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Review

Life course socioeconomic conditions and multimorbidity in old age – A scoping review

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ABSTRACT

Multimorbidity disproportionally affects individuals exposed to socioeconomic disadvantage. It is, however, unclear how adverse socioeconomic conditions (SEC) at different periods of the life course predict the occurrence of multimorbidity in later life. In this scoping review, we investigate the association between life course SEC and later-life multimorbidity, and assess to which extent it supports different life course causal models (critical period, sensitive period, accumulation, pathway, or social mobility). We identified four studies (25,209 participants) with the first measure of SEC in childhood (before age 18). In these four studies, childhood SEC was associated with multimorbidity in old age, and the associations were partially or fully attenuated upon adjustment for later-life SEC. These results are consistent with the sensitive period and the pathway models. We identified five studies (91,236 participants) with the first measure of SEC in young adulthood (after age 18), and the associations with multimorbidity in old age as well as the effects of adjustment for later-life SEC differed from one study to the other. Among the nine included studies, none tested the social mobility or the accumulation models. In conclusion, SEC in early life could have an effect on multimorbidity, attenuated at least partly by SEC in adulthood.

1. Introduction

In ageing populations, the rise in the number of individuals suffering from multiple chronic health conditions is a major public health concern (Mathers and Loncar, 2005). Multimorbidity, the co-occurrence of two or more chronic diseases, decreases quality of life and increases risks for disability and mortality (Makovski et al., 2019; Nunes et al., 2016; Quiñones et al., 2016). Compared to frailty and disability, multimorbidity would have the strongest association with mortality, making it a central target for population health interventions (Dugravot et al., 2020; Nunes et al., 2016). Further, as life expectancy continues to rise globally, the burden of multimorbidity is expected to grow unless preventative measures are taken (Kingston et al., 2018).

Multimorbidity disproportionally affects groups exposed to disadvantaged socioeconomic conditions (SEC) (Ingram et al., 2021; Marengoni et al., 2011; Pathirana and Jackson, 2018). Hence, SEC at different periods of life has been shown to predict the risk of later-life multimorbidity. Most studies have however focused on either current SEC, i.e., at the time of multimorbidity assessment, like current education or current employment (Nagel et al., 2008; van den Akker et al., 2000), or SEC during one life period, either during childhood or young adulthood (Haas and Oi, 2018; Marengoni et al., 2008; Yang et al., 2021). However, this approach does not allow accounting for the change in SEC across the life course, i.e., along trajectories that could have differential effects on multimorbidity. There is also evidence that lifetime SEC is a stronger predictor for disease outcomes in later life than SEC at any singular life point (Tucker-Seeley et al., 2011).

What remains unclear is the causal relationship between life course SEC and multimorbidity. Different non-mutually exclusive life course causal models have been proposed to explain the link between exposures at different times across the life course and health and disease in later life. They are the critical period, sensitive period, accumulation, pathway, and social mobility models. Importantly, these theories have rarely been backed up and systematically evaluated with empirical data. Health outcomes that were reviewed through such a life course lens include quality of life or chronic diseases, among others, but not

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multimorbidity (Lynch and Smith, 2005; Niedzwiedz et al., 2012; Pudrovska and Anikputa, 2014). Thus, in this scoping review, we aimed to describe how SEC at different periods during the life course predict the risk of multimorbidity in later life. Further, we assessed to which extent the different life course causal models were supported by empirical studies.

2. Methods

2.1. Definition of life course models

In this review, we consider several life course models, that is, the (1) critical period, (2) sensitive period, (3) pathway, (4) accumulation, and (5) social mobility model.

The critical, or sensitive, period model (also called the "latency" model) refers to limited time windows during which exposures have an effect on an outcome occurring at a later point. It is an extension of the idea of biological or fetal programming that was proposed in the biological sciences to explain the "long arm of childhood", i.e., the long-lasting health effects of experiences in early life (Barker, 1997; Blane et al., 2007). The terms "critical" and "sensitive" are not homogenously defined in the literature. They can be used to distinguish between the permanence of an exposure: sensitive periods allow for a capacity to recover, whereas exposures during a critical period have a more irreversible impact, like the exposure of a fetus to tobacco or alcohol. However, some authors also use them to distinguish between the impact of an exposure, i.e., the same exposure has a greater effect if it occurs during a critical period compared to if it occurred during a sensitive period.

The pathway model views individual risk factors as interconnected. Also known as the "chain of risk" model or as the "social trajectory" model (Hendricks, 2012), the pathway model describes a sequence of exposures that are linked together: one bad experience tends to lead to another and so forth (Kuh et al., 2003). Thus, health inequalities in early life lead to further health problems, which over time widens the gap between the most advantaged and the most disadvantaged. One counter argument is the age-as-level-theory which states that, on average, discrepancies decrease over time, meaning that health inequalities in early life will eventually level out (Lynch, 2003).

The accumulation model states that it is not the timing of an exposure that matters, but its duration. Similar to a dose-response relationship, harmful exposures accumulate over the course of one's life to reach their full effect in later life. The underlying hypothesis is that stressors, like adverse health behaviors, injury, or illness, create cumulative damage that the body is eventually unable to compensate (Kuh et al., 2003).

Finally, the social mobility model focuses on how individuals move between different social groups across their life. The assumption is that this movement, whether upward or downward, has an effect on health outcomes later on (Lynch et al., 1994). This can take place on the individual, group, or intergenerational level and, depending on the field of research, may refer to movement between different social classes or income groups.

2.2. Search strategy and inclusion criteria

We conducted a scoping review following the PRISMA guidelines for scoping reviews (Tricco et al., 2018) (see Appendix B). We have chosen to conduct a non-systematic review since we have a broad research question and aim to identify a gap in current knowledge, not to estimate specific associations. We started with studies that we were familiar with due to our own expertize. To identify additional studies of interest, we scanned the reference list in those initial studies and searched for citing articles in Google Scholar. Finally, we conducted a search of online databases using PubMed and Google Scholar between April 1, 2021 and August 31, 2021. The search terms were "life course" AND "multimorbidity" OR "comorbidity" AND "socioeconomic"; the full electronic search strategy for PubMed is described in Appendix A. We only considered full-text articles published in English. There were no limitations regarding article publication date. The search was conducted by CW and SC; any disagreements regarding inclusion were resolved through discussion until consensus was established. We have not registered a research protocol prior to this work.

We considered cohort studies with prospective or retrospective data as well as cross-sectional studies with retrospective data, conducted in high-income countries. We chose to focus on high-income countries due to the rapid expansion of morbidity in these countries driven by increasing life expectancies (Hay et al., 2017; Spiers et al., 2021). Studies were considered if they examined multimorbidity at age 50 and above as an outcome, and measured SEC at different moments of the life course (at least twice). Multimorbidity could be assessed once or multiple times, self-reported or based on medical records or administrative data. Different definitions for multimorbidity were eligible, as long as they were explicitly defined.

We base our understanding of socioeconomic conditions (SEC) on previous studies in health research (Galobardes et al., 2007; Shaw et al., 2007). We define them as factors that grant individuals differential access to material, social, cultural, etc. resources within a socially stratified society. SEC could be assessed in different ways, including but not limited to income, wealth, education, etc., with a minimum of two measures across two different life periods (Shaw et al., 2007). For simplification, we have split the life course into two periods: childhood (between birth and age 18) and adulthood (ages 18 +). Periods of the life course could be uterine life, childhood, adolescence, young adulthood, middle age, or old age.

2.3. Data analysis

We summarized and described the included studies, focusing on key findings. First, we extracted information regarding SEC measurement, definition and measurement of multimorbidity, and how the association between the two was assessed. Second, we appraised if the results of the included studies support specific life course causal models (Fig. 1). We considered that:

(1) the **critical period model** was supported if an association between a SEC indicator in early life (developmental phase) and multimorbidity in later life was found, if this association was not attenuated after adjusting for later-life SEC indicators, and if the later-life SEC indicator was not associated with multimorbidity.

(2) the **sensitive period model** was supported if an association between a SEC indicator in the developmental phase of the life course and old age multimorbidity was found, if the association was attenuated but remained significant after adjusting for later-life SEC indicators, and if the later-life SEC indicator was associated with multimorbidity.

(3) the **pathway model** was supported if a SEC indicator in early life, or in later life course periods, was fully mediated by one or more later SEC indicators, suggesting an indirect effect of SEC over difference periods of the life course.

(4) the **accumulation model** was supported if any forms of an accumulation of multiple SEC exposures (in a minimum of two life course periods) was operationalized into one variable (e.g., as a score or latent variable) and found to be associated with later-life multimorbidity.

(5) the **social mobility model** was supported if an association between downward or upward social mobility and later-life multimorbidity was found. This mobility refers to the direction of an individual's change (over the life course) on the same social status indicator (e.g., starting in low social class in young adulthood and ending in high social class in late adulthood means upward social mobility).

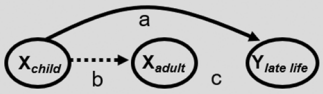
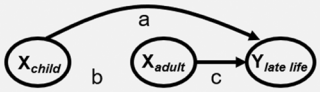
Life course models	Graphical representation
Critical period model Childhood (or any other developmental phase) is a critical period if c=0 and a≠0.	
Sensitive period model Childhood (or any other developmental phase) is a sensitive period if both c and a are ≠0.	
Pathway model Early-life exposures are fully mediated by one or more later exposures.	
Accumulation model Any form of duration of SEC exposures over the life course is operationalized.	*Not applicable*
Social mobility model The direction of intra-individual change (upward or downward mobility) is associated with the outcome.	*Not applicable*

Fig. 1. List and graphical representation of various life course causal models to understand how socioeconomic conditions (SEC) across the life course has an effect on multimorbidity later in life. X_{child} = Exposure in childhood. X_{adult} = Exposure in adulthood. $Y_{late\ life}$ = Outcome in later life.

3. Results

3.1. Search results

We identified articles that measured the association between SEC and later-life multimorbidity (Table 1). After a full-text review, ten studies were excluded because they did not fit the eligibility criteria. Eight studies were excluded because SEC was assessed during one life period only, either during childhood or adulthood (Aminisani et al., 2020; Marengoni et al., 2008; Nagel et al., 2008; Pathirana and Jackson, 2018; Roberts et al., 2015; Schäfer et al., 2012; van den Akker et al., 2000; Yang et al., 2021). Two studies did not focus on individual life trajectories, but either on differences between birth cohorts (Canizares et al., 2018) or between individuals of different age groups (McLean et al., 2014). The final number of studies included in this review was nine, all published within the last ten years.

In these nine studies, multimorbidity was defined as the co-occurrence of min. 2 chronic conditions, with the exception of Schäfer et al. (2012) who defined it as min. 3 chronic conditions. The list of chronic conditions considered to define multimorbidity varied between studies, ranging from 5 to 46 conditions. The number of study participants ranged from 1673 (Aminisani et al., 2020) to 63,842 (Nielsen et al., 2017), with a total of 116,445 across the nine studies examined. These studies were conducted over twenty different countries, specifically New Zealand, South Korea, England, United States, and across 15 European countries included in the SHARE cohort study (Börsch-Supan et al., 2013).

3.2. Childhood as first SEC exposure

In four studies, the first SEC exposure was measured in childhood before the age of 18 (Dekhtyar et al., 2019; Henchoz et al., 2019; Pavela and Latham, 2016; Tucker-Seeley et al., 2011). Of these, two studies assessed childhood socioeconomic conditions via a composition of multiple variables: (a) child labor and parental unemployment or business failure (Henchoz et al., 2019), and (b) family's relative socioeconomic standing, whether the respondent's family has moved for financial reasons, and parental education (Pavela and Latham, 2016). One study assessed the occupation of the father during childhood (Dekhtyar et al., 2019). The fourth study assessed childhood SEC via the question "While you were growing up, before age 16, did financial difficulties ever cause you or your family to move to a different place?" (Tucker-Seeley et al., 2011). A majority of studies (n = 3) thus focused on financial variables to describe early-life SEC while one study focused on parental occupation exclusively.

Later-life SEC exposures were measured at study baseline, with the exception of Henchoz et al. (2019) who used exclusively retrospective exposures. Later-life SEC exposures included adolescence or young adulthood, with education featuring in three studies. Additional SEC exposure measurements were income and wealth in old age (Pavela and Latham, 2016) and lifetime earnings during young and middle adulthood (Tucker-Seeley et al., 2011).

In these four studies, there was an association between childhood SEC and later-life multimorbidity. Further, in these four studies, the association was partially or fully attenuated by later-life SEC exposures. Therefore, none of the studies supported childhood SEC as a critical period. They provided support for the pathway (Dekhtyar et al., 2019; Henchoz et al., 2019; Pavela and Latham, 2016) and sensitive period models (Pavela and Latham, 2016; Tucker-Seeley et al., 2011). Nothing can be said regarding the social mobility model nor the accumulation model since none of the included studies performed the necessary analyses.

3.3. Adulthood as first SEC exposure

Five studies measured respondents' first SEC in young adulthood, i.e., after the age of 18 (Aminisani et al., 2020; Nielsen et al., 2017; Schäfer et al., 2012; Singer et al., 2019; Yi et al., 2019). The SEC indicators were education and later-life income in all five studies.

Regarding the association between SEC and multimorbidity in later life, the findings were inconsistent. Aminisani et al. (2020) reported no association between old age income nor education and multimorbidity in a fully adjusted model. Singer et al. (2019), found an association for old age household wealth, but not for education; social status and occupation in middle age had minimal effects in their study. Both Nielsen et al. (2017) and Schäfer et al. (2012) found an association for education and household income, respectively household-size adjusted net income. For Yi et al. (2019), findings differed slightly depending on location, with a stronger impact of SEC in urban regions compared to rural ones. Education was only associated with multimorbidity in urban locations, not in rural ones. Higher income was associated with a lower multimorbidity risk regardless of location.

Table 1
Overview of included studies measuring associations between socioeconomic exposures and multimorbidity in later life.

Authors, Year	Country (cohort), sample size, age and sex distribution at baseline	Exposures[a] **Childhood (ages 0 – 18)**	**Adulthood (ages 18–50)**	Life course model(s) supported	Controlled for	Main results
Aminisani et al. (2020)	New Zealand (Health, Work and Retirement Study), n = 1673, age groups (percentage): 55–64 (76.7%), ≥ 65 (23.3%), 51.9% female	Education	Education, income	No model supported	Sex, ethnicity, education, income, BMI	Higher education and income were protective factors against multimorbidity onset.
Dekhtyar et al. (2019)	Sweden (SNAC-K), n = 2589, age groups (percentage): 60–66 (44.7%), 72–78 (30.6%), 81–87 (17.0%), ≥ 90 (7.8%), 62.0% female	Father's occupation, education	Education, occupation	Pathway	Sex, age, smoking, alcohol, dropout status, underweight, number of medications at baseline	Speed of disease accumulation was lower in individuals with more than elementary education and for active occupations compared with high-strain jobs. The association between childhood circumstances and speed of disease accumulation was attenuated by later-life experiences.
Henchoz et al. (2019)	Switzerland (Lc65 +), n = 4731, mean age 67.9 ± 1.5 years (SD), 58.0% female	Education, child labor, family economic environment, food restrictions	Education, Socioeconomic status, stressful live events in adulthood, supplemental retirement benefits	Pathway	Problematic alcohol consumption, smoking, BMI, physical activity, education, living arrangement, supplemental retirement benefits, stressful live events in adulthood	All childhood adversity indicators, including poor family economic environment, child labor, and food restrictions, were significantly associated with multimorbidity.
Nielsen et al. (2017)	15 European countries (SHARE), n = 63,842, age groups (percentage): 50–59 (28.3%), 60–69 (34.9%), 70–79 (24.4%), 80 + (12.4%), 55.4% female	Education	Household income	Sensitive period	Age, gender	Across all studied European regions, lower education and lower household income were independently and significantly associated with higher odds of multimorbidity.
Pavela and Latham (2016)	USA (HRS), n = 10,584, mean age 54.9 ± 5.76 years (SD), 55.0% female	Education, family's socioeconomic standing, moving due to financial reasons, mother's education, father's education, father's occupation	Education, income, wealth	Sensitive period, pathway	Demographics, baseline adult health, health behaviors	Lower childhood socioeconomic status (SES) was associated with increased number of chronic conditions; however, childhood SES was no longer associated with chronic conditions after adjustment for adult SES.
Schäfer et al. (2012)	Germany (MultiCare Cohort Study), n = 3189, mean age 74.4 ± 5.2 years (SD), 59.3% female	Education	Education, income, former occupation, home ownership	Sensitive period	Age, gender, marital status, household type, education, degree of autonomy at former occupation, household-size adjusted net income, home ownership	Multimorbidity was associated with education and income. Former occupation and home ownership were not associated with multimorbidity.
Singer et al. (2019)	England (English Longitudinal Study of Ageing), n = 15,046, median age 64 years (56–73 interquartile range), 53.7% female	Education	Education, household wealth, subjective social status, occupation	No model supported	Social engagement, social support and individual sense of control, physical activity, alcohol consumption, tobacco smoking, wave, age, sex	The likelihood of multimorbidity was consistently associated with household wealth. People with low subjective social status and in routine or semi-routine occupations had slightly increased odds of multimorbidity. Education was not associated with multimorbidity.
Tucker-Seeley et al. (2011)	USA (HRS), n = 7305, mean age 65 years, 53.6% female	Education, financial hardship	Education, lifetime earnings	Sensitive period	Education, gender, race, ethnicity, age	Childhood financial hardship was positively associated with a higher number of chronic conditions. Lifetime earnings was negatively associated with multimorbidity, although the noted association was relatively small.
Yi et al. (2019)	Korea (KLoSA), n = 7486, 66.8	Education	Education, income, working for pay	No model supported	Unclear	Lower education levels, lower income levels and not

(*continued on next page*)

Table 1 (*continued*)

	± 10.2 years (SD), 53.8% female		currently working for pay were associated with higher odds of having multimorbidity.

[a] The listed exposures are not extensive but have been selected as the ones with most relevance for this study. For a full list of measured exposures please refer back to the original studies.

Two of the five studies provided results supporting the sensitive period model (with education as an indicator of the period encompassing late adolescence and young adulthood, hereafter "young adulthood"), although not convincingly (Nielsen et al., 2017; Schäfer et al., 2012). For Nielsen et al. (2017), the association between young adulthood SEC (education) and multimorbidity was partially attenuated in a multivariable model, but it was not specified whether this attenuation was due the adjustment for later-life SEC (household income) or due to another covariate (age, sex). For Schäfer et al. (2012), young adulthood SEC (education) and later-life (income) were both associated with multimorbidity in a multivariable model. However, it was not clear which exposures were included in the multivariable model. The remaining three studies performed their analyses in a way that did not allow for testing of the life course models as we have defined them.

4. Discussion

In this scoping review, we investigated the association between SEC across the life course and later-life multimorbidity, defined as two or more chronic conditions, and assess to which extent it supports different life course causal models. In four studies, childhood SEC was associated with multimorbidity, and the associations were partially or fully attenuated upon adjustment for later-life SEC, what is consistent with a sensitive period or a pathway model. In six studies with the first measure of SEC in young adulthood, the associations with multimorbidity as well as the effects of adjustment for later-life SEC differed from one study to the other. The critical period model was not supported and there was no study to test the social mobility or the accumulation model.

The examined associations between adulthood SEC and multimorbidity risk were mostly in line with previous findings. Notably, higher educational achievement and higher economic resources had an inverse relationship with multimorbidity risk in later life when they were found to be associated. However, we examined as well studies that did not find an association between education and multimorbidity risk (Aminisani et al., 2020; Singer et al., 2019; Yi et al., 2019); a previous meta-analysis has reported on the heterogeneous results of studies assessing the association between education and multimorbidity and named differing methods of multimorbidity ascertainment as one of the possible reasons (Pathirana and Jackson, 2018). On the other hand, with the exception of (Aminisani et al., 2020), all studies found an association between economic resources (personal income, household income, wealth, etc.) and multimorbidity risk.

Importantly, the critical period model was not supported in the four studies examining the impact of childhood SEC. In other words, the association between poor SEC exposures in early life and the risk of multimorbidity in later life was modified by mid-life exposures and the later-life SEC indicator was associated with multimorbidity. This highlights the importance of intervention strategies across different periods of the life course, as no single life period seems to entirely determine multimorbidity risk. The right interventions, targeting the right predictors at the right time (or period of the life course), can decrease the burden of multimorbidity in the population. A better understanding of the link between life course socioeconomic position and multimorbidity in later life is the first step in that direction.

There are multiple possibilities for mechanisms underlying the sensitive period and pathway models. Being born into a poor family increases (i) the risk of having a low birth weight or being premature (Kuh et al., 2004), (ii) the risk of exposure to adverse childhood experiences (Walsh et al., 2019) and psychosocial stress (Kraft and Kraft, 2021), or (iii) the risk of exposure to environmental pollution (Hajat et al., 2015; Miao et al., 2015). Growing up in a family with poor socioeconomic conditions may jeopardize the development of the child across biological (e.g., brain), cognitive (e.g., language skills, memory) and social (e.g., education) characteristics, resulting in a health gradient between the most and least disadvantaged (Cooper and Stewart, 2021; Herbaut and Geven, 2019; Kuh et al., 2004; Kulic et al., 2019; Rakesh and Whittle, 2021). Alternatively, one can view early-life "success" as a form of capital that can be used to receive more advantages and benefits later on (Ferraro et al., 2009). Thus, there are most likely both biological and social drivers underlying these life course models.

However, it is important to note that for the purpose of this review, we have developed an operationalization of the life course models in which they are mutually exclusive. This may not correspond to the reality of the bio-psycho-social mechanisms underlying the association between life course SEC and multimorbidity in later life, whereby a mixture of models may be at work.

4.1. Limitations

Our study has major limitations. Firstly, both the exposure and the outcome of interest were measured heterogeneously across studies. For the exposure, different socioeconomic variables were considered by the study authors, with their own operationalizations. Further, multimorbidity was most often self-reported, which leads to an underestimation of the prevalence of multimorbidity (Ofori-Asenso et al., 2019). Additionally, though almost all studies defined multimorbidity as the co-occurrence of a minimum of two chronic conditions, the list of eligible chronic conditions differed between studies. For example, Tucker-Seeley et al. (2011) investigated multimorbidity within six common chronic conditions, whereas Schäfer et al. (2012) used a list of 46 chronic conditions in their study. The heterogeneity in how multimorbidity is constructed and examined in public health research has already been described in the literature (Diederichs et al., 2011; Ho et al., 2021; Willadsen et al., 2016). Further, it is possible that the association between multimorbidity and SEC differs depending on the disease, hence explaining some of the different findings of the included studies. Lastly, there are methodological limitations to scoping reviews. Our search was not systematic, thus we might have missed studies that could change our conclusions. We have also not assessed the quality of the included studies, increasing the risk that our findings are biased.

5. Conclusion

In this study, we studied the association between life course SEC and multimorbidity in later life and assessed the support of different life course causal models underlying this association. We have found limited support for the pathway and sensitive period models, suggesting that (a) there are developmental periods of the life course (childhood and young adulthood) which can influence multimorbidity risk in later life and (b) socioeconomic exposures may follow a chain of risk pattern in determining this risk. Based on these results, we suggest that interventions and health promotion aimed at reducing the risk of multimorbidity in old age should consider the early-life socioeconomic conditions of the targeted population. We have identified an important gap in the

literature and urge future research on multimorbidity to consider potential interactions between exposures across multiple life periods.

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Author contributions

All authors designed the study. CW and SC made the literature search. All authors reviewed the study findings. CW drafted the manuscript. All co-authors revised the first draft of the manuscript. All authors approved the final version of the manuscript before submission.

Data sharing

Access to data requires contacting the last author.

Acknowledgment

Results of this work were presented at the Swiss Public Health Conference, 25th/26th August 2021, Bern, Switzerland.

Conflicts of interest

We declare no conflicts of interest.

Appendix A

PubMed search strategy

((("life change events"[MeSH Terms] OR ("life"[All Fields] AND "change"[All Fields] AND "events"[All Fields]) OR "life change events"[All Fields] OR ("life"[All Fields] AND "course"[All Fields]) OR "life course"[All Fields]) AND ("multimorbid"[All Fields] OR "multimorbidities"[All Fields] OR "multimorbidity"[MeSH Terms] OR "multimorbidity"[All Fields])) OR ("comorbid"[All Fields] OR "comorbidity"[MeSH Terms] OR "comorbidity"[All Fields] OR "comorbidities"[All Fields] OR "comorbids"[All Fields])) AND ("socioeconomic factors"[MeSH Terms] OR ("socioeconomic"[All Fields] AND "factors"[All Fields]) OR "socioeconomic factors"[All Fields] OR "socioeconomics"[All Fields] OR "socioeconomic"[All Fields] OR "socioeconomical"[All Fields] OR "socioeconomically"[All Fields]).

Appendix B

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist.

Section	Item	Prisma-ScR Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5–6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	5
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	–
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	–
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5–6
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	7–8
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	–
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	7–8

(*continued on next page*)

(*continued*)

Section	Item	Prisma-ScR Checklist item	Reported on page #
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	7–8
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	9
Limitations	20	Discuss the limitations of the scoping review process.	9–10
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	10
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	11

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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