



Systematic review of methods used to study the intersecting impact of sex and social locations on health outcomes

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ABSTRACT

Purpose: Independent health impacts of sex or social circumstances are well-studied, particularly among older adults. Less theorized or examined is how combinations or intersections of these underpin differential health effects. Nevertheless, and often without naming it as such, an intersectional framework aligns with studies of social determinants of health, life-course epidemiology and eco-epidemiology. In this systematic review we examined and aimed to identify research methods used to operationalize, whether intentionally or inadvertently, interconnected effects of sex and social locations on health outcomes for 45+ year olds.

Methods: Using broad search terms, numerous databases, and following Prisma guidelines, 732 of 9214 papers initially identified, met inclusion criteria for full review.

Results: Of the 501 papers included after full review, methods used in considering intersections of sex and social circumstances/location(s) included regression (112 of 365 papers), growth curves (7 of 22), multilevel (15 of 25), decomposition (6 of 9), mediation (10 of 17), structural equation modelling (23 of 25), and other (2 of 3). Most (n = 157) approximated intersectional analyses by including interaction terms or sex-stratifying results.

Discussion: Few authors used the inherent strength of some study methods to examine intersecting traits. As even fewer began with an intersectionality framework their subsequent failure to deliver cannot be faulted, despite many studies including data and methodologies that would support intersectional analyses. There appeared to be a gap, not in analytic potential but rather in theorizing that differential distributions of social locations describe heterogeneity within the categories 'men' and 'women' that can underlie differential, gendered effects on older adults' health. While SEM, mediation and decomposition analyses emerged as particularly robust methods, the unexpected outcome was finding how few researchers consider intersectionality as a potential predictor of health.

1. Introduction

Social circumstances merit consideration and accurate delineation in epidemiologic research, not only because of their pronounced impact on health but also because they are often amenable to change. Unequal health outcomes that are systemic or contextual are neither biologically inevitable nor immutable (Berkman & Soh, 2017; Braveman & Gottlieb, 2014; Marmot et al., 2008). Combinations of social circumstances, alternatively referred to as social factors, locations, identities, or strata (Berkman & Soh, 2017; Crenshaw, 1991; Hankivsky, 2012; McCall, 2005) work their way 'into the body' in different ways that, in turn, vary depending on individual characteristics. Among those individual

characteristics is sex, the biology of being a man or a woman. We will refer to intersections of sex and role expectations, constraints, and opportunities inherent in being a man or woman in a given setting as the social location of gender, but recognize that because gender is entwined with the biology of sex, a more accurate term might be sex/gender.

Increasingly, there have been calls from funders and journals for research to account for sex and/or gender. This often translates into categorizing study participants by sex (CIHR, 2012; Lacasse et al., 2020; Tannenbaum et al., 2016). Such a binary division of study populations is, however, generally of limited explanatory value. The aim of this systematic review of methods used to study gender in health outcomes research is to identify quantitative methods that go beyond considering

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sex as an independent variable and examine heterogeneity within the groupings 'men' and 'women' arising from intersecting social circumstances. While research subjects are multidimensional, inserting social complexity into quantitative analysis, and, particularly, studying intra-category (for example – within the category 'men') variation remains elusive. This study addresses aspects of that gap by reviewing whether and how the health impact of multidimensionality, of interconnections between sex and social locations among middle and older aged adults has been and could further be examined.

1.1. Theoretical framework

Power and marginalization associated with health outcomes are rarely defined by single categories such as sex or income. Instead, at any given time individuals occupy a specific stratum of interconnected characteristics. This social location can change over time with shifts in individual social circumstances across the life course. Conceptually few would argue that the health impact of being an economically deprived woman and one with access to substantial resources is identical merely because both are women, or that it is different specifically because of income disparities. Although no one is only their sex or their skin color, epidemiologic approaches often equate all women, or all people of colour, or all who share a single social characteristic, leaving an understanding of within-category heterogeneity as "one of the great unanswered challenges in epidemiology" (Green et al., 2017).

Overlapping social locations such as race or education interact with sex to jointly add to or diminish the power relationships that shape health outcomes. Intersectionality "does not situate the problems associated with particular identities within individuals or identities, themselves, but within structural power hierarchies, social processes, and social determinants that shape social experiences of individuals with those intersectional identities." (Evans, 2018) However, being of colour and female cannot be assumed to confer the additive advantage/disadvantage of each category, alone, as was described by Crenshaw when she proposed a framework she called intersectionality (Crenshaw, 1989). With roots in sociology and the study of inequality (Bauer, 2014; Collins, 1990; Crenshaw, 1989) intersectionality theory generally assumes interlocking systems of oppression arising from membership in marginalized groups (Hankivsky, 2012). In reality, however, the intersectional impact of, for example, being a woman of colour might combine harms of discrimination with concomitant strengths, resilience, and power arising from combinations of social locations (Bauer, 2014; Bowleg, 2012; Evans et al., 2018).

1.2. Intersectionality and gender in epidemiology

While well integrated into social sciences and qualitative research, the concept of intersectionality in quantitative methods of epidemiology is in flux. We will consider intersectionality as a framework for explaining how unequal and interlocking distributions of power and resources alter individual health. The study of intersections of sex and social circumstances offers an indicator of and method for quantifying gender as defined earlier. Existing literature is confusing, often conflating sex with gender, or equating dichotomized analyses of men and women with gender analysis. Intersectional approaches that include sex as a characteristic can insert gender conceptually and methodologically. Researchers could measure gender by stratifying differential distributions of social locations by sex. This stratification into intersectional contexts could then be used to study the differential effects in the strength and direction of associations between strata and health outcomes, that is, to perform intersectional analyses. We presume that there are many epidemiologic studies that account for such differential effects of sex combined with social locations and, thus, consider intersectionality regardless of whether their authors have explicitly used the term. Although our assumption absolves researchers from basing practice on explicit theory it recognizes that much of social epidemiology rests on an

intersectional framework without naming it as such.

1.3. Intersectionality, life-course and eco-epidemiology

Addressing individual characteristics and interconnected social circumstances or locations within epidemiology is not new. The life-course perspective of social epidemiologists posits that social factors and events experienced across life's trajectory have a cumulative impact on health. They function independently but also interdependently in ways that are dynamic and not merely additive (Ben-Shlomo & Kuh, 2002; Kuh et al., 2013). Similarly, eco-epidemiology conceptualizes the determinants of health as arising from entwined individual and contextual circumstances. Intersectionality aligns with these while also potentially turning the predominant risk factor paradigm of medicine, that looks at independent effects of single risk factors, on its head by moving beyond a search for single, independent predictors of health outcomes (Rose, 2008; Susser & Susser, 1996). What intersectionality can add to life-course and eco-epidemiologic perspectives is consideration of the complex interplay between individual characteristics such as race or sex and multiple social circumstances in their shaping of health (Agénor, 2020).

1.4. Integrating intersectionality into research; beyond interactions

There remains a tension between the necessity of categorizing participants into study groups, and individual uniqueness, plasticity, vulnerability and resilience that defy categorization. Taken to the extreme, that there can be no groups but only individuals, renders intersectionality theory incompatible with social epidemiology and quantitative research by eliminating the social. In contrast, a variety of research approaches have been used to look for variability across groupings defined by social locations such as racism, socio-economic status, (SES) or social capital. These have yielded extensive evidence of embodiment, that is, of the body being a repository for accumulated social effects. However, although bodies integrate the health impact of multiple social locations, this integration is noticeably absent in research (Bauer, 2014). "It is precisely the impossibility of expecting individuals to decompose their individual experience that reveals the need for comparison groups, providing contrasts between participants at each intersectional position under study (e.g. black gay men, white lesbian women, straight white men) in order to render the health impacts at each intersectional position visible." (Bauer, 2014). Volumes have been written describing the averaged health impact of single social locations. Employing analytic methods to examine multiple, interconnected social locations embodied in an individual is less frequent (Bauer & Scheim, 2019; Cairney et al., 2014; Evans et al., 2018; Jackson & VanderWeele, 2019; Merlo, 2018; Wemrell et al., 2017). Commentaries lament the failure of quantitative, population health research to explore interconnections of social locations in determining health outcomes (Agénor, 2018; Hankivsky, 2012; Merlo, 2018) noting that few have translated a theoretical framework into study methodology. While research subjects may be seen as multidimensional, integrating social complexity with innate individual characteristics such as sex into quantitative analyses to study within category variation remains elusive.

Often without naming them as such, measures and methods that consider intersectionality do appear in population health studies. Perhaps the most frequent approach to moving beyond risk factor analyses in which social locations are controlled for rather than studied has been to examine interactions between pairs of social measures or of single measures and sex. However, including multiple interactions can become unwieldy, requiring large sample sizes to look at numerous pairs of identities and even larger sample sizes to address interactions of multiple rather than only paired characteristics. As Evans et al. (2018) state, "the fixed effects approach to interactions struggles with issues of scalability, model parsimony, reduced sample size in some intersectional strata, and occasionally, issues of interpretability."

Acknowledging these limitations, a few epidemiologists have proposed various ways to address intersectionality in health outcomes research. Among these are multilevel analyses (MLA) (Bell et al., 2019; Evans, 2019; Evans et al., 2018; Merlo, 2018) that place individuals within various social locations and measure residual variability both across and within groups. By clustering participants, whether by physical or social locations, MLA can correct for a central, but arguably erroneous assumption of regression, that of independence of participants. A novel application of MLA for quantitative exploration of intersectionality is the method of multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA). MAIHDA reorganizes concepts used in multilevel regression analyses and provides a more coherent conceptualization for the intersectional analysis of health. This approach considers intersectional strata as social contexts rather than individual characteristics. It further distinguishes additive from interactive effects and provides information on the accuracy of intersectional strata for differentiating individuals according to health outcomes. By providing simultaneous estimation of intersection-specific effects and tests of interactions MAIHDA brings statistical efficiency into intersectionality analysis (Merlo 2019; Merlo, 2014). Lively debate on the use of this method is ongoing (Evans, 2020; Lizotte, 2020).

Also proposed are decomposition methods (Hosseinpoor et al., 2012; Oaxaca, 1973) to partition measured differences in outcome first between women and men (for studying gender) and then across social locations. Bauer and Sheim and others (Bauer & Scheim, 2019; Jackson & VanderWeele, 2019) proposed a refinement of this that they called decomposition mediation analysis. In addition to quantifying the contribution of each characteristic, this approach differentiates between mediation effects due to disparate levels versus disparate effects of a mediator, providing a model that is applicable to a wide range of health-related inquiries. Machine learning or decision tree approaches constitute another proposed analytic framework (Bi et al., 2019; Cairney et al., 2014). This one involves successive subgroupings of a sample based on ‘within group’ similarities in terms of the health outcome variable. The final decision tree, usually presented as a graphic, starts with a root node that includes all the characteristics of the study sample. Subsequent sequentially produced nodes subdivide that sample into groups that are increasingly homogeneous. Proponents of each approach are convincing in arguing for the singular merit of a specific method and the shortcomings of other, often less intricate designs, leaving those wanting to enter the intersectionality arena somewhat confused as to next steps. As few studies to date have used the same real data to compare strengths of various methods, empirical guidance is limited.

1.5. Intersectionality and older adults

We have chosen to limit our review to research on middle and older aged adults for a number of reasons. At a theoretical level intersectionality and life-course approaches share an emphasis on the importance to health outcomes of context, accumulation of strengths and risks, mediation and modification, and dynamic changes across time and social locations. Middle and older aged adults should comprise a population where the effects of experienced exposures/oppressions/privileges associated with intersecting identities are more aggregated and, perhaps, more apparent. They are also the cohort that we, as a research group, study. Our anecdotal impression has been that explicit intersectional approaches have not permeated this research. Because age can be a proxy for a cohort effect it could be considered as a social location in addition to an individual characteristic. Narrowing the age range studied will limit an averaging effect that could arise from looking at all age cohorts together. For all these reasons, research among this age group could generate rich, deep and nuanced information regarding the health impact of gender, that is, about how sex and social locations, expectations and constraints intersect to shape health.

1.6. Objective of this systematic review

Our objective was to examine whether quantitative research on adults age 45 and older considers interactions of sex and social locations, that is, gender, and the merit of methods used for doing this. Via a systematic review of study methods used in sex/social locations and health outcomes research we aimed to identify statistical approaches capable of including this aspect of intersectionality. We reviewed intersectionality theories to be guided by, but not to critique or advance them.

2. Methods

2.1. Search strategy

Following on a series of exploratory searches and review of a number of relevant, key studies, we developed a list of search terms using Ovid MEDLINE to address four key concepts (Table 1). The term, intersectionality, was included in the search as an ‘or’ option (appendix 2). We considered carefully what constituted a social location or a health outcome, excluding, for example, outcome measures such as obesity that we classified as risks factors rather than illnesses.

This search was performed using the following databases: Ovid MEDLINE, Ovid EMBASE, CINAHL, Cochrane Library, Web of Science and ProQuest Dissertations & Theses Global. All searches were conducted on July 24, 2019 and were limited by publication year from 2014 to July 2019. To remove duplicates (n = 4317) and facilitate screening, citation results were imported into Covidence to yield 9214 unique citations for screening. Appendix 1 summarizes the number of citation results from each database, and the total number of citations after

Table 1
Search terms used in Ovid MEDLINE.

Concept 1: Older Adults	Concept 2: Gender	Concept 3: Health	Concept 4: Social Factors
Age Factors/	Sex Factors/	Health/	Continental Population Groups/
Aging/	Gender Identity/	health status.mp	race.mp
aging.mp	gender.mp	health outcome*.mp	Ethnic Groups/
ageing.mp	intersectionality.mp	Health Status/	ethnicity.mp
Aged/		Health Status Disparities/	Race Factors/
Aged, 80 and over/		Social Determinants of Health/	Socioeconomic Factors/
Middle Aged/		Geriatric Assessment/	Sociological Factors/
older adult*.mp		Health Status Indicators/	socioeconomic.mp
older people.mp		Health Surveys/	sociodemographic.mp
elderly.mp		Quality of Life/	Social Class/
senior*.mp		Activities of Daily Living/	Social Support/
		activit* of daily living.mp	social determinant*.mp
		activit* of daily life.mp	social relation*.mp
		daily living activit*.mp	social interaction*.mp
		daily life activit*.mp	social status.mp
		ADL.mp	Educational Status/
		ADLs.mp	
		IADL.mp	
		IADLs.mp	

/indicates that the search term is a Medical Subject Heading (MeSH).

.mp indicates that the search term was searched as a keyword.

* indicates that the search term was truncated to include multiple suffixes.

deduplication.

2.2. Study selection and data extraction

All titles and abstracts were reviewed independently by two authors and discrepancies were resolved via discussion. We included studies involving participants aged 45+, that employed a quantitative approach to evaluate intersecting impacts of sex and any other social factor as an exposure or a predictive variable for predefined health outcomes. Inclusion/exclusion criteria are detailed in [Table 2](#).

The same two authors reviewed full texts of the included papers (n = 711) to verify the initial title/abstract screen. Data on author, place, year, health outcomes, social variables, stratification by sex, and analytic methods were extracted. As stated earlier, only studies with measures that would allow for intersectional analyses were included in the full paper review. We next examined whether authors studied what we, although not necessarily they refer to as intersectionality. Papers were reclassified as follows:

- collected data on sex and social location but only described these
- controlled for rather than measuring the impact of either sex or the social location
- embedded sex intersecting with social location(s), and within category heterogeneity in analysis

2.3. Funding and ethics

Ethics approval for the review was received from Queen's

Table 2
Screening Criteria for titles/abstracts.

Criterion 1: Population
Does the study include <u>human populations age 45 and older</u> ?
Exclude:
1) Adolescent, adolescence, youth, children, young adults, only adults under age 45
2) Women or men only studies
3) Animal studies
4) Lab/biological studies on human tissues
5) Studies on health care professionals (physicians, nurses, etc.)
Criterion 2: Methodology and research question
Is the study designed to answer a quantitative question about a <u>health outcome</u> ?
Such as estimation of an effect or correlation?
Exclude (based on type of the study):
1) Qualitative research (include mixed methods)
2) Individual case studies
3) Matched on sex/gender case-control studies
4) Program evaluation studies
5) KAP (knowledge, attitude, and practice) studies
Exclude (based on outcome):
1) Health care utilization (access to care, hospitalization rates, use of insurance systems, satisfaction with care)
2) Social participation (or lack thereof such as loneliness, isolation)
3) Health behaviors (smoking, drinking, physical activity, etc.)
4) Health literacy
5) Medication adherence
6) Obesity, change in BMI
7) Nutrition status/food consumption/intake of food or supplements
8) Fear of falling
9) Suicide/suicide ideation
10) Elder abuse/neglect
11) Telomere length
Criterion 3: Intersectionality information
Does the study include sex <u>and</u> any other social factor as an exposure or a predictive factor for a health outcome?
Exclude:
1) Studies on 'gender identity'
Ineligible as sole social factor:
1) Marital status
2) Family structure
3) Number of household members
4) Religion/religiosity (include social support due to religion activity, church attendance)

University's Health Sciences Research Ethics Board.

3. Results

3.1. Search results

The initial search yielded 9214 citations (see [Fig. 1](#): Prisma chart) that, after title and abstract review, and using the predetermined exclusion criteria ([Table 2](#)), were narrowed to 732. A further 231 were excluded on full-text review because articles named sex or gender and social locations in abstracts but did not include these in analyses. Of the 501 articles that met inclusion criteria, 35 performed descriptive but no multivariate analysis and 253 regression models controlled for, rather than exploring the impact of interactions among sex and social identities/locations.

3.2. Methods identified

The remaining papers (n = 213) applied a number of methodologies in ways that could be seen as intersectional. Of these, 112 used regression and considered differential impacts of social locations across groups categorized by sex, by either incorporating the interaction of sex and at least one specific social factor in multivariate models, or by performing sex-stratified analyses. Another 101 papers (see [Table 3](#)) used analyses identified by others as valid approaches to intersectionality such as multi-level (n = 25), structural equation modelling (SEM) (n = 25), mediation/path (n = 17), growth curve and trajectory models (n = 22), decomposition (n = 9), and three 'other' methods. However, these 101 did not generally use the inherent strength of their chosen method but instead, controlled for (n = 37) or included interactions or sex-stratification to deliver elements of gender (n = 37), and therefore only implicitly analyzed intersectionality. The remaining 18 papers performed explicit intersectional analyses in ways described in the next paragraph. Among all reviewed papers that used methods other than regression (n = 101) six introduced the term intersectionality: SEM = 3 ([Assari et al., 2017, 2019](#); [Carter & Assari, 2017](#)); growth curve models = 2 ([Ang, 2019](#); [McClendon et al., 2019](#)); and multilevel analysis = 1 ([Brown et al., 2016](#)). Four regression only studies wrote of intersectionality without explicitly including this construct in their analysis (data not shown).

Papers were then reclassified by whether they approximated aspects of intersectional analyses ([Table 3](#)). Least robust with respect to intersectionality were those studies that collected data on sex and social location but only described this information. These papers presented counts of various social locations and of sex of participants (n = 35), but did not utilize these categories in examining health outcomes. Next, were studies that controlled for, rather than measuring the intersecting impact of sex and at least one social location on the outcome being measured (n = 290). All these looked at effects of risk factors singly. Finally, were studies that embedded sex intersecting with social location (s), and simple within-category heterogeneity in analyses (n = 157) or more performed sophisticated intra-categorical assessment (n = 18). Two mediation studies ([Chen et al., 2018](#); [Li et al., 2015](#)), included sex as part of their pathways. [Chen et al. \(2018\)](#) demonstrated that the combined effects of sex and education on disability were mediated through leisure time activity, a proxy measure for social connectedness. Using a similar methodology [Li et al. \(2015\)](#) evaluated the association of combinations of sex and either race/ethnicity or geographic region with mortality from coronary artery disease among older adults, and found the main mediator to be quality of care. Several SEM studies included the effects of sex and social locations in defining latent factors mediating the path to health outcomes. Intersectionality was inserted into a few other SEM papers via examination of the combined effects of sex and education on either oral health ([Rebello et al., 2016](#)) or quality of life ([Liang & Wu, 2014](#)). Also using SEM, [Shiu](#) studied the intersecting effect of sex and social support on quality of life ([Shiu et al., 2014](#)), [Tetzner](#)

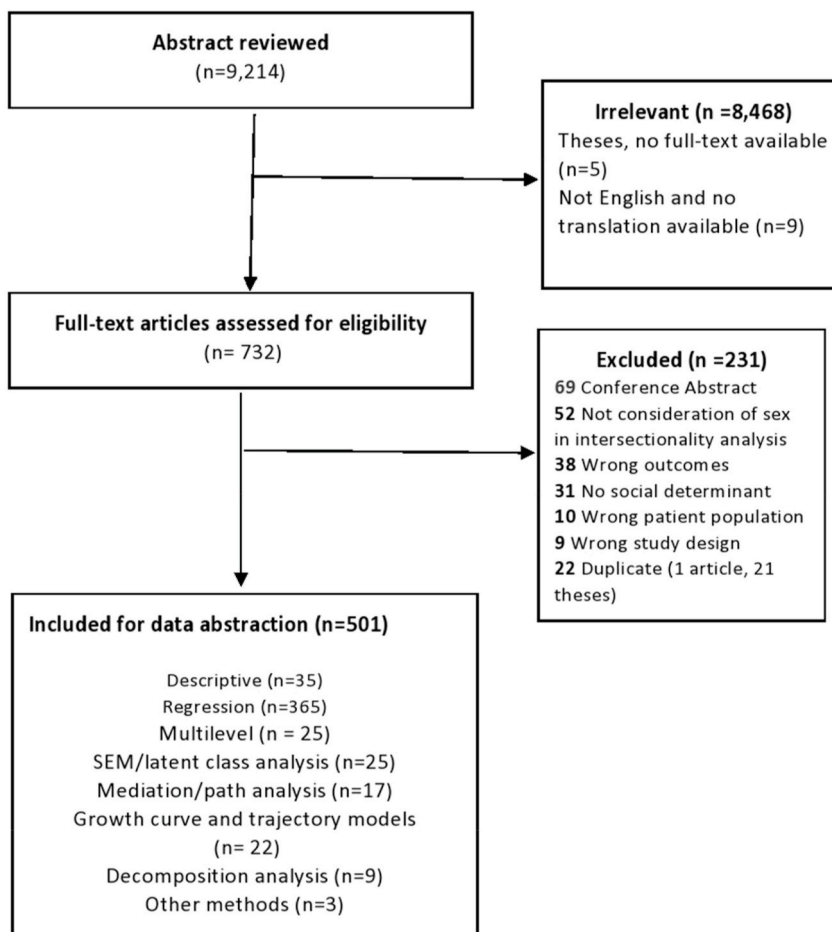


Fig. 1. Prisma chart.

Table 3
Differentiating papers by methods used and inclusion of intersectional analysis.

Table 3: Intersectional analysis by study methodology

(total n = 501)	Adjusted for sex	Interactions/sex-stratification i.e. implicit, basic intersectional analysis	Performed explicit intersectional analyses	Total
Regression	253	112	0	365
Multilevel	10	15	0	25
Structural equation modelling	2	11	12	25
Mediation	7	8	2	17
Growth curve	14	7	22 ^a	22 ^a
Decomposition	3	3	3	9
Other	1	1	1	3
Descriptive only	–	–	–	35
Total	290	157	18	

^a One study neither adjusted for nor stratified by sex.

identified whether sex and education, together, are part of the pathway leading to anxiety in older age (Tetzner & Schuth, 2016), and Godin looked at sex, education and social vulnerability linked to cognitive decline and frailty (Godin et al., 2017). Stephens et al. (2014) also via SEM, examined upstream effects of sex and social context variables on social engagement and the downstream effect of network engagement on social support and health (Stephens et al., 2014). In perhaps the most nuanced and deep examination of intersectionality, Shen (2014) used SEM to developed an intricate intersectional web, including sex and

social conditions during childhood, and studied how these, together, shape both adult SES and health in old age (Shen & Zeng, 2014). By employing decomposition analysis techniques three papers identified factors that explained inequalities between men and women. Using Blinder-Oaxaca decomposition, Adjei et al. (Adjei et al., 2017) partitioned differences in self-rated health by social locations such as education, employment and land tenure, while Stewart Williams et al. (2017) used education and marital status to decompose gender inequalities in disability (Stewart Williams et al., 2017). Employing yet another decomposition technique, Pandey and Ladusingh (2015) quantified contributions of social support and SES measures in explaining gender inequalities in self-rated health (Pandey & Ladusingh, 2015).

Our aim was to examine methods rather than outcomes and associated social locations which we will, therefore, only summarize briefly here. Among the 501 full-text review papers most frequent outcomes were disability (80 studies) and quality of life (48 studies) although there was a wide range of other health measures considered. Social locations varied in nature and number considered. Most frequently included were education (302 studies) and income (114 studies) with each measured in a variety of ways.

4. Discussion

The purpose of this systematic review was to explore methods in use for assessing the relationship between intersections of social locations and sex (i.e. of gender) with health, a relationship that approaches, although does not entirely define intersectionality. Few authors explicitly conceptualized intersectionality or its inherent power dynamics as

useful frameworks when studying health outcomes among 45+ year old adults. The resulting overall lack of intentional, and presence of occasional inadvertent intersectional analyses speaks to a gap in theory that has been better-developed in qualitative research but rarely named in quantitative studies.

4.1. Intersectionality without naming it

Because intersectionality is not well embedded in epidemiology we did not limit our search to studies that used this term. Intersectionality was included via an 'OR' function in our search. To be inclusive, we searched broadly for elements essential to performing intersectional analyses, limiting the search period to 2014–19 for practical reasons and because of a noticeable recent growth in related theoretical papers. Many social epidemiology researchers recognize the impact of power differentials on health outcomes and that power does not arise from single social characteristics, but often do not name this realization 'intersectionality'. This was our rationale for the expansive search. Although >90% of papers identified initially ($n = 9214$) did not meet inclusion criteria the breadth of the search likely ensured that few relevant papers were missed. Although almost none conceptualized or named it explicitly, 213 papers did provide information that could be considered to address intersectionality to some extent. The stated objective of most authors was to identify the independent contribution of numerous factors to differences in specific health outcomes. We, therefore cautiously assess strengths of methods for examining intersectionality. What we were able to do was to identify a breadth of methods in use and the frequency with which each addressed the intersecting impact of sex and social location.

4.2. Opportunities without results

As few of the reviewed papers set out to examine intersectionality, a priori, authors cannot be faulted for not explicitly reporting such findings. We appreciate and agree with the longstanding epidemiological recommendation that sub-group analyses should only be conducted in a directed and purposeful manner based on explicit hypotheses, and not routinely in an exploratory way that could yield spurious associations. This lack of hypothesis about intersectionality represents more of a missed conceptual opportunity than an analytic shortcoming. A majority of full papers reviewed documented measures such as sex, and race, education, or other social locations but then, methodologically eliminated their overlapping impact from view, and with it, the complex impact of intersecting marginalization on health. This speaks to both the possibilities of accessing data but also the lack of visibility of intersectionality as a framework to guide analyses. In adjusting for sex, for example, even the limited explanatory merit of this dichotomous variable disappears, as does the option of examining intersections with social locations to identify heterogeneity within the categories 'women' and 'men'. The result is an inability to address the "great challenge of epidemiology" noted earlier (Green et al., 2017). There will be many times when sex, gender, and social circumstances do not explain variability in health outcomes, however without including such measures in analyses neither their predictive value nor the lack of it can be recognized.

Approximately 30% ($n = 112$) of the regression papers reviewed started down the path to intersectionality by examining interactions between sex and social locations. Methodologically, studying whether the impact of, for example, education on the health outcome under consideration is different for men and women, which is the essence of including a sex by education interaction, or of stratifying the impact of education by sex, has limitations. Because sample sizes needed increase exponentially with the addition of each interaction term researchers will, of necessity, opt for parsimony, hypothesizing what the most likely interactions might be and only testing these. In so doing they may build in assumptions, narrow the scope of current to past exploration, and

preclude asking whether other identities matter. For example, looking for an interaction between education and sex assumes there is one. Not looking at the multiple interactions that arise from intersections of sex, race, marital status and education similarly assumes there are none. Interactions will only reveal what is imagined.

4.3. Research methods: met and unmet potential

To what extent did each research method reviewed demonstrate whether differential distributions of social locations by sex have differential impacts on any of a variety of health outcomes? All methods reviewed had this potential, however, only a minority of authors utilized it. Regression analyses, without interactions or stratification by sex, were unable to provide the information about differential distribution of social locations by sex that would be needed to examine resulting differential health effects. Trajectory/growth curve models can account for within subject variation in health outcomes. However, as with regression, studies employing these methods did not provide intersectionality information unless they stratified by sex (growth models = 7/22). Similarly, mediation and SEM do not intrinsically address the intersectionality of gender unless sex and social location are explicitly considered. The 8/17 mediation analyses that stratified by sex did identify differential effects of social locations for each sex. A further 2/17 included sex as part of the mediation pathway model, deepening intersectionality analyses (Chen et al., 2018; Li et al., 2015). Of 25 SEM papers reviewed, the 12 that included sex as part of the model were able to address differential effects, while the 11 that stratified by sex tackled only differential distribution.

Others (Bauer & Scheim, 2019; Bowleg, 2012; Cairney et al., 2014; Evans et al., 2018; Merlo, 2018) have identified multilevel analyses, MAIHDA, decomposition, or regression trees as particularly robust, nuanced and meaningful ways to measure intersectional positions. Multilevel modelling can address within category heterogeneity arising from differences in social locations by nesting participants within matrices defined by combinations of variables such as sex, race/ethnicity, income, education, age. This allows individual variance to be examined both within and between strata. In other words, multilevel analysis inherently identifies heterogeneity within, as well as across groupings (Merlo, 2018). The recently developed multilevel analysis of MAIHDA, by simultaneously estimating specific effects of intersectional strata and tests of interactions, provides an innovative way of examining intersectionality. This, then, is a method that inherently addresses intersectionality, although not necessarily gender. Among the multilevel papers reviewed ($n = 25$), none used MAIHDA, precluding assessment of it in this review. Fifteen papers did examine interactions between sex and a social location, or stratified by sex, and hence, approached the potential to address aspects of intersectionality. These studies did not, however, use the strength of MLA to look at whether there are differential effects arising from clusters of social locations and thus, missed the opportunity to more deeply examine within sex/social group heterogeneity. Of the decomposition studies ($n = 9$), only the 3 for which sex was the initial variable considered as a determinant of inequality in health outcomes delivered, although unintentionally, an intersectional analysis. Despite the reported strength of regression tree analyses for examining intersectional effects on health (Cairney et al., 2014) none of the identified studies used this methodology.

4.4. Recommendations

A strength of intersectionality is that it moves beyond the essentialism of assuming that all those belonging to a specific category share innate characteristics. Intersectionality theory recognizes the social nature of gender and race, and inherently acknowledges that power structures underlie and shape health. Central to intersectionality theory is the concept that multiple social locations act together, but differentially depending on each individual's combination of social locations, to

create health advantages or disadvantages that are not the same as those for a single location, alone. “While inter-categorical intersectionality is a useful tool for studying differences between populations, regression models with numerous interaction terms inherently overlook the heterogeneity of risk that remains within these identities” (Wemrell et al., 2017). In this review we aimed to identify quantitative methodologies that are being used effectively for studying intersections of sex and social circumstances or locations on health, and, specifically among middle aged and older adults.

We considered both the potential and the realized ability of each method identified via the review to display the health impacts of within group as well as across group heterogeneity. While adjusting for sex evades any measure of intersectionality, all other methods and approaches identified have strengths and weaknesses as outlined above. No single method consistently and inherently produced an answer to how intersections of sex and social locations contribute to health effects. This shortcoming was not one of methodology but, rather, of theory. Generally, authors did not conceptualize that an intersectional framework might enhance understanding of the outcome being studied and, in particular, that categorizing men or women as homogeneous groupings might be erroneous. In other words, the absence of intersectional analysis was the outcome of a blind spot among researchers. Our main recommendation, therefore, is that the study of how social locations shape health outcomes would be strengthened by an intersectional framework. Among the reviewed papers, SEM, decomposition and mediation produced robust intersectional analyses, however more frequently used approaches such as regression can yield some, although limited information if interactions or sex-stratification are included.

4.5. Limitations

As intersectionality theory is an evolving construct and one that is only just percolating into the area of social epidemiology, our review was limited to papers published in or after 2014. Earlier studies would, therefore, have been missed. We have not addressed the statistical complexity of some of the methods that have been reported elsewhere as key for addressing intersectionality (Bauer & Scheim, 2019; Bowleg, 2012; Jackson & VanderWeele, 2019; Merlo, 2018). The merit of these might be weighed against the inability of some non-statistician researchers, or, perhaps many, to either operationalize or interpret them. Although models for comparing analytic methods using the same data exist (Evans et al., 2020) none emerged from our search and, therefore, we can annotate and hypothesize about each method’s strengths as used, but not describe ‘head to head’ analyses. As stated earlier, almost none ($n = 6$) of the reviewed research intentionally used an intersectionality framework. Although all included sex and at least one social location as potential associations with a health outcome, few set out to study intersectionality, explicitly and, therefore, cannot be faulted for shortcomings in doing this. Nevertheless, by including only studies that promised an assessment of the health impact of sex and some other social location, that is, of intersectionality without naming it as such, this work has provided a systematic review of approaches to and merits of analytic methods that describe intersectional health outcomes research among middle and older aged adults.

Declaration of conflicts of interest

No author has any conflicts to declare.

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Ethics

This manuscript meets the ethical requirements as outlined in your online document: <https://www.elsevier.com/about/policies/publishing-ethics>.

CRediT authorship contribution statement

S.P. Phillips: Writing - review & editing, Writing - original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Vafaei A:** Writing - review & editing, Writing - original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Yu S:** Writing - review & editing, Methodology, Data curation, Conceptualization. **Rodrigues R:** Writing - review & editing, Methodology, Funding acquisition, Conceptualization. **Ilinca S:** Writing - review & editing, Methodology, Conceptualization. **Zolyomi E:** Writing - review & editing, Methodology, Conceptualization. **Fors S:** Writing - review & editing, Methodology, Funding acquisition, Conceptualization.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2020.100705>.

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