–849.
Gerds, T.A., Cai, T., Schumacher, M., 2008. The performance of risk prediction models. Biom J. 50, 457–479.
Girtli Nygren, K., Olofsson, A., 2014. Intersectional approaches in health-risk research: a critical review. Sociol. Compass 8, 1112–1126.
Glymour, M.M., Rudolph, K.E., 2016. Causal inference challenges in social epidemiology: bias, specificity, and imagination. Soc. Sci. Med. 166, 258–265.
Goff, D.C., Lloyd-Jones, D.M., Bennett, G., Coady, S., D'Agostino, R.B., Gibbons, R., et al., 2014. ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American college of cardiology/American heart association task force on practice guidelines. J. Am. Coll. Cardiol. 63, 2935–2959.
Goldstein, H., Browne, W., Rasbash, J., 2002. Partitioning variation in multilevel models. Understand Stat. 1, 223–231.
Gould, S.J., 1996. The Mismeasure of Man. WW Norton & Company.
Guttman, N., Salmon, C.T., 2004. Guilt, fear, stigma and knowledge gaps: ethical issues in public health communication interventions. Bioethics 18, 531–552.
Guyatt, G., Sackett, D., Taylor, D.W., Ghong, J., Roberts, R., Pugsley, S., 1986. Determining optimal therapy—randomized trials in individual patients. N. Engl. J. Med. 314, 889–892.
Hankivsky, O., 2012. Women's health, men's health, and gender and health: implications of intersectionality. Soc. Sci. Med. 74, 1712–1720.
Hinze, S.W., Lin, J., Andersson, T.E., 2012. Can we capture the intersections? Older black women, education, and health. Womens Health Issues 22, E91–E98.
Hogben, L., Sim, M., 1953. The self-controlled and self-recorded clinical trial for low-grade morbidity. Br. J. Prev. Soc. Med. 7, 163–179.
Holsinger, K.E., Weir, B.S., 2009. Genetics in geographically structured populations: defining, estimating and interpreting FST. Nat. Rev. Genet. 10, 639–650.
Ivert, A.K., Mulinari, S., van Leeuwen, W., Wagner, P., Merlo, J., 2016. Appropriate assessment of ethnic differences in adolescent use of psychotropic medication: multilevel analysis of discriminatory accuracy. Ethn. Health 21, 578–595.
Juarez, S.P., Wagner, P., Merlo, J., 2014. Applying measures of discriminatory accuracy to revisit traditional risk factors for being small for gestational age in Sweden: a national cross-sectional study. Bmj Open 4, e005388.
Kapilashrami, A., Hill, S., Meer, N., 2015. What can health inequalities researchers learn from an intersectionality perspective? Understanding social dynamics with an inter-categorical approach? Soc. Theory Health 13, 288–307.
Kaplan, J.M., Winther, R.G., 2013. Prisoners of abstraction? The theory and measure of genetic variation, and the very concept of “race”. Biol. Theory 7, 401–412.
Krieger, N., 1994. Epidemiology and the web of causation - has anyone seen the spider. Soc. Sci. Med. 39, 887–903.
Krieger, N., 2011. Epidemiology and the People's Health: Theory and Context. Oxford

University Press, New York.

Kurian, A.K., Cardarelli, K.M., 2007. Racial and ethnic differences in cardiovascular disease risk factors: a systematic review. Ethn. Dis. 17, 143–152.

Lillie, E.O., Patay, B., Diamant, J., Issell, B., Topol, E.J., Schork, N.J., 2011. The n-of-1 clinical trial: the ultimate strategy for individualizing medicine? Prev. Med. 8, 161–173.

Lofters, A., O'Campo, P., 2012. Differences that matter. In: O'Campo, P., Dunn, J. (Eds.), Rethinking Social Epidemiology. Towards a Science of Change. Springer, Dordrecht, pp. 93–109.

Manrique-Garcia, E., Sidorchuk, A., Hallqvist, J., Moradi, T., 2011. Socioeconomic position and incidence of acute myocardial infarction: a meta-analysis. J. Epidemiol. Community Health 65, 301–309.

McCall, L., 2005. The complexity of intersectionality. Signs 30, 1771–1800.

Merlo, J., 2003. Multilevel analytical approaches in social epidemiology: measures of health variation compared with traditional measures of association. J. Epidemiol. Community Health 57, 550–552.

Merlo, J., 2014. Invited commentary: multilevel analysis of individual heterogeneity - a fundamental critique of the current probabilistic risk factor epidemiology. Am. J. Epidemiol. 180, 208–212.

Merlo, J., Asplund, K., Lynch, J., Råstam, L., Dobson, A., 2004. Population effects on individual systolic blood pressure: a multilevel analysis of the World Health Organization MONICA Project. Am. J. Epidemiol. 159, 1168–1179.

Merlo, J., Chaix, B., Ohlsson, H., Beckman, A., Johnell, K., Hjerpe, P., et al., 2006. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. J. Epidemiol. Community Health 60, 290–297.

Merlo, J., Mulinari, S., 2015. Measures of discriminatory accuracy and categorizations in public health: a response to Allan Krasnik's editorial. Eur. J. Public Health 25, 910.

Merlo, J., Ohlsson, H., Lynch, K.F., Chaix, B., Subramanian, S.V., 2009. Individual and collective bodies: using measures of variance and association in contextual epidemiology. J. Epidemiol. Community Health 63, 1043–1048.

Merlo, J., Viciana-Fernandez, F.J., Ramiro-Farinas, D., Research Group of Longitudinal Database of Andalusian, P., 2012. Bringing the individual back to small-area variation studies: a multilevel analysis of all-cause mortality in Andalusia, Spain. Soc. Sci. Med. 75, 1477–1487.

Merlo, J., Wagner, P., 2012. The tyranny of the averages and the indiscriminate use of risk factors in public health: a call for revolution. Eur. J. Epidemiol. 28, 148.

Merlo, J., Wagner, P., Ghith, N., Leckie, G., 2016. An original stepwise multilevel logistic regression analysis of discriminatory accuracy: the case of neighbourhoods and health. PLoS One 11, e0153778.

Merlo, J., Wagner, P., Hedblad, B., 2013a. Discriminatory accuracy and population attributable fractions: the case of traditional risk factors and novel biomarkers for coronary heart disease. Eur J Epidemiol 28, S147.

Merlo, J., Wagner, P., Juarez, S., Mulinari, S., Hedblad, B., 2013b. The Tyranny of the Averages and the Indiscriminate Use of Risk Factors and Population Attributable Fractions in Public Health: the Case of Coronary Heart Disease. Working paper. Unit for Social Epidemiology. Lund University.

Merlo, J., Yang, M., Chaix, B., Lynch, J., Råstam, L., 2005. A brief conceptual tutorial on multilevel analysis in social epidemiology: investigating contextual phenomena in different groups of people. J. Epidemiol. Community Health 59, 729–736.

Møller, A., Jennions, M.D., 2002. How much variance can be explained by ecologists and evolutionary biologists? Oecologia 132, 492–500.

Mosca, L., Barrett-Connor, E., Wenger, N.K., 2011. Sex/gender differences in cardiovascular disease prevention what a difference a decade makes. Circulation 124, 2145–2154.

Mulinari, S., Bredstrom, A., Merlo, J., 2015a. Questioning the discriminatory accuracy of broad migrant categories in public health: self-rated health in Sweden. Eur. J. Public Health 25, 911–917.

Mulinari, S., Juarez, S.P., Wagner, P., Merlo, J., 2015b. Does maternal country of birth matter for understanding offspring's birthweight? A multilevel analysis of individual heterogeneity in Sweden. PLoS One 10, e0129362.

Ng, E., Muntaner, C., 2014. A critical approach to macrosocial determinants of population health: engaging scientific realism and incorporating social conflict. Curr. Epidemiol. Rep. 1, 27–37.

O'Campo, P., Dunn, J.R., 2012. Rethinking Social Epidemiology: towards a Science of Change. Springer, Dordrecht; New York.

Olofsson, A., Zinn, J.O., Griffin, G., Nygren, K.G., Cebulla, A., Hannah-Moffat, K., 2014. The mutual constitution of risk and inequalities: intersectional risk theory. Health Risk Soc. 16, 417–430.

Page, R.M., Cole, G.E., Timmreck, T.C., 1995. Basic Epidemiological Methods and Biostatistics: a Practical Guidebook. Jones & Bartlett Learning.

Pepe, M.S., Janes, H., Longton, G., Leisenring, W., Newcomb, P., 2004. Limitations of the odds ratio in gauging the performance of a diagnostic, prognostic, or screening marker. Am. J. Epidemiol. 159, 882–890.

Pred, A., 2000. Even in Sweden: Racisms, Racialized Spaces, and the Popular Geographical Imagination. Univ of California Press.

Razak, F., Smith, G.D., Subramanian, S., 2016. The idea of uniform change: is it time to revisit a central tenet of Rose's "Strategy of Preventive Medicine"? Am. J. Clin. Nutr. 104, 1497–1507.

Rockhill, B., 2005. Theorizing about causes at the individual level while estimating effects at the population level - implications for prevention. Epidemiology 16, 124–129.

Rose, G.A., 1992. The Strategy of Preventive Medicine. Oxford University Press, Oxford England, New York.

Shaw, M., Galobardes, B., Lawlor, D., Lynch, J., Wheeler, B., Davey-Smith, G., 2007. The Handbook of Inequality and Socioeconomic Position: Conceptes and Measures. The Policy Press.

Sheldon, T.A., Parker, H., 1992. Race and ethnicity in health research. J. Public Health 14, 104–110.

Shim, J.K., 2014. Heart-sick. The Politics of Risk, Inequality, and Heart Disease. New York University Press, New York.

Smith, G.D., 2011. Epidemiology, epigenetics and the 'Gloomy Prospect': embracing randomness in population health research and practice. Int. J. Epidemiol. 40, 537–562.

Susser, M., Susser, E., 1996. Choosing a future for epidemiology: II. From black box to Chinese boxes and eco-epidemiology. Am. J. Public Health 86, 674–677.

Tabery, J., 2011. Commentary: Hogben vs the tyranny of averages. Int. J. Epdemiol 40, 1454–1458.

Veenstra, G., 2011. Race, gender, class, and sexual orientation: intersecting axes of inequality and self-rated health in Canada. Int. J. Equity Health 10, 3.

Venters, M., Jacobs, D.R., Pirie, P., Luepker, R.V., Folsom, A.R., Gillum, R.F., 1986. Marital status and cardiovascular risk: the Minnesota heart survey and the Minnesota heart health program. Prev. Med. 15, 591–605.

Wagner, P., Merlo, J., 2015. Discriminatory accuracy of a random effect in multilevel logistic regression. Int. J. Epidemiol. 44, i49–i50.

Walby, S., Armstrong, J., Strid, S., 2012. Intersectionality: multiple inequalities in social theory. Sociology-the J. Br. Sociol. Assoc. 46, 224–240.

Wemrell, M., Merlo, J., 2016. Kategorier av risk: om epidemiologi och intersektionalitetsteori. Soc. Med. Tidskr. 93, 306–320.

Wemrell, M., Merlo, J., Mulinari, S., Hornborg, A.C., 2016. Contemporary epidemiology: a review of critical discussions within the discipline and a call for further dialogue with social theory. Sociol. Compass 10, 153–171.

Wilkinson, R., Pickett, K., 2010. The Spirit Level: Why Equality Is Better for Everyone. Penguin Books Ltd, London.

Yang, D., Dzayee, D.A.M., Beiki, O., de-Faire, U., Alfredsson, L., Moradi, T., 2011. Incidence and case fatality after day 28 of first time myocardial infarction in Sweden 1987-2008. Eur. J. Cardiovasc Prev. Rehabil. 19, 1304–1315.

Yusuf, S., Hawken, S., Ôunpuu, S., Dans, T., Avezum, A., Lanas, F., et al., 2004. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet 364, 937–952.

Study III

Social Science & Medicine 178 (2017) 217–219

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

An intersectional approach to multilevel analysis of individual heterogeneity (MAIH) and discriminatory accuracy

Maria Wemrell, M.A. [a, *], Shai Mulinari, Ph.D [a, b], Juan Merlo, M.D., Ph.D [a, c]

[a] Unit of Social Epidemiology, Faculty of Medicine, Lund University, Malmö, Sweden
[b] Department of Sociology, Faculty of Social Sciences, Lund University, Lund, Sweden
[c] Center for Primary Health Research, Region Skåne, Malmö, Sweden

ARTICLE INFO

Article history:
Received 27 February 2017
Accepted 28 February 2017
Available online 1 March 2017

In their commentary on our recent article (Wemrell et al., 2017), Green et al. (2017) affirm the value of integrating intersectional approaches in epidemiology, and outline further research avenues. We appreciate and agree with the points raised by the authors, while welcoming the opportunity to clarify parts of our argument.

As observed in the commentary, our application of measurements of discriminatory accuracy (DA) within an intersectionality framework aligns with an anti-categorical (McCall, 2005) intersectional approach. Our results point to levels of heterogeneity within and overlaps between social categorizations that merit the questioning of their relevance for prediction of ischemic heart disease in the studied context. This, note Green et al. (2017), may spur arguments for adoption of an anti-categorical, rather than inter-categorical, intersectional approach in epidemiology. That, however, is not our aim. We are not opposed to categorization *per se*, and do not intend to delineate our approach as *a priori* anti-categorical. If the DA of a certain categorization is found to be low, the implication can indeed be anti-categorical in relation to the studied outcome. High DA would on the other hand confirm the relevance of the categorization in relation to that outcome, thus meriting an inter-categorical approach. In any case, inquiry into the DA of categorizations should complement rather than replace measures of average between-group risk, in epidemiology and Public Health, while interpretation of tension between such measures can be informed by anti-categorical as well as inter-categorical approaches. This both-and, rather than either-or, approach should perhaps most appropriately be defined as intra-categorical (McCall, 2005). Intra-categorical complexity falls between anti- and inter-categorical approaches, writes McCall (2005), as interest is here aimed toward the construction and definition of social categories, while the existing relationships of inequality represented by those categories are simultaneously acknowledged and investigated. Such relationships of inequality are indeed the object and *raison d'être* of social epidemiology as well as of intersectionality research, and our intention is certainly to develop rather than deprioritize their study.

Green et al. (2017) point to multilevel modeling as a promising way forward for intersectionality in epidemiology (Jones et al., 2016). We strongly agree, and are in fact working toward integration of intersectionality in a multilevel research framework. As we have previously argued (Merlo, 2003, 2014; Merlo et al., 2004, 2009; Merlo and Mulinari, 2015; Mulinari et al., 2015b), multilevel analysis represents a path beyond the dislocation of individual and population levels of analysis that is often found in epidemiology and Public Health (Merlo, 2014; Merlo and Mulinari, 2015; Smith, 2011). A multilevel approach does not separate individual variance from population (i.e., group or category) variance but considers the existence of a continuum of individual variance that can be decomposed at different levels of analysis, and thus enable simultaneous exploration of both between-population and within-population components of individual heterogeneity. Population effects are thereby appraised not through mere study of differences between population averages, but through quantification of the

---

DOIs of original article: http://dx.doi.org/10.1016/j.socscimed.2017.01.050, http://dx.doi.org/10.1016/j.socscimed.2017.02.029.

[*] Corresponding author. Clinical Research Center, Jan Waldenströms gata 35, 205 02 Malmö, Sweden.

E-mail address: maria.wemrell@med.lu.se (M. Wemrell).

http://dx.doi.org/10.1016/j.socscimed.2017.02.040

share of the individual heterogeneity (i.e., variance) that exists at the population level (Merlo, 2003, 2014; Merlo et al., 2004; Merlo et al., 2009). We do not necessarily posit this approach as Eco-Epidemiology, which at least in its early formulation does not self-evidently engage with questions of distribution or exercise of power within or between levels (Jackson, 2003; Susser and Susser, 1996). Rather, we propose a research framework of multilevel analysis of individual heterogeneity (MAIH) (Merlo, 2014) informed, in this instance, by intersectionality theory.

Another important point observed by Green et al. (2017), is that integration of intersectionality in epidemiological study will be most productive when researchers do not lose sight of relationships and structures of power, or of social theory on production of health disparities, in the framing of their study designs and results. We want to add that engagement of intersectionality in population health science would further benefit from remaining attentive to ongoing debates within intersectionality research at large, for example regarding distinctions between study of categories of identity and structures of power (Cho et al., 2013), or the importance of investigating not only interconnections but also differences between interlocking systems of oppression. Gimenez (2001) argues, for example, against the use of the term “classism”, employed by Green et al. (2017) in conjunction with sexism and racism, as class-based oppression differs from sexism and racism by consisting less of an ideology: “it denotes exploitative relations between people mediated by their relations to the means of production.” In other words, inclusion of intersectionality theory in epidemiology should not only consist of development of statistical models, but also of engagement with insights produced and complexities found within the field of intersectionality research.

Discriminatory accuracy, write Green et al. (2017), is a descriptive tool that does not offer actual explanations for within-group heterogeneity. While this is true, we argue that measures of DA provide information that reaches beyond the current focus on probabilistic knowledge in epidemiology (Merlo, 2014; Merlo and Wagner, 2012; Wemrell et al., 2016). Mechanistic approaches, in epidemiology, seek to establish casual hypotheses by explaining how something works. While this stance relates comfortably, in principle, to biomedical visions of specific etiology (Mulinari, 2014) and propels the drive towards causal inference, the rise of multifactorial webs of causation and the concomitant focus on risk, evaluated by means of difference between group averages and expressed in probabilistic measures such as odds ratios, has brought probabilistic approaches to the center of epidemiology. Measures of probability establish the extent to which an event is likely to occur, rather than the dynamics through which such events are brought about, and the resultant lack of attention paid to mechanism has been a major cause of criticism against probabilistic risk factor or “black-box” epidemiology (Ng and Muntaner, 2014; Susser, 1998). Many argue that epidemiologists must pay more attention to the biological (Galea and Link, 2013) and social (Ng and Muntaner, 2014) mechanisms of disease causation. We agree, and argue that measures of DA in combination with theorization and hypotheses-testing informed by intersectionality theory can yield valuable contributions to knowledge about social mechanisms of disease causation. At the same time, and as noted by Green et al. (2017), achieving high DA is likely often not feasible. In fact, measurement of low DA lays bare and explicit the present lack of knowledge about causation mechanisms in epidemiology. In a recent publication, Glymour and Rudolph (2016) attend to the typically low levels of variance explained (r^2), analogous to low DA, pertaining to predictors studied in social as well as genetic epidemiology. Stating that the “gaps in our understanding of what truly drives health are readily apparent”, Glymour and Rudolph recommend inclusion of social theory and qualitative research in epidemiology, as well as open acknowledgement of the uncertainties of existing conceptual and statistical models. While we believe in the merits of multilevel analysis of individual heterogeneity informed by intersectionality theory as a way forward for epidemiology, we agree that epidemiologists should take on an attitude of openness and humility, with regards to knowledge gaps and low DA.

Having said that, we argue that low DA does not mitigate against broad macro- or meso-level policies that, under the principle of *primum non nocere*, can be beneficial across groups, and particularly enable underprivileged groups (Sheldon and Parker, 1992), while avoiding misguided and potentially stigmatizing policies targeting individuals based on social categorization (Merlo and Mulinari, 2015; Mulinari et al., 2015a). At the same time, targeted macro-level interventions can be called for when population groups are identified with high DA. In essence and in sum, we argue that average between-group risk and DA both, and inter- and anti-categorical intersectional approaches both, should be carefully considered in relation to the specific outcome or question at hand, in future epidemiology and Public Health.

Acknowledgements

This work was supported by the Swedish Research Council (JM&MW, grant 2013-2484; SM&MW, grant 2013-1695).

References

Cho, S., Crenshaw, K.W., McCall, L., 2013. Toward a field of intersectionality studies: theory, applications, and praxis. Signs 38, 785–810.

Galea, S., Link, B.G., 2013. Six paths for the future of social epidemiology. Am. J. Epidemiol. 178, 843–849.

Gimenez, M.E., 2001. Marxism, and class, gender, and race: rethinking the trilogy. Race, Gend. Cl. 8, 23–33.

Glymour, M.M., Rudolph, K.E., 2016. Causal inference challenges in social epidemiology: bias, specificity, and imagination. Soc. Sci. Med. 166, 258–265.

Green, M., Evans, C., Subramanian, S.V., 2017. Can intersectionality theory enrich population health research? Soc. Sci. Med. in press.

Jackson, B., 2003. Situating epidemiology. Adv. Gend. Res. 7, 11–58.

Jones, K., Johnston, R., Manley, D., 2016. Uncovering interactions in multivariate contingency tables: a multi-level modelling exploratory approach. Methodol. Innov. 9, 2059799116672874.

McCall, L., 2005. The complexity of intersectionality. Signs 30, 1771–1800.

Merlo, J., 2003. Multilevel analytical approaches in social epidemiology: measures of health variation compared with traditional measures of association. J. Epidemiol. Community Health 57, 550–552.

Merlo, J., 2014. Invited commentary: multilevel analysis of individual heterogeneity - a fundamental critique of the current probabilistic risk factor epidemiology. Am. J. Epidemiol. 180, 208–212.

Merlo, J., Asplund, K., Lynch, J., Råstam, L., Dobson, A., 2004. Population effects on individual systolic blood pressure: a multilevel analysis of the World Health Organization MONICA Project. Am. J. Epidemiol. 159, 1168–1179.

Merlo, J., Mulinari, S., 2015. Measures of discriminatory accuracy and categorizations in public health: a response to Allan Krasnik's editorial. Eur. J. Public Health 25, 910.

Merlo, J., Ohlsson, H., Lynch, K.F., Chaix, B., Subramanian, S.V., 2009. Individual and collective bodies: using measures of variance and association in contextual epidemiology. J. Epidemiol. Community Health 63, 1043–1048.

Merlo, J., Wagner, P., 2012. The tyranny of the averages and the indiscriminate use of risk factors in public health: a call for revolution. Eur. J. Epidemiol. 28, 148.

Mulinari, S., 2014. The specificity triad: notions of disease and therapeutic specificity in biomedical reasoning. Philos. Ethics Humanit Med. 9.

Mulinari, S., Bredstrom, A., Merlo, J., 2015a. Questioning the discriminatory accuracy of broad migrant categories in public health: self-rated health in Sweden. Eur. J. Public Health 25, 911–917.

Mulinari, S., Juarez, S.P., Wagner, P., Merlo, J., 2015b. Does maternal country of birth matter for understanding offspring's birthweight? A multilevel analysis of individual heterogeneity in Sweden. PLoS One 10, e0129362.

Ng, E., Muntaner, C., 2014. A critical approach to macrosocial determinants of population health: engaging scientific realism and incorporating social conflict. Curr. Epidemiol. Rep. 1, 27–37.

Sheldon, T.A., Parker, H., 1992. Race and ethnicity in health research. J. Public Health 14, 104–110.

Smith, G.D., 2011. Epidemiology, epigenetics and the 'Gloomy Prospect': embracing randomness in population health research and practice. Int. J. Epidemiol. 40, 537–562.

Susser, M., 1998. Does risk factor epidemiology put epidemiology at risk? Peering into the future. J. Epidemiol. Community Health 52, 608–611.
Susser, M., Susser, E., 1996. Choosing a future for epidemiology: II. From black box to Chinese boxes and eco-epidemiology. Am. J. Public Health 86, 674–677.
Wemrell, M., Merlo, J., Mulinari, S., Hornborg, A.C., 2016. Contemporary epidemiology: a review of critical discussions within the discipline and a call for further dialogue with social theory. Sociol. Compass 10, 153–171.
Wemrell, M., Mulinari, S., Merlo, J., 2017. Intersectionality and risk for ischemic heart disease in Sweden: categorical and anti-categorical approaches. Soc. Sci. Med. 177, 213–222.

Study IV

CRITICAL PUBLIC HEALTH, 2017
http://dx.doi.org/10.1080/09581596.2017.1316831

Taylor & Francis
Taylor & Francis Group

RESEARCH PAPER

OPEN ACCESS Check for updates

Categorical and anti-categorical approaches to US racial/ethnic groupings: revisiting the National 2009 H1N1 Flu Survey (NHFS)

Shai Mulinari[a,b], Maria Wemrell[b], Björn Rönnerstrand[c], S. V. Subramanian[d] and Juan Merlo[b,e]

[a]Faculty of Social Sciences, Department of Sociology, Lund University, Lund, Sweden; [b]Faculty of Medicine, Department of Clinical Sciences, Unit of Social Epidemiology, Lund University, Malmö, Sweden; [c]Department of Political Science, University of Gothenburg, Göteborg, Sweden; [d]Department of Social and Behavioral Sciences, Harvard School of Public Health, Boston, MA, USA; [e]Center for Primary Health Care Research, Region Skåne, Malmö, Sweden

ABSTRACT

Intersectionality theory calls for the understanding of race/ethnicity, sex/gender and class as interlinked. Intersectional analysis can contribute to public health both through furthering understanding of power dynamics causing health disparities, and by pointing to heterogeneities within, and overlap between, social groups. The latter places the usefulness of social categories in public health under scrutiny. Drawing on McCall we relate the first approach to categorical and the second to anti-categorical intersectionality. Here, we juxtapose the categorical approach with traditional between-group risk calculations (e.g. odds ratios) and the anti-categorical approach with the statistical concept of discriminatory accuracy (DA), which is routinely used to evaluate disease markers in epidemiology. To demonstrate the salience of this distinction, we use the example of racial/ethnic identification and its value for predicting influenza vaccine uptake compared to other conceivable ways of organizing attention to social differentiation. We analyzed data on 56,434 adults who responded to the NHFS. We performed logistic regressions to estimate odds ratios and computed the area under the receiver operating characteristic curve (AU-ROC) to measure DA. Above age, the most informative variables were education and household poverty status, with race/ethnicity providing minor additional information. Our results show that the practical value of standard racial/ethnic categories for making inferences about vaccination status is questionable, because of the high degree of outcome variability within, and overlap between, categories. We argue that, reminiscent of potential tension between categorical and anti-categorical perspectives, between-group risk should be placed and understood in relationship to measures of DA, to avoid the lure of misguided individual-level interventions.

ARTICLE HISTORY
Received 14 October 2016
Accepted 27 March 2017

KEYWORDS
Epidemiology; ethnicity; race; racism; intersectionality; vaccination; discriminatory accuracy

Introduction

Over recent decades, intersectionality theory, which calls for understanding of categories like race/ethnicity, sex/gender and class as interlinked rather than as separate has been advocated and sometimes integrated into studies of population health (Bauer, 2014). McCall (2005) distinguishes between *categorical* intersectionality research, which aims to analyze how interlocking systems of oppression drive disparities between existing social groupings, and *anti-categorical* intersectionality, which critiques

CONTACT Shai Mulinari shai.mulinari@soc.lu.se

categorization *per se,* as use of social categories may in itself contribute to perpetuation, creation or essentialization of difference between groups. In epidemiology, categorical intersectionality can inform the field's traditional mapping of health disparities, through the use of intersectional social categories, in measurement of between-group average risk (Bauer, 2014). In contrast, anti-categorical intersectionality poses a greater challenge to epidemiology since it urges researchers to make explicit the variability within, and overlap between, socially defined groups; and to consider implications of this heterogeneity for the usefulness of social categories and the design of public health policies. However, the important tensions between average risk and heterogeneity, which can be related to potential friction between categorical and anti-categorical perspectives, are seldom teased out in epidemiology, which may result in ambiguous recommendations to researchers and policy-makers regarding the use and value of social categories. For example, Lofters and O'Campo (2012, p. 105) ask epidemiologists to use quantitative intersectional methodologies to 'highlight the most vulnerable subgroups where action is most urgently needed and ensure the best use of resources for ameliorating inequities' *and* to consider heterogeneity within socially defined groups to avoid the lure of misguided individual-level interventions, but without discussing the potential conflict between the two recommendations.

This article seeks to further a conceptual and methodological discussion on use of categorical and anti-categorical approaches in studies of population health and US racial/ethnic groupings. We do this by juxtaposing, on the one hand, a categorical approach with traditional between-group risk calculations (e.g. odds ratios, ORs), and, on the other hand, the anti-categorical approach with the statistical concept of discriminatory accuracy (DA), which is routinely used to evaluate the performance of diagnostic, prognostic, or screening markers in epidemiology (Pepe, Janes, Longton, Leisenring, & Newcomb, 2004). The underpinning idea of the concept of DA is that, to be suitable for individual-level inference, most exposure categories, whether social, geographic, or biological, need to be robust in their capacity to discriminate between individuals who do and do not demonstrate the outcome of interest (Merlo, 2014; Merlo & Wagner, 2013). Therefore, measures of DA are highly relevant in public health even if they are still infrequently reported in the literature (Merlo & Mulinari, 2015; Mulinari, Bredström, & Merlo, 2015; Wemrell, Mulinari, & Merlo, 2017a). We demonstrate the salience of this approach using the empirical example of US racial/ethnic identification and its value for predicting non-receipt of seasonal influenza vaccine compared to other conceivable ways of organizing attention to social differentiation in public health.

In the US context, a large number of studies have investigated how seasonal influenza vaccine uptake is linked to socioeconomic and demographic factors such as household income, educational level, age, gender, and race/ethnicity (Ding et al., 2011; Linn, Guralnik, & Patel, 2010; Vlahov, Bond, Jones, & Ompad, 2012). In this literature, some studies focus specifically on racial/ethnic disparities (Lu, Singleton, Euler, Williams, & Bridges, 2013; Lu et al., 2014, 2015). Notably, the US Centers for Disease Control and Prevention (CDC) regularly publishes influenza vaccination rates using a four-level race/ethnicity standard: Hispanic (any race); non-Hispanic white only; non-Hispanic black only; and non-Hispanic, all other races or multiple races (CDC, 2011). Over the last two decades, data have consistently revealed higher influenza vaccination coverage among non-Hispanic White adults than among non-Hispanic Black adults or Hispanic adults (Lu et al., 2013, 2014, 2015), believed to translate into differences in flu-associated morbidity and mortality (Dee et al., 2011). The well-established and persistent racial/ethic disparities found in prior studies, together with the importance of other socioeconomic and demographic factors, provide an appropriate empirical setting for the intersectional approach advanced in this article.

Another reason for selecting seasonal influenza vaccine uptake as an empirical example is the on-going discussions on appropriate policies to reduce racial/ethnic disparities (Fiscella, 2005; Hutchins, Fiscella, Levine, Ompad, & McDonald, 2009). The majority of the suggested policies are broad, including, e.g. increasing vaccine availability; reducing patient 'out of pocket' costs; making the offering of vaccines in health care and other settings as a routine practice; educating about risks and benefit of vaccines; using patient reminder and recall systems; and standing orders for vaccination (Lu et al., 2014, 2015). A shared feature of such policies is that they do not target individuals based on racial or ethnic identification, and may be beneficial across racial/ethnic groups while simultaneously reducing differences between racial/ethnic groups. For example, offering free or low-cost vaccination may increase vaccination rates in all groups, in particular among low-income individuals, but may also reduce differences because of disproportionately high poverty rates in some racial/ethnic groups.

However, in addition to broad interventions, policies targeting specific racial/ethnic groups have been proposed (Chen, Fox, Cantrell, Stockdale, & Kagawa-Singer, 2007; Phillips, Kumar, Patel, & Arya, 2014; Wooten, Wortley, Singleton, & Euler, 2012). For example, it has been suggested that Black and Hispanic adults should be targeted with a text message campaign prompting them to talk to their doctors about vaccination to help address knowledge gaps and dispel misconceptions (Phillips et al., 2014). Conceptually, racially or ethnically tailored interventions involve the translation of group-level rates to individual-level risk. Yet this translation is questionable at best because of potentially important variability in outcome within groups and overlap between groups (Kaplan, 2014; Merlo, 2014; Mulinari et al., 2015). Leaving concerns about stigmatization aside (Guttman & Salmon, 2004), suggestions to implement racially or ethnically tailored policies raise questions about the value of racial/ethnic identification as a predictor of vaccination status and its predictive value compared to and above other relevant social categorizations, e.g. those based on age, income, education, or gender, or of a combination of social categorizations.

With that in mind, our purpose was threefold. First, we sought to investigate average associations between standard social categorizations and non-receipt of seasonal influenza vaccine, consistent with the conventional mapping of health disparities. Second, we sought to explore the heterogeneity of observational effects within standard racial/ethnic categories by stratifying racial/ethnic groups by gender and education, consistent with a categorical intersectionality perspective. Third, we sought to investigate how well racial/ethnic categories predicted non-receipt of the vaccine compared to and above other relevant social categorizations. Consistent with an anti-categorical intersectionality perspective, the latter analysis of DA may challenge the practical value of standard social categories for individual-level prediction. For all purposes, we used data from 56,434 adults who responded to the National 2009 H1N1 Flu Survey (NHFS) (CDC, 2012).

Methods

The National 2009 H1N1 Flu Survey

The publically available NHFS and survey data have been described elsewhere (Ding et al., 2011). In brief, the NHFS was a one-time telephone survey conducted from October 2009 through June 2010 on behalf of the CDC to monitor and evaluate the 2009–2010 vaccination campaign (CDC, 2012). The survey collected data on the uptake of both the pandemic pH1N1 and usual trivalent seasonal influenza vaccines among adults and children. Among the contacted adults, 56,656 (45.2%) completed the interview. Individual-level and household-level socio-demographic information was requested from interviewees. For some variables (race/ethnicity, gender, age), missing values were imputed. The NHFS used a sequential hot-deck method to assign imputed values, which involves replacing missing values for a non-respondent with observed values from a respondent that is similar to the non-respondent with respect to characteristics observed by both cases (CDC, 2012). There is no information in the NHFS on the amount of imputed values but according to the CDC the amount was ‘very small’ (personal communication).

Assessment of variables

Outcome variable

The outcome variable was seasonal flu vaccination (yes or no). ‘Yes’ indicated that the person had received at least one seasonal influenza vaccination since August 2009. Two hundred and two (0.4%) individuals with missing values on this variable were excluded from the analysis.

NHFS explanatory variables

We used socio-demographic variables defined in the NHFS. 'Race and ethnicity' were based on self-reported information. It included the following groups: Hispanic (any race), non-Hispanic White, non-Hispanic Black, and non-Hispanic, other races or multiple races. This four-level race and ethnicity variable was derived from answers to two questions in the NHFS. Consistent with the revised Office of Management and Budget (OMB, 1997) standards for classification of race and ethnicity, the first question was 'Are you of Hispanic or Latino origin?' The interviewer was instructed to offer the following alternatives: 'Mexican/Mexicano, Mexican-American, Central American, South American, Puerto Rican, Cuban/Cuban American, or other Spanish-Caribbean'. This was followed by a second question: '[In addition to being Hispanic or Latino,] Are you White, Black or African-American, American Indian, Alaska Native, Asian, Native Hawaiian or other Pacific Islander?' The race/ethnicity variable in the NHFS, however, contains only four race/ethnicity categories; the NHFS 'other races or multiple races' category includes Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, and other races, as well as any non-Hispanic respondent selecting more than one race.

'Gender' was either man or woman. While from an intersectionality perspective, binary classification of gender is a limitation; an 'other' category was not permitted by the survey data. 'Age' was divided into five groups (18–34; 35–44; 45–54; 55–64; and 65 or more years). We assessed socioeconomic position using two variables: the 'poverty status' of the person's household and the participant's self-reported 'level of education' (college graduate; some college; 12 years;<12 years; missing or unknown). Household poverty categories (>=$75,000/year; above the poverty threshold but <$75,000/year; below the poverty threshold; poverty status unknown) were based on the number of adults and children reported in the household, the reported household income, and the 2008 Census poverty thresholds (CDC, 2012).

Intersectional explanatory variables

Recent public health studies have stressed the importance of considering social categories not only distinctly but also intersectionally (i.e. simultaneously in individuals) (Lofters & O'Campo, 2012). For instance, it is possible that the average risk of non-receipt of the vaccine is similar in intersectional subgroups defined by *different* 'race/ethnicity' (e.g. Black women vs. White men) but divergences within the *same* racial/ethnic group (e.g. White men vs. White women). If this was true, it would point to important heterogeneity of effects within and between standard racial/ethnic categories. Therefore, in addition to existing variables in the NHFS, we created two novel intersectional variables by stratifying the 'race and ethnicity' categories by, first, 'gender' and, second, 'gender' and 'education'. We used education rather than household poverty as a proxy for socioeconomic position in this combined variable because fewer values were missing for the former (5% vs. 17%).

Statistical analysis

Measures of association

We used logistic regression to examine the association between the potentially explanatory variables and non-receipt of seasonal influenza vaccine. We developed a series of analyses that modeled one variable at a time followed by more elaborate models that adjusted for age, household poverty, and level of education. In addition, we conducted separate analyses using the two intersectional variables mentioned above, created to investigate heterogeneity of effects within and between racial/ethnic groups. In all analyses, we used the provided survey weights that are calculated using a number of socioeconomic and demographic variables including age, gender, race/ethnicity, and state of residence (CDC, 2012). We expressed associations by means of ORs and 95% confidence intervals (CIs). The reference groups in the analyses were those presenting the highest vaccination rates.

Analysis of discriminatory accuracy

DA measures the ability of a diagnostic tool, marker or category to correctly discriminate between people with or without an outcome of interest (Merlo, 2014; Pepe et al., 2004). In principle, diagnostic tools, markers, or categories, often included as covariates in statistical models, need to have high DA to be deemed valid for diagnostic or prognostic assessment. It is well known that measures of association alone are inappropriate for gauging the DA of statistical models (Pepe et al., 2004). In fact, what we normally consider a strong association between an exposure and an outcome (e.g. an OR of 10) may be related to a rather low capacity of the exposure to discriminate cases and non-cases. For linear regression models, DA corresponds with the concept of variance explained (r^2) used to evaluate the general strength of findings in research fields including epidemiology (Merlo & Wagner, 2013). For logistic regression models, DA is assessed by means of receiver operating characteristic (ROC) curve analysis. The ROC curves were created by plotting sensitivity, or the true positive fraction (TPF), vs. 1-specificity, or the false positive fraction (FPF), at various threshold settings of predicted risk obtained from the logistic regression models. The TPF expresses the probability that given some covariates an unvaccinated individual belongs to the class coded as 1 (the individual is predicted to be unvaccinated) at a specific threshold setting of predicted risk. The FPF expresses the probability that, using the same threshold, a vaccinated individual belongs to the class coded as 1, i.e. the individual is misclassified as unvaccinated. We calculated the area under the ROC curve (AU-ROC), or C statistic, as a measure of DA. AU-ROC assumes a value from 0.5 to 1 where 1 is perfect discrimination and 0.5 is as informative as flipping an unbiased coin (i.e. the covariates have no predictive power) (Pepe et al., 2004). Here, the AU-ROC can be interpreted as the probability that a randomly selected non-vaccinated individual will have a higher predicted risk of non-receipt than a randomly selected vaccinated individual. For example, an AU-ROC = 0.6 means that if we randomly select one unvaccinated and one vaccinated individual, the probability of having a higher predicted risk of non-receipt for the unvaccinated individual is 60%. If the AU-ROC = 1, every unvaccinated individual would have higher predicted risk of non-receipt than every vaccinated individual.

In an initial series of simple logistic regression models, we calculated the AU-ROCs with 95% CIs of models including age alone or age plus one or more other variables. We assessed the incremental discriminatory value of a model by calculating the increase in AU-ROC. We used the AU-ROC of age as the baseline from which to assess the incremental discriminatory value of other models because age is a major determinant of influenza vaccine receipt and also a confounder of the association between race/ethnicity and influenza vaccination receipt (Lu et al., 2013, 2014, 2015). In a second series of logistic regression models, we calculated the AU-ROCs with 95% CIs of models including age and the variable 'race and ethnicity' together with 'gender' or with 'gender', 'household poverty status', and 'educational level'. This second series of modeling was done to assess the incremental discriminatory value of more elaborate models. Finally, we calculated the AU-ROCs with 95% CIs of models including age and the two intersectional variables to test whether the use of intersectional sub-groupings lead to improvement of DA compared to models that include 'race/ethnicity', 'gender' and 'education' as separate terms.

We performed the statistical analyses using SPSS Version 22.0 (SPSS Inc., Chicago, Illinois, USA) and STATA (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

Results

Mapping of disparities through measurement of between-group average risk

As shown in Table 1, the overall non-receipt of seasonal influenza vaccine in the sample was 53.3%. According to the raw data, coverage was higher for individuals identified as non-Hispanic White compared to each of the other racial/ethnic groups, as well as in men compared to women. Vaccination coverage also generally increased with increasing age, household income, and educational level.

Our analyses revealed that, compared to the non-Hispanic White group, rates of non-vaccination receipt were significantly higher among non-Hispanic Blacks (OR = 1.72, CI 95% 1.52–1.94), Hispanics (OR = 1.88, CI 95% 1.63–2.17), and people identified as being of other or multiple races (OR = 1.19, CI 95% 1.04–1.37) (Table 2). The associations remained conclusive for non-Hispanic Blacks and Hispanics after adjustment for age, but the strength of the associations diminished for both groups and especially

Table 1. Characteristics of sample.

	Total (*n*)	Total (%)	Non-receipt of seasonal influenza vaccine (%)
All	56,434	100	53.3
Racial/ethnic category			
Non-Hispanic White	44,909	79.6	51.0
Non-Hispanic Black	4553	8.1	63.5
Hispanic, any race	3651	6.5	66.7
Non-Hispanic, other or multiple races	3321	5.9	57.0
Gender			
Female	33,458	59.3	50.5
Male	22,976	40.7	57.5
Age			
18–34	11,022	19.5	71.0
35–44	8244	14.6	63.6
45–54	11,077	19.6	60.3
55–64	11,699	20.7	48.8
>=65	14,392	25.5	32.3
Education			
College graduate	21,390	37.9	48.6
Some college	14,882	26.4	54.9
12 years	12,164	21.6	54.7
<12 years	5020	8.9	60.3
Missing or unknown	2978	5.3	62.2
Poverty status of household			
>=$75,000	14,398	25.5	49.9
<$75,000, above poverty threshold	26,994	47.8	52.1
Below poverty threshold	5587	9.9	64.5
Missing or unknown	9455	16.8	55.5

for Hispanics (OR = 1.35, CI 95% 1.18–1.56). Additional adjustment for educational level and household poverty status further weakened associations but they remained statistically conclusive (Table 2). Moreover, men had a higher rate of non-receipt of seasonal influenza vaccine than women, and there were conclusive differences across age groups, as well as across household poverty and educational level categories (Table 2).

Heterogeneity of effects between and within racial and ethnic categories

The combination of the race/ethnicity and gender variables that created 8 different intersectional subgroups revealed that in comparison to non-Hispanic White women, all other subgroups except women identified as being of 'other or multiple races' had higher rates of non-vaccination receipt (Table 3). However, ORs were similar for non-Hispanic White men (OR = 1.20, CI 95% 1.11–1.30) and Hispanic women (OR = 1.41, CI 95% 1.19–1.67), showing that the risk of non-vaccination receipt is heterogeneously distributed within and between racial/ethnic categories. Combining race/ethnicity, gender, and education variables to create 40 different intersectional subgroups resulted in an even more complex picture: we observed substantial heterogeneity of effects within and between groups defined by race/ethnicity (Table 3).

Measuring the discriminatory accuracy of social categorizations

Despite these statistically significant associations, the DA of the categories studied was very low. Table 4 shows the AU-ROCs of models that included age alone or age together with one or more of the explanatory variables. The AU-ROC for age alone was 0.658 (Model 1) and it increased only slightly (+0.005) when information on race/ethnicity was included (Model 2). That is, if we randomly select one unvaccinated and one vaccinated individual from the NHFS, the probability of having a higher predicted risk of non-receipt for the unvaccinated individual in the two models is 65.8 and 66.3%, respectively. Similarly, information on gender did little to improve the DA above the model that included age (+0.006) (Model

Table 2. Measures of association between social categories and non-receipt of seasonal influenza vaccine.

	Unadjusted		Age-adjusted		Adjusted for age, educational level, household poverty status	
	OR[a]	CI[b] 95%	OR	CI 95%	OR	CI 95%
Racial/ethnic category						
Non-Hispanic White	1		1		1	
Non-Hispanic Black	1.72	1.52–1.94	1.57	1.38–1.78	1.40	1.23–1.60
Hispanic, any race	1.88	1.63–2.17	1.35	1.18–1.56	1.18	1.02–1.36
Non-Hispanic, other or multiple races	1.19	1.04–1.37	0.97	0.84–1.13	0.93	0.80–1.08
Gender						
Female	1		1		1	
Male	1.27	1.19–1.35	1.19	1.11–1.27	1.23	1.14–1.32
Age						
18–34	4.98	4.48–5.54				
35–44	3.24	3.45–4.04				
45–54	3.14	2.84–3.47				
55–64	1.92	1.74–2.16				
>=65	1					
Education						
College graduate	1		1			
Some college	1.24	1.14–1.34	1.25	1.15–1.37		
12 years	1.29	1.18–1.41	1.48	1.35–1.63		
<12 years	1.60	1.41–1.80	1.92	1.69–2.18		
Missing or unknown	1.81	1.56–2.10	1.60	1.37–1.87		
Poverty status of household						
>=$75,000	1		1			
<$75,000, above poverty threshold	1.12	1.04–1.22	1.43	1.32–1.56		
Below poverty threshold	1.73	1.53–1.96	1.86	1.64–2.10		
Missing or unknown	1.31	1.18–1.45	1.76	1.58–1.96		

[a] Odds ratio.
[b] Confidence interval.

3) or age and race (+0.004) (Model 4; compare to Model 2). Household poverty status and educational level were the most informative variables beyond age (each +0.014, not shown), but the model including age, household poverty status, and educational level still reached only an AU-ROC = 0.678 (+0.020) (Model 5). Notably, including race/ethnicity only added +0.001 (Model 6), which is consistent with a strong relationship between class and race/ethnicity. We observed the highest DA (AU-ROC = 0.681) for the model that included all explanatory variables (Model 7). However, this higher DA compared to the model including age only (+0.022) was mainly due to the socioeconomic variables. In the final analysis, we tested whether the composite intersectional variables improved the DA compared with the models where the 'race and ethnicity', 'gender' and 'educational level' variables were kept separate; we found that use of intersectional sub-groupings did little to further improve DA (Models 4 vs. 8 and 7 vs. 9).

Discussion

Eliminating health disparities along lines of race/ethnicity is an important goal of public health policy. Our results confirm findings that adult seasonal influenza vaccination coverage is higher among non-Hispanic White adults than among non-Hispanic Black adults or Hispanic adults (Lu et al., 2013, 2014, 2015; CDC, 2011). The group defined as 'non-Hispanic, other races or multiple races' also had lower vaccination coverage than the White majority group, but the difference disappeared when we controlled for age. When faced with no evidence of a difference between broadly defined racial/ethnic groups, researchers have sometimes sought to disaggregate groups since aggregating data can conceal inequities between sub-groups. For example, a study found no differences in vaccination coverage between the non-Hispanic White group and the broad Asian/Pacific Islander group, but found differences between the non-Hispanic White group and the Filipino American sub-group (Chen et al., 2007).

Table 3. Age-adjusted measures of association between subgroups and non-receipt of seasonal influenza vaccine.

				Educational level									
				College Graduate		Some College		12 years		<12 years		Missing or unknown	
Racial/ethnic category	Gender	OR[a]	95% CI[b]	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Non-Hispanic White	Female	1		1		1.22	1.08–1.37	1.36	1.19–1.56	1.81	1.47–2.22	1.99	1.57–2.53
	Male	1.20	1.11–1.30	1.14	1.01–1.29	1.62	1.38–1.88	1.87	1.60–2.19	2.07	1.60–2.69	1.58	1.23–2.02
Non-Hispanic Black	Female	1.64	1.41–1.91	1.43	1.07–1.94	2.00	1.55–2.57	2.14	1.58–2.90	3.34	2.38–4.69	1.58	0.76–3.32
	Male	1.79	1.43–2.26	2.70	1.88–3.87	1.26	0.78–2.04	2.65	1.87–3.76	3.58	2.24–5.72	1.84	0.89–3.81
Hispanic, any race	Female	1.41	1.19–1.67	1.57	1.11–2.22	1.38	0.97–1.86	2.47	1.69–3.62	1.68	1.23–2.29	1.75	0.99–3.10
	Male	1.53	1.21–1.93	0.89	0.54–1.49	1.68	1.01–2.78	2.92	2.00–4.26	2.50	1.77–3.54	2.82	1.56–5.10
Non-Hispanic, other or multiple races	Female	0.91	0.74–1.12	1.14	0.83–1.55	0.98	0.66–1.45	1.12	0.67–1.90	1.55	0.87–2.77	0.81	0.33–1.94
	Male	1.26	1.03–1.55	1.31	0.95–1.82	1.52	1.00–2.32	1.45	0.96–2.18	3.32	1.71–6.44	1.65	0.91–3.02

[a] Odds ratio.
[b] Confidence interval.

Table 4. AU-ROC analysis to evaluate the DA of different models for non-receipt of seasonal influenza vaccine.

Variables in model	Model no.								
NHFS original variables	1	2	3	4	5	6	7	8	9
Age	■	■	■	■	■	■	■	■	■
Racial/ethnic category		■		■		■	■		
Gender			■	■			■		
Education					■	■	■		
Poverty status of household					■	■	■		■
Intersectional variables									
Racial/ethnic category stratified by gender								■	
Racial/ethnic category stratifed by gender and education									■
AU-ROC[a]	0.658	0.663	0.664	0.668	0.678	0.679	0.681	0.669	0.682
ΔAU-ROC	Ref.	0.005	0.006	0.010	0.020	0.021	0.023	0.011	0.024

[a] 95% confidence intervals are ± 0.005 or 0.004.

The gray shading indicates which variables are included in Models 1-9. For example, Model 1 only included the variable age.

A recognized problem with sub-group analyses is that conclusive findings may represent spurious associations (Sun, Ioannidis, Agoritsas, Alba, & Guyatt, 2014). However, our study highlights another issue of major importance to public health practice and research: while aggregate data may conceal differences *between* groups (Pande & Yazbeck, 2003), aggregating data can also conceal substantial outcome variability (and thus inequality) *within* groups and overlap *between* groups (Bleich, Thorpe, Sharif-Harris, Fesahazion, & LaVeist, 2010). If this heterogeneity is considerable, references to between-group differences in mean values, without simultaneous reference to within-group variation and between-group overlap, risk overemphasizing the value of racial/ethnic categories as a means of predicting the health-related or health care-seeking behavior of individuals (Mulinari, Juárez, Wagner, & Merlo, 2015; Mulinari et al., 2015). Reminiscent of potential tension between categorical and anti-categorical approaches (McCall, 2005), then, between-group average risk should be placed and understood in relationship to measures of DA to avoid the lure of misguided individual-level interventions.

Assertion of the limited value of racial/ethnic categories for individual-level prediction is not new (Kaplan, 2014; Kaplan & Bennett, 2003), and its relevance extends beyond medicine and public health, e.g. to profiling by law enforcement and security personnel (Engel, 2008). In medicine, a meta-analysis of racial differences in response to antihypertensive drugs found that despite differences between US Whites and Blacks at the aggregate level, race has little value in predicting response to antihypertensive drugs, because Whites and Blacks overlap greatly in their response to all categories of drugs (Sehgal, 2004). Similarly, the use of human racial/ethnic categories in genetics has been heavily criticized because of the large genetic diversity within groups and continuous overlap between groups despite average differences in allele frequencies (Lewontin, 1972; Holsinger & Weir, 2009). The novelty of our study is the introduction of ROC curves as a measure of DA to gauge the overlap between US racial/ethnic categories. ROC curve analysis, or similar approaches like the multilevel analysis of individual heterogeneity (Merlo, 2003, 2014; Wemrell, Mulinari, & Merlo, 2017b), can be used to identify when biological (Juarez, Wagner & Merlo, 2014), geographical (Merlo, Viciana-Fernández, Ramiro-Fariñas, & Research Group of the Longitudinal Database of the Andalusian Population (LDAP), 2012), socioeconomic or ethnic (Beckman et al., 2004; Mulinari et al., 2015) categorizations are valid as instruments for individual-level predictions. In the present case, the large overlaps in vaccination coverage are reflected in the low DA of the racial/ethnic categories used. A low DA effectively refutes the argument that although not every individual within a racial/ethnic group possesses a particular trait, racial/ethnic categories function well enough in predicting which individuals possess it. Because standard racial/ethnic categories do not function well enough for individual-level prediction, the reliance on racial/ethnic identification as a proxy in medical decision-making may lead to inappropriate treatment based on stereotyping (Kaplan, 2014). This does not preclude the possibility of other racial/ethnic categorizations having a higher DA, or that existing categorizations are more relevant for predicting other outcomes, but to our knowledge such a case awaits empirical confirmation.

Another argument professed in favor of using racial/ethnic identification to predict vaccination behavior is based on reports of unique barriers to adult influenza vaccination in different racial/ethnic groups (Chen et al., 2007). Yet on closer inspection, most of those barriers are not unique to any particular group. For example, Chen et al. (2007) found that 32% of African-American influenza vaccination absentees cited concerns over the vaccine causing influenza or serious side effects, while 18% of Whites, 13% of Latinos, 11% of Japanese Americans, and 22% of Filipino Americans cited the same reason. Nonetheless, the authors called for 'ethnic specific strategies to address the issues of mistrust by African-American expressed in sentiments such as their concern that the influenza vaccine causes influenza' (Chen et al., 2007). While there may be issues of mistrust among African-Americans related to racism and social exclusion, mistrust is not a racially unique phenomenon (Boulware, Cooper, Ratner, LaVeist, & Powe, 2003), nor is it a racially unique reason for not being vaccinated (Chen et al., 2007). Social inequity in vaccination coverage and social patterning of trust are unlikely to be effectively addressed by racially tailored interventions. On the contrary, experiences with tailored social programs suggest they tend to undermine social trust (Kumlin & Rothstein, 2005). Interventions may be particularly misguided when targeted at altering the behavior of selected individuals, as opposed to changing macro- or meso-level factors that enable and constrain behaviors because targeting individuals carries a higher risk of stigmatization (Guttman & Salmon, 2004). To be clear, we are not questioning the importance of race/ethnicity as an identity, or the lived experience of people in a racialized society. Rather, our concern is with the use of racial/ethnic categories for individual-level prediction and profiling. We believe this use would be dramatically reduced, if measures of DA be routinely reported alongside measures of associations when gauging group-level differences.

Our study also raises questions about the value of racial/ethnic identification for predicting vaccination status compared to other conceivable ways of organizing attention to social differentiation in public health. That the CDC routinely releases vaccination coverage data by race/ethnicity is consistent with federal mandates requiring agencies under the Department of Health and Human Services to collect and report race/ethnicity-based statistics to monitor and combat inequalities (Epstein, 2008). A major argument for collecting race/ethnicity-based statistics is that race/ethnicity is a primary axis of social distinction and is therefore associated with a broad array of factors with important modifying effects on health and health care delivery (Kaplan & Bennett, 2003). However, as pointed out by Epstein (2008), the federal endorsement of a specific set of racial/ethnic categories has resulted in the proliferation of studies that treat these taxonomic categories as the standardized formal units of analysis; in the process, other ways of classifying health risks, such as behavioral practices, and other ways of classifying populations, such as by social class, receive far less attention.

The CDC does not consistently report influenza vaccination coverage by socioeconomic status indicators such as income or education. The CDC acknowledges that racial/ethnic disparities in influenza vaccination coverage have been studied more extensively compared to other potentially relevant disparity domains, such as gender and socioeconomic position (Setse et al., 2011), suggesting that disparities along these lines are considered of lesser concern. Yet information on variables relevant to other disparity domains is readily available, and our analysis shows conclusive differences between women and men irrespective of age (i.e. not fully explained by pregnancy) and across socioeconomic groups, consistent with the results reported by others (Setse et al., 2011). These differences appear to be as large as or larger than those observed between individuals identified as Black or White. In fact, the ROC curve analysis showed that above age, the most informative variables were education and household poverty status (+0.020), with race/ethnicity providing very little additional information (+0.001). It is important to note that race/ethnicity and socioeconomic position are not independent, as the disadvantage that members of some minority groups suffer will translate into, on average, lower income and educational levels. Polices that effectively address socioeconomic inequities are therefore predicted to diminish, albeit not eliminate, racial/ethnic gaps. Ignoring socioeconomic inequalities risks diverting attention away from policies that could have major impact on vaccination rates among minority group members while simultaneously benefitting the large group of deprived Whites.

Intersectionality theory posits that social differentiation takes place along multiple, non-independent, and possibly interacting axes (McCall, 2005). In the case of vaccination coverage, one consequence of this social complexity is that most individuals can be construed as belonging to one or more major social groups with lower vaccination coverage than one or more comparison groups. It also means that, through application of a categorical intersectionality perspective, groups can be split into a number of smaller taxonomic units through the combination of more than one major axis of social differentiation, as we have done in this paper. Yet the ROC curve analysis showed that the composite intersectional variables did little to improve the DA compared with the models where the 'race and ethnicity', 'gender' and 'educational level' variables were kept separate. This highlights the fact that splitting the population into increasingly smaller taxonomic units to 'hone in on … the most vulnerable subgroups' (Lofters & O'Campo, 2012, p. 105) may not ensure the best use of resources for ameliorating inequalities because of the high degree of outcome variability within, and overlap between, social categories. The problem, therefore, is how to justify focusing on one particular axis of social differentiation rather than any other. Decisions to focus on one particular set of social positions or intersection of positions will be guided by political, theoretical, and pragmatic choices and constraints. This point is underlined by the fact that routine stratification by race/ethnicity is primarily a US practice bolstered by federal mandates and standards (Epstein, 2008). While measures of DA provide no escape from this situation, at least they underscore the important points that social structures, such as racism, generate persistent patterns of inequality but not law-like regularities (Muntaner, 2013), and that there is a great deal of variance in health and health care seeking behavior that is not readily mapped onto social position (Dunn, 2012).

In sum, our study shows that the practical value of standard racial/ethnic categories, and other relevant social categorizations, for making inferences about individuals' vaccination status is questionable despite seemingly large and conclusive differences between groups. More generally, our study highlights the tension between average, between-group, risk and measures of DA, related to and understood by means of categorical and anti-categorical intersectionality. While quantitative intersectionality research has often been of the categorical type, anti-categorical approaches have usually been furthered through qualitative research, often encompassing philosophical critique of social categorization as potentially leading to demarcation, exclusion and furthered inequality. Operationalized through measurement of DA, anti-categorical approaches can also be investigated, expressed and developed within a quantitative framework.

Limitations

Because it is based on a cross-sectional telephone survey, our study has several weaknesses. Among these, it should be stressed that the response rate was relatively low (45.2%), which increases the risk of non-response bias, and that information was self-reported and may be subject to recall error. According to the CDC (2011), the survey overestimates seasonal influenza vaccination coverage; in part this may because of misclassification of pandemic pH1N1 vaccine for seasonal influenza vaccine. To test if the low DA of racial/ethnic categories was limited to seasonal influenza vaccination, we ran the analyses with 2009 pandemic pH1N1 vaccination status as the outcome, but conclusions were the same (available upon request). Finally, our analysis does not consider the fact that vaccination levels changed over the duration of survey administration which could a have slight effect on vaccination coverage estimates.

There is a substantial body of literature discussing the strength and weakness of different methods for assignment to racial/ethnic categories including self-report, investigator-assigned, based on administrative records, and using genetic markers; and study results can differ substantially depending on the method used (reviewed in Kaplan, 2014). In epidemiology, the 'gold standard' for racial/ethnic assignment is self-report, consistent with the principle that people are who they say they are. Yet the complexity and fluidity of individual identity make it impossible to divide the population into non-overlapping racial/ethnic groups, or to validly and reliably allocate people to any given set of categories. Accordingly, research studies have found inconsistencies in the way that race and ethnicity are self-reported and recoded by investigators (Kaplan, 2014). However, because our purpose was to evaluate standard racial/ethnic categories used regularly by public health researchers and authorities, any limitations of race/ethnicity data, although important to acknowledge, do not undermine our finding that standard racial/ethnic categories have low DA for the studied outcome.

Acknowledgement

We thank Judith B. Kaplan for important comments on an earlier draft.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the Swedish Research Council (VR) [grant number 2013-1268 to S.M], [grant number 2013-1695 to S.M] and [grant number 2013-2484 to J.M] and the Public Health Unit at Scania County Council (Region Skåne) [grant number 2013 to J.M].

References

Bauer, G. R. (2014). Incorporating intersectionality theory into population health research methodology: Challenges and the potential to advance health equity. *Social Science & Medicine, 110*, 10–17.

Beckman, A., Merlo, J., Lynch, J. W., Gerdtham, U. G., Lindström, M., & Lithman, T. (2004). Country of birth, socioeconomic position, and healthcare expenditure: a multilevel analysis of Malmö, Sweden. *Journal of Epidemiology and Community Health, 58*, 145–149.

Bleich, S. N., Thorpe, R. J., Sharif-Harris, H., Fesahazion, R., & LaVeist, T. A. (2010). Social context explains race disparities in obesity among women. *Journal of Epidemiology and Community Health, 64*, 465–469.

Boulware, L. E., Cooper, L. A., Ratner, L. E., LaVeist, T. A., & Powe, N. R. (2003). Race and trust in the health care system. *Public Health Reports, 118*, 358.

Centers for Disease Control and Prevention (CDC) (2012, August 20). *Datasets and Related Documentation for the National 2009 H1N1 Flu Survey (NHFS)*. Retrieved May 26, 2016, from http://www.cdc.gov/nchs/nis/data_files_h1n1.htm

Centers for Disease Control and Prevention (CDC). (2011, May 13). *Final estimates for 2009–2010 seasonal influenza and influenza A (H1N1) 2009 monovalent vaccination coverage–United States, August 2009 through May, 2010*. Retrieved May 26, 2016, from http://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm

Chen, J. Y., Fox, S. A., Cantrell, C. H., Stockdale, S. E., & Kagawa-Singer, M. (2007). Health disparities and prevention: Racial/ethnic barriers to flu vaccinations. *Journal of Community Health, 32*, 5–20.

Dee, D. L., Bensyl, D. M., Gindler, J., Truman, B. I., Allen, B. G., D'Mello, T., … Fowlkes, A. (2011). Racial and ethnic disparities in hospitalizations and deaths associated with 2009 pandemic influenza A (H1N1) virus infections in the United States. *Annals of Epidemiology, 21*, 623–630.

Ding, H., Santibanez, T. A., Jamieson, D. J., Weinbaum, C. M., Euler, G. L., Grohskopf, L. A., … Singleton, J.A. (2011). Influenza vaccination coverage among pregnant women–National 2009 H1N1 Flu Survey (NHFS). *American Journal of Obstetrics and Gynecology, 204*, S96–S106.

Dunn, J. R. (2012). "Explanation", philosophy and theory in health inequalities research: Towards a critical realist approach. In P. O'Campo & J. R. Dunn (Eds.), *Rethinking social epidemiology* (pp. 23–42). New York, NY: Springer.

Engel, R. S. (2008). A critique of the "outcome test" in racial profiling research. *Justice Quarterly, 25*(1), 1–36.

Epstein, S. (2008). *Inclusion: The politics of difference in medical research*. Chicago, IL: University of Chicago Press.

Fiscella, K. (2005). Commentary-anatomy of racial disparity in influenza vaccination. *Health Services Research, 40*, 539–550.

Guttman, N., & Salmon, C. T. (2004). Guilt, fear, stigma and knowledge gaps: Ethical issues in public health communication interventions. *Bioethics, 18*, 531–552.

Holsinger, K. E., & Weir, B. S. (2009). Genetics in geographically structured populations: Defining, estimating and interpreting FST. *Nature Reviews Genetics, 10*, 639–650.

Hutchins, S. S., Fiscella, K., Levine, R. S., Ompad, D. C., & McDonald, M. (2009). Protection of racial/ethnic minority populations during an influenza pandemic. *American Journal of Public Health, 99*, S261–S270.

Juárez, S. P., Wagner, P., & Merlo, J. (2014). Applying measures of discriminatory accuracy to revisit traditional risk factors for being small for gestational age in Sweden: A national cross-sectional study. *BMJ Open, 4*, e005388.

Kaplan, J. B. (2014). The quality of data on "race" and "ethnicity": Implications for health researchers, policy makers, and practitioners. *Race and Social Problems, 6*, 214–236.

Kaplan, J. B., & Bennett, T. (2003). Use of race and ethnicity in biomedical publication. *Journal of the American Medical Association, 289*, 2709–2716.

Kumlin, S., & Rothstein, B. (2005). Making and breaking social capital the impact of welfare-state institutions. *Comparative Political Studies, 38*, 339–365.

Lewontin, R. C. (1972). The apportionment of human diversity. *Evolutionary Biology, 6*, 381–398.

Linn, S. T., Guralnik, J. M., & Patel, K. V. (2010). Disparities in influenza vaccine coverage in the United States, 2008. *Journal of the American Geriatrics Society, 58*, 1333–1340.

Lofters, A., & O'Campo, P. (2012). Differences that matter. In P. O'Campo & J. R. Dunn (Eds.), *Rethinking social epidemiology* (pp. 93–109). New York, NY: Springer.

Lu, P. J., Singleton, J. A., Euler, G. L., Williams, W. W., & Bridges, C. B. (2013). Seasonal influenza vaccination coverage among adult populations in the United States, 2005–2011. *American Journal of Epidemiology, 178*, 1478–1487.

Lu, P. J., O'Halloran, A., Bryan, L., Kennedy, E. D., Ding, H., Graitcer, S. B., … Singleton, J. A. (2014). Trends in racial/ethnic disparities in influenza vaccination coverage among adults during the 2007–2008 through 2011–2012 seasons. *American Journal of Infection Control, 42*(7), 763–769.

Lu, P. J., O'Halloran, A., Williams, W. W., Lindley, M. C., Farrall, S., & Bridges, C. B. (2015). Racial and ethnic disparities in vaccination coverage among adult populations in the US. *American Journal of Preventive Medicine, 49*, S412–S425.

McCall, L. (2005). The complexity of intersectionality. *Signs: Journal of Women in Culture and Society, 30*, 1771–1800.

Merlo, J. (2003). Multilevel analytical approaches in social epidemiology: Measures of health variation compared with traditional measures of association. *Journal of Epidemiology and Community Health, 57*, 550–552.

Merlo, J. (2014). Invited commentary: multilevel analysis of individual heterogeneity – A fundamental critique of the current probabilistic risk factor epidemiology. *American Journal of Epidemiology, 180*, 208–212.

Merlo, J., & Mulinari, S. (2015). Measures of discriminatory accuracy and categorizations in public health: A response to Allan Krasnik's editorial. *The European Journal of Public Health, 25*, 910–910.

Merlo, J., Viciana-Fernández, F. J., Ramiro-Fariñas, D., & Research Group of the Longitudinal Database of the Andalusian Population (LDAP) (2012). Bringing the individual back to small-area variation studies: A multilevel analysis of all-cause mortality in Andalusia. *Spain. Social Science & Medicine, 75*, 1477–1487.

Merlo, J., & Wagner, P. (2013). The tyranny of the averages and the indiscriminate use of risk factors in public health: A call for revolution. *European Journal of Epidemiology, 28*(Suppl. 1), 148.

Mulinari, S., Bredström, A., & Merlo, J. (2015). Questioning the discriminatory accuracy of broad migrant categories in public health: Self-rated health in Sweden. *The European Journal of Public Health, 25*, 911–917.

Mulinari, S., Juárez, S. P., Wagner, P., & Merlo, J. (2015). Does maternal country of birth matter for understanding offspring's birthweight? A multilevel analysis of individual heterogeneity in Sweden. *PLoS One, 10*, e0129362.

Muntaner, C. (2013). Invited commentary: On the future of social epidemiology – A case for scientific realism. *American Journal of Epidemiology, 178*, 852–857.

Office of Management and Budget (OMB) (1997, October 30). *Revisions to the standards for the classification of federal data on race and ethnicity*. Retrieved January 11, 2017, from http://www.whitehouse.gov/omb/fedreg_1997standards

Pande, R. P., & Yazbeck, A. S. (2003). What's in a country average? Wealth, gender, and regional inequalities in immunization in India. *Social Science & Medicine, 57*, 2075–2088.

Pepe, M. S., Janes, H., Longton, G., Leisenring, W., & Newcomb, P. (2004). Limitations of the odds ratio in gauging the performance of a diagnostic, prognostic, or screening marker. *American Journal of Epidemiology, 159*, 882–890.

Phillips, A. L., Kumar, D., Patel, S., & Arya, M. (2014). Using text messages to improve patient–doctor communication among racial and ethnic minority adults: An innovative solution to increase influenza vaccinations. *Preventive Medicine, 69*, 117–119.

Sehgal, A. R. (2004). Overlap between whites and blacks in response to antihypertensive drugs. *Hypertension, 43*, 566–572.

Setse, R. W., Euler, G. L., Gonzalez-Feliciano, A. G., Bryan, L. N., Furlow, C., Weinbaum, C. M., & Singleton, J. A. (2011). Influenza vaccination coverage – United States, 2000–2010. *Morbidity and Mortality Weekly Report (MMWR) Surveillance Summaries, 60*, 38–41.

Sun, X., Ioannidis, J. P., Agoritsas, T., Alba, A. C., & Guyatt, G. (2014). How to use a subgroup analysis: Users' guide to the medical literature. *Journal of the American Medical Association, 311*, 405–411.

Vlahov, D., Bond, K. T., Jones, K. C., & Ompad, D. C. (2012). Factors associated with differential uptake of seasonal influenza immunizations among underserved communities during the 2009–2010 influenza season. *Journal of Community Health, 37*, 282–287.

Wemrell, M., Mulinari, S., & Merlo, J. (2017a). Intersectionality and risk for ischemic heart disease in Sweden: Categorical and anti-categorical approaches. *Social Science & Medicine, 177*, 213–222.

Wemrell, M., Mulinari, S., & Merlo, J. (2017b). An intersectional approach to multilevel analysis of individual heterogeneity (MAIH) and discriminatory accuracy. *Social Science & Medicine, 178*, 217–219.

Wooten, K. G., Wortley, P. M., Singleton, J. A., & Euler, G. L. (2012). Perceptions matter: Beliefs about influenza vaccine and vaccination behavior among elderly white, black and Hispanic Americans. *Vaccine, 30*, 6927–6934.

Study V

Complementary
Medicine Research
Practice | Methods | Perspectives

Original Article · Originalarbeit

Complement Med Res
DOI: 10.1159/000464442

Two-Thirds of Survey Respondents in Southern Sweden Used Complementary or Alternative Medicine in 2015

Maria Wemrell[a] Juan Merlo[a, c] Shai Mulinari[a, b] Anne-Christine Hornborg[d]

[a] Unit of Social Epidemiology, Faculty of Medicine, Lund University, Malmö, Sweden;
[b] Department of Sociology, Faculty of Social Sciences, Lund University, Lund, Sweden;
[c] Center for Primary Health Research, Region Skåne, Malmö, Sweden;
[d] Center for Theology and Religious Studies, Lund University, Lund, Sweden

Keywords
Complementary and alternative medicine · CAM · Prevalence · Survey · I-CAM-Q

Summary

Background: Research has long suggested that a large and possibly growing number of people use complementary or alternative medicine (CAM). However, in many countries, such as Sweden, national and regional research on CAM use is still very limited. Existing prevalence studies are few and characterized by low comparability. This study aims to contribute towards addressing this knowledge gap. **Methods:** A web-based survey measured the use of and attitude towards CAM and conventional medicine in the southernmost Swedish province of Scania, while taking part in the development of a measurement tool for the standardized study of CAM use within the European Union (EU; I-CAM-Q). **Results:** 71% of the respondents (n = 1,534) reported having used some form of CAM in the past year. CAM consumption here includes visits to CAM providers, use of natural remedies, and use of self-help methods. Reported use was more common among women, younger age groups, and people with tertiary education. 69% of the respondents stated that collaboration between conventional medicine and complementary medicine should increase. The survey's response rate was 31%. **Conclusions:** The study confirms that CAM forms a considerable part of the health care offered to and used by the population. In the face of the existing lack of national and regional data on CAM usage, it affirms the importance of furthered investigation of CAM consumption, policy, practice, regulation, and education.

Schlüsselwörter
Komplementär- und Alternativmedizin · CAM · Prävalenz · Umfrage · I-CAM-Q

Zusammenfassung

Hintergrund: In der wissenschaftlichen Forschung gibt es schon länger Hinweise darauf, dass eine große und wahrscheinlich wachsende Anzahl von Leuten die Angebote der Komplementär- oder Alternativmedizin (CAM) in Anspruch nimmt. In vielen Ländern, wie z.B. Schweden, ist die nationale und regionale Forschungslage zur CAM-Nutzung jedoch immer noch sehr begrenzt. Existierende Studien zur Prävalenz sind rar und zeichnen sich durch eine geringe Vergleichbarkeit aus. Diese Studie soll dazu beitragen, diese Wissenslücke zu schließen. **Methoden:** Eine Internet-basierte Umfrage ermittelte die Nutzung von und die Einstellung zu CAM sowie konventioneller Medizin in Skåne, der südlichsten Provinz Schwedens. Sie trug gleichzeitig dazu bei, ein Messwerkzeug (I-CAM-Q) zur standardisierten Untersuchung der CAM-Nutzung innerhalb der Europäischen Union (EU) zu entwickeln. **Ergebnisse:** 71% der Antwortenden (n = 1534) berichteten, dass sie innerhalb des vergangenen Jahres CAM in irgendeiner Form genutzt hätten. CAM-Nutzung umfasst hier Besuche bei CAM-Anbietern, die Anwendung von Naturheilmitteln und den Gebrauch von Selbsthilfemethoden. Berichte von CAM-Nutzung waren üblicher bei Frauen, Gruppen jüngeren Alters oder Menschen mit Universitätsausbildung. 69% der Teilnehmer sagten aus, dass die Zusammenarbeit zwischen der konventionellen und der Komplementärmedizin verstärkt werden sollte. Die Rücklaufquote der Umfrage betrug 31%. **Schlussfolgerungen:** Die Studie bestätigt, dass die CAM einen beträchtlichen Anteil an der angebotenen und von der Bevölkerung genutzten Gesundheitsversorgung ausmacht. Angesichts des bestehenden Mangels an nationalen und regionalen Daten zur CAM-Nutzung bestätigt sie außerdem die Wichtigkeit der weitergehenden Erforschung der CAM-Inanspruchnahme, -Grundsätze, -Praktiken, -Vorschriften und -Ausbildung.

KARGER

Fax +49 761 4 52 07 14
Information@Karger.com

Maria Wemrell
Clinical Research Center
Jan Waldenströms gata 35, 205 02 Malmö, Sweden
maria.wemrell@med.lu.se

Introduction

Many research results suggest that a large and possibly growing number of people today use complementary or alternative medicine (CAM). However, in many countries, such as Sweden, national and regional research on CAM use is still very limited. Existing prevalence studies are few, far between, and characterized by low comparability. This study aims to contribute towards addressing this knowledge gap, by measuring the use of and attitude towards CAM in the Swedish province of Scania, while taking part in the development of a survey tool for standardized measurement of CAM use within the European Union (EU; International CAM Questionnaire (I-CAM-Q)) [1].

According to the US National Institutes of Health (NIH), CAM is ‘a group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine’ [2]. Complementary medicine refers to therapy used in combination with conventional medicine, while alternative medicine is a term for medicine used instead of it. The NIH divide CAM into 5 groups [2]: alternative medical systems (e.g., homeopathy, Chinese medicine, and Ayurvedic medicine), mind-body interventions (e.g., meditation, mental training, and art therapy), biologically based therapies (e.g., herbs and nutritional supplements), manipulation therapies (e.g., chiropractic and massage), and energy therapies (e.g., healing).

Previous CAM prevalence research [3–5], e.g., from the USA [6], Great Britain [7], Canada [8] and Australia [9], suggests that a large part of the studied populations make use of CAM, which has been said to be subject to ‘exponential growth’ around the world [10]. A range of studies has found high rates of CAM use in various population groups [11–13], and among people with diverse diseases such as cancer [14, 15], cardiovascular disease [16], asthma [17], and others [18–20]. Studies have also looked at reasons for, or factors associated with, the use of CAM [21–24]. Scandinavian research [25, 26] includes a study estimating, in 2005, that 45% of the Danish population and 34% of the Norwegian population had used CAM [27].

In Sweden, analogous studies are few. An investigation made in the 1980s [28] found that 22% of the population had used CAM, while 40% were open to trying CAM in the future. Scania (previously Malmöhus), the southernmost region of the country, was the area where CAM usage was at its lowest (14%). According to a 2001 study measuring CAM use among inhabitants of Stockholm [29], 49% of the population had used CAM in the previous year. Alongside these more overarching prevalence studies, research has looked at the use of nutritional supplements, herbal medicine, and/or natural remedies [30–32], patient groups with certain diseases [33–35], and CAM use in a small municipality [36]. In all, despite research made, up-to-date and adequate knowledge of CAM use in Sweden, as in other countries, is lacking. This is due not only to a paucity of large studies but also to high levels of incertitude and low comparability of the existing studies [5, 37]. Studies differ, e.g., regarding the definitions of CAM and the included study populations and time frames [38, 39]. Questions of how prevalent CAM consumption is and of how it is distributed between population groups are thereby largely left unanswered [40].

Material and Methods

The present survey study was conducted in collaboration with the market research company TNS Sifo (*www.tns-sifo.se*), between January 22 and February 4, 2016. The questionnaire was completed by 1,534 adults (18–79 years) living in the region of Scania, the inhabitants of which (1.25 million) make up 13% of Sweden’s total population.

Respondents were randomly selected from TNS Sifo’s web panel, which consists of around 120,000 people recruited through previous survey studies. The web panel is representative, with regard to categories of age and gender, of the part of the Swedish population that has regular access to the Internet. Population groups with lower income and shorter education are somewhat underrepresented. For the present study, the sample was non-proportional in order to cover the population according to age and gender, and to compensate for lower response rates among younger respondents, and it was shown to be sufficiently representative of the population regarding those categories of gender and age. Each person could only respond once, and only surveys fully completed were included in the data.

The overall response rate was 31%. Web panel surveys run by TNS Sifo have an average response rate of around 40%, and the lower rate in this case is likely due to the relatively large number of questions included in the survey. The response rate was higher in the older age groups than in the younger ones (48% for age 65–79 years, 35% for age 30–49 years, 20% for age 30–49 years, and 19% for age 18–29 years). This uneven distribution was, as mentioned, compensated for by allocation of a larger number of surveys to respondents of younger age.

The questionnaire was based on the model I-CAM-Q [1], which has been developed by an international expert group, on the initiative of the National Research Center in Complementary and Alternative Medicine (NAFKAM) in Norway, with the aim of functioning as a standardized measurement instrument for the study of CAM prevalence in the EU. The questionnaire includes questions about visits to CAM providers, reception of complementary treatment in or through conventional health care, use of natural remedies like nutritional supplements and herbal medicine, and use of self-help practices such as yoga or relaxation exercises, in the last 12 months. This survey model has been adapted, validated and used in a selection of European countries [38, 39, 41].

The I-CAM-Q was adapted to Swedish conditions, e.g., through adjustment of the complementary treatments available within conventional health care or through referral. It was also modified according to experiences and critiques of previous users [38, 39], through simplification of the survey layout, reduction of some questions (primarily regarding the regularity of CAM use), and the addition of questions on the use of conventional medicine. The latter was done to increase the face validity among non-CAM users and to enable comparison between types of health care consumption. In addition, background questions regarding demographic variables and health condition and questions regarding the attitude towards CAM and conventional medicine were added. Most of these questions had been validated and used in the Public Health Survey of the Region Skåne [42] or in a previous study of CAM use in Stockholm [29].

The parts of the questionnaire adapted from the I-CAM-Q format were translated into Swedish by a professional translator, and the developed version was assessed by 4 experts in the field. An initial pilot study, including open questions about the types of CAM used and queries on the clarity of the questionnaire, was sent via e-mail to 100 randomly selected students at Lund University. The validation process was based on the description of appropriate measures in translation, adaptation, and validation of surveys on health by Sousa and Rojjanasrirat [43].

The respondents received e-mails including a brief introductory text about the survey and a reference to more information on a website belonging to the Unit of Social Epidemiology, Lund University, together with a personal link to the survey. Respondents then completed the survey via computer or mobile phone. In questions about the types of health care use, the order of response options was randomized to avoid any skewing of the results due to the sequence of alternatives.

After completion, TNS Sifo delivered the anonymized raw data to the research group. We performed the statistical analyses using SPSS Version 22.0

Table 1. Types of CAM use

	Total (n = 1,534)	Women (n = 767)	Men (n = 765)
Total CAM	71.0% (1,089)	78.1% (599)	63.9% (489)
Visits to CAM providers	32.9% (505)	36.9% (283)	28.9% (221)
Use of natural remedies	53.0% (813)	58.9% (452)	47.1% (360)
Use of self-help methods	31.7% (486)	42.8% (328)	20.5% (157)
Total CAM excluding nutritional supplements	60.6% (930)	69.5% (533)	51.8% (396)

Table 2. Types of CAM use: subcategories

CAM providers	Total (n = 505)[a]	Women (n = 283)	Men (n = 221)
Massage	52.5% (265)	52.7% (149)	52.0% (115)
Chiropractic	17.0% (86)	14.5% (41)	20.4% (45)
Naprapathy	11.3% (57)	11.0% (31)	11.8% (26)
Osteopathy	1.8% (9)	1.4% (4)	2.3% (5)
Acupuncture	5.5% (28)	6.0% (17)	5.0% (11)
Homeopathy	1.2% (6)	0.7% (2)	1.8% (4)
Reflexology	1.6% (8)	1.4% (4)	1.8% (4)
Healing	2.6% (13)	3.9% (11)	0.9% (2)
Other	6.5% (33)	8.5% (24)	4.1% (9)
Natural remedies	Total (n = 813)[b]	Women (n = 452)	Men (n = 360)
Nutritional supplements	68.5% (557)	67.5% (305)	69.7% (251)
Herbal medicine	25.3% (206)	26.1% (118)	24.4% (88)
Other remedies	6.2% (50)	6.4% (29)	5.8% (21)
Self-help practices	Total (n = 485)[c]	Women (n = 328)	Men (n = 157)
Meditation	3.9% (19)	1.8% (6)	8.3% (13)
Yoga	20.2% (98)	23.2% (76)	13.4% (21)
QiGong/TaiQi	1.6% (8)	2.4% (8)	0% (0)
Relaxation	16.5% (80)	14.3% (47)	21.0% (33)
Breathing	26.3% (128)	29.0% (95)	21.0% (33)
Visualization	7.8% (38)	6.7% (22)	10.2% (16)
Prayer	7.6% (37)	6.7% (22)	9.6% (15)
Other	16.0% (78)	15.9% (52)	16.6% (26)

[a] Respondents who report visits to CAM providers, i.e., 33% of the study population.
[b] Respondents who report use of natural remedies, i.e., 53% of the study population.
[c] Respondents who report use of self-help practice, i.e., 32% of the study population.

(SPSS Inc., Chicago, IL, USA). We performed simple descriptive statistics, as well as multiple logistic regressions modeling the use of CAM versus conventional medicine as a function of several predictors to estimate the odds ratios (ORs) and 95% confidence intervals (95% CIs). The results were not weighted.

The study has been approved by the Regional Board of Ethics (Dnr 2015/289). It is to be regarded as a pilot study, aimed towards possible future Regional Council (Region Skåne) surveys.

Results

Use of CAM

In total, 71% of the respondents (78% of the women, 64% of the men) reported having used some form of CAM in the last year. Total CAM use here includes visits to CAM providers, use of natural remedies such as nutritional supplements or herbal medicine, and use of self-help methods like yoga and breathing exercises (table 1). This category of total CAM use does not include complementary forms of treatment given within conventional health care or through referral.

The most common types of CAM, reportedly used in the last year by 53% of the population sample, were natural remedies including herbal medicines and nutritional supplements. When nutritional supplements (like vitamins, minerals, and oils) were excluded from the total CAM use, the user percentage decreased from 71% to 61% (70% among the women, 52% among the men).

CAM providers had been consulted by 33% of the respondents (37% of the women, 29% of the men) (table 2). The large majority (53% of the mentioned 33%) of treatments consisted of massage, followed by chiropractic (17%), naprapathy (11%), acupuncture (6%), healing (3%), osteopathy (2%), reflexology (2%), homeopathy (1%), and other (7%). Massage was used frequently by both men (52%) and women (53%). More men visited chiropractors, while a larger share of women turned to healing and methods categorized as 'other'.

Table 3. Description of CAM and conventional health care users: gender, age, education, social status, and civil status

	CAM total[a]	MED total[b]	CAM only[c]	MED only[d]	CAM + MED[e]	No usage[f]
Total (n = 1,534)	71.0% (1,089)	97.5% (1,495)	1.4% (21)	27.8% (427)	69.6% (1,068)	1.2% (18)
Women	55.0% (599)	50.3% (751)	42.9% (9)	37.8% (161)	55.3% (590)	38.9% (7)
Men	44.9% (489)	49.7% (742)	57.1% (12)	62.2% (265)	44.7% (477)	61.1% (11)
Age 18–39 years	33.3% (363)	30.0% (448)	38.1% (8)	21.8% (93)	33.2% (355)	33.3% (6)
Age 40–64 years	51.3% (559)	51.0% (763)	52.4% (11)	50.4% (215)	51.3% (548)	53.0% (9)
Age 65–79 years	15.3% (167)	19.0% (284)	9.5% (2)	27.9% (119)	15.4% (165)	16.7% (3)
Basic education	5.5% (60)	6.5% (97)	9.5% (2)	9.1% (39)	5.4% (58)	25.0% (4)
Secondary education	33.3% (363)	34.4% (515)	42.9% (9)	37.7% (161)	33.1% (354)	43.8% (7)
Tertiary education	61.2% (666)	59.1% (883)	47.6% (10)	33.1% (354)	61.4% (656)	31.3% (5)
Low social status	35.3% (384)	8.5% (127)	14.3% (3)	9.8% (42)	8.0% (85)	0% (0)
Medium social status	48.3% (526)	75.0% (1,121)	72.2% (16)	73.8% (315)	75.5% (806)	66.7% (12)
High social status	15.5% (169)	15.4% (230)	9.5% (2)	14.8% (63)	15.6% (167)	33.3% (5)
Cohabiting	67.7% (737)	70.1% (1,030)	52.4% (11)	71.6% (303)	69.4% (727)	66.7% (10)
Living alone	30.4% (331)	29.9% (440)	47.6% (10)	28.4% (120)	30.6% (320)	33.3% (5)

[a] Respondents reporting visits to CAM providers, use of natural remedies, and/or use of self-help methods.
[b] Respondents reporting visits to conventional health care providers and/or use of pharmaceutical drugs.
[c] Respondents reporting use of CAM (visits to CAM providers, use of natural remedies, and/or use of self-help methods) and no use of conventional medicine.
[d] Respondents reporting use of conventional health care (visits to conventional health care providers and/or use of pharmaceutical drugs) and no use of CAM.
[e] Respondents reporting use of CAM and conventional medicine.
[f] Respondents reporting no use of CAM or conventional medicine.

Natural remedies, herbal medicines, or nutritional supplements were, as mentioned, used by 53% of the respondents (59% of the women, 47% of the men) (table 2). 69% of this consumption referred to nutritional supplements, while herbal medicine accounted for 25%, and other natural remedies for 6%.

Self-help methods were used by 32% of the respondents (43% of the women, 21% of the men) (table 2). Breathing exercises (26%), yoga (20%), and relaxation exercises (17%) were most common. More men used meditation, while yoga was more frequently practiced among women.

A majority of the survey respondents (70%) reported the use of both CAM and conventional medicine. Only 1.4% of the population sample reported the sole use of CAM.

Use of Conventional Medicine

Conventional medicine, reportedly used by 98% of the respondents (98% of the women, 97% of the men), here includes visits to conventional health care providers and the use of pharmaceutical drugs.

Of the respondents, 88% (90% of the women, 86% of the men) had seen a conventional health care provider in the last year. These include medical doctors, nurses, physiotherapists, psychologists, psychoanalysts, and dentists. Dentists were the most commonly visited type of providers. If this often routinely consulted provider is excluded, the level of use decreased to 31% (32% among the women, 29% among the men).

Pharmaceutical drugs were used by 91% of the population (94% of the women, 89% of the men) in the last year.

While 70% of the respondents, as mentioned in ‘Use of CAM’, reported the use of conventional medicine and CAM, 28% said they had used only conventional medicine.

Complementary Treatment Received within or via Conventional Health Care

A share of 8% of the respondents (10% of the women, 6% of the men) reported having received some form of complementary treatment within a conventional health care setting or through referral. Types of treatment included acupuncture (22%), massage (21%), mindfulness (15%), chiropractic (5%), naprapathy (4%), natural remedies (2%), and others (32%). More women than men received acupuncture, while more men had treatment categorized as ‘other’.

The relatively large share of reported treatments defined as ‘other’ suggests that the questionnaire, despite the validation process, did not cover the full range of complementary treatments available within conventional health care or through referral.

Gender, Age, Education, Income, and Social Status

The survey posed questions about the level of education, the self-rated social status [44], and the civil status of the respondents (table 3). Information on age and gender was gathered from the respondents’ background data. The level of education was categorized as basic, secondary, or tertiary, while in the analysis it was dichotomized as tertiary or not. The civil status was, in the analysis, dichotomized as cohabiting or living alone. The social status was self-rated along a range from 1 to 10, which in the analysis was divided into 3 levels: low (1–3), medium (4–7), and high (8–10).

Table 4. Associations between CAM and conventional health care use and gender, age, education, social status, and civil status, expressed in odds ratios (ORs) and 95% confidence intervals (CIs)

	CAM (total)[a]		MED (total)[b]	
	OR	95% CI	OR	95% CI
Women[c]	*1.87*	*(1.48–2.37)*	1.49	(0.74–3.00)
Medium age[d]	*2.33*	*(1.66–3.26)*	0.52	(0.16–1.66)
Young age[e]	*1.68*	*(1.26–2.25)*	0.54	(0.18–1.62)
Tertiary education	*1.29*	*(1.01–1.65)*	2.00	(0.98–4.10)
High social status	*1.03*	*(0.96–1.11)*	0.94	(0.76–1.17)
Living alone	*0.95*	*(0.73–1.24)*	1.95	(0.96–3.93)

[a] Respondents reporting visits to CAM providers, use of natural remedies and/or use of self-help methods.
[b] Respondents reporting visits to conventional health care providers and/or use of pharmaceutical drugs.
[c] Categories statistically associated with health care use are presented in italics.
[d] Age 40–64 years, compared to 65–79 years.
[e] Age 18–39 years, compared to 65–79 years.

Table 5. Associations between CAM and conventional health care use and health condition, expressed in odds ratios (ORs) and 95% confidence intervals (CIs)

	CAM (total)[a]		MED (total)[b]	
	OR	95% CI	OR	95% CI
Bad self-rated health	1.10	(0.86–1.41)	0.90	(0.39–2.08)
Long-term health problem[c]	*1.35*	*(1.05–1.73)*	*7.26*	*(2.12–24.86)*
High level of stress	*1.64*	*(1.16–2.32)*	1.87	(0.56–6.27)
Regular exercise	*1.61*	*(1.28–2.02)*	1.03	(0.52–2.04)
Following a diet	*1.67*	*(1.18–2.34)*	0.56	(0.25–1.26)

[a] Respondents reporting visits to CAM providers, use of natural remedies, and/or use of self-help methods.
[b] Respondents reporting visits to conventional health care providers and/or use of pharmaceutical drugs.
[c] Categories statistically associated with health care use are presented in italics.

Logistic regression showed a higher prevalence of CAM use among women (OR = 1.87, 95% CI 1.48–2.37), younger age groups (18–39 years and 40–64 years) (OR = 2.33, 95% CI 1.66–3.26 and OR = 1.68, 95% CI 1.26–2.25), and people with tertiary education (OR = 1.29, 95% CI 1.01–1.65). No statistically significant association was found between CAM use and categories of social or civil status. The references used in the regressions were males, belonging to the oldest age group (65–75 years), living alone, with less than tertiary education, and low social status, respectively (table 4).

The corresponding analysis of conventional medicine use showed no clear association with any of the mentioned factors (table 4).

This analysis does not include users of complementary medicine in conventional health care settings or through referral.

Health Status

Respondents were asked about their self-rated health, any long-term health problems or injuries, experiences of everyday stress, exercise habits, and their following of any particular diet. The questions on long-term health problems and diet were of yes/no character. The others were multiple choice questions, responses to which were later dichotomized into yes/no or good/bad.

CAM consumption was associated with high levels of experienced stress (OR = 1.64, 95% CI 1.16–2.32) and long-term health problems (OR = 1.35, 95% CI 1.05–1.73), but not with bad self-rated health. Associations were also found with good exercise habits (OR = 1.61, 95% CI 1.28–2.02) and the following of particular diets (OR = 1.67, 95% CI 1.18–2.34). The references used in the regressions were persons with good self-rated health and no long-term health problems who experienced lower levels of stress, exercised less and did not follow a particular diet, respectively. The association between CAM use and exercise and adherence to particular diets may suggest that CAM consumption correlates with an interest in lifestyle issues or health-promoting behavior.

Conventional medicine usage was strongly associated with long-term health problems (OR = 7.26, 95% CI 2.12–24.86), but not with any of the other factors (table 5). This analysis does not include use of complementary medicine in conventional health care settings or through referral.

Purpose of Health Care Use

In relation to each reported type of health care used, except for natural remedies and pharmaceutical drugs, the respondents were asked whether the purpose was treatment, disease prevention, diagnosis, well-being, or other (table 6). CAM providers were most commonly consulted for well-being (49%), treatment (35%), and prevention (22%). Visits to conventional caregivers, in turn, had the main purposes of diagnosis (68%), treatment (51%), and prevention (23%). When the category of dentists is excluded, the visits to conventional care for purposes of prevention dropped to 0%. Complementary care sought in or via a conventional medical setting had the purposes of treatment (57%), prevention (16%), and well-being (15%). Self-help methods, finally, were used for the purposes of well-being (75%), prevention (17%), and treatment (14%).

Table 6. Self-described purpose of CAM and conventional health care use

	Treatment	Prevention	Diagnosis	Well-being	Other
Visits to CAM providers	35.2% (178)	21.8% (110)	3.4% (17)	49.1% (248)	2.6% (13)
Visits to MED providers	50.7% (685)	23.1% (312)	68.1% (920)	9.9% (134)	9.1% (123)
Visits to MED excl. dentists	56.6% (267)	0% (0)	46.8% (221)	7.8% (37)	11.9% (56)
CAM in/via MED	56.1% (69)	16.3% (20)	6.5% (8)	14.6% (18)	7.3% (9)
Self-help methods	14.2% (69)	16.5% (80)	0.2% (1)	75.1% (365)	5.8% (28)

CAM = Complementary and alternative medicine; MED = conventional medicine; excl. = excluding.

Table 7. Perceived degree of helpfulness of CAM and conventional health care use

	Very helpful	Helpful	A little helpful	Possibly helpful	Not helpful
Visits to CAM providers	69.9% (353)	27.7% (140)	5.1% (26)	1.6% (8)	1.0% (5)
Visits to MED providers	60.7% (819)	42.4% (572)	7.6% (103)	3.4% (46)	1.6% (22)
Visits to MED excl. dentists	48.7% (230)	31.8% (150)	8.3% (39)	4.2% (20)	1.5% (7)
CAM in/via MED	50.4% (62)	30.9% (38)	14.6% (18)	4.9% (6)	3.3% (4)
Self-help methods	29.0% (141)	48.6% (236)	26.3% (128)	14.6% (71)	3.7% (18)

CAM = Complementary and alternative medicine; MED = conventional medicine; excl. = excluding.

In summary, then, reported visits to CAM providers largely aimed at prevention and well-being, but also at disease treatment. Conventional medicine was mainly consulted for diagnosis and treatment. The larger emphasis on prevention found in reported CAM use supports the question of which role CAM plays, or might play, in actual disease prevention.

Perceived Degree of Helpfulness

The respondents were further asked about the perceived degree of helpfulness of each type of health care used, except for natural remedies and pharmaceutical drugs (table 7). The types of health care most commonly rated as very helpful were visits to CAM providers (70%), followed by visits to conventional caregivers (61%), complementary care in or via a conventional setting (50%), conventional care excluding dentistry (49%), and self-help methods (29%).

Matters of Opinion

Asked about the levels of trust, 59% of the respondents expressed confidence in CAM while 90% reported confidence in conventional medicine. While both genders expressed trust in conventional medicine, the level of trust in CAM was higher among the women (68%) than among the men (50%).

Regarding cooperation between conventional health care and CAM, a majority of the respondents (69%, 76% of the women and 63% of the men) expressed the opinion that it should increase. 6% of the women and 15% of the men stated that collaboration should remain the same or decrease.

Finally, the survey posed questions about opinions on background factors for disease and about attentiveness to studies and/or media reports on health risks. The data offers a very limited basis for comparison between types of health care users, due to the size of the population sample and the large and overlapping groups of health care users (CAM 71%, conventional medicine 98%, CAM and conventional medicine 70%). A minor tendency towards higher evaluation of the influence of an individual's own actions and lifestyle as well as of economic, social, and political societal conditions on health can be seen among CAM users, as compared to users of conventional medicine. A small tendency towards higher evaluation of one's own attentiveness towards studies and media reports on health risks, and of attempts towards changing one's own lifestyle accordingly, also appears among CAM users.

Conclusions and Discussion

Of the survey respondents, 71% reported having used some form of CAM in the past year. CAM use was more common among women, in younger age groups, and among people with tertiary education. It was associated with high levels of experienced stress and long-term health problems and injuries, as well as with good exercise habits and the adherence to any particular diets. The stated purposes of CAM use were well-being and prevention and treatment of disease, and users reported having experienced a high level of helpfulness. The respondents expressed a lower level of trust in CAM than in conventional medicine. Still, the majority stated that cooperation between CAM and conventional medicine should increase.

A main limitation of the present study is the survey's low response rate (31%). The result may overestimate CAM use, as people with a favorable attitude towards or interest in CAM might have been more likely to complete the survey than others without such an interest or attitude. It is also noteworthy that people with tertiary education, who according to the present analysis are more likely to use CAM, are slightly overrepresented in the TNS Sifo web panel. On the other hand, such an overestimation may be counteracted by the lower response rates in younger age groups, among which CAM use appears to be more common. In any case, a survey completed by 1,534 individuals, with a response frequency of 31%, provides a limited base for drawing conclusions. Critique aimed towards much CAM prevalence research regarding low levels of certitude [5, 37, 38] thus pertains to this study as well. However, while corroborating research from Sweden and other countries, this study confirms that a large number of people in Scania do indeed use various forms of CAM.

While some have questioned the relevance of CAM prevalence research [45], others have emphasized its importance both in terms of revealing the necessity of further investigation of CAM use and users, and of forming an essential part of wider projects of CAM research and development [10]. Knowledge about CAM prevalence is important for answering questions such as which population or patient groups turn to different types of CAM, and why. How can or does CAM consumption affect the population health, in positive [46] or negative [47] directions? What economic consequences does CAM use have? What needs for education, pertaining to conventional [48, 49] as well as CAM caregivers, can be identified? Do patients disclose their CAM use in clinical encounters with conventional health care [50, 51], and if not, why? Is the field sufficiently regulated and researched [40]? Proper handling of such issues, on regional and national levels, requires current data on CAM usage.

In the face of the existing lack of knowledge about CAM use, nationally and regionally, and the still often marginal position of CAM in medical research and discussion, the study points to the necessity of further investigation of CAM consumption. It motivates the posing of questions about the reasons and effects of CAM use, while affirming the importance of further investigation and discussion of CAM consumption, policy, practice, and education.

Disclosure Statement

This work was supported by Risénstiftelsen (M.W.), Region Skåne (J.M.), and The Swedish Research Council (J.M., grant 2013-2484). We thank Raquel Pérez Vicente for the help with the construction of the database and the statistical analysis.

References

1 Quandt SA, Verhoef MJ, Arcury TA, Lewith GT, Steinsbekk A, Kristoffersen AE, et al: Development of an international questionnaire to measure use of complementary and alternative medicine (I-CAM-Q). J Altern Complement Med 2009;15:331–339.

2 National Center for Complementary and Alternative Medicine (NCCAM): What is complementary and alternative medicine (CAM)? Publication No. D156. Bethesda, National Institutes of Health, 2006.

3 Harris P, Cooper K, Relton C, Thomas K: Prevalence of complementary and alternative medicine (CAM) use by the general population: a systematic review and update. Int J Clin Pract 2012;66:924–939.

4 Frass M, Strassl RP, Friehs H, Müllner M, Kundi M, Kaye AD: Use and acceptance of complementary and alternative medicine among the general population and medical personnel: a systematic review. Ochsner J 2012; 12:45–56.

5 Eardley S, Bishop FL, Prescott P, Cardini F, Brinkhaus B, Santos-Rey K, et al: A systematic literature review of complementary and alternative medicine prevalence in EU. Forsch Komplementmed 2012;19:18–28.

6 Clarke TC, Black LI, Stussman BJ, Barnes PM, Nahin RL: Trends in the use of complementary health approaches among adults: United States, 2002–2012. Natl Health Stat Report 2015;(79):1–16.

7 Hunt KJ, Coelho HF, Wider B, Perry R, Hung S, Terry R, et al: Complementary and alternative medicine use in England: results from a national survey. Int J Clin Pract 2010;64:1496–1502.

8 Metcalfe A, Williams J, McChesney J, Patten SB, Jetté N: Use of complementary and alternative medicine by those with a chronic disease and the general population – results of a national population based survey. BMC Complement Altern Med 2010;10:1.

9 D'Onise K, Haren MT, Misan GM, McDermott RA: Who uses complementary and alternative therapies in regional South Australia? Evidence from the Whyalla Intergenerational Study of Health. Aust Health Rev 2013;37:104–111.

10 Adams J: Restricting CAM consumption research: denying insights for practice and policy. Complement Ther Med 2007;15:75–76.

11 Johnson PJ, Kozhimannil KB, Jou J, Ghildayal N, Rockwood TH: Complementary and alternative medicine use among women of reproductive age in the United States. Womens Health Issues 2016;26:40–47.

12 Wilson KM, Klein JD: Adolescents' use of complementary and alternative medicine. Ambul Pediatr 2002;2: 104–110.

13 Zuzak TJ, Boňková J, Careddu D, Garami M, Hadjipanayis A, Jazbec J, et al: Use of complementary and alternative medicine by children in Europe: published data and expert perspectives. Complement Ther Med 2013; 21:S34–S47.

14 Frieiro ET, Martýnez-Garcýa J, Lajara JA, Fuentes JC, Cascales MLG, Gutierrez AS, et al: 1553 Complementary and alternative medicine in oncology patients. Eur J Cancer 2015;51:S222.

15 Horneber M, Bueschel G, Dennert G, Less D, Ritter E, Zwahlen M: How many cancer patients use complementary and alternative medicine: a systematic review and metaanalysis. Integr Cancer Ther 2012;11:187–203.

16 Grant SJ, Bin YS, Kiat H, Chang DH-T: The use of complementary and alternative medicine by people with cardiovascular disease: a systematic review. BMC Public Health 2012;12:1.

17 Shen J, Oraka E: Complementary and alternative medicine (CAM) use among children with current asthma. Prev Med 2012;54:27–31.

18 Alaaeddine N, Okais J, Ballane L, Baddoura RM: Use of complementary and alternative therapy among patients with rheumatoid arthritis and osteoarthritis. J Clin Nurs 2012;21:3198–3204.

19 Haliloğlu B, İşgüven P, Yıldız M, Arslanoğlu İ, Ergüven M: Complementary and alternative medicine in children with type 1 diabetes mellitus. J Clin Res Pediatr Endocrinol 2011;3:139–143.

20 Fuhrmann T, Smith N, Tausk F: Use of complementary and alternative medicine among adults with skin disease: updated results from a national survey. J Am Acad Dermatol 2010;63:1000–1005.

21 Arthur K, Belliard JC, Hardin SB, Knecht K, Chen C-S, Montgomery S: Practices, attitudes, and beliefs associated with complementary and alternative medicine (CAM) use among cancer patients. Integr Cancer Ther 2012;11:232–242.

22 Thomson P, Jones J, Evans JM, Leslie SL: Factors influencing the use of complementary and alternative medicine and whether patients inform their primary care physician. Complement Ther Med 2012;20:45–53.

23 Sirois FM: Motivations for consulting complementary and alternative medicine practitioners: a comparison of consumers from 1997–8 and 2005. BMC Complement Altern Med 2008;8:1.

24 Richardson J: What patients expect from complementary therapy: a qualitative study. Am J Public Health 2004;94: 1049–1053.

25 Steinsbekk A, Rise MB, Johnsen R: Changes among male and female visitors to practitioners of complementary and alternative medicine in a large adult Norwegian population from 1997 to 2008 (the HUNT studies). BMC Complement Altern Med 2011;11:1.

26 Fønnebø V, Launsø L: High use of complementary and alternative medicine inside and outside of the government-funded health care system in Norway. J Altern Complement Med 2009;15:1061–1066.

27 Hanssen B, Grimsgaard S, Launso L, Fonnebo V, Falkenberg T, Rasmussen NK: Use of complementary and alternative medicine in the Scandinavian countries. Scand J Prim Health 2005;23:57–62.

28 Alternativmedicinkommittén: Fakta och röster om alternativ medicin: en delrapport från Alternativmedicinkommittén. Stockholm, Socialdepartementet, 1987.

29 Eklöf M, Tegern G: Stockholmare och den komplementära medicinen. Stockholm, HSN, Stockholms läns landsting, 2001.

30 Messerer M, Johansson SE, Wolk A: Use of dietary supplements and natural remedies increased dramatically during the 1990s. J Intern Med 2001;250:160–166.

31 Wallström P, Elmståhl S, Johansson U, Östergren PO, Hanson BS: Usage and users of natural remedies in a middle-aged population: demographic and psychosocial characteristics. Results from the Malmö Diet and Cancer Study. Pharmacoepidemiol Drug Saf 1996;5: 303–314.

32 Nilsson M, Trehn G, Asplund K: Use of complementary and alternative medicine remedies in Sweden. A population-based longitudinal study within the northern Sweden MONICA Project. J Intern Med 2001;250: 225–233.

33 Lasse S, Peter HN: Investigating use of CAM treatments among members with multiple sclerosis in the Nordic MS societies. Eur J Integr Med 2012;4:174.

34 Klingberg E, Wallerstedt SM, Torstenson T, Håwi G, Forsblad-d'Elia H: The use of complementary and alternative medicine in outpatients with inflammatory rheumatic diseases in Sweden. Scand J Rheumatol 2009;38:472–480.

35 Hederos C-A: Vanligt med alternativ behandling av allergiskt sjuka barn. Läkartidningen 1988;85:3580–3581.

36 Al-Windi A: Predictors of herbal medicine use in a Swedish health practice. Pharmacoepidemiol Drug Saf 2004;13:489–496.

37 Ernst E: Prevalence surveys: to be taken with a pinch of salt. Complement Ther Clin Pract 2006;12:272–275.

38 Eardley S, Bishop FL, Cardini F, Santos-Rey K, Jong MC, Ursoniu S, et al: A pilot feasibility study of a questionnaire to determine European Union-wide CAM use. Forsch Komplementmed 2012;19:302–310.

39 Re ML, Schmidt S, Güthlin C: Translation and adaptation of an international questionnaire to measure usage of complementary and alternative medicine (I-CAM-G). BMC Complement Altern Med 2012;12:259.

40 Jensen I: Complementary and Alternative Medicine (CAM): A Systematic Review of Intervention Research in Sweden. Stockholm, Swedish Council for Working Life and Social Research (FAS), 2007.

41 Güthlin C, Re ML, Gerlach F, Schmidt S: Comprehensive validation of a questionnaire asking for CAM use (I-CAM-Q-Questionnaire) – Are results valid and is the questionnaire suitable for use in different languages? Eur J Integr Med 2010;2:207–208.

42 Fridh M, Modén B, Lindström M, Grahn M, Rosvall M: Folkhälsorapport Skåne 2013. Malmö, Region Skåne, 2013.

43 Sousa VD, Rojjanasrirat W: Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: a clear and user-friendly guideline. J Eval Clin Pract 2011;17:268–274.

44 Adler N, Stewart J: The MacArthur Scale of Subjective Social Status. San Francisco, Psychosocial Notebook, Psychosocial Working Group, 2007.

45 Ernst E: Keynote comment: dumbing down of complementary medicine. Lancet Oncol 2005;6:442–443.

46 Chan A, Tan HL, Ching TH, Tan HC: Clinical outcomes for cancer patients using complementary and alternative medicine. Altern Ther Health Med 2012;18:12–17.

47 Taylor DM, Walsham N, Taylor SE, Wong L: Potential interactions between prescription drugs and complementary and alternative medicines among patients in the emergency department. Pharmacotherapy 2006;26:634–640.

48 Gaylord SA, Mann JD: Rationales for CAM education in health professions training programs. Acad Med 2007;82:927–933.

49 Wetzel MS, Eisenberg DM, Kaptchuk TJ: Courses involving complementary and alternative medicine at US medical schools. JAMA 1998;280:784–787.

50 Berg E, McGregor J, Burkart M, Poulton C, Hogan S: What everybody is doing but no one is talking about: complementary and alternative medicine (CAM) prevalence in the ANCA SVV population. La Presse Médicale 2013;42:775.

51 Sidora-Arcoleo K, Yoos HL, Kitzman H, McMullen A, Anson E: Don't ask, don't tell: parental nondisclosure of complementary and alternative medicine and over-the-counter medication use in children's asthma management. J Pediatr Health Care 2008;22:221–229.

Printed by Media-Tryck, Lund 2017 NORDIC ECOLABEL, 3041 0903

This thesis by Maria Wemrell (M.A.) integrates intersectionality theory into social epidemiological study. The purposes are to improve understanding of heterogeneities in population groups and thus increase the discriminatory accuracy (DA) of social categorizations, and to incorporate a theoretical framework that aims attention toward power dynamics driving the production of health inequities as well as toward the measurement of such disparities.

LUND UNIVERSITY
Faculty of Medicine

Lund University
Department of Clinical Sciences Malmö

Lund University, Faculty of Medicine
Doctoral Dissertation Series 2017:126
ISBN 978-91-7619-509-3
ISSN 1652-8220