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Theoretical explanations for socioeconomic inequalities in multimorbidity – A Scoping Review

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The authors have no competing interests to declare.

ABSTRACT

Objective: To document socio-epidemiologic theories used to explain the causal relationship between socioeconomic disadvantage and multimorbidity.

Design: Scoping review

Methods: A search strategy was developed and then applied to multiple electronic databases including Medline, EMBASE, PsychInfo, Web of Science, Scielo, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts. After the selection of studies, data was extracted using a data charting plan. Extracted data included: study design, country, population sub-groups, measures of socioeconomic inequality, assessment of multimorbidity and conclusion on the association between socioeconomic variables and multimorbidity. Included studies were furtherly assessed on their use of theory, type of theories used and context of application. Finally, we conducted a meta-narrative synthesis to summarise the results.

Results: A total of 36 studies were included in the review. Of these, 13 papers included theories as explanations for the association between socioeconomic inequalities and multimorbidity, and within this group, seven explicitly stated those theories. Behavioural theories were the most frequently used, followed by psychosocial and then materialist theories. Only four studies tested the explanatory potential of socio-epidemiologic theories and the remaining studies used them as post hoc explanations for their findings. Supportive evidence was found for the role of material, behavioural and life course theories.

Conclusion: Pathways from socioeconomic disadvantage to multimorbidity are mostly unexplored. Generating evidence of these pathways will guide the development of intervention and public policies to prevent multimorbidity among people living in social disadvantage.

Keywords: multimorbidity, socioeconomic inequalities, scoping review, theoretical explanations, epidemiology

Strengths and limitations:

- First scoping review exploring the use of theories to explain the association between socioeconomic position.
- The identification of numerous gaps in the literature that future research should address to inform intervention design and public policies aiming at reducing socioeconomic inequalities in multimorbidity.
- The use of a robust methodology, including a comprehensive a search strategy, already piloted and verified in previous work.
- Non-English articles were excluded in our review. Which could have obstructed the inclusion of papers from developing countries, therefore limiting the generalisability of our findings.

INTRODUCTION

Multimorbidity is a societal challenge and an increasingly recognised public health concern (1-3). It is described as the co-occurrence of two or more chronic conditions in an individual (4). Negative consequences of multimorbidity include: reduced quality of life; functional decline; increased healthcare utilisation; polypharmacy; higher treatment burdens; psychological distress; and increased risk of pre-mature death (5). There is an emerging threat of increased multimorbidity worldwide, primarily due to population aging and epidemiological transition from communicable to non-communicable diseases (6). Furthermore, abundant empirical evidence shows socioeconomic inequalities in multimorbidity across countries at different levels of economic development (7-11). However, pathways through which socioeconomic disadvantage leads to multimorbidity are not well studied.

Theories are used in epidemiology to understand causal relationships. This is particularly helpful to inform intervention designs. Mainly because theories provide insight into the mechanism through which an exposure (e.g. socioeconomic position) leads to a health outcome. (12). Since the release of the Black Report in 1982, several categories of theories are proposed to explain associations between social inequalities and health (13, 14):

I. Behavioural: The behavioural explanation posits that people from different backgrounds behave differently and make health-related choices based on their social background. As people experience socioeconomic deprivation, they also encounter more barriers to adopting healthy lifestyles. For instance, individual health damaging and promoting behaviours are differentially distributed across the social scale, with more disadvantaged groups more likely to engage in health damaging behaviours such as smoking(15), and advantaged groups more likely to engage in health promoting behaviours such as physical activity (15). As a result, poor health outcomes are commonly clustered in the lower end of the social scale (13).

II. Psychosocial: this theory postulates that the emotions that arise due to social inequality can directly affect biological health (16). This can be caused in two ways, either through the practice of health compromising behaviours or through biological changes due to the individual being in a sustained state of stress (16). Hence, the behavioural explanation can be a descendent of psychosocial processes under this explanation.

III. Materialist: the material environment has a significant impact on the health of an individual. Exposure to health-risk or health-protective factors varies according to social position based on access to material resources; this difference is more evident in non-egalitarian societies. For instance, individuals living in economic disadvantage are less likely to access information and resources necessary to maintain good health than more advantaged counterparts (13). Economically deprived individuals are also exposed to hazardous working environments (13). The materialist theory proposes these explanations as pathways from social deprivation to health inequalities (13).

IV. Social support: this theory holds that strong social networks and good social relationships are linked to good health. Conversely, poor social relations and weak social support networks are deleterious to health. That is because positive social support mitigates the detrimental effect of economic deprivation in health (17, 18).

V. Social capital: While variously defined, social capital is broadly understood to describe the functioning of social groups through a shared sense of identity, trust, cooperation, reciprocity and shared understandings, norms, and values (19). Social capital emphasises that more unequal distribution in income undermines trust and damages social relationships at a population level. This theory attempts to explain why egalitarian societies tend to be healthier than non-egalitarian societies (20, 21).

In addition to the abovementioned theories, a life course framework examines the effect of early life social exposures on later health outcomes (22). Two models are proposed to explain the life course framework: the accumulation model and the critical periods model. The accumulation model emphasises the cumulative effect of exposure to disadvantage across different stages in life and increased risk of poor health outcomes. The critical periods model focuses on the effect of exposure to factors influencing health during critical periods of development on the risk of disease (23). Finally, a neo-liberal framework for health inequalities encompasses the political arrangements that lead to propagation of social inequalities and in turn health inequalities(24).

We aim to review the applied socio-epidemiologic theories in the literature to explain the causal relationship between social disadvantage and multimorbidity in the population. Where possible, we examined whether such theories were tested using analytical methods such as mediation analysis to explain the relationship between social disadvantage and multimorbidity.

METHODS

We conducted a scoping review to examine epidemiologic theories applied to explain the association between social disadvantage and multimorbidity (25, 26), and to map the information available in the current literature. Because the primary purpose of this study was to identify and categorise the theories being used in the existing literature, a scoping review was preferred over a systematic review. We followed the steps of a scoping review as per previously defined guidelines (25, 26).

Stage I: Identifying the Research Question

Our review question was: "How are the socio-epidemiologic theories applied to explain the relationship between social disadvantage and multimorbidity?"

Stage II: Identifying Relevant Studies

We identified search terms and keywords relevant to social disadvantage, theoretical pathways and multimorbidity from published systematic reviews (27, 28) and tailored them to answer our research question. First, a detailed search strategy was developed using keywords and hierarchically defined subject headings. Once the search terms were agreed upon, they were adapted for multiple electronic databases including Medline, EMBASE, PsychInfo (Ovid platform), Web of Science, Scielo, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts (see *Appendix 1*). The reference lists of all selected articles were screened to identify any additional studies. Search alerts were set up to notify the research team of articles published after 25th of May 2018 when literature search was implemented. This search was updated on 11 December 2019.

Stage III: Study Selection

We applied strict inclusion and exclusion criteria; these are displayed in Table 1. We excluded studies on "comorbidity" as such studies may be focussed on an index condition (e.g. diabetes) (29). The terms multimorbidity and comorbidity are often used interchangeably as both describe the presence of multiple chronic conditions. However, comorbidity is a disease-centred term that describes the presence of additional conditions associated with an index disease (4). The focus of this review is multimorbidity only. Studies on institutionalised individuals, qualitative research, and those written in a language other than English were excluded. A detailed list of inclusion and exclusion criteria can be found in *Table 1*. Abstracts and full-text articles were reviewed for inclusion by LFA using the citation manager EndNote. A second reviewer (AS) cross-checked 10% of these articles.

See Table 1

Stage IV: Charting the Data

A data charting form was created which included study details (study design, country, population sub-groups, measures of socioeconomic inequality, assessment of multimorbidity and conclusion on the association between socioeconomic variables and multimorbidity), use of theory (inferred or explicitly mentioned), type of theories and context of application. Data charting was performed by LFA and 10% of the studies were cross checked by AS.

Each study was examined for the type of theory (example: psychosocial or material), extent of use (whether used in a post hoc manner or integrated within an analysis) and their context of use (background, methods or discussion section of retrieved paper(s)). We recorded whether theories that were directly mentioned or inferred were consistent with any of the existing socio-epidemiologic theories. Types of theories were recorded verbatim. This approach follows the precedent previously applied in a published study examining the application of socio-epidemiologic theories in studies on the relationship between social inequality and oral health (28).

Stage V: Collating, Summarizing and Reporting the Results

We carried out a narrative synthesis to summarise the results from the retrieved data.

RESULTS

Our search led to the identification of 751 unique papers that underwent title and abstract screening. Sixty-nine papers were deemed eligible for full-text review. Two additional studies were included for full-text review from additional sources. After the full-text review and one additional search, thirty-six studies proceeded to data charting stage. A flowchart of this process is shown in Figure 1.

Figure 1 Flow chart of the study selection process *(2-column fitting image)*

(*see figure 1*)

Summary characteristics of included studies

Twelve studies were from low- and middle-income countries (11, 30-40) and the remaining 24 studies were from high income countries. The majority of articles were conducted among adults and only one study included children (41). Most studies (n=24/36) were cross-sectional and only 12/36 used longitudinal data (8, 9, 35, 41-47) (Table 2).

Educational attainment was the preferred measure of socioeconomic position (n=26/36). The majority of studies (n=18/36) simply documented the presence of multimorbidity and only a few (n=6/36) additionally examined different patterns of multimorbidity (8, 33, 40, 45, 48, 49) (Table 2).

See Table 2

Types of theories

Overall, 16/36 of studies referred to at least one socio-epidemiological theory. Therefore, 20 studies can be considered largely atheoretical without any emphasis to pathways through which social disadvantage leads to multimorbidity whatsoever. In the sixteen studies following theories were referred to: behavioural (9, 30-35, 40, 43, 50, 51), materialist (34, 35, 47) and psychosocial (30, 31, 35, 42, 52). In addition, three studies applied sense of coherence, an indicator of self-efficacy and psychosocial well-being (consistent with psychosocial explanations) (46), and social capital (31), and social support (42) widely considered as psychosocial assets (Table 3). Three studies used a life-course framework. Collectively, psychosocial theory was the most referred to among studies.

Context of application of theories

Of the papers using theories, seven explicitly stated those theories (9, 32, 34, 42, 46, 47, 52), and the other six were inferred to be consistent with a presumed theoretical pathway, based on definitions from existing literature.

See Table 3

Testing the explanatory potential of theories

Only four studies (9, 34, 51, 53) tested variables consistent with theoretical pathways as mediators between socioeconomic disadvantage and multimorbidity. Applying material theory, Chung, Mercer (34), examined perception of financial hardship, an indicator of economic deprivation, as a mediator between housing tenure and multimorbidity. They found a small mediation effect, indicating that increased financial burden puts private housing residents at a higher risk of suffering multiple conditions when compared with public housing residents (34).

Drawing on behavioural theory as well as a life course framework, Katikireddi, Skivington (9), quantified mediation by five behavioural risk factors (diet, smoking, physical activity,

alcohol and BMI) acting in the association between two socioeconomic measures (area-based deprivation and household income) and multimorbidity over the life course. Their analyses showed that behavioural factors partially mediated the inverse association between area level deprivation and multimorbidity.

The life course framework was applied by Johnston, Black (53) in their examination of educational attainment during adulthood as a mediator of the association between father's occupational, social class at birth and multimorbidity. Their analyses showed a partial mediatory effect of educational attainment in the association between childhood socioeconomic status and multimorbidity.

Mondor, Cohen (51) also drew on behavioural theory in their study that quantified the mediation effect of lifestyle factors (physical activity, smoking and BMI) in the association between income inequalities and multimorbidity. Lifestyle factors only explained a small proportion of observed income-related inequalities in multimorbidity.

Five studies (30, 32, 35, 50, 52) used theories in a post-hoc manner in their discussion to explain their findings. These were: behavioural (30, 32, 35, 50); psychosocial (30, 35, 52), and materialist (35).

DISCUSSION

Summary of findings

Overall, we found limited use of theories to explain the association between socioeconomic status and multimorbidity. When used, such theories were often explicitly mentioned but not tested. Among all the potential explanations, behavioural theories were the most frequently used, followed by psychosocial and then materialist theories.

Only four studies tested the explanatory potential of theories and their mediation effect on the association between socioeconomic position and multimorbidity. Although we identified the use of seven different theories, the only tested theories were materialist, behavioural and life course. Supportive evidence was found for the role of these theories (9, 34, 51, 53). However, their use was mostly limited to post-hoc explanations of findings in the discussion section.

Strengths and limitations

Our study has some strengths and limitations. To our knowledge, this is the first scoping review exploring the use of theories to explain the association between socioeconomic position and multimorbidity in the current literature. We identified numerous gaps in the

literature that need to be filled to improve our understanding of socioeconomic inequalities in multimorbidity, a growing public health problem. Our search strategy comprised a wide range of electronic databases, and we used a robust methodology, already piloted and verified in previous work (28). A key limitation is that non-English articles were excluded in our review.

Our findings are consistent with the two major evidence gaps highlighted in the report 'Multimorbidity: a priority for global health research' (4). First, consistent with our review, evidence on multimorbidity, and on the relationship between socioeconomic disadvantage and multimorbidity is largely cross-sectional. Temporal ordering between exposure (social disadvantage) and outcome (multimorbidity), a key undisputed criterion of causality (54), is however difficult to establish cross-sectionally. Second, there is a paucity of evidence on causal pathways between shared causal factor(s) (for example: social disadvantage) and multiple conditions that co-occur in multimorbidity (4). The lack of evidence precludes policy makers from intervening on causal mechanisms that can prevent, or mitigate observed socioeconomic inequalities in multimorbidity (55). In addition to these, we found a dominance of testing of behavioural theory as pathways for socioeconomic inequalities in multimorbidity. However, the use of contemporary approaches to causal inference was limited (56). Therefore, we cannot rule out bias arising from mediator-outcome confounding, time varying confounding or the presence exposure-outcome interaction. The weight of evidence needs to shift towards a more comprehensive examination of these and other pathways, and multiple pathways at once, to allow policymakers to select interventions with maximum capacity to reduce inequalities.

CONCLUSION

Our understanding of pathways from socioeconomic inequalities to multimorbidity is limited and mostly unexplained. Studies are often focused on the patterns of distribution of multiple chronic conditions across the population, rather than the mechanisms shaping this distribution. Robust evidence from longitudinal and interventional studies is needed to understand the pathways between socioeconomic disadvantage and multimorbidity. Generating such evidence will guide the development of interventions and public policies to prevent multimorbidity among people living in disadvantage.

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Table 1. Study selection criteria.

Inclusion criteria	**Exclusion criteria**
-Studies with participants from any age group -Community representative participants -Individual and population-based epidemiological studies looking at the association between socio-economic disadvantage and multi-morbidity -Intervention studies involving examining moderators or mediators derived from theoretical constructs -Studies in English language	-Studies on institutionalised individuals -Studies on comorbidity -Qualitative studies -Study protocols, editorials and commentaries that do not report on association between social disadvantage and multi-morbidity

Table 2. Summary characteristics of included studies

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
Afshar et al. 2015	Cross-sectional	28 Low to middle-income countries	Adults aged 18 and over	Presence of multimorbidity.	Level of education.	Level of education was negatively associated with presence of multimorbidity.
Agborsangaya et al. 2012	Cross-sectional	Canada	Adults aged 18 and over	Presence of multimorbidity.	Educational level and annual household income.	Education and household income were both negatively associated with presence of multimorbidity.
Alaba et al. 2013	Cross-sectional	South Africa	Adults aged 18 and over	Presence or absence of multimorbidity.	Years of schooling, household income, social assistance, employment.	Household income and receiving social assistance were positively associated with presence of multimorbidity. The association was absent for employment and education.

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
Alimohammadian et al. 2017	Cross-sectional	Iran	Adults aged 40-75 years	Presence of multimorbidity.	Socioeconomic status: derived from a cluster analysis with the use of similarities for family assets, ethnicity, sex, employment status, age at onset of the first job, home ownership status and house size. Education.	Socioeconomic status and education were negatively associated with presence of multimorbidity in males and females. Both associations were stronger in females. Prevalence ratio of multimorbidity was higher in unemployed.
Ba et al. 2019	Cross-sectional	Vietnam	Individuals aged 15 years and over	Presence of multimorbidity.	Educational level and occupational status	Educational level and occupational status were inversely associated with multimorbidity.
Banjare et al. 2014	Cross-sectional	India	Adults aged over 60 years	Extent of multimorbidity classified as: having no morbidity, having	Education, state of economic independence, quintiles of wealth, living	No association was found between wealth index, education, living

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
				one morbidity, having two morbidities and having three or more morbidities.	arrangement and caste	arrangement and multimorbidity, except for caste and state of economic independence, which were negatively associated with odds of multimorbidity
Calderon-Larrañaga et al. 2018	Longitudinal	Sweden	Adults aged 60 years and over	Presence of multimorbidity was explored as rapid or slow development of multiple chronic conditions according to the cumulative rate of chronic diseases and time to follow-up.	Educational level and occupation	Education was negatively associated with rapid development of multimorbidity, Manual workers had a faster development of multimorbidity than non-manual workers.
Canizares et al. 2017	Longitudinal	Canada	Adults aged 20-69	Presence and extent of multimorbidity.	Education, and household income.	Household income was negatively associated with

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						presence of multimorbidity. No association was found between education and multimorbidity.
Chung et al. 2015	Cross-sectional	China	Adults aged 15 years and older	Presence and extent of multimorbidity.	Household income, educational attainment, employment status and type of housing.	Household income, educational attainment, employment and type of housing were negatively associated with presence of multimorbidity and count of chronic conditions.
Congdon, 2016	Cross-sectional	London, UK	Adults aged between 65-75 years	Presence of multimorbidity.	Area-level socioeconomic deprivation	Area-level of deprivation was positively associated with multimorbidity rates.

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
Cornish et al. 2013	Longitudinal	Bristol, UK	Children aged 0 to 18 years	Presence and extent of multimorbidity.	Parent's educational level. Occupational social class. Housing tenure. Family adversity index during pregnancy. Townsend score as measure of socioeconomic deprivation.	Maternal education was negatively associated with multimorbidity in children and positively associated in adolescents. Occupation and family adversity index were not associated with multimorbidity. Townsend score was negatively associated with presence and number of chronic conditions. Children whose parents reported being renters had higher odds of multimorbidity.

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
Costa et al. 2018	Cross-sectional	Brazil	Adults aged 60 years and over	Presence and nature of multimorbidity	Educational level and monthly income per capita (National Economic Index)	Education level and quintiles of economic index were inversely associated with multimorbidity.
Demirchyan et al. 2013	Longitudinal	Armenia	Adults aged 37 to 90 years	Presence of multimorbidity.	Education, perceived low affordability of healthcare services and perceived living standards.	Level of education was negatively associated with multimorbidity. Perceived poor living standard and current low affordability of health care were positively associated with multimorbidity.
Diaz et al. 2015	Cross-sectional	Norway	Immigrants aged 15 years and over	Presence of multimorbidity.	Personal income level, Reason for migration.	Income was negatively associated with odds of multimorbidity in family reunification, labour and

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						refugees' immigrants. Income was positively associated with multimorbidity in education immigrants.
Garin et al. 2016	Cross-sectional	9 low to upper middle-income countries	Adults aged 50 years of age	Presence of multimorbidity.	Household income, education	Income was negatively associated with multimorbidity in China, Spain, Finland and Poland and positively associated in Ghana, Russia and South Africa. Income was not associated with multimorbidity in India and Mexico. Education was negatively associated with multimorbidity in

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						China, Finland. India, Poland, Russia, South-Africa and Spain. In Mexico and Ghana education was not associated with multimorbidity.
Habib et al. 2014	Cross-sectional	Lebanon	Palestinian refugees aged between 14 and 87 years old	Presence and extent of multimorbidity.	Educational attainment, wealth index.	Educational attainment was negatively associated with multimorbidity. Respondents from the lowest wealth index showed higher risk of multimorbidity (two or three or more poor health outcomes) than those in the highest.
Hayek et al. 2017	Longitudinal	Israel	Adults aged 21 years and over	Presence of multimorbidity.	Monthly household income	Household income was negatively

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
					and years of schooling	associated with presence of multimorbidity. Education was not associated with multimorbidity.
Jackson et al. 2016	Longitudinal	Australia	Women aged 45 to 50 years	Multimorbidity patterns were classified as psychosomatic, musculoskeletal, cardiometabolic, cancer and respiratory syndromes.	Education, occupation and income management.	Low education and difficulties managing income were associated with higher odds of psychosomatic, musculoskeletal and cardiometabolic patterns of multimorbidity. Occupation was not associated with any pattern of multimorbidity. Cancer and respiratory patterns were not associated with any of the

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						socioeconomic measures
Johnston et al. 2019	Longitudinal	Scotland	Adults aged 45 to 51 years	Presence of multimorbidity	Father's occupation during childhood. Educational attainment in adulthood	Inverse association between father's occupational class and multimorbidity
Katikireddi et al. 2017	Longitudinal	Scotland	Adults aged 35 to 75 years	Presence and extent of multimorbidity.	Area-based deprivation level.	Area-based deprivation level was positively associated with multimorbidity (2 and 3 or more chronic conditions).
Ki et al. 2017	Longitudinal	South Korea	Adults aged 30 years and over	Presence and extent of multimorbidity.	Educational attainment, employment status and relative poverty index.	Participants with lower socio-economic status showed higher odds of multimorbidity. Stronger associations were generally observed with more diseases,

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						particularly at ages 50s, 60s, and 70s, but the strongest associations were observed at 30s for poverty index (positive trend) and employment status (higher odds of multimorbidity in non-employed individuals).
McLean et al. 2014	Cross-sectional	Scotland	Adults aged 25 years and over	Presence and pattern of multimorbidity. Pattern of multimorbidity was classified as physical only, mental only and mixed physical and mental multimorbidity.	Area-based deprivation.	Area-based deprivation was positively associated with presence of multimorbidity. Physical only multimorbidity was similar across all areas. Area-based deprivation was positively associated with

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						mental-only and mixed physical and mental multimorbidity patterns.
Mondor et al. 2018	Cross-sectional	Canada	Adults aged 18 years and older	Presence of multimorbidity	Household income and educational level inequalities.	Inverse association between multimorbidity and socioeconomic inequalities (income and educational level)
Nielsen et al. 2017	Cross-sectional	15 European countries	Adults aged 50 years and over	Presence of multimorbidity.	Educational level, household income.	Household income and educational level were negatively correlated with multimorbidity.
Nunes et al. 2017	Cross-sectional	Brazil	Adults aged 18 years and over	Presence of multimorbidity.	State level of education and wealth quintiles.	Multimorbidity was not associated with wealth quintiles but presented a negative association with

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						education regardless Brazilian regions.
Park et al. 2019	Cross-sectional	South Korea	Adults aged 50 years and older	Presence and nature of multimorbidity	Household income, educational level and occupation	Household income, educational and occupational level were inversely associated with both, cardiometabolic and arthritis/asthma/allergy/depression/thyroid patterns of multimorbidity.
Prazeres and Santiago, 2015	Cross-sectional	Portugal	Adults aged 18 years and older	Extent and presence of multimorbidity.	Years of educations, professional status and self-perceived Socioeconomic status.	Education was negatively associated with multimorbidity (2 and 3 or more chronic conditions). Monthly income was not associated with multimorbidity.

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						Higher odds of multimorbidity (2 or 3 or more chronic conditions) were found on pensioners/retired, unemployed and housewives.
Puth et al. 2017	Cross-sectional	Germany	Adults aged 18 years and older	Presence of multimorbidity	Level of education	People with a lower educational level showed higher rates of multimorbidity compared with those with a higher educational level.
Roberts et al. 2015	Cross-sectional	Canada	Adults aged 20 years and older	Presence and extent of multimorbidity	Educational level and household income	Negative association between education, household income and multimorbidity (2 or more and 3 or

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						more chronic conditions)
Schäfer et al. 2012	Longitudinal	Germany	Adults aged 65 years and older	Presence and two patterns of multimorbidity were explored including cardiometabolic disorders (CMD) and anxiety, depression, somatoform disorders and pain (ADS/P).	Education, autonomy on former occupation and household income	Negative association between number of chronic conditions and education, degree of autonomy at former occupation and household income. Negative association between number of CMD, household income educational level. Negative association between household income, educational level and number of ADS/P. Associations were stronger for

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						number of CMDs and socioeconomic variables.
Stanley et al. 2018	Cross-sectional	New Zealand	Adults aged 18 years and older	Presence of multimorbidity.	Area-based measure of socioeconomic deprivation	Area-based deprivation was positively associated with multimorbidity.
Stokes et al. 2018	Cross-sectional	New Zealand	Pacific and Maori adults aged 35 years and older	Presence of multimorbidity.	Area-based measure of socioeconomic deprivation	Positive association between area of deprivation, and multimorbidity.
Tomasdottir et al. 2016	Longitudinal	Norway	Adults aged 20-59 years	Presence of multimorbidity.	Financial hardship (worries)	Financial hardship was positively associated with multimorbidity.
Tucker-Seeley et al. 2011	Longitudinal	United States	Adults aged 50 years and over	Presence and extent of multimorbidity.	Childhood financial hardship (yes/no). Average lifetime earnings during young and middle adulthood. Educational attainment as	Childhood financial hardship was positively associated with number of chronic conditions. Education and lifetime earnings

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
					indicator of adult SES	were negatively associated with multimorbidity. The association between childhood financial hardship was modified by lifetime financial earnings, an increase in 10000 USD decreased the expected number of morbidities in adults who experienced childhood financial hardship
Violan et al. 2014	Cross-sectional	Spain	Adults aged 19 years and older	Presence of multimorbidity.	Area-level of deprivation	Positive association of multimorbidity and area-level of deprivation
Weiman et al. 2013	Cross-sectional	South Africa	People aged 15 years and older	Presence of multimorbidity.	Multidimensional poverty index	Positive association between poverty

Study	Study design	Location	Population focus	Assessment of multimorbidity – (Presence/ Nature/Extent/ Both)	Measure of Socioeconomic disadvantage	Conclusion on socioeconomic inequalities in multimorbidity
						index and multimorbidity

Table *3.* Types of theories and context of application

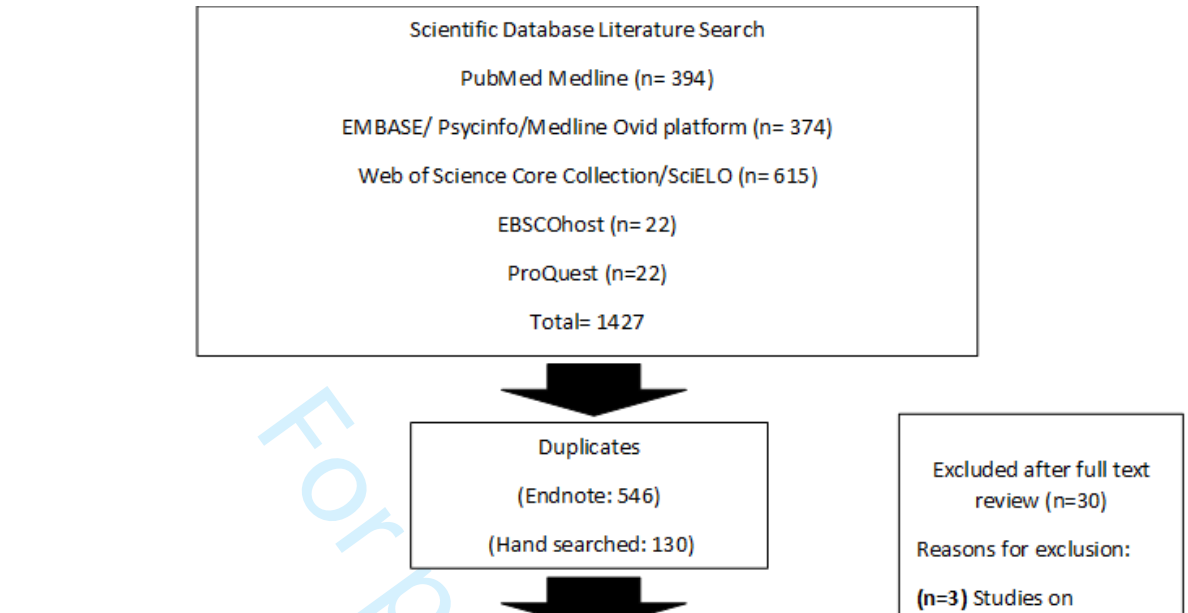
Study	Type of theory	Inferred/ Explicitly mentioned	Context of use	Explanatory potential tested
Johnston et al. 2019	Life course theory	Explicitly mentioned	Introduction: authors framed the importance of understanding the role of adulthood educational attainment in the pathway between childhood SES and multimorbidity. Methods: authors included the theoretical pathway (life course through adulthood educational attainment) in the methods section to plan their analyses. Results: authors reported partial mediatory effect of educational attainment during adulthood in the association between childhood SES and multimorbidity. Discussion: authors explicitly mentioned the life course theory in explaining their findings.	Yes
Calderon-Larrañaga et al. 2018	Psychosocial/social support	Explicitly mentioned	Methods: authors measured social network as a proxy for social support and used this variable as an exposure.	No

Study	Type of theory	Inferred/ Explicitly mentioned	Context of use	Explanatory potential tested
Mondor et al. 2018	Behavioural	Explicitly mentioned	Introduction: authors stated within their objectives to "identify the relative contribution of key determinants of multimorbidity to this inequality including … lifestyle … factors". Methods: authors included health-related behaviours (physical activity, smoking and body mass index) in their analysis. Results: authors reported the relative contribution of physical activity, smoking and body mass index in the association between income inequalities and multimorbidity. Discussion: authors discussed the role of physical activity as the major behavioural contributor to income related inequalities in multimorbidity. Overall, physical activity explained only a small proportion of income inequalities in multimorbidity.	Yes
Alimohammadian et al. 2017	Behavioural	Explicitly mentioned	Discussion: authors mentioned lifestyle/behavioural factors as possible pathways between low SES and multimorbidity.	No

Study	Type of theory	Inferred/ Explicitly mentioned	Context of use	Explanatory potential tested
Katikireddi et al. 2017	Life course and behavioural	Explicitly mentioned	Methods: behavioural factors (smoking, alcohol use, type of diet, physical activity and BMI) were added to the model as mediators between area level of deprivation and inequalities in multimorbidity outcomes. The effect of area-based deprivation over the life course and development of multimorbidity was also explored.	Yes
Tomasdottir et al. 2016	Sense of coherence-psychosocial	Explicitly mentioned	Methods: a selection of binary variables expressing perception of existential unease was used as an indicator of sense of coherence. These variables were used as exposures.	No
Chung et al. 2015	Materialist, behavioural	Explicitly mentioned	Methods: authors analysed the possible mediation between socio-economic measures (type of housing) and multimorbidity through financial burden. The authors also measured the association between smoking status and multimorbidity but not as a pathway between SES and presence of multimorbidity or number of chronic conditions.	Yes

Study	Type of theory	Inferred/ Explicitly mentioned	Context of use	Explanatory potential tested
Agborsangaya et al. 2012	Psychosocial	Explicitly mentioned	Methods: family structure used as confounder variable. Discussion: authors mentioned the importance of family support as protective factor for developing multimorbidity.	No
Tucker-Seeley et al. 2011	Life course and materialist	Explicitly mentioned	Methods: Lifetime earnings was fitted as an effect modifier for the association between childhood financial hardship and presence of multimorbidity	No
Costa et al. 2018	Behavioural	Inferred	Discussion: authors referred to health-related behaviours as possible explanations for their findings	No
Canizares et al. 2017	Behavioural	Inferred	Methods: the authors adjusted for behavioural risk factors to explain age cohort differences in multimorbidity prevalence	No
Puth et al. 2017	Behavioural	Inferred	Discussion: the authors proposed lifestyle habits as explanatory variables for the association between educational level and multimorbidity	No
Afshar et al. 2015	Behavioural and psychosocial	Inferred	Discussion: used in this section to explain the findings	No

Study	Type of theory	Inferred/ Explicitly mentioned	Context of use	Explanatory potential tested
Banjare et al. 2014	Behavioural	Inferred	Methods: lifestyle factors (smoking and chewing tobacco) were fitted in the model as independent variables, but no mediation analysis was tested.	No
Alaba et al. 2013	Behavioural, psychosocial and social capital	Inferred	Methods: authors included smoking, obesity, depression, health facility visits and civic participation as risk factors for multimorbidity but did not used them as explanatory variables of the association between SES and multimorbidity.	No
Demirchyan et al. 2013	Psychosocial, behavioural and materialist	Inferred	Methods: Authors measured the mediation of stressful life events between age and onset of multimorbidity. Discussion: materialist, psychosocial and behavioural theories were used in the discussion section as possible explanations of the findings	No



Appendices

Contents

Appendix 1. Detailed search strategy according to electronic databases 2
MEDLINE 2
WEB OF SCIENCE 6
PUBMED 8
Appendix 2. Reasons for exclusion of studies after full-text review 11
References 12

Appendix 1. Detailed search strategy according to electronic databases

MEDLINE

Outcome	Exposure	Phenomenon
(multimorb$ or multi?morb$ or multiple chronic conditions$ or multiple chronic diseases$).ti.	Psychosocial Deprivation* .ti. OR exp Family characteristics/ OR exp Hierarchy, Social/ OR Social Hierarch* .ti. OR Minority Group* .ti. OR exp Social Class/ OR Social class* .ti. OR Social Mobilit* .ti. OR Caste* .ti. OR Social Condition* .ti. OR exp Sociology/ OR Poverty .ti. OR exp Socioeconomic Factors/ OR Socioeconomic*.ti. OR Salary .ti. OR Salaries .ti. OR Income* .ti. OR Wage* .ti. OR Remuneration* .ti. OR Occupation* .ti. OR Unemploy* .ti. OR Labour* .ti. OR	Inequalit*.ab. OR Unequal*.ab. OR Disparit* .ab. OR Inequit* .ab. OR Difference* .ab. OR Different*.ab. OR Discriminat* .ab. OR Marginali*.ab OR Marginali*.ti OR Depriv* .ab. OR Inequalit*.ti. OR Disparit* .ti. OR Inequit* .ti. OR Difference* .ti. OR Discriminat* .ti. OR Depriv* .ti. OR Disadvantage*.ti. OR Disadvantage*.ab. OR Vulnerab*.ab OR Vulnerab*.ti.

	Labor* .ti. OR Employment* .ti OR Employment* .ab OR Educational Status.ti. OR Educational Achievement*.ti. OR Educational level*.ti OR Educational level*.ab OR Educational attainment .ti OR Educational attainment .ab OR exp Ethnic Groups/ OR Ethnic* .ti. OR Race* .ti. OR Raci* .ti. OR exp Sexism/ OR Sexis* .ti. OR exp Gender Identity/ OR Gender* .ti. OR Social Capital* .ti. OR Neomaterial* .ti. OR Social Cohesi* .ti. OR Materalis* .ti. OR Psychosocial Deprivation* .ab. OR Social Hierarch* .ab. OR Minority Group* .ab. OR	

	Social class* .ab. OR Social Mobilit* .ab. OR Caste* .ab. OR Social Condition* .ab. OR Poverty .ab. OR Socioeconomic*.ab. OR Salary .ab. OR Salaries .ab. OR Income* .ab. OR Wage* .ab. OR Remuneration* .ab. OR Occupation* .ab. OR Unemploy* .ab. OR Labour* .ab. OR Labor* .ab. OR Educational Status.ab. OR Educational Achievement*.ab. OR Ethnic* .ab. OR Race* .ab. OR Raci* .ab. OR Sexis* .ab. OR Gender* .ab. OR Social Capital* .ab. OR Neomaterial* .ab. OR Social Cohesi* .ab. OR	

	Materalis* .ab. OR Neomaterial* .ab.	

WEB OF SCIENCE

Outcome	Exposure	Phenomenon
TS = (multimorb* OR multi-morb* OR "multiple chronic condition*" OR "multiple chronic disease*")Med	TS = ("Psychosocial Deprivation*" OR "Family characteristics" OR "Social Hierarch*" OR "Minority Group*" OR "Social Class" OR "Social Mobilit*" OR Caste* OR "Social Condition*" OR Sociology OR Poverty. OR "Socioeconomic Factors" OR Socioeconomic* OR Salary OR Salaries OR Income* OR Wage* OR Remuneration* OR Occupation* OR Unemploy* OR Labour* OR Labor* OR Employment* OR Employment* OR "Educational Status" OR	TS = (Inequalit* OR Unequal* OR Disparit* OR Inequit* OR Difference* OR Different* OR Discriminat* OR Marginali* OR Depriv* OR Disadvantage* OR Vulnerab*)

	"Educational Achievement*" OR "Educational level*" OR "Educational attainment" OR "Ethnic Groups" OR Ethnic* OR Race* OR Raci* OR Sexism OR Sexis* OR "Gender Identity" OR Gender* OR "Social Capital*" OR "Social Cohesi*" OR Materalis* OR Neomaterial* OR Materalis* OR Neomaterial*)	

PUBMED

Outcome	Exposure	Phenomenon
multimorb*[TIAB] OR multimorbidity[MH] OR multi-morb*[TIAB] OR multiple chronic condition*[TIAB] OR multiple chronic disease*[TIAB] OR multiple chronic disease [MH]	Psychosocial Deprivation*[TIAB] OR Family characteristics [TIAB] OR Social Hierarch*[TIAB] OR Minority Group*[TIAB] OR Social Class[TIAB] OR Social Mobilit*[TIAB] OR Caste*[TIAB] OR Social Condition*[TIAB] OR Sociology[TIAB] OR Poverty [TIAB] OR Socioeconomic Factors[TIAB] OR Socioeconomic*[TIAB] OR Salary[TIAB] OR Salaries[TIAB] OR Income*[TIAB] OR Wage*[TIAB] OR Remuneration*[TIAB] OR Occupation*[TIAB] OR Unemploy*[TIAB] OR Labour*[TIAB] OR Labor*[TIAB] OR Employment*[TIAB] OR Educational Status [TIAB] OR	Inequalit*[TIAB] OR Unequal*[TIAB] OR Disparit*[TIAB] OR Inequit*[TIAB] OR Difference*[TIAB] OR Different*[TIAB] OR Discriminat*[TIAB] OR Marginali*[TIAB] OR Depriv*[TIAB] OR Disadvantage*[TIAB] OR Vulnerab*[TIAB]

	Educational Achievement*[TIAB] OR Educational level*[TIAB] OR Educational attainment [TIAB] OR Ethnic Groups[TIAB] OR Ethnic*[TIAB] OR Race*[TIAB] OR Raci*[TIAB] OR Sexism[TIAB] OR Sexis*[TIAB] OR "Gender Identity"[TIAB] OR Gender*[TIAB] OR Social Capital*[TIAB] OR Social Cohesi*[TIAB] OR Materalis*[TIAB] OR Neomaterial*[TIAB] OR Materalis*[TIAB] OR Neomaterial*[TIAB]	

PROQUEST (Applied Social Sciences/ERIC/Humanities Index/ProQuest Central/ProQuest dissertation and Thesis Global/Sociological Abstracts)

multimorb* OR multi-morb* OR "multiple chronic condition*" OR "multiple chronic diseases*"

AND
"Psychosocial Deprivation*" OR "Family characteristics" OR "Social Hierarch*" OR "Minority Group*" OR "Social Class" OR "Social Mobilit*" OR Caste* OR "Social Condition*" OR Sociology OR Poverty. OR "Socioeconomic Factors" OR Socioeconomic* OR Salary OR Salaries OR Income* OR Wage* OR Remuneration* OR Occupation* OR

Unemploy* OR Labour* OR Labor* OR Employment* OR Employment* OR "Educational Status" OR "Educational Achievement*" OR "Educational level*" OR "Educational attainment" OR "Ethnic Groups" OR Ethnic* OR Race* OR Raci* OR Sexism OR Sexis* OR "Gender Identity" OR Gender* OR "Social Capital*" OR "Social Cohesi*" OR Materalis* OR Neomaterial* OR Materalis* OR Neomaterial*

AND

Inequalit* OR Unequal* OR Disparit* OR Inequit* OR Difference* OR Different* OR Discriminat* OR Marginali* OR Depriv* OR Disadvantage* ORVulnerab*

Appendix 2. Reasons for exclusion of studies after full-text review

Comorbidity Barnett, Mercer (1), Gallacher, McQueenie (2), Alonso-Moran, Orueta (3)

Unclear definition of multimorbidity Chau, Baumann (4), Reis-Santos, Gomes (5)

Did not explore the association between socioeconomic disadvantage and multimorbidity Charlton, Rudisill (6), Galenkamp, Gagliardi (7), Golinowska, Sowa (8), Jessen, Pallesen (9), Koroukian, Schiltz (10), Mujica-Mota, Roberts (11), Orueta, Garcia-Alvarez (12), Phaswana-Mafuya, Peltzer (13), Rodrigues, Gregorio (14), Thavorn, Maxwell (15), Tran, Kiran (16), van den Akker, Buntinx (17), Wang, Wang (18), Ward (19), Woo and Leung (20), Cassell, Edwards (21), Brinda, Attermann (22)

Absence of comparative group Eakin, Bull (23), Frakes, Brownie (24), Kangovi, Mitra (25), Leiser, Deruaz-Luyetl (26), Smith, Ferede (27), von dem Knesebeck, Bickel (28)

Full-text unavailable Jantz (29), Pati and Swain (30), Russel, Grant (31)

Duplicate Myung, Yo Han (32), Srinivasa Vittal, Skivington (33)

Use of the same sample Ahmadi, Alimohammadian (34), Ataguba (35), Kunna, Miguel San (36), Nunes, Thume (37), Habib, Mikati (38)

No primary data Shadmi (39)

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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.	
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.	
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.	
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.	
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.	
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.	
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.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
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.	
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.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
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.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
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.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
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.	
Limitations	20	Discuss the limitations of the scoping review process.	
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.	
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.	

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).

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Theoretical explanations for socioeconomic inequalities in multimorbidity – A Scoping Review

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ABSTRACT

Objective: To document socio-epidemiologic theories used to explain the relationship between socioeconomic disadvantage and multimorbidity.

Design: Scoping review

Methods: A search strategy was developed and then applied to multiple electronic databases including Medline, EMBASE, PsychInfo, Web of Science, Scielo, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts. After the selection of studies, data was extracted using a data charting plan. The last search was performed on 28/09/2021. Extracted data included: study design, country, population sub-groups, measures of socioeconomic inequality, assessment of multimorbidity and conclusion on the association between socioeconomic variables and multimorbidity. Included studies were further assessed on their use of theory, type of theories used and context of application. Finally, we conducted a meta-narrative synthesis to summarise the results.

Results: A total of 64 studies were included in the review. Of these, 33 papers included theories as explanations for the association between socioeconomic position and multimorbidity. Within this group, sixteen explicitly stated those theories and five tested at least one theory. Behavioural theories (health behaviours) were the most frequently used, followed by materialist (access to health resources) and psychosocial (stress pathways) theories. Most studies used theories as post hoc explanations for their findings or for study rationale. Supportive evidence was found for the role of material, behavioural and life course theories in explaining the relationship between social inequalities and multi-morbidities.

Conclusion: Given the widely reported social inequalities in multimorbidity and its increasing public health burden there is a critical gap in evidence on pathways from socioeconomic disadvantage to multimorbidity. Generating evidence of these pathways will guide the development of intervention and public policies to prevent multimorbidity among people living in social disadvantage. Material, behavioural and life course pathways can be targeted to reduce the negative effect of low socioeconomic position on multi-morbidities.

Keywords: multimorbidity, socioeconomic inequalities, scoping review, theoretical explanations, epidemiology

Strengths and limitations:

- This is the first scoping review exploring the use of theories to explain the association between socioeconomic position and multiple chronic conditions.
- We identified numerous gaps in the literature that future research should address to inform intervention design and public policies aiming at reducing socioeconomic inequalities in multimorbidity.
- We used a robust methodology, including a comprehensive a search strategy, already piloted and verified with previous research.
- Articles that were not in English were excluded from our review. This could have obstructed the inclusion of papers from developing countries, therefore limiting the generalisability of our findings.

INTRODUCTION

Multimorbidity is a societal challenge and an increasingly recognised public health concern (1-3). It is described as the co-occurrence of two or more chronic conditions in an individual (4). Negative consequences of multimorbidity include: reduced quality of life; functional decline; increased healthcare utilisation; polypharmacy; high treatment burdens; psychological distress; and increased risk of premature death (5). There is an emerging threat of increased multimorbidity worldwide, primarily due to population aging and the epidemiological transition from communicable to non-communicable diseases (6). The COVID-19 pandemic has put a spotlight on multimorbidity as people with existing chronic conditions have suffered a higher risk of its infection, as well as more severe consequences of SARS-CoV-2 infection (7). Furthermore, abundant empirical evidence shows socioeconomic inequalities in multimorbidity across countries at different levels of economic development (8-12).

A meta-analysis of 24 cross-sectional studies reported that low education compared to high education was associated with 64% higher odds of multimorbidity (13). Another systematic review with 41 studies from North America, Europe and Australasia reported that people with the lowest level of income had 4.4 times higher odds of multimorbidity than those with the highest level of income, while those in most deprived areas had 1.42 times higher odds of multimorbidity than those in the least deprived areas (14). A clear causal relationship between socioeconomic conditions and multimorbidity has also been argued based on empirical evidence (10), however, pathways through which socioeconomic disadvantage leads to multimorbidity are not well studied (4).

Theories are used in epidemiology to understand the relationships between exposure to, for example, socioeconomic disadvantage and non-communicable diseases. This is mainly because, as opposed to conceptual frameworks, specific theoretical pathways can be tested using empirical data. Theories provide insight into the mechanisms through which an exposure (e.g. socioeconomic position) leads to a health outcome (15), and as such, they are particularly helpful in informing intervention designs. Since the release of the Black Report in 1982 (16), several categories of theories have been proposed to explain associations between social inequalities and health outcomes (16, 17); albeit in the context of single diseases or health measure. These include:

I. Behavioural: The behavioural explanation posits that people from different backgrounds behave differently and make health-related choices that are commonly based on their socioeconomic background. As people experience socioeconomic deprivation, they also encounter more barriers to adopting healthy lifestyles. For instance, individual health damaging and promoting behaviours are differentially distributed across the social scale, with more disadvantaged groups more likely to engage in health damaging behaviours such as smoking, and advantaged groups more likely to engage in health promoting behaviours such as physical activity (18). As a result, poor health outcomes are commonly clustered at the lower end of the socioeconomic scale (17). Behavioural theory can be extended to apply to multimorbidity from a common risk factor approach, as a behavioural risk factor can cause multiple diseases (for example, smoking can cause cancer, asthma, cardiovascular diseases (19, 20)).

II. Psychosocial: this theory postulates that the emotions that arise due to social inequality can directly affect biological health (17). This can be caused in two ways, either through the practice of health compromising behaviours or through biological changes due to the individual being in a sustained state of stress (17). Hence, the behavioural explanation can be a descendent of psychosocial processes under this explanation. The perceived lack of control and psychosocial stress may lead to adverse health behaviours and may activate neuro-endocrine mechanisms, and in doing so, may affect multiple body systems and lead to multimorbidity.

III. Materialist: the material environment has a significant impact on the health of an individual. Exposure to health-risk or health-protective factors varies according to socioeconomic position due to differential access to material resources; differences are more evident in non-egalitarian societies. For instance, individuals living in socioeconomic disadvantage are less likely to be able to access information and resources necessary to maintain good health compared to their more advantaged counterparts (17). Socioeconomically deprived individuals are also more likely to be exposed to hazardous working environments (17). The materialist theory proposes these explanations as pathways between socioeconomic deprivation and health inequalities (17). Lack of material resources such as inadequate housing for example, can lead to multimorbidity by causing depression as well as respiratory illnesses such as asthma.

IV. Social support: this theory holds that positive social support mitigates the detrimental effect of socioeconomic deprivation in health (21, 22). Accordingly, strong social networks and good social relationships are linked to good health and conversely, poor social relations and weak social support networks are deleterious to health. Social support is considered to be a distal determinant of health that may influence health through multiple mechanisms, for example by reducing stress and providing access to local resources, and in doing so, may prevent both mental and physical multimorbidities.

V. Social capital: While variously defined, social capital is broadly described as the functioning of social groups through a shared sense of identity, trust, cooperation, reciprocity and shared understandings, norms, and values (23). Social capital emphasises that a more unequal distribution in income undermines trust and damages social relationships at a population level. This theory attempts to explain why egalitarian societies tend to be healthier than non-egalitarian societies (24, 25). Similar to social support, high social capital is likely to boost health and prevent multiple chronic conditions by reducing stressors and increasing access to shared resources.

In addition to the abovementioned theories, a life course framework examines the effect of early life socioeconomic exposures on later health outcomes (26). Two models are proposed to explain the life course framework: the accumulation model and the critical periods model. The accumulation model emphasises the cumulative effect of exposure to socioeconomic disadvantage across different stages in life on subsequent increased risk of poor health outcomes. The critical periods model focuses on the effect of exposure to factors influencing health during critical periods of development (27). Finally, a neo-liberal framework for health inequalities emphasises the role of political arrangements in leading to socioeconomic inequalities, and in turn health inequalities.

We aim to review the socio-epidemiologic theories applied to explain the relationship between socioeconomic disadvantage and multimorbidity in the population. Where possible, we examined whether theories applied were tested using robust analytical methods such as mediation analysis.

METHODS

We conducted a scoping review to examine epidemiologic theories applied to explain the association between socioeconomic disadvantage and multimorbidity (28, 29), and to map the information available in the current literature. Because the primary purpose of this study was to identify and categorise the theories being used in the existing literature, a scoping review was preferred over a systematic review. We followed the steps of a scoping review as per previously defined guidelines (28, 29).

Stage I: Identifying the Research Question

Our review question was: "How are the socio-epidemiologic theories applied to explain the relationship between socioeconomic disadvantage and multimorbidity?"

Stage II: Identifying Relevant Studies

We identified search terms and keywords relevant to socioeconomic disadvantage, theoretical pathways and multimorbidity from published systematic reviews (13, 30) and tailored them to answer our research question. First, a detailed search strategy was developed using keywords and hierarchically defined subject headings. Once the search terms were agreed upon, they were adapted for multiple electronic databases including Medline, EMBASE, PsychInfo (Ovid platform), Web of Science, Scielo, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts (see *Appendix 1*). The reference lists of all selected articles were screened to identify any additional studies. Search alerts were set up to notify the research team of articles published after 25th of May 2018 when literature search was implemented. This search was updated on 11 December 2019 and then on 28 September 2021.

Stage III: Study Selection

We applied a strict inclusion and exclusion criteria; these are displayed in Table 1. Socioeconomic condition or status indicates the position in which an individual or a group is located within the social structure. It can be measured using educational attainment, income, occupation, wealth and area level measures (deprivation, socio-economic scores). We use the term socioeconomic inequalities in health to indicate the differences in rates of disease between individuals living in different socioeconomic conditions. Socioeconomic disadvantage refers to those who have the lowest socioeconomic conditions. For inclusion in this review, socioeconomic position could be measured using the following indicators:

occupation, income (household or individual), educational attainment, area level socioeconomic deprivation, wealth, and social class (17, 31).

We excluded studies on "comorbidity" as such studies are focussed on an index condition (e.g. diabetes) (32). The terms multimorbidity and comorbidity are often used interchangeably as both describe the presence of multiple chronic conditions. However, comorbidity is a disease-centred term that describes the presence of additional conditions associated with an index disease (4). The focus of this review is multimorbidity only. Studies on institutionalised individuals, qualitative research, and those written in a language other than English were excluded. A detailed list of inclusion and exclusion criteria can be found in *Table 1*. Abstracts and full-text articles were reviewed for inclusion by LFA using the citation manager EndNote. A second reviewer (AS) cross-checked 10% of these articles.

See Table 1

Stage IV: Charting the Data

A data charting form was created which included study details (study design, country, population sub-groups, measures of socioeconomic inequality, assessment of multimorbidity and conclusion on the association between socioeconomic variables and multimorbidity), use of theory, type of theories and context of application. Use of theory was categorised as inferred by us (reviewers/readers) or explicitly mentioned by the original study authors. It is important to distinguish between the two because the former relies on the reviewers/readers' subjective judgement (which may not be accurate) while the latter accurately reflects the theoretical reasoning of the original authors. Data charting was performed by LFA and 10% of the studies were cross checked by AS.

Each study was examined for the type of theory (example: psychosocial or material), extent of use (whether used in a post hoc manner or integrated within an analysis) and their context of use (background, methods or discussion section of retrieved paper(s)). We recorded whether theories that were directly mentioned or inferred were consistent with any of the existing socio-epidemiologic theories. When directly mentioned, types of theories were recorded verbatim. This follows the approach previously applied in a published study examining the application of socio-epidemiologic theories in studies on the relationship between social inequality and oral health (30).

Stage V: Collating, Summarizing and Reporting the Results

We carried out a narrative synthesis to summarise the results from the retrieved data. Because the objective of this review is to offer a snapshot of the available evidence of theories explaining socioeconomic inequalities in multimorbidity and not on assessing the effect of socioeconomic disadvantage on multimorbidity development, we did not assess the quality of included papers in accordance with the guidelines for conducing scoping reviews (28).

Patient and public involvement

No patient involved

RESULTS

Our search led to the identification of 751 unique papers that underwent title and abstract screening. Sixty-nine papers were deemed eligible for full-text review. Two additional studies were included for full-text review from additional sources. After the full-text review and, thirty-six studies proceeded to data charting stage. In the updated search on 28 September 2021 an additional 573 new records were identified of which 461 titles and abstracts were screened. After full text screening of 44 studies 2827 new studies were included in the review increasing the total of included studies to 64. A flowchart of this process is shown in Figure 1.

Figure 1 Flow chart of the study selection process *(2-column fitting image)*

(*see figure 1*)

Summary characteristics of included studies

Twenty studies were from low- and middle-income countries (12, 33-51) and the remaining 45 studies were from high income countries. The majority of articles were conducted among adults and only three study included children (52-54). More than half (n=38/64) were cross-sectional and 26/64 used longitudinal data (9, 10, 41, 53, 55-75)(Table 2).

Educational attainment was the preferred measure of socioeconomic position (n=38/64) and 38 studies used multiple measures of socioeconomic position as exposures. The majority of studies (n=51/64) simply documented the presence of multimorbidity and approximately one third (n=13/64) additionally examined different patterns of multimorbidity (9, 39, 40, 44, 46, 52, 54, 66-69, 71, 74, 76, 77)(Table 2).

See Table 2

Types of theories

Overall, nearly half of studies (33/64) referred to at least one socio-epidemiological theory. Therefore, 31 studies can be considered largely atheoretical, without any emphasis on pathways through which socioeconomic disadvantage leads to multimorbidity. In the thirty three studies applying a theory, the following theories were referred to: behavioural (10, 33, 34, 36, 37, 39-41, 45, 50-52, 58, 70, 71, 78-81) materialist (37, 40, 41, 44, 45, 47, 49, 51, 70, 71, 73, 78, 81-84) and psychosocial (33, 41, 50, 51, 56, 71, 72, 81, 83-85). In addition, four studies applied a theoretical construct called 'sense of coherence', which indicates an individual's coping capacity to deal with life and stressful events (86), and is an indicator of self-efficacy and psychosocial well-being (consistent with psychosocial explanations) (72), and also encompasses social capital (50), and social support (56) which are widely considered as psychosocial assets (Table 3). Five studies used a life-course framework (10, 54, 62, 63, 73). Collectively, behavioural theory was the most referred to among studies.

Context of application of theories

Of the papers using theories, fifteen explicitly stated those theories (10, 34, 37, 40, 56, 62, 63, 71-73, 79, 81, 83-85), and the other 21 studies were inferred to be consistent with a presumed theoretical pathway, based on definitions from existing literature.

See Table 3

Testing the explanatory potential of theories

Only five studies (10, 37, 62, 71, 79) tested variables consistent with theoretical pathways as mediators between socioeconomic disadvantage and multimorbidity. Applying material theory, Chung et al. (37), examined perceptions of financial hardship, an indicator of economic deprivation, as a mediator between housing tenure and multimorbidity. They found a small mediation effect, indicating that increased financial burden puts private housing residents at a higher risk of suffering multiple conditions when compared with public housing residents (37).

Drawing on behavioural theory as well as a life course framework, Katikireddi et al. (10), quantified mediation by five behavioural risk factors (diet, smoking, physical activity, alcohol and BMI) acting on the association between two socioeconomic measures (area-based deprivation and household income) and multimorbidity over the life course. Their analyses showed that behavioural factors partially mediated the inverse association between area level deprivation and multimorbidity.

The life course framework was applied by Johnston et al. (62) in their examination of educational attainment during adulthood as a mediator of the association between father's occupational social class at birth and multimorbidity. Their analyses showed a partial mediational effect of educational attainment on the association between childhood socioeconomic position and multimorbidity.

Mondor et al. (79) also drew on behavioural theory in their study that quantified the mediation effect of lifestyle factors (physical activity, smoking and BMI) on the association between income inequalities and multimorbidity. Lifestyle factors only explained a small proportion of observed income-related inequalities in multimorbidity.

Finally, Singh et al. (71) examined social support as a mediator between financial hardship and multimorbidity among Australian adults and found that 30% of the total effect of financial hardship on multimorbidity was transmitted through social support.

DISCUSSION

Summary of findings

Overall, we found limited use of theories to explain the relationship between socioeconomic position and multimorbidity. When used, theories were seldom explicitly mentioned or tested. Among all the potential explanations, behavioural theories were the most frequently used, followed by materialist and then psychosocial theories.

Only five studies tested the explanatory potential of theories and their mediation effect on the association between socioeconomic position and multimorbidity. Although we identified the use of seven different theories, materialist, behavioural, psychosocial and life course theories were the only ones tested. Existing evidence partially support these theories (10, 37, 62, 71, 79), however their use was mostly limited to post-hoc explanations of findings in the overall literature.

Our findings are consistent with the two major evidence gaps highlighted in the report 'Multimorbidity: a priority for global health research'(4). First, evidence of the relationship between socioeconomic disadvantage and multimorbidity is largely cross-sectional. This is a limitation of the existing evidence, as temporal ordering between exposure (social disadvantage) and outcome (multimorbidity), a key undisputed criterion of causality (87), is difficult to establish cross-sectionally. Second, there is a paucity of evidence regarding pathways (e.g. behavioural, material, psychosocial) between the shared causal factor

(exposure to socioeconomic disadvantage) and multiple conditions that co-occur in multimorbidity (4). The lack of evidence precludes policy makers from intervening on causal mechanisms that can prevent, or mitigate observed socioeconomic inequalities in multimorbidity (88). Among those studies testing theories, there was a predominance of the application of the behavioural theory. However, the use of contemporary approaches to causal inference, using a counterfactual framework to maximise exchangeability between exposed and unexposed participants, was limited (71, 88). Therefore, we cannot rule out bias arising from mediator-outcome confounding, time varying confounding or the presence exposure-outcome interaction. Approaches need to shift towards a more comprehensive examination of pathways to allow policymakers to select interventions with maximum capacity to reduce inequalities. It is also worth noting that given the variations in the relationship of interest by country level of income and age group, future studies should examine the relevance of theories across different contexts and ages.

Strengths and limitations

Our study has some strengths and limitations. To our knowledge, this is the first scoping review that explores the use of theories to explain the association between socioeconomic position and multimorbidity in the current literature. We identified numerous gaps in the literature that need to be addressed to improve our understanding of the socioeconomic inequalities in multimorbidity. Our search strategy drew on a wide range of electronic databases, and we used a robust methodology, already piloted and verified in previous work (30). A key limitation is that articles not in English were excluded in our review. Moreover, we did not use any tool to assess the quality of the included studies. This information is already provided by existing reviews (13, 14). Lastly, we restricted this review to articles assessing only multimorbidity and excluded those looking at comorbidities. We acknowledge that some authors use both terms interchangeably, therefore papers using the term comorbidity to indicate the presence of multiple independent chronic conditions may be missing from this review.

CONCLUSION

Our understanding of the pathways between socioeconomic inequalities and multimorbidity is limited and mostly unexplained. Studies often focus on the patterns of distribution of multiple chronic conditions across the population, rather than the mechanisms shaping these distributions. Robust evidence from longitudinal and interventional studies is needed to

understand the pathways between socioeconomic disadvantage and multimorbidity. Generating such evidence will guide the development of interventions and public policies to prevent multimorbidity among people living in disadvantage.

Authors contribution statement:
LFA contributed towards the development of search strategy, screening, data extraction and appraisal of included studies and manuscript preparation. AS contributed towards the design, development of search strategy, screening, data extraction and appraisal of included studies and manuscript preparation. EY contributed towards the development of search strategy, data extraction of included studies and manuscript preparation. TK and DCS contributed towards the development of search strategy and manuscript preparation. SZ contributed towards manuscript preparation.

Competing interests
The authors have no competing interests to declare.

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Data availability statement
All data relevant to the study are included in the article or uploaded as supplementary information.

Ethics approval statement
This study uses publicly available data and does not directly involve human participants.

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Table 1. Study selection criteria.

Inclusion criteria	**Exclusion criteria**
-Studies with participants from any age group -Community representative participants -Individual and population-based epidemiological studies looking at the association between socio-economic disadvantage and multi-morbidity -Intervention studies involving examining moderators or mediators derived from theoretical constructs -Studies in English language	-Studies on institutionalised individuals -Studies on comorbidity -Qualitative studies -Study protocols, editorials and commentaries that do not report on association between social disadvantage and multi-morbidity

Table 2. Summary characteristics of included studies

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Andersen et al. 2021 (78)	Cross-sectional	Finland	Adults aged 20-69 years	Presence of multimorbidity Cut-off of 2 conditions	18 chronic conditions including: respiratory diseases, cardiovascular diseases, diabetes, mental disorders, dyspepsia/reflux disease, chronic kidney failure, sleep apnea, osteoporosis, and chronic pain	Occupation.
Calvo et al. 2021 (57)	Longitudinal	US	Adults aged 60-61 and 70- 71 years	Count of chronic conditions	Eight conditions including high blood pressure, diabetes, cancer, chronic lung disease, heart problems, stroke, mental illness, arthritis or rheumatism.	Retirement sequence
Craig et al. 2021 (40)	Cross-sectional	Jamaica	Individuals aged 15-74 years	Patterns of multimorbidity	11 chronic conditions including hypertension, obesity, hypercholesterolemia, diabetes, asthma, arthritis, cardiovascular disease, mental health disorders, COPD, stroke, and glaucoma.	Occupational status, education and income level.
Head et al. 2021 (61)	Longitudinal	England	Adults aged 18 years and over	Presence of multimorbidity. Cut-off of 2 and 3 conditions	211 conditions listed elsewhere (62)	Area level deprivation
Hernandez et al. 2021 (76)	Cross-sectional	4 high income countries	Adults aged 52-85 years	Patterns of multimorbidity	10 conditions including cardiovascular diseases, diabetes, arthritis, cancer, lung disease,	Education, household income and employment.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					osteoporosis. and psychological disorders	
Hone et al. 2021 (51)	Cross-sectional	Brazil	Individuals of any age	Presence of multimorbidity Count of chronic conditions	53 chronic conditions	Education
Khanolkar et al. 2021 (63)	Longitudinal	UK	Adults aged 36 to 69 years	Presence of multimorbidity Count of chronic conditions	18 health conditions including metabolic conditions, cardiovascular diseases, cancer, respiratory disorders, kidney disorders, gastrointestinal disorders, skin disorders, osteoarthritis, rheumatoid arthritis, neurological disorders and mental disorders.	Social class and education
Lee et al. 2021 (66)	Longitudinal	South Korea	Adults aged 45 years and over	Multimorbidity clusters Cut-off of 2 conditions	9 chronic conditions including: hypertension, diabetes, cancer,chronic lung disease, liver disease, heart disease, cerebrovascular disease, arthritis or rheumatoid arthritis and depression	Education, household income and employment
Moin et al. 2021 (89)	Cross-sectional	Canada	Adults aged 22 to 95 years	Presence of multimorbidity Cut-off of 2 and 3 conditions	18 chronic diseases including cardiovascular diseases, respiratory conditions, diabetes, mental illness, musculoskeletal conditions, renal	Household income and education

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					failure, inflammatory bowel failure and cancers.	
Zacarías-Pons et al. 2021 (74)	Longitudinal	Europe	People aged 50 years and older	Latent transition analysis for types of multimorbidity	Heart attack, hypertension, hypercholesterolaemia, stroke or cerebral vascular disease, diabetes or high blood sugar, chronic lung disease [COPD], cancer, stomach or duodenal ulcer, Parkinson disease, cataracts, dementia, other affective or emotional disorders, rheumatoid arthritis, osteoarthritis and osteoporosis	Education, employment and material deprivation index
Vidyashree et al 2021 (47)	Cross-sectional	India	People aged 60 and above in rural area	Presence of multimorbidity (Cut off unclear)	Unclear	Economic dependency
Sharma 2021 (46)	Cross-sectional	India	People aged 60 and above	Presence and patterns of multimorbidity Cut-off of 2 conditions	Arthritis, Rheumatism or Osteoarthritis, Cerebral embolism stroke or Thrombosis, Heart diseases, Diabetes, Chronic lung disease, Asthma, Depression, Hypertension, Alzheimer's disease, Cancer, Dementia, Liver or Gall bladder illness, Osteoporosis, Renal or Urinary tract infection, Cataract,	Educational attainment, working status, wealth quintile

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					Loss of all-natural teeth, Accidental injury in the past one year, injury due to fall, skin disease and paralysis	
Singh 2021 (71)	Longitudinal	Australia	People aged 15 and above	Presence of multimorbidity Cut-off of 2 conditions	Arthritis, cancer, type 1 diabetes mellitus, type 2 diabetes mellitus, hypertension, heart disease, asthma, bronchitis or depression	Financial hardship
Aminisani et al. 2019 (55)	Longitudinal	New Zealand	Adults aged 55-70 year	Presence of multimorbidity Cut-off of 2 conditions	Nine groups of chronic diseases: cardiovascular diseases, neurologic diseases, musculoskeletal conditions, diabetes mellitus, respiratory diseases, chronic liver conditions, cancer and mental disorders.	Education and income
Chamberlain et al. 2020 (82)	Cross-sectional	US	Adults aged 20 years and over	Presence of multimorbidity. Cut-off of 2 conditions	21 conditions including cardiovascular diseases, metabolic conditions, respiratory diseases, arthritis, osteoporosis, chronic kidney disease, autism spectrum disorder, hepatitis, human immunodeficiency virus,	Area level deprivation

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					depression, dementia, schizophrenia, and substance	
Costa et al. 2020 (38)	Cross-sectional	Brazil	Adults aged 20-59 years	Presence of multimorbidity Cut-off of 2 conditions	14 conditions including cardiovascular diseases, metabolic diseases, chronic pulmonary disease, digestive disorders, neurological disorders, cancer, kidney disease and depression	Economic status and education
Kim et al. 2020 (65)	Longitudinal	South Korea	Adults aged 19 years and over	Presence of multimorbidity Cut-off of 2 conditions	28 chronic conditions as listed elsewhere (63)	Household income and education
Moller et al. 2020 (67)	Longitudinal	Denmark	People aged 16 years and over	Multimorbidity patterns or classes (LCA)	47 diseases	Education and employment
Odland et al. 2020 (44)	Cross-sectional	Burkina Faso	Adults aged 40 years and older	Presence and patterns of multimorbidity Cut-off of 2 conditions	11 conditions including: cancer, HIV, chronic respiratory disease, stroke heart disease, hypertension, diabetes, anxiety, depression and dementia/cognitive decline.	Education and wealth

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Pati et al. 2020 (45)	Cross-sectional	India	Adults aged 18 years and older	Presence of multimorbidity Cut-off of 2 conditions	21 chronic conditions	Poverty level and education
Zhao et al. 2020 (49)	Longitudinal	China	People aged 50 years and older	Presence of multimorbidity. Cut-off of 2 conditions	Diagnosed	Annual per-capita household consumption
Yidiz et al. 2020 (84)	Cross-sectional	Netherlands	People aged 18-64 years	Presence of multimorbidity Cut-off of 2 and 3 conditions most prevalent chronic diseases (cardiovascular	List of most prevalent chronic diseases (cardiovascular diseases, psychological disorders, inflammatory conditions and respiratory diseases)	Employment status and education
Wister et al. 2020 (81)	Cross-sectional	Canada	People aged 45-85 years	Presence of multimorbidity Cut-off of 2 conditions	High blood pressure, osteoarthritis, back problems, cancer, diabetes, heart disease, thyroid dysfunction, lung disease, osteoporosis, urinary incontinence, migraine headaches, irritable bowel syndrome, intestinal and stomach ulcer, glaucoma, peripheral vascular disease, angina, macular degeneration, heart attack,	Vancouver

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					transient ischemic attack, kidney disease, rheumatoid arthritis, bowel incontinence, stroke, multiple sclerosis, epilepsy, Parkinson's disease, as well as dementia and Alzheimer's disease.	
Vinjerui 2020 (83)	Cross-sectional	Norway	People aged 25-100 years	Complex multimorbidity Three or more diseases involving three or more different body (organ) systems	51 chronic conditions including following body systems or types: neoplasms; endocrine/nutritional/metabolic; mental/behavioural; eye/adnexa; ear/mastoid; circulatory system; respiratory system; digestive system; skin/subcutaneous tissue; musculoskeletal/ connective tissue and genitourinary systems	Occupational groups
Ba et al. 2019 (35)	Cross-sectional	Vietnam	Individuals aged 15 years and over	Presence of multimorbidity. Cut-off of 2 conditions	A list of 11 conditions including: cancer, heart and circulatory conditions, chronic joint problems, chronic pulmonary diseases, chronic kidney problems, chronic digestive problems, psychological illness, diabetes, and/or other chronic conditions (such as eye, nose, sore and throat, teeth problems, etc)	Educational level and occupational status

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Dugravot et al. 2019 (59)	Longitudinal	UK	Adults aged 35-55 years	Presence of multimorbidity Cut-off of 2 and 5 conditions	9 conditions including diabetes, coronary heart disease, stroke, chronic obstructive pulmonary disease, depression, arthritis, cancer, dementia and Parkinson's disease	Occupational position, education.
Johnston et al. 2019 (62)	Longitudinal	Scotland	Adults aged 45 to 51 years	Presence of multimorbidity Cut-off of 2 conditions	Six conditions. List not provided	Father's occupation during childhood. Educational attainment in adulthood
Park et al. 2019 (68)	Longitudinal	South Korea	Adults aged 50 years and older	Presence and patterns of multimorbidity (LCA) Cut-off of 2 conditions	10 chronic diseases: hypertension, dyslipidaemia, stroke, osteoarthritis, tuberculosis, asthma, allergic	Household income, educational level and occupation
Russell et al 2019 (54)	Longitudinal	New Zealand	Age 2 years	Presence of multimorbidity Cut-off of 2 conditions	Asthma requiring medication, eczema requiring medication, a birth condition, epilepsy, permanent hearing problems, vision problems not correctable with glasses, and obesity	Index constructed from maternal education, employment, financial stress, beneficiary status, housing tenure, overcrowding,

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
						and residential mobility
Seo 2019 (70)	Longitudinal	South Korea	Working age adults	Presence of multimorbidity Cut-off of 2 conditions	23 conditions	Type of employment, income, education
Calderon-Larrañaga et al. 2018 (56)	Longitudinal	Sweden	Adults aged 60 years and over	Presence of multimorbidity was explored as rapid or slow development of multiple chronic conditions. Cut-off of 2 conditions	List not provided. A disease was considered chronic if it had a long and if residual disability remained or life quality was worsened or long period of care, treatment or rehabilitation was needed.	Educational level and occupation
Costa et al. 2018 (39)	Cross-sectional	Brazil	Adults aged 60 years and over	Presence and nature of multimorbidity Cut-off of 2 conditions	31 conditions: cardiovascular diseases, metabolic conditions, musculoskeletal conditions, incontinence and constipation, neurological diseases, mental disorders, cancer, respiratory diseases and kidney disease.	Educational level and monthly income per capita (National Economic Index)

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Mondor et al. 2018 (79)	Cross-sectional	Canada	Adults aged 18 years and older	Presence of multimorbidity Cut-off of 2 conditions	12 chronic conditions including high blood pressure, diabetes, osteoarthritis, rheumatoid arthritis, heart attack, stroke, cancer, chronic lung disease, hip fracture, Parkinson's disease, Alzheimer's disease, affective disorders.	Household income and educational level inequalities.
Stanley et al. 2018 (3)	Cross-sectional	New Zealand	Adults aged 18 years and older	Presence of multimorbidity. Cut-off of 2 conditions	List of diseases not provided but listed elsewhere (64).	Area based measure of socioeconomic deprivation
Stokes et al. 2018 (90)	Cross-sectional	New Zealand	Pacific and Maori adults aged 35 years and older	Presence of multimorbidity. Cut-off of 2 conditions	31 chronic conditions	Area based measure of socioeconomic deprivation
Alimohammadian et al. 2017 (34)	Cross-sectional	Iran	Adults aged 40-75 years	Presence of multimorbidity. Cut-off of 2 conditions	A total of nine conditions were explored: cardiovascular disease, diabetes (type I and II), chronic obstructive pulmonary disease, chronic liver disease, tuberculosis, gastro-oesophageal reflux disease (GORD), and cancers	Socioeconomic status. Education.
Canizares et al. 2017 (58)	Longitudinal	Canada	Adults aged 20-69	Presence and extent of multimorbidity.	18 chronic conditions were explored: arthritis, back problems, respiratory conditions, allergies	Education, and household income.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
				Cut-off of 2 conditions	(excluding food allergies), cardiovascular diseases, diabetes, cancer, ulcers, urinary incontinency, dementia, migraine, glaucoma, and cataracts.	
Hayek et al. 2017 (60)	Longitudinal	Israel	Adults aged 21 years and over	Presence of multimorbidity. Cut-off of 2 conditions	10 conditions were assessed: asthma, arthritis, cancer, diabetes, dyslipidemia, heart attack, hypertension, migraine, osteoporosis, or thyroid disease.	Monthly household income and years of schooling
Katikireddi et al. 2017 (10)	Longitudinal	Scotland	Adults aged 35 to 75 years	Presence and extent of multimorbidity. Cut-off of 2 conditions	40 conditions	Area-based deprivation level.
Ki et al. 2017 (64)	Longitudinal	South Korea	Adults aged 30 years and over	Presence and extent of multimorbidity. Cut-off of 2 conditions	66 chronic conditions.	Educational attainment, employment status and relative poverty index.
Nielsen et al. 2017 (91)	Cross-sectional	15 European countries	Adults aged 50 years and over	Presence of multimorbidity. Cut-off of 2 conditions	13 chronic conditions: high blood pressure, diabetes, osteoarthritis, rheumatoid arthritis, heart attack, stroke, cancer, chronic lung disease, hip fracture, Parkinson's disease,	Educational level, household income.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					Alzheimer's disease, affective disorders.	
Nunes et al. 2017 (12)	Cross-sectional	Brazil	Adults aged 18 years and over	Presence of multimorbidity. Cut-off of 2 conditions	21 chronic conditions including: cardiovascular diseases, respiratory conditions, mental disorders, musculoskeletal conditions, metabolic disorders, arthritis/rheumatism, cancer, kidney problem.	State level of education and wealth quintiles.
Puth et al. 2017 (80)	Cross-sectional	Germany	Adults aged 18 years and older	Presence of multimorbidity Cut-off of 2 conditions	15 chronic diseases: hypertension, coronary heart disease, myocardial infarction, chronic heart failure, stroke, diabetes mellitus, bronchial asthma, any type of cancer, hypercholesterolemia, chronic bronchitis, chronic liver disease, arthrosis, osteoporosis, arthritis and depression	Level of education
Congdon, 2016 (92)	Cross-sectional	London, UK	Adults aged between 65-75 years	Presence of multimorbidity. Cut-off of 2 conditions	A list of 15 chronic conditions were assessed: cardiovascular diseases, diabetes, asthma, chronic obstructive pulmonary disease, dementia, depression, serious mental illness (psychosis or bipolar disorder), cancer, and chronic kidney disease.	Area-level socioeconomic deprivation

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Garin et al. 2016 (42)	Cross-sectional	9 low to upper middle-income countries	Adults aged 50 years of age	Presence of multimorbidity. Cut-off of 2 conditions	9 conditions explored: arthritis, asthma, cataract, chronic obstructive pulmonary disease (COPD), depression, diabetes, edentulism, hypertension, cognitive impairment, obesity, and stroke.	Household income, education
Jackson et al. 2016 (9)	Longitudinal	Australia	Women aged 45 to 50 years	Multimorbidity patterns (psychosomatic, musculoskeletal, cardiometabolic, cancer and respiratory syndromes).	23 conditions examined including cardiovascular diseases, musculoskeletal conditions, respiratory diseases, cancer, allergies, mental conditions, diabetes, impaired glucose tolerance, chronic fatigue syndrome.	Education, occupation and income management.
Tomasdottir et al. 2016 (72)	Longitudinal	Norway	Adults aged 20-59 years	Presence of multimorbidity. Cut-off of 2 conditions	17 chronic conditions	Financial hardship (worries)
Afshar et al. 2015 (33)	Cross-sectional	28 Low to middle-income countries	Adults aged 18 and over	Presence of multimorbidity. Cut-off of 2 conditions	Seven chronic conditions including: arthritis, angina pectoris, asthma, depression, schizophrenia or psychosis and diabetes.	Level of education.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Chung et al. 2015 (37)	Cross-sectional	China	Adults aged 15 years and older	Presence and extent of multimorbidity. Cut-off of 2 conditions	List not provided	Household income, educational attainment, employment status and type of housing.
Diaz et al. 2015 (93)	Cross-sectional	Norway	Immigrants aged 15 years and over	Presence of multimorbidity. Cut-off of 2 conditions	List not provided	Personal income level. Reason for migration.
Prazeres and Santiago, 2015 (94)	Cross-sectional	Portugal	Adults aged 18 years and older	Extent and presence of multimorbidity. Cut-off of 2 and 3 conditions	List not provided	Years of educations, professional status and self-perceived Socioeconomic status.
Roberts et al. 2015 (95)	Cross-sectional	Canada	Adults aged 20 years and older	Presence and extent of multimorbidity Cut-off of 2 or 3 conditions	A list of 9 conditions including arthritis, mood disorder and/or anxiety, asthma, diabetes mellitus, heart disease, chronic obstructive pulmonary disease, cancer, stroke, and Alzheimer's disease	Educational level and household income

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Banjare et al. 2014 (36)	Cross-sectional	India	Adults aged over 60 years	Extent of multimorbidity (no morbidity, one morbidity, two morbidities and three or more morbidities)	23 chronic conditions were assessed: musculoskeletal conditions, cardiovascular disease, respiratory conditions, neurological disorders, severe dental conditions, kidney or renal disorders, depression, liver or gall bladder illness, accidental injury, injury due to fall, skin disease.	Education, state of economic independence, quintiles of wealth, living arrangement and caste.
Habib et al. 2014 (43)	Cross-sectional	Lebanon	Palestinian refugees aged between 14 and 87 years old	Presence and extent of multimorbidity. Cut-off of 2 conditions	List not provided	Educational attainment, wealth index.
McLean et al. 2014 (77)	Cross-sectional	Scotland	Adults aged 25 years and over	Presence and pattern of multimorbidity (physical only, mental only and mixed physical and mental multimorbidity). Cut-off of 2 conditions	A list of 35 physical and 8 mental conditions were included but not specified on the paper.	Area-based deprivation.
Violan et al. 2014 (96)	Cross-sectional	Spain	Adults aged 19	Presence of multimorbidity.	31 chronic conditions	Area-level of deprivation

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
			years and older	Cut-off of 2 conditions		
Alaba et al. 2013 (50)	Cross-sectional	South Africa	Adults aged 18 and over	Presence or absence of multimorbidity. Cut-off of 2	Eight chronic conditions were assessed including tuberculosis, high blood pressure, diabetes or high blood sugar, stroke, asthma and cancer.	Years of schooling, household income, social assistance, employment.
Cornish et al. 2013 (53)	Longitudinal	Bristol, UK	Children aged 0 to 18 years	Presence and extent of multimorbidity. Cut-off of 2 conditions	As listed in the Johns Hopkins University Adjusted Clinical Groups (ACG) System	Parent's educational level. Occupational social class. Housing tenure. Family adversity index during pregnancy. Area socioeconomic deprivation.
Demirchyan et al. 2013 (41)	Longitudinal	Armenia	Adults aged 37 to 90 years	Presence of multimorbidity. Cut-off of 2 conditions	List not provided	Education, perceived low affordability of healthcare services and perceived living standards.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Weiman et al. 2016 (48)	Cross-sectional	South Africa	People aged 15 years and older	Presence of multimorbidity. Cut-off of 2 conditions	List not provided	Multidimensional poverty index
Agborsangaya et al. 2012 (85)	Cross-sectional	Canada	Adults aged 18 and over	Presence of multimorbidity. Cut-off of 2 conditions	>16 chronic conditions explored, including diabetes, respiratory conditions, cardiovascular diseases, depression or anxiety, chronic pain, arthritis, gastrointestinal tract disease and kidney diseases.	Educational level and annual household income.
Barnett et al. 2012 (52)	Cross-sectional	UK	Individuals from all ages	Presence of multimorbidity Cut-off of 2 conditions	40 chromic conditions	Area level deprivation
Schäfer et al. 2012 (69)	Longitudinal	Germany	Adults aged 65 years and older	Presence and patterns of multimorbidity (cardiometabolic disorders (CMD) and anxiety, depression, somatoform disorders and pain (ADS/P)) Cut-off of 3 conditions	29 chronic conditions	Education, autonomy on former occupation and household income

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Tucker-Seeley et al. 2011 (73)	Longitudinal	United States	Adults aged 50 years and over	Presence and extent of multimorbidity. Count of chronic conditions	Six chronic conditions: cancer, heart disease, lung disease, stroke, diabetes, and hypertension	Childhood financial hardship (yes/no). Average lifetime earnings during young and middle adulthood. Educational attainment as indicator of adult SES

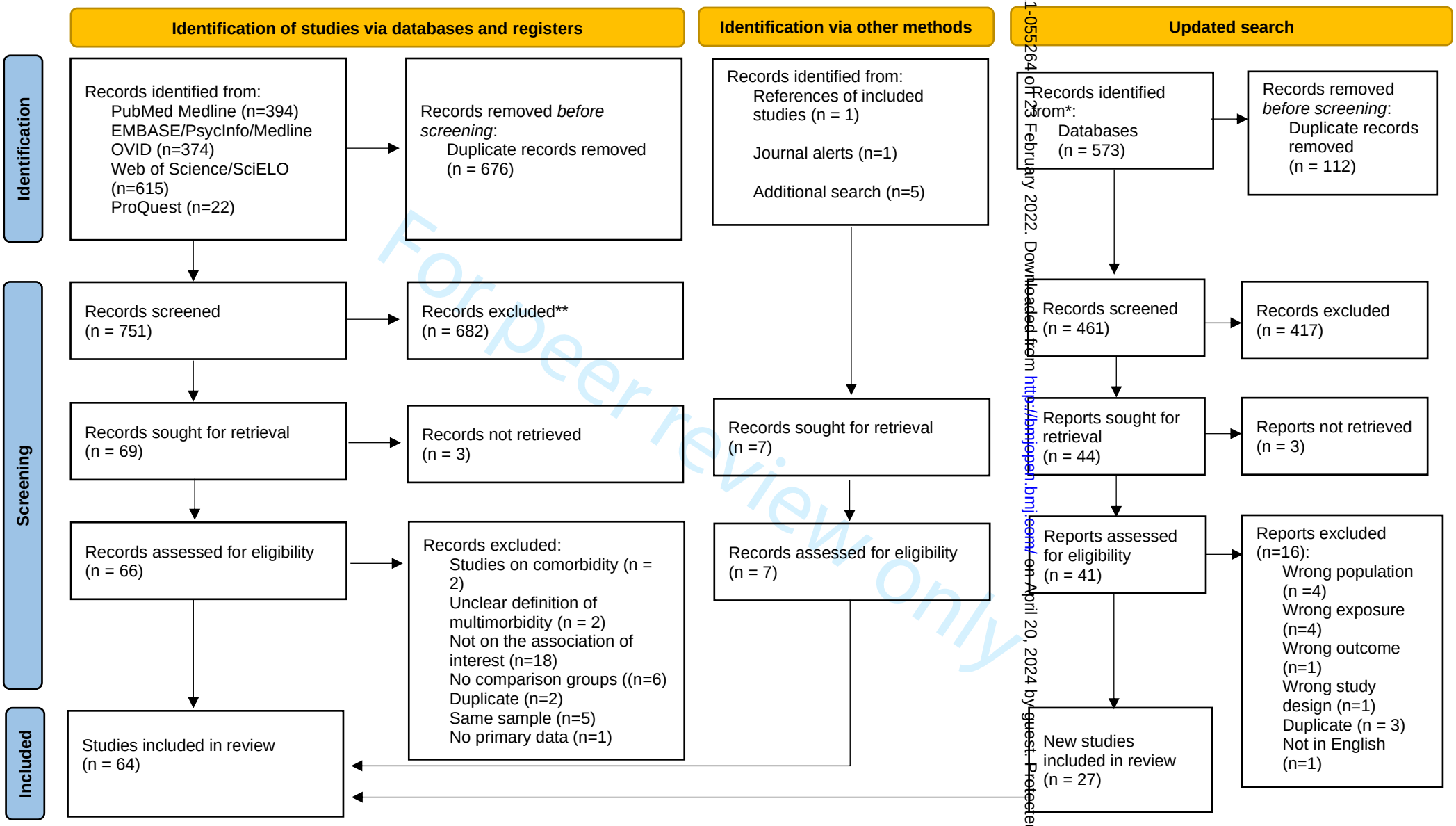
Table *3.* Types of theories and context of application

Study*	Theoretical application	Materialist	Behavioural	Psychosocial	Social capital	Life course	Neo-liberal
Vidyashree et al 2021[b]		✓			✓		
Singh 2021[a]	Theory tested	✓	✓	✓	✓		
Hone et al. 2021[b]		✓	✓	✓			
Hernandez et al. 2021[b]							✓
Khanolkar et al. 2021[a]						✓	
Craig et al. 2021[a]		✓	✓				
Andersen 2021[b]			✓				
Zhao et al. 2020[b]		✓					
Yidiz et al. 2020[a,b]		✓		✓	✓		
Wister et al. 2020[a,b]		✓	✓	✓			
Vinjerui 2020 [a,b]		✓		✓	✓		
Chamberlain 2020[b]		✓					
Odland et al. 2020[b]		✓					
Pati et al. 2020[b]		✓	✓				
Russell et al 2019[b]						✓	
Seo 2019[b]		✓	✓				
Johnston et al. 2019[a]	Theory tested					✓	
Calderon-Larrañaga et al. 2018[a]				✓			

Study*	Theoretical application	Materialist	Behavioural	Psychosocial	Social capital	Life course	Neo-liberal
Mondor et al. 2018[a]	Theory tested		✓				
Alimohammadian et al. 2017[a]			✓				
Katikireddi et al. 2017[a]	Theory tested		✓			✓	
Tomasdottir et al. 2016[a]				✓			
Chung et al. 2015[a]	Theory tested	✓	✓				
Barnett 2012[b]			✓				
Agborsangaya et al. 2012[a]				✓			
Tucker-Seeley et al. 2011[a]		✓				✓	
Costa et al. 2018[b]			✓				
Canizares et al. 2017[b]			✓				
Puth et al. 2017[b]			✓				
Afshar et al. 2015[b]			✓	✓			
Banjare et al. 2014[b]			✓				
Alaba et al. 2013[b]			✓	✓	✓		
Demirchyan et al. 2013[b]		✓	✓	✓			

Notes: * Restricted to studies with identified use of theories.
[a] Specific theory was explicitly mentioned by the authors
[b] Theory was identified and inferred by the reviewers
[ab] One or more theories were explicitly mentioned but one or more identified and inferred by the reviewers

PRISMA flow diagram



Appendices

Contents

Appendix 1. Detailed search strategy according to electronic databases 2
MEDLINE 2
WEB OF SCIENCE 6
PUBMED 8
Appendix 2. Reasons for exclusion of studies after full-text review 11
References 12

Appendix 1. Detailed search strategy according to electronic databases

MEDLINE

Outcome	Exposure	Phenomenon
(multimorb$ or multi?morb$ or multiple chronic conditions$ or multiple chronic diseases$).ti.	Psychosocial Deprivation* .ti. OR exp Family characteristics/ OR exp Hierarchy, Social/ OR Social Hierarch* .ti. OR Minority Group* .ti. OR exp Social Class/ OR Social class* .ti. OR Social Mobilit* .ti. OR Caste* .ti. OR Social Condition* .ti. OR exp Sociology/ OR Poverty .ti. OR exp Socioeconomic Factors/ OR Socioeconomic*.ti. OR Salary .ti. OR Salaries .ti. OR Income* .ti. OR Wage* .ti. OR Remuneration* .ti. OR Occupation* .ti. OR Unemploy* .ti. OR Labour* .ti. OR	Inequalit*.ab. OR Unequal*.ab. OR Disparit* .ab. OR Inequit* .ab. OR Difference* .ab. OR Different*.ab. OR Discriminat* .ab. OR Marginali*.ab OR Marginali*.ti OR Depriv* .ab. OR Inequalit*.ti. OR Disparit* .ti. OR Inequit* .ti. OR Difference* .ti. OR Discriminat* .ti. OR Depriv* .ti. OR Disadvantage*.ti. OR Disadvantage*.ab. OR Vulnerab*.ab OR Vulnerab*.ti.

	Labor* .ti. OR Employment* .ti OR Employment* .ab OR Educational Status.ti. OR Educational Achievement*.ti. OR Educational level*.ti OR Educational level*.ab OR Educational attainment .ti OR Educational attainment .ab OR exp Ethnic Groups/ OR Ethnic* .ti. OR Race* .ti. OR Raci* .ti. OR exp Sexism/ OR Sexis* .ti. OR exp Gender Identity/ OR Gender* .ti. OR Social Capital* .ti. OR Neomaterial* .ti. OR Social Cohesi* .ti. OR Materalis* .ti. OR Psychosocial Deprivation* .ab. OR Social Hierarch* .ab. OR Minority Group* .ab. OR	

	Social class* .ab. OR Social Mobilit* .ab. OR Caste* .ab. OR Social Condition* .ab. OR Poverty .ab. OR Socioeconomic*.ab. OR Salary .ab. OR Salaries .ab. OR Income* .ab. OR Wage* .ab. OR Remuneration* .ab. OR Occupation* .ab. OR Unemploy* .ab. OR Labour* .ab. OR Labor* .ab. OR Educational Status.ab. OR Educational Achievement*.ab. OR Ethnic* .ab. OR Race* .ab. OR Raci* .ab. OR Sexis* .ab. OR Gender* .ab. OR Social Capital* .ab. OR Neomaterial* .ab. OR Social Cohesi* .ab. OR	

	Materalis* .ab. OR Neomaterial* .ab.	

WEB OF SCIENCE

Outcome	Exposure	Phenomenon
TS = (multimorb* OR multi-morb* OR "multiple chronic condition*" OR "multiple chronic disease*")	TS = ("Psychosocial Deprivation*" OR "Family characteristics" OR "Social Hierarch*" OR "Minority Group*" OR "Social Class" OR "Social Mobilit*" OR Caste* OR "Social Condition*" OR Sociology OR Poverty. OR "Socioeconomic Factors" OR Socioeconomic* OR Salary OR Salaries OR Income* OR Wage* OR Remuneration* OR Occupation* OR Unemploy* OR Labour* OR Labor* OR Employment* OR Employment* OR "Educational Status" OR	TS = (Inequalit* OR Unequal* OR Disparit* OR Inequit* OR Difference* OR Different* OR Discriminat* OR Marginali* OR Depriv* OR Disadvantage* OR Vulnerab*)

	"Educational Achievement*" OR "Educational level*" OR "Educational attainment" OR "Ethnic Groups" OR Ethnic* OR Race* OR Raci* OR Sexism OR Sexis* OR "Gender Identity" OR Gender* OR "Social Capital*" OR "Social Cohesi*" OR Materalis* OR Neomaterial* OR Materalis* OR Neomaterial*)	

PUBMED

Outcome	Exposure	Phenomenon
multimorb*[TIAB] OR multimorbidity[MH] OR multi-morb*[TIAB] OR multiple chronic condition*[TIAB] OR multiple chronic disease*[TIAB] OR multiple chronic disease [MH]	Psychosocial Deprivation*[TIAB] OR Family characteristics [TIAB] OR Social Hierarch*[TIAB] OR Minority Group*[TIAB] OR Social Class[TIAB] OR Social Mobilit*[TIAB] OR Caste*[TIAB] OR Social Condition*[TIAB] OR Sociology[TIAB] OR Poverty [TIAB] OR Socioeconomic Factors[TIAB] OR Socioeconomic*[TIAB] OR Salary[TIAB] OR Salaries[TIAB] OR Income*[TIAB] OR Wage*[TIAB] OR Remuneration*[TIAB] OR Occupation*[TIAB] OR Unemploy*[TIAB] OR Labour*[TIAB] OR Labor*[TIAB] OR Employment*[TIAB] OR Educational Status [TIAB] OR	Inequalit*[TIAB] OR Unequal*[TIAB] OR Disparit*[TIAB] OR Inequit*[TIAB] OR Difference*[TIAB] OR Different*[TIAB] OR Discriminat*[TIAB] OR Marginali*[TIAB] OR Depriv*[TIAB] OR Disadvantage*[TIAB] OR Vulnerab*[TIAB]

	Educational Achievement*[TIAB] OR Educational level*[TIAB] OR Educational attainment [TIAB] OR Ethnic Groups[TIAB] OR Ethnic*[TIAB] OR Race*[TIAB] OR Raci*[TIAB] OR Sexism[TIAB] OR Sexis*[TIAB] OR "Gender Identity"[TIAB] OR Gender*[TIAB] OR Social Capital*[TIAB] OR Social Cohesi*[TIAB] OR Materalis*[TIAB] OR Neomaterial*[TIAB] OR Materalis*[TIAB] OR Neomaterial*[TIAB]	

PROQUEST (Applied Social Sciences/ERIC/Humanities Index/ProQuest Central/ProQuest dissertation and Thesis Global/Sociological Abstracts)

multimorb* OR multi-morb* OR "multiple chronic condition*" OR "multiple chronic diseases*"

AND
"Psychosocial Deprivation*" OR "Family characteristics" OR "Social Hierarch*" OR "Minority Group*" OR "Social Class" OR "Social Mobilit*" OR Caste* OR "Social Condition*" OR Sociology OR Poverty. OR "Socioeconomic Factors" OR Socioeconomic* OR Salary OR Salaries OR Income* OR Wage* OR Remuneration* OR Occupation* OR

Unemploy* OR Labour* OR Labor* OR Employment* OR Employment* OR "Educational Status" OR "Educational Achievement*" OR "Educational level*" OR "Educational attainment" OR "Ethnic Groups" OR Ethnic* OR Race* OR Raci* OR Sexism OR Sexis* OR "Gender Identity" OR Gender* OR "Social Capital*" OR "Social Cohesi*" OR Materalis* OR Neomaterial* OR Materalis* OR Neomaterial*

AND

Inequalit* OR Unequal* OR Disparit* OR Inequit* OR Difference* OR Different* OR Discriminat* OR Marginali* OR Depriv* OR Disadvantage* ORVulnerab*

Appendix 2. Reasons for exclusion of studies after full-text review

Comorbidity Barnett, Mercer (1), Gallacher, McQueenie (2), Alonso-Moran, Orueta (3)

Unclear definition of multimorbidity Chau, Baumann (4), Reis-Santos, Gomes (5)

Did not explore the association between socioeconomic disadvantage and multimorbidity Charlton, Rudisill (6), Galenkamp, Gagliardi (7), Golinowska, Sowa (8), Jessen, Pallesen (9), Koroukian, Schiltz (10), Mujica-Mota, Roberts (11), Orueta, Garcia-Alvarez (12), Phaswana-Mafuya, Peltzer (13), Rodrigues, Gregorio (14), Thavorn, Maxwell (15), Tran, Kiran (16), van den Akker, Buntinx (17), Wang, Wang (18), Ward (19), Woo and Leung (20), Cassell, Edwards (21), Brinda, Attermann (22), Kone, Mondor (23)

Absence of comparative group Eakin, Bull (24), Frakes, Brownie (25), Kangovi, Mitra (26), Leiser, Deruaz-Luyetl (27), Smith, Ferede (28), von dem Knesebeck, Bickel (29)

Full-text unavailable Jantz (30), Pati and Swain (31), Russel, Grant (32), Cezard, Keenan (33), Zou, Wang (34)

Duplicate Myung, Yo Han (35), Srinivasa Vittal, Skivington (36), Aminisani, Stephens (37), Chamberlain, Rutten (38), Pati, Swain (39)

Use of the same sample Ahmadi, Alimohammadian (40), Ataguba (41), Kunna, Miguel San (42), Nunes, Thume (43), Habib, Mikati (44)

No primary data Shadmi (45)

Not in English Melo and Lima (46)

Not peer-reviewed Korea National Health & Nutrition Survey (47)

Wrong exposure Basham (48), Douglas, Vinjerui (49), Guimaraes and Andrade (50), Harrison, Britt (51)

Wrong outcome Kivimaki, Batty (52)

Wrong population Calderon-Larranaga, Marengoni (53), Carrilero, Dalmau-Bueno (54), Shang, Peng (55), Vinjerui, Boeckxstaens (56)

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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.	
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.	
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.	
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.	
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.	
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.	
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.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
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.	
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.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
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.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
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.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
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.	
Limitations	20	Discuss the limitations of the scoping review process.	
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.	
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.	

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).

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Theoretical explanations for socioeconomic inequalities in multimorbidity – A Scoping Review

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ABSTRACT

Objective: To document socio-epidemiologic theories used to explain the relationship between socioeconomic disadvantage and multimorbidity.

Design: Scoping review

Methods: A search strategy was developed and then applied to multiple electronic databases including Medline, EMBASE, PsychInfo, Web of Science, Scielo, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts. After the selection of studies, data was extracted using a data charting plan. The last search was performed on the 28th of September 2021. Extracted data included: study design, country, population sub-groups, measures of socioeconomic inequality, assessment of multimorbidity and conclusion on the association between socioeconomic variables and multimorbidity. Included studies were further assessed on their use of theory, type of theories used and context of application. Finally, we conducted a meta-narrative synthesis to summarise the results.

Results: A total of 64 studies were included in the review. Of these, 33 papers included theories as explanations for the association between socioeconomic position and multimorbidity. Within this group, sixteen explicitly stated those theories and five tested at least one theory. Behavioural theories (health behaviours) were the most frequently used, followed by materialist (access to health resources) and psychosocial (stress pathways) theories. Most studies used theories as post hoc explanations for their findings or for study rationale. Supportive evidence was found for the role of material, behavioural and life course theories in explaining the relationship between social inequalities and multimorbidity.

Conclusion: Given the widely reported social inequalities in multimorbidity and its increasing public health burden there is a critical gap in evidence on pathways from socioeconomic disadvantage to multimorbidity. Generating evidence of these pathways will guide the development of intervention and public policies to prevent multimorbidity among people living in social disadvantage. Material, behavioural and life course pathways can be targeted to reduce the negative effect of low socioeconomic position on multimorbidity.

Keywords: multimorbidity, socioeconomic inequalities, scoping review, theoretical explanations, epidemiology

Strengths and limitations:

- This is the first scoping review exploring the use of theories to explain the association between socioeconomic position and multimorbidity.
- Our review has identified critical gaps in the literature that must be addressed if interventions and public policies are to be designed to reduce socioeconomic inequalities in multimorbidity.
- We applied a comprehensive search strategy to identify relevant articles and applied a peer-reviewed robust methodology to assess theories in studies on socioeconomic inequalities in multimorbidity.
- Articles that were not in English were excluded from our review. This could have obstructed the inclusion of papers from countries where English is not the main language, therefore limiting the generalisability of our findings.

INTRODUCTION

Multimorbidity is a societal challenge and an increasingly recognised public health concern (1-3). It is described as the co-occurrence of two or more chronic conditions in an individual (4). Multimorbidity leads to reduced quality of life, high psychological distress, burden of polypharmacy and managing multiple treatment protocols, and an increased risk of premature death in people (5). There is an emerging threat of increased multimorbidity worldwide, primarily due to population aging and the epidemiological transition from communicable to non-communicable diseases (6). The COVID-19 pandemic has put a spotlight on multimorbidity as people with existing chronic conditions have suffered a higher risk of its infection, as well as more severe consequences of SARS-CoV-2 infection (7). Furthermore, multiple studies have reported socioeconomic inequalities in multimorbidity within countries regardless of their level of economic development (8-12).

A meta-analysis of 24 cross-sectional studies reported that low education compared to high education was associated with 64% higher odds of multimorbidity (13). Another systematic review with 41 studies from high income countries reported that people with the lowest level of income had 4.4 times higher odds of multimorbidity than those with the highest level of income, while those in most deprived areas had 1.42 times higher odds of multimorbidity than those in the least deprived areas (14). A clear causal relationship between socioeconomic conditions and multimorbidity has also been argued based on empirical evidence (10), however, pathways through which socioeconomic disadvantage leads to multimorbidity are not well studied (4).

Theories are used in epidemiology to understand the relationships between exposure to, for example, socioeconomic disadvantage and non-communicable diseases. This is mainly because, as opposed to conceptual frameworks, specific theoretical pathways can be tested using empirical data. Theories provide insight into the mechanisms through which an exposure (e.g. socioeconomic position) leads to a health outcome (15), and as such, they are particularly helpful in informing intervention designs. Since the release of the Black Report in 1982 (16), several categories of theories have been proposed to explain associations between social inequalities and health outcomes (16, 17); albeit in the context of single diseases or health measure. These include:

I. Behavioural: The behavioural explanation posits that people from different backgrounds behave differently and make health-related choices that are commonly

based on their socioeconomic background. As people experience socioeconomic deprivation, they also encounter more barriers to adopting healthy lifestyles. For instance, individual health damaging and promoting behaviours are differentially distributed across the social scale, with more disadvantaged groups more likely to engage in health damaging behaviours such as smoking, and advantaged groups more likely to engage in health promoting behaviours such as physical activity (18). As a result, poor health outcomes are commonly clustered at the lower end of the socioeconomic scale (17). Behavioural theory can be extended to apply to multimorbidity from a common risk factor approach, as a behavioural risk factor can cause multiple diseases (for example, smoking can cause cancer, asthma, cardiovascular diseases (19, 20)).

II. Psychosocial: this theory postulates that the emotions that arise due to social inequality can directly affect biological health (17). This can be caused in two ways, either through the practice of health compromising behaviours or through biological changes due to the individual being in a sustained state of stress (17). Hence, the behavioural explanation can be a descendent of psychosocial processes under this explanation. The perceived lack of control and psychosocial stress may lead to adverse health behaviours and may activate neuro-endocrine mechanisms, and in doing so, may affect multiple body systems and lead to multimorbidity.

III. Materialist: the material environment has a significant impact on the health of an individual. Exposure to health-risk or health-protective factors varies according to socioeconomic position due to differential access to material resources; differences are more evident in non-egalitarian societies. For instance, individuals living in socioeconomic disadvantage are less likely to be able to access information and resources necessary to maintain good health compared to their more advantaged counterparts (17). Socioeconomically deprived individuals are also more likely to be exposed to hazardous working environments (17). The materialist theory proposes these explanations as pathways between socioeconomic deprivation and health inequalities (17). Lack of material resources such as inadequate housing for example, can lead to multimorbidity by causing depression as well as respiratory illnesses such as asthma.

IV. Social support: this theory holds that positive social support mitigates the detrimental effect of socioeconomic deprivation in health (21, 22). Accordingly, strong social networks and good social relationships are linked to good health and conversely, poor

social relations and weak social support networks are deleterious to health. Social support is considered to be a distal determinant of health that may influence health through multiple mechanisms, for example by reducing stress and providing access to local resources, and in doing so, may prevent both mental and physical multimorbidity.

V. Social capital: While variously defined, social capital is broadly described as the functioning of social groups through a shared sense of identity, trust, cooperation, reciprocity and shared understandings, norms, and values (23). Social capital emphasises that a more unequal distribution in income undermines trust and damages social relationships at a population level. This theory attempts to explain why egalitarian societies tend to be healthier than non-egalitarian societies (24, 25). Similar to social support, high social capital is likely to boost health and prevent multimorbidity by reducing stressors and increasing access to shared resources.

In addition to the abovementioned theories, a life course framework examines the effect of early life socioeconomic exposures on later health outcomes (26). Two models are proposed to explain the life course framework: the accumulation model and the critical periods model. The accumulation model emphasises the cumulative effect of exposure to socioeconomic disadvantage across different stages in life on subsequent increased risk of poor health outcomes (27). The critical periods model focuses on the effect of exposure to factors influencing health during critical periods of development (27). Finally, a neo-liberal framework for health inequalities emphasises the role of political arrangements in leading to socioeconomic inequalities, and in turn health inequalities (28).

We aim to review the socio-epidemiologic theories applied to explain the relationship between socioeconomic disadvantage and multimorbidity in the population. Where possible, we examined whether theories applied were tested using robust analytical methods such as mediation analysis.

METHODS

We conducted a scoping review to examine epidemiologic theories applied to explain the association between socioeconomic disadvantage and multimorbidity (29, 30), and to map the information available in the current literature. Because the primary purpose of this study was to identify and categorise the theories being used in the existing literature, a scoping review

was preferred over a systematic review. We followed the steps of a scoping review as per previously defined guidelines (29, 30).

Stage I: Identifying the Research Question

Our review question was: "How are the socio-epidemiologic theories applied to explain the relationship between socioeconomic disadvantage and multimorbidity?"

Stage II: Identifying Relevant Studies

We identified search terms and keywords relevant to socioeconomic disadvantage, theoretical pathways and multimorbidity from published systematic reviews (13, 31) and tailored them to answer our research question. First, a detailed search strategy was developed using keywords and hierarchically defined subject headings. Once the search terms were agreed upon, they were adapted for multiple electronic databases including Medline, EMBASE, PsychInfo (Ovid platform), Web of Science, Scielo, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts (see *Appendix 1*). The reference lists of all selected articles were screened to identify any additional studies. Search alerts were set up to notify the research team of articles published after 25th of May 2018 when literature search was implemented. This search was updated on 11 December 2019 and then on 28 September 2021.

Stage III: Study Selection

We applied a strict inclusion and exclusion criteria; these are displayed in Table 1. We use the term socioeconomic position to reflect socioeconomic status of individuals or groups in the population. Socioeconomic status indicates the position in which an individual or a group is located within the social structure. It can be measured using educational attainment, income, occupation, wealth and area level measures (deprivation, socio-economic scores). We use the term socioeconomic inequalities in health to indicate the differences in disease levels between people living with different socioeconomic positions. Socioeconomic disadvantage refers to those who have the low socioeconomic position. For inclusion in this review, socioeconomic position could be measured using the following indicators: occupation, income (household or individual), educational attainment, area level socioeconomic deprivation, wealth, and social class (17, 32).

We excluded studies on "comorbidity" as such studies are focussed on an index condition (e.g. diabetes) (33). The terms multimorbidity and comorbidity are often used interchangeably as both describe the presence of multiple chronic conditions. However,

comorbidity is a disease-centred term that describes the presence of additional conditions associated with an index disease (4). The focus of this review is multimorbidity only. Studies on institutionalised individuals, qualitative research, and those written in a language other than English were excluded. A detailed list of inclusion and exclusion criteria can be found in *Table 1*. Abstracts and full-text articles were reviewed for inclusion by LFA using the citation manager EndNote. A second reviewer (AS) cross-checked 10% of these articles.

See Table 1

Stage IV: Charting the Data

A data charting form was created which included study details (study design, country, population sub-groups, measures of socioeconomic inequality, assessment of multimorbidity and conclusion on the association between socioeconomic variables and multimorbidity), use of theory, type of theories and context of application. Use of theory was categorised as inferred by us (reviewers/readers) or explicitly mentioned by the original study authors. It is important to distinguish between the two because the former relies on the reviewers/readers' subjective judgement (which may not be accurate) while the latter accurately reflects the theoretical reasoning of the original authors. Data charting was performed by LFA and 10% of the studies were cross checked by AS.

Each study was examined for the type of theory (example: psychosocial or material), extent of use (whether used in a post hoc manner or integrated within an analysis) and their context of use (background, methods or discussion section of retrieved paper(s)). We recorded whether theories that were directly mentioned or inferred were consistent with any of the existing socio-epidemiologic theories. When directly mentioned, types of theories were recorded verbatim. This follows the approach previously applied in a published study examining the application of socio-epidemiologic theories in studies on the relationship between social inequality and oral health (31).

Stage V: Collating, Summarizing and Reporting the Results

We carried out a narrative synthesis to summarise the results from the retrieved data. Because the objective of this review is to offer a snapshot of the available evidence of theories explaining socioeconomic inequalities in multimorbidity and not on assessing the effect of socioeconomic disadvantage on multimorbidity development, we did not assess the quality of included papers in accordance with the guidelines for conducing scoping reviews (29).

Patient and public involvement

No patients were directly involved in this study as this is a review of published studies.

RESULTS

Our initial search led to the identification of 751 unique papers that underwent title and abstract screening. Sixty-nine papers were deemed eligible for full-text review. In addition, two studies were included for full-text review from other sources. Thirty-six studies proceeded to data charting stage after completion of full-text review. Appendix 2 displays a list of studies with reasons for exclusion after full-text review. The updated search on 28 September 2021 led to a further screening of 461 titles and abstracts from the 573 newly identified records. After full text screening of 44 studies, 27 new studies were included in the review. A total of 64 studies were included in this review. A flowchart of this process is shown in Figure 1.

Figure 1 Flow chart of the study selection process *(2-column fitting image)*

(*see figure 1*)

Summary characteristics of included studies

Twenty studies were from low- and middle-income countries (12, 34-52) and the remaining 45 studies were from high income countries. The majority of articles were conducted among adults and only three study included children (53-55). More than half (n=38/64) were cross-sectional and 26/64 used longitudinal data (9, 10, 42, 54, 56-76)(Table 2).

Educational attainment was the preferred measure of socioeconomic position (n=38/64) and 38 studies used multiple measures of socioeconomic position as exposures. The majority of studies (n=51/64) simply documented the presence of multimorbidity and approximately one third (n=13/64) additionally examined different patterns of multimorbidity (9, 40, 41, 45, 47, 53, 55, 67-70, 72, 75, 77, 78)(Table 2).

See Table 2

Types of theories

Overall, nearly half of studies (33/64) referred to at least one socio-epidemiological theory. Therefore, 31 studies can be considered largely atheoretical, without any emphasis on pathways through which socioeconomic disadvantage leads to multimorbidity. In the thirty three studies applying a theory, the following theories were referred to: behavioural (10, 34,

35, 37, 38, 40-42, 46, 51-53, 59, 71, 72, 79-82) materialist (38, 41, 42, 45, 46, 48, 50, 52, 71, 72, 74, 79, 82-85) and psychosocial (34, 42, 51, 52, 57, 72, 73, 82, 84-86). In addition, four studies applied a theoretical construct called 'sense of coherence', which indicates an individual's coping capacity to deal with life and stressful events (87), and is an indicator of self-efficacy and psychosocial well-being (consistent with psychosocial explanations) (73), and also encompasses social capital (51), and social support (57) which are widely considered as psychosocial assets (Table 3). Five studies used a life-course framework (10, 55, 63, 64, 74). Collectively, behavioural theory was the most referred to among studies.

Context of application of theories

Of the papers using theories, fifteen explicitly stated those theories (10, 35, 38, 41, 57, 63, 64, 72-74, 80, 82, 84-86), and the other 21 studies were inferred to be consistent with a presumed theoretical pathway, based on definitions from existing literature.

See Table 3

Testing the explanatory potential of theories

Only five studies (10, 38, 63, 72, 80) tested variables consistent with theoretical pathways as mediators between socioeconomic disadvantage and multimorbidity. Applying material theory, Chung et al. (38), examined perceptions of financial hardship, an indicator of economic deprivation, as a mediator between housing tenure and multimorbidity. They found a small mediation effect (1.41%), indicating that increased financial burden puts private housing residents at a higher risk of suffering multimorbidity when compared with public housing residents (38).

Drawing on behavioural theory as well as a life course framework, Katikireddi et al. (10), quantified mediation by five behavioural risk factors (diet, smoking, physical activity, alcohol and BMI) acting on the association between two socioeconomic measures (area-based deprivation and household income) and multimorbidity over the life course. Their analyses showed that the combination of behavioural factors partially mediated (by 40.8%) the inverse association between area level deprivation and multimorbidity.

The life course framework was applied by Johnston et al. (63) in their examination of educational attainment during adulthood as a mediator of the association between father's occupational social class at birth and multimorbidity. Their analyses showed a partial attenuation of the effect of childhood socioeconomic position on multimorbidity by

educational attainment. Authors did not report the proportion of effect that was mediated by adult educational attainment.

Mondor et al. (80) also drew on behavioural theory in their study that quantified the mediation effect of lifestyle factors (physical activity, smoking and BMI) on the association between income inequalities and multimorbidity. Lifestyle factors only explained a small proportion of observed income-related inequalities in multimorbidity. Physical activity explained 10.9% of income inequalities, while smoking and BMI only accounted for 1.8% and 0.4% respectively.

Finally, Singh et al. (72) examined social support as a mediator between financial hardship and multimorbidity among Australian adults and found that 30% of the total effect of financial hardship on multimorbidity was transmitted through social support.

DISCUSSION

Summary of findings

Overall, we found limited use of theories to explain the relationship between socioeconomic position and multimorbidity. When used, theories were seldom explicitly mentioned or tested. Among all the potential explanations, behavioural theories were the most frequently used, followed by materialist and then psychosocial theories.

Only five studies tested the explanatory potential of theories and their mediation effect on the association between socioeconomic position and multimorbidity. Although we identified the use of seven different theories, materialist, behavioural, psychosocial and life course theories were the only ones tested. Existing evidence partially support these theories (10, 38, 63, 72, 80), however their use was mostly limited to post-hoc explanations of findings in the overall literature.

Our findings are consistent with the two major evidence gaps highlighted in the report 'Multimorbidity: a priority for global health research'(4). First, evidence of the relationship between socioeconomic disadvantage and multimorbidity is largely cross-sectional. This is a limitation of the existing evidence, as temporal ordering between exposure (social disadvantage) and outcome (multimorbidity), a key undisputed criterion of causality (88), is difficult to establish cross-sectionally. Second, there is a paucity of evidence regarding pathways (e.g. behavioural, material, psychosocial) between the shared causal factor (exposure to socioeconomic disadvantage) and multiple conditions that co-occur in

multimorbidity (4). The lack of evidence precludes policy makers from intervening on causal mechanisms that can prevent, or mitigate observed socioeconomic inequalities in multimorbidity (89). Among those studies testing theories, there was a predominance of the application of the behavioural theory. However, the use of contemporary approaches to causal inference, using a counterfactual framework to maximise exchangeability between exposed and unexposed participants, was limited (72, 89). Therefore, we cannot rule out bias arising from mediator-outcome confounding, time varying confounding or the presence exposure-outcome interaction. Approaches need to shift towards a more comprehensive examination of pathways to allow policymakers to select interventions with maximum capacity to reduce inequalities. It is also worth noting that given the variations in the relationship of interest according to individual (e.g. age) and contextual characteristics (e.g. country level of income development), future studies should examine the relevance of theories across different contexts and age groups.

Strengths and limitations

Our study has some strengths and limitations. To our knowledge, this is the first scoping review that explores the use of theories to explain the association between socioeconomic position and multimorbidity in the current literature. We identified numerous gaps in the literature that need to be addressed to improve our understanding of the socioeconomic inequalities in multimorbidity. Our search strategy drew on a wide range of electronic databases, and we used a robust methodology, already piloted and verified in previous work (31). A key limitation is that articles not in English were excluded in our review. Moreover, we did not use any tool to assess the quality of the included studies. This information is already provided by existing reviews (13, 14). Lastly, we restricted this review to articles assessing only multimorbidity and excluded those looking at comorbidities. We acknowledge that some authors use both terms interchangeably, therefore papers using the term comorbidity to indicate the presence of multiple independent chronic conditions may be missing from this review.

CONCLUSION

Our understanding of the pathways between socioeconomic inequalities and multimorbidity is limited and mostly unexplained. Studies often focus on the patterns of distribution of multimorbidity across the population, rather than the mechanisms shaping these distributions. Robust evidence from longitudinal and interventional studies is needed to understand the

pathways between socioeconomic disadvantage and multimorbidity. Generating such evidence will guide the development of interventions and public policies to prevent multimorbidity among people living in disadvantage.

Authors contribution statement:
LFA contributed towards the development of search strategy, screening, data extraction and appraisal of included studies and manuscript preparation. AS contributed towards the design, development of search strategy, screening, data extraction and appraisal of included studies and manuscript preparation. EY contributed towards the development of search strategy, data extraction of included studies and manuscript preparation. TK and DCS contributed towards the development of search strategy and manuscript preparation. SZ contributed towards manuscript preparation.

Competing interests
The authors have no competing interests to declare.

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Data availability statement
All data relevant to the study are included in the article or uploaded as supplementary information.

Ethics approval statement
This study uses publicly available data and does not directly involve human participants.

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Table 1. Study selection criteria.

Inclusion criteria	**Exclusion criteria**
-Studies with participants from any age group -Community representative participants -Individual and population-based epidemiological studies looking at the association between socio-economic disadvantage and multimorbidity -Intervention studies involving examining moderators or mediators derived from theoretical constructs -Studies in English language	-Studies on institutionalised individuals -Studies on comorbidity -Qualitative studies -Study protocols, editorials and commentaries that do not report on association between social disadvantage and multimorbidity -Literature reviews, scoping reviews and systematic reviews

Table 2. Summary characteristics of included studies

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Andersen et al. 2021 (79)	Cross-sectional	Finland	Adults aged 20-69 years	Presence of multimorbidity Cut-off of 2 conditions	18 chronic conditions including: respiratory diseases, cardiovascular diseases, diabetes, mental disorders, dyspepsia/reflux disease, chronic kidney failure, sleep apnea, osteoporosis, and chronic pain	Occupation.
Calvo et al. 2021 (58)	Longitudinal	US	Adults aged 60-61 and 70- 71 years	Count of chronic conditions	Eight conditions including high blood pressure, diabetes, cancer, chronic lung disease, heart problems, stroke, mental illness, arthritis or rheumatism.	Retirement sequence
Craig et al. 2021 (41)	Cross-sectional	Jamaica	Individuals aged 15-74 years	Patterns of multimorbidity	11 chronic conditions including hypertension, obesity, hypercholesterolemia, diabetes, asthma, arthritis, cardiovascular disease, mental health disorders, COPD, stroke, and glaucoma.	Occupational status, education and income level.
Head et al. 2021 (62)	Longitudinal	England	Adults aged 18 years and over	Presence of multimorbidity. Cut-off of 2 and 3 conditions	211 conditions listed elsewhere (62)	Area level deprivation
Hernandez et al. 2021 (77)	Cross-sectional	4 high income countries	Adults aged 52-85 years	Patterns of multimorbidity	10 conditions including cardiovascular diseases, diabetes, arthritis, cancer, lung disease,	Education, household income and employment.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					osteoporosis. and psychological disorders	
Hone et al. 2021 (52)	Cross-sectional	Brazil	Individuals of any age	Presence of multimorbidity Count of chronic conditions	53 chronic conditions	Education
Khanolkar et al. 2021 (64)	Longitudinal	UK	Adults aged 36 to 69 years	Presence of multimorbidity Count of chronic conditions	18 health conditions including metabolic conditions, cardiovascular diseases, cancer, respiratory disorders, kidney disorders, gastrointestinal disorders, skin disorders, osteoarthritis, rheumatoid arthritis, neurological disorders and mental disorders.	Social class and education
Lee et al. 2021 (67)	Longitudinal	South Korea	Adults aged 45 years and over	Multimorbidity clusters Cut-off of 2 conditions	9 chronic conditions including: hypertension, diabetes, cancer,chronic lung disease, liver disease, heart disease, cerebrovascular disease, arthritis or rheumatoid arthritis and depression	Education, household income and employment
Moin et al. 2021 (90)	Cross-sectional	Canada	Adults aged 22 to 95 years	Presence of multimorbidity Cut-off of 2 and 3 conditions	18 chronic diseases including cardiovascular diseases, respiratory conditions, diabetes, mental illness, musculoskeletal conditions, renal	Household income and education

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					failure, inflammatory bowel failure and cancers.	
Zacarías-Pons et al. 2021 (75)	Longitudinal	Europe	People aged 50 years and older	Latent transition analysis for types of multimorbidity	Heart attack, hypertension, hypercholesterolaemia, stroke or cerebral vascular disease, diabetes or high blood sugar, chronic lung disease [COPD], cancer, stomach or duodenal ulcer, Parkinson disease, cataracts, dementia, other affective or emotional disorders, rheumatoid arthritis, osteoarthritis and osteoporosis	Education, employment and material deprivation index
Vidyashree et al 2021 (48)	Cross-sectional	India	People aged 60 and above in rural area	Presence of multimorbidity (Cut off unclear)	Unclear	Economic dependency
Sharma 2021 (47)	Cross-sectional	India	People aged 60 and above	Presence and patterns of multimorbidity Cut-off of 2 conditions	Arthritis, Rheumatism or Osteoarthritis, Cerebral embolism stroke or Thrombosis, Heart diseases, Diabetes, Chronic lung disease, Asthma, Depression, Hypertension, Alzheimer's disease, Cancer, Dementia, Liver or Gall bladder illness, Osteoporosis, Renal or Urinary tract infection, Cataract,	Educational attainment, working status, wealth quintile

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					Loss of all-natural teeth, Accidental injury in the past one year, injury due to fall, skin disease and paralysis	
Singh 2021 (72)	Longitudinal	Australia	People aged 15 and above	Presence of multimorbidity Cut-off of 2 conditions	Arthritis, cancer, type 1 diabetes mellitus, type 2 diabetes mellitus, hypertension, heart disease, asthma, bronchitis or depression	Financial hardship
Aminisani et al. 2019 (56)	Longitudinal	New Zealand	Adults aged 55-70 year	Presence of multimorbidity Cut-off of 2 conditions	Nine groups of chronic diseases: cardiovascular diseases, neurologic diseases, musculoskeletal conditions, diabetes mellitus, respiratory diseases, chronic liver conditions, cancer and mental disorders.	Education and income
Chamberlain et al. 2020 (83)	Cross-sectional	US	Adults aged 20 years and over	Presence of multimorbidity. Cut-off of 2 conditions	21 conditions including cardiovascular diseases, metabolic conditions, respiratory diseases, arthritis, osteoporosis, chronic kidney disease, autism spectrum disorder, hepatitis, human immunodeficiency virus,	Area level deprivation

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					depression, dementia, schizophrenia, and substance	
Costa et al. 2020 (39)	Cross-sectional	Brazil	Adults aged 20-59 years	Presence of multimorbidity Cut-off of 2 conditions	14 conditions including cardiovascular diseases, metabolic diseases, chronic pulmonary disease, digestive disorders, neurological disorders, cancer, kidney disease and depression	Economic status and education
Kim et al. 2020 (66)	Longitudinal	South Korea	Adults aged 19 years and over	Presence of multimorbidity Cut-off of 2 conditions	28 chronic conditions as listed elsewhere (63)	Household income and education
Moller et al. 2020 (68)	Longitudinal	Denmark	People aged 16 years and over	Multimorbidity patterns or classes (LCA)	47 diseases	Education and employment
Odland et al. 2020 (45)	Cross-sectional	Burkina Faso	Adults aged 40 years and older	Presence and patterns of multimorbidity Cut-off of 2 conditions	11 conditions including: cancer, HIV, chronic respiratory disease, stroke heart disease, hypertension, diabetes, anxiety, depression and dementia/cognitive decline.	Education and wealth

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Pati et al. 2020 (46)	Cross-sectional	India	Adults aged 18 years and older	Presence of multimorbidity Cut-off of 2 conditions	21 chronic conditions	Poverty level and education
Zhao et al. 2020 (50)	Longitudinal	China	People aged 50 years and older	Presence of multimorbidity. Cut-off of 2 conditions	Diagnosed	Annual per-capita household consumption
Yidiz et al. 2020 (85)	Cross-sectional	Netherlands	People aged 18-64 years	Presence of multimorbidity Cut-off of 2 and 3 conditions most prevalent chronic diseases	List of most prevalent chronic diseases (cardiovascular diseases, psychological disorders, inflammatory conditions and respiratory diseases)	Employment status and education
Wister et al. 2020 (82)	Cross-sectional	Canada	People aged 45-85 years	Presence of multimorbidity Cut-off of 2 conditions	High blood pressure, osteoarthritis, back problems, cancer, diabetes, heart disease, thyroid dysfunction, lung disease, osteoporosis, urinary incontinence, migraine headaches, irritable bowel syndrome, intestinal and stomach ulcer, glaucoma, peripheral vascular disease, angina, macular degeneration, heart attack, transient ischemic attack, kidney	Vancouver

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					disease, rheumatoid arthritis, bowel incontinence, stroke, multiple sclerosis, epilepsy, Parkinson's disease, as well as dementia and Alzheimer's disease.	
Vinjerui 2020 (84)	Cross-sectional	Norway	People aged 25-100 years	Complex multimorbidity Three or more diseases involving three or more different body (organ) systems	51 chronic conditions including following body systems or types: neoplasms; endocrine/nutritional/metabolic; mental/behavioural; eye/adnexa; ear/mastoid; circulatory system; respiratory system; digestive system; skin/subcutaneous tissue; musculoskeletal/ connective tissue and genitourinary systems	Occupational groups
Ba et al. 2019 (36)	Cross-sectional	Vietnam	Individuals aged 15 years and over	Presence of multimorbidity. Cut-off of 2 conditions	A list of 11 conditions including: cancer, heart and circulatory conditions, chronic joint problems, chronic pulmonary diseases, chronic kidney problems, chronic digestive problems, psychological illness, diabetes, and/or other chronic conditions (such as eye, nose, sore and throat, teeth problems, etc)	Educational level and occupational status

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Dugravot et al. 2019 (60)	Longitudinal	UK	Adults aged 35-55 years	Presence of multimorbidity Cut-off of 2 and 5 conditions	9 conditions including diabetes, coronary heart disease, stroke, chronic obstructive pulmonary disease, depression, arthritis, cancer, dementia and Parkinson's disease	Occupational position, education.
Johnston et al. 2019 (63)	Longitudinal	Scotland	Adults aged 45 to 51 years	Presence of multimorbidity Cut-off of 2 conditions	Six conditions. List not provided	Father's occupation during childhood. Educational attainment in adulthood
Park et al. 2019 (69)	Longitudinal	South Korea	Adults aged 50 years and older	Presence and patterns of multimorbidity (LCA) Cut-off of 2 conditions	10 chronic diseases: hypertension, dyslipidaemia, stroke, osteoarthritis, tuberculosis, asthma, allergic	Household income, educational level and occupation
Russell et al 2019 (55)	Longitudinal	New Zealand	Age 2 years	Presence of multimorbidity Cut-off of 2 conditions	Asthma requiring medication, eczema requiring medication, a birth condition, epilepsy, permanent hearing problems, vision problems not correctable with glasses, and obesity	Index constructed from maternal education, employment, financial stress, beneficiary status, housing tenure, overcrowding,

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
						and residential mobility
Seo 2019 (71)	Longitudinal	South Korea	Working age adults	Presence of multimorbidity Cut-off of 2 conditions	23 conditions	Type of employment, income, education
Calderon-Larrañaga et al. 2018 (57)	Longitudinal	Sweden	Adults aged 60 years and over	Presence of multimorbidity was explored as rapid or slow development of multiple chronic conditions. Cut-off of 2 conditions	List not provided. A disease was considered chronic if it had a long and if residual disability remained or life quality was worsened or long period of care, treatment or rehabilitation was needed.	Educational level and occupation
Costa et al. 2018 (40)	Cross-sectional	Brazil	Adults aged 60 years and over	Presence and nature of multimorbidity Cut-off of 2 conditions	31 conditions: cardiovascular diseases, metabolic conditions, musculoskeletal conditions, incontinence and constipation, neurological diseases, mental disorders, cancer, respiratory diseases and kidney disease.	Educational level and monthly income per capita (National Economic Index)

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Mondor et al. 2018 (80)	Cross-sectional	Canada	Adults aged 18 years and older	Presence of multimorbidity Cut-off of 2 conditions	12 chronic conditions including high blood pressure, diabetes, osteoarthritis, rheumatoid arthritis, heart attack, stroke, cancer, chronic lung disease, hip fracture, Parkinson's disease, Alzheimer's disease, affective disorders.	Household income and educational level inequalities.
Stanley et al. 2018 (3)	Cross-sectional	New Zealand	Adults aged 18 years and older	Presence of multimorbidity. Cut-off of 2 conditions	List of diseases not provided but listed elsewhere (64).	Area based measure of socioeconomic deprivation
Stokes et al. 2018 (91)	Cross-sectional	New Zealand	Pacific and Maori adults aged 35 years and older	Presence of multimorbidity. Cut-off of 2 conditions	31 chronic conditions	Area based measure of socioeconomic deprivation
Alimohammadian et al. 2017 (35)	Cross-sectional	Iran	Adults aged 40-75 years	Presence of multimorbidity. Cut-off of 2 conditions	A total of nine conditions were explored: cardiovascular disease, diabetes (type I and II), chronic obstructive pulmonary disease, chronic liver disease, tuberculosis, gastro-oesophageal reflux disease (GORD), and cancers	Socioeconomic status. Education.
Canizares et al. 2017 (59)	Longitudinal	Canada	Adults aged 20-69	Presence and extent of multimorbidity.	18 chronic conditions were explored: arthritis, back problems, respiratory conditions, allergies	Education, and household income.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
				Cut-off of 2 conditions	(excluding food allergies), cardiovascular diseases, diabetes, cancer, ulcers, urinary incontinency, dementia, migraine, glaucoma, and cataracts.	
Hayek et al. 2017 (61)	Longitudinal	Israel	Adults aged 21 years and over	Presence of multimorbidity. Cut-off of 2 conditions	10 conditions were assessed: asthma, arthritis, cancer, diabetes, dyslipidemia, heart attack, hypertension, migraine, osteoporosis, or thyroid disease.	Monthly household income and years of schooling
Katikireddi et al. 2017 (10)	Longitudinal	Scotland	Adults aged 35 to 75 years	Presence and extent of multimorbidity. Cut-off of 2 conditions	40 conditions	Area-based deprivation level.
Ki et al. 2017 (65)	Longitudinal	South Korea	Adults aged 30 years and over	Presence and extent of multimorbidity. Cut-off of 2 conditions	66 chronic conditions.	Educational attainment, employment status and relative poverty index.
Nielsen et al. 2017 (92)	Cross-sectional	15 European countries	Adults aged 50 years and over	Presence of multimorbidity. Cut-off of 2 conditions	13 chronic conditions: high blood pressure, diabetes, osteoarthritis, rheumatoid arthritis, heart attack, stroke, cancer, chronic lung disease, hip fracture, Parkinson's disease,	Educational level, household income.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
					Alzheimer's disease, affective disorders.	
Nunes et al. 2017 (12)	Cross-sectional	Brazil	Adults aged 18 years and over	Presence of multimorbidity. Cut-off of 2 conditions	21 chronic conditions including: cardiovascular diseases, respiratory conditions, mental disorders, musculoskeletal conditions, metabolic disorders, arthritis/rheumatism, cancer, kidney problem.	State level of education and wealth quintiles.
Puth et al. 2017 (81)	Cross-sectional	Germany	Adults aged 18 years and older	Presence of multimorbidity Cut-off of 2 conditions	15 chronic diseases: hypertension, coronary heart disease, myocardial infarction, chronic heart failure, stroke, diabetes mellitus, bronchial asthma, any type of cancer, hypercholesterolemia, chronic bronchitis, chronic liver disease, arthrosis, osteoporosis, arthritis and depression	Level of education
Congdon, 2016 (93)	Cross-sectional	London, UK	Adults aged between 65-75 years	Presence of multimorbidity. Cut-off of 2 conditions	A list of 15 chronic conditions were assessed: cardiovascular diseases, diabetes, asthma, chronic obstructive pulmonary disease, dementia, depression, serious mental illness (psychosis or bipolar disorder), cancer, and chronic kidney disease.	Area-level socioeconomic deprivation

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Garin et al. 2016 (43)	Cross-sectional	9 low to upper middle-income countries	Adults aged 50 years of age	Presence of multimorbidity. Cut-off of 2 conditions	9 conditions explored: arthritis, asthma, cataract, chronic obstructive pulmonary disease (COPD), depression, diabetes, edentulism, hypertension, cognitive impairment, obesity, and stroke.	Household income, education
Jackson et al. 2016 (9)	Longitudinal	Australia	Women aged 45 to 50 years	Multimorbidity patterns (psychosomatic, musculoskeletal, cardiometabolic, cancer and respiratory syndromes).	23 conditions examined including cardiovascular diseases, musculoskeletal conditions, respiratory diseases, cancer, allergies, mental conditions, diabetes, impaired glucose tolerance, chronic fatigue syndrome.	Education, occupation and income management.
Tomasdottir et al. 2016 (73)	Longitudinal	Norway	Adults aged 20-59 years	Presence of multimorbidity. Cut-off of 2 conditions	17 chronic conditions	Financial hardship (worries)
Afshar et al. 2015 (34)	Cross-sectional	28 Low to middle-income countries	Adults aged 18 and over	Presence of multimorbidity. Cut-off of 2 conditions	Seven chronic conditions including: arthritis, angina pectoris, asthma, depression, schizophrenia or psychosis and diabetes.	Level of education.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Chung et al. 2015 (38)	Cross-sectional	China	Adults aged 15 years and older	Presence and extent of multimorbidity. Cut-off of 2 conditions	List not provided	Household income, educational attainment, employment status and type of housing.
Diaz et al. 2015 (94)	Cross-sectional	Norway	Immigrants aged 15 years and over	Presence of multimorbidity. Cut-off of 2 conditions	List not provided	Personal income level. Reason for migration.
Prazeres and Santiago, 2015 (95)	Cross-sectional	Portugal	Adults aged 18 years and older	Extent and presence of multimorbidity. Cut-off of 2 and 3 conditions	List not provided	Years of educations, professional status and self-perceived Socioeconomic status.
Roberts et al. 2015 (96)	Cross-sectional	Canada	Adults aged 20 years and older	Presence and extent of multimorbidity Cut-off of 2 or 3 conditions	A list of 9 conditions including arthritis, mood disorder and/or anxiety, asthma, diabetes mellitus, heart disease, chronic obstructive pulmonary disease, cancer, stroke, and Alzheimer's disease	Educational level and household income

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Banjare et al. 2014 (37)	Cross-sectional	India	Adults aged over 60 years	Extent of multimorbidity (no morbidity, one morbidity, two morbidities and three or more morbidities)	23 chronic conditions were assessed: musculoskeletal conditions, cardiovascular disease, respiratory conditions, neurological disorders, severe dental conditions, kidney or renal disorders, depression, liver or gall bladder illness, accidental injury, injury due to fall, skin disease.	Education, state of economic independence, quintiles of wealth, living arrangement and caste.
Habib et al. 2014 (44)	Cross-sectional	Lebanon	Palestinian refugees aged between 14 and 87 years old	Presence and extent of multimorbidity. Cut-off of 2 conditions	List not provided	Educational attainment, wealth index.
McLean et al. 2014 (78)	Cross-sectional	Scotland	Adults aged 25 years and over	Presence and pattern of multimorbidity (physical only, mental only and mixed physical and mental multimorbidity). Cut-off of 2 conditions	A list of 35 physical and 8 mental conditions were included but not specified on the paper.	Area-based deprivation.
Violan et al. 2014 (97)	Cross-sectional	Spain	Adults aged 19	Presence of multimorbidity.	31 chronic conditions	Area-level of deprivation

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
			years and older	Cut-off of 2 conditions		
Alaba et al. 2013 (51)	Cross-sectional	South Africa	Adults aged 18 and over	Presence or absence of multimorbidity. Cut-off of 2	Eight chronic conditions were assessed including tuberculosis, high blood pressure, diabetes or high blood sugar, stroke, asthma and cancer.	Years of schooling, household income, social assistance, employment.
Cornish et al. 2013 (54)	Longitudinal	Bristol, UK	Children aged 0 to 18 years	Presence and extent of multimorbidity. Cut-off of 2 conditions	As listed in the Johns Hopkins University Adjusted Clinical Groups (ACG) System	Parent's educational level. Occupational social class. Housing tenure. Family adversity index during pregnancy. Area socioeconomic deprivation.
Demirchyan et al. 2013 (42)	Longitudinal	Armenia	Adults aged 37 to 90 years	Presence of multimorbidity. Cut-off of 2 conditions	List not provided	Education, perceived low affordability of healthcare services and perceived living standards.

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Weiman et al. 2016 (49)	Cross-sectional	South Africa	People aged 15 years and older	Presence of multimorbidity. Cut-off of 2 conditions	List not provided	Multidimensional poverty index
Agborsangaya et al. 2012 (86)	Cross-sectional	Canada	Adults aged 18 and over	Presence of multimorbidity. Cut-off of 2 conditions	>16 chronic conditions explored, including diabetes, respiratory conditions, cardiovascular diseases, depression or anxiety, chronic pain, arthritis, gastrointestinal tract disease and kidney diseases.	Educational level and annual household income.
Barnett et al. 2012 (53)	Cross-sectional	UK	Individuals from all ages	Presence of multimorbidity Cut-off of 2 conditions	40 chromic conditions	Area level deprivation
Schäfer et al. 2012 (70)	Longitudinal	Germany	Adults aged 65 years and older	Presence and patterns of multimorbidity (cardiometabolic disorders (CMD) and anxiety, depression, somatoform disorders and pain (ADS/P)) Cut-off of 3 conditions	29 chronic conditions	Education, autonomy on former occupation and household income

Study	Study design	Location	Population focus	Assessment of multimorbidity (Presence/ Nature/Extent/ Both)	List of chronic conditions	Measure of Socioeconomic disadvantage
Tucker-Seeley et al. 2011 (74)	Longitudinal	United States	Adults aged 50 years and over	Presence and extent of multimorbidity. Count of chronic conditions	Six chronic conditions: cancer, heart disease, lung disease, stroke, diabetes, and hypertension	Childhood financial hardship (yes/no). Average lifetime earnings during young and middle adulthood. Educational attainment as indicator of adult SES

Table *3.* Types of theories and context of application

Study*	Theoretical application	Materialist	Behavioural	Psychosocial	Social capital	Life course	Neo-liberal
Vidyashree et al 2021[b]		✓			✓		
Singh 2021[a]	Theory tested	✓	✓	✓	✓		
Hone et al. 2021[b]		✓	✓	✓			
Hernandez et al. 2021[b]							✓
Khanolkar et al. 2021[a]						✓	
Craig et al. 2021[a]		✓	✓				
Andersen 2021[b]			✓				
Zhao et al. 2020[b]		✓					
Yidiz et al. 2020[a,b]		✓		✓	✓		
Wister et al. 2020[a,b]		✓	✓	✓			
Vinjerui 2020 [a,b]		✓		✓	✓		
Chamberlain 2020[b]		✓					
Odland et al. 2020[b]		✓					
Pati et al. 2020[b]		✓	✓				
Russell et al 2019[b]						✓	
Seo 2019[b]		✓	✓				
Johnston et al. 2019[a]	Theory tested					✓	
Calderon-Larrañaga et al. 2018[a]				✓			

Study*	Theoretical application	Materialist	Behavioural	Psychosocial	Social capital	Life course	Neo-liberal
Mondor et al. 2018[a]	Theory tested		✓				
Alimohammadian et al. 2017[a]			✓				
Katikireddi et al. 2017[a]	Theory tested		✓			✓	
Tomasdottir et al. 2016[a]				✓			
Chung et al. 2015[a]	Theory tested	✓	✓				
Barnett 2012[b]			✓				
Agborsangaya et al. 2012[a]				✓			
Tucker-Seeley et al. 2011[a]		✓				✓	
Costa et al. 2018[b]			✓				
Canizares et al. 2017[b]			✓				
Puth et al. 2017[b]			✓				
Afshar et al. 2015[b]			✓	✓			
Banjare et al. 2014[b]			✓				
Alaba et al. 2013[b]			✓	✓	✓		
Demirchyan et al. 2013[b]		✓	✓	✓			

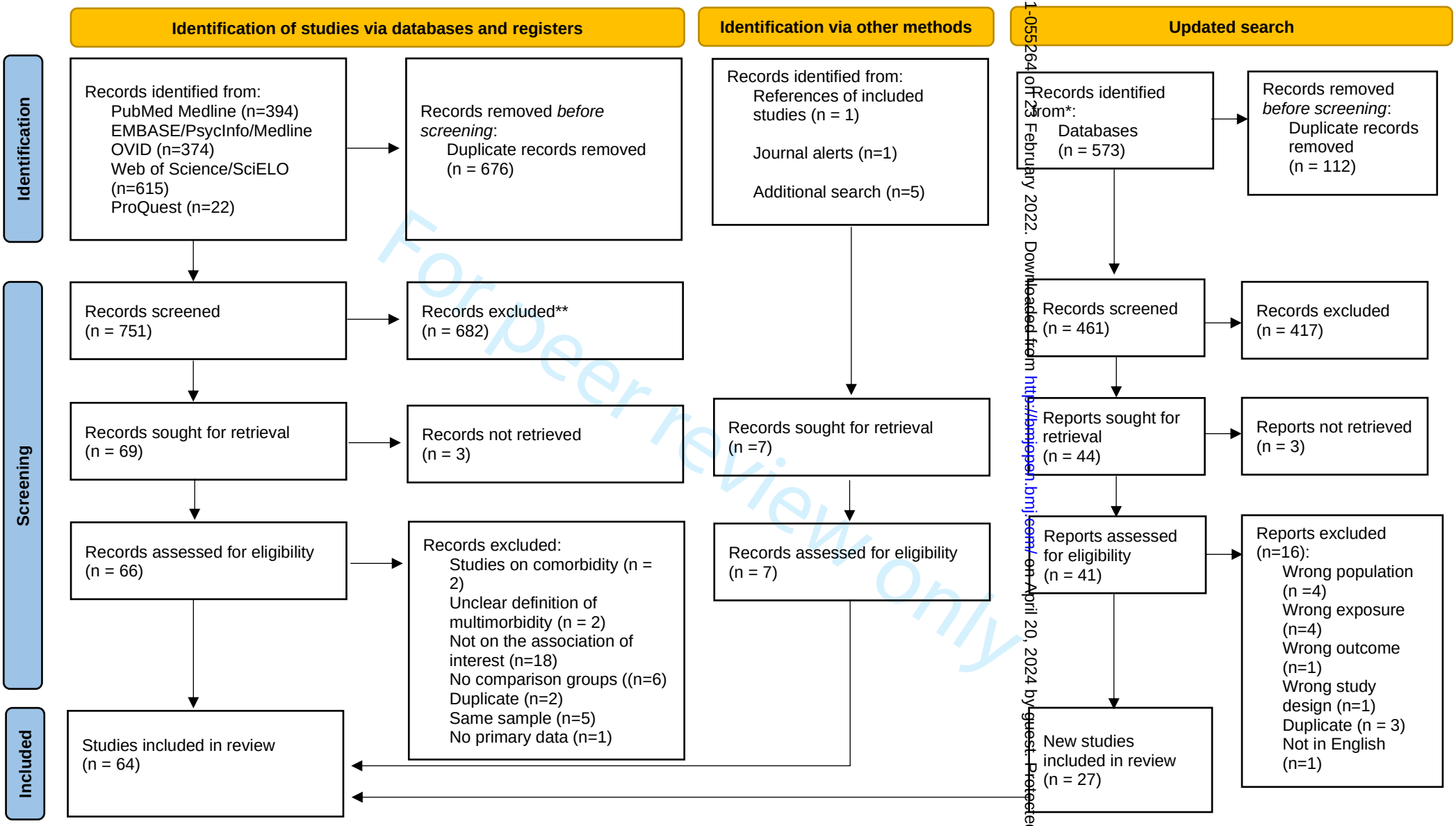
Notes: * Restricted to studies with identified use of theories.

[a] Specific theory was explicitly mentioned by the authors

[b] Theory was identified and inferred by the reviewers

[ab] One or more theories were explicitly mentioned but one or more identified and inferred by the reviewers

PRISMA flow diagram



Appendices

Contents

Appendix 1. Detailed search strategy according to electronic databases 2
MEDLINE 2
WEB OF SCIENCE 6
PUBMED 8
Appendix 2. Reasons for exclusion of studies after full-text review 11
References 12

Appendix 1. Detailed search strategy according to electronic databases

MEDLINE

Outcome	Exposure	Phenomenon
(multimorb$ or multi?morb$ or multiple chronic conditions$ or multiple chronic diseases$).ti.	Psychosocial Deprivation* .ti. OR exp Family characteristics/ OR exp Hierarchy, Social/ OR Social Hierarch* .ti. OR Minority Group* .ti. OR exp Social Class/ OR Social class* .ti. OR Social Mobilit* .ti. OR Caste* .ti. OR Social Condition* .ti. OR exp Sociology/ OR Poverty .ti. OR exp Socioeconomic Factors/ OR Socioeconomic*.ti. OR Salary .ti. OR Salaries .ti. OR Income* .ti. OR Wage* .ti. OR Remuneration* .ti. OR Occupation* .ti. OR Unemploy* .ti. OR Labour* .ti. OR	Inequalit*.ab. OR Unequal*.ab. OR Disparit* .ab. OR Inequit* .ab. OR Difference* .ab. OR Different*.ab. OR Discriminat* .ab. OR Marginali*.ab OR Marginali*.ti OR Depriv* .ab. OR Inequalit*.ti. OR Disparit* .ti. OR Inequit* .ti. OR Difference* .ti. OR Discriminat* .ti. OR Depriv* .ti. OR Disadvantage*.ti. OR Disadvantage*.ab. OR Vulnerab*.ab OR Vulnerab*.ti.

	Labor* .ti. OR Employment* .ti OR Employment* .ab OR Educational Status.ti. OR Educational Achievement*.ti. OR Educational level*.ti OR Educational level*.ab OR Educational attainment .ti OR Educational attainment .ab OR exp Ethnic Groups/ OR Ethnic* .ti. OR Race* .ti. OR Raci* .ti. OR exp Sexism/ OR Sexis* .ti. OR exp Gender Identity/ OR Gender* .ti. OR Social Capital* .ti. OR Neomaterial* .ti. OR Social Cohesi* .ti. OR Materalis* .ti. OR Psychosocial Deprivation* .ab. OR Social Hierarch* .ab. OR Minority Group* .ab. OR	

	Social class* .ab. OR Social Mobilit* .ab. OR Caste* .ab. OR Social Condition* .ab. OR Poverty .ab. OR Socioeconomic*.ab. OR Salary .ab. OR Salaries .ab. OR Income* .ab. OR Wage* .ab. OR Remuneration* .ab. OR Occupation* .ab. OR Unemploy* .ab. OR Labour* .ab. OR Labor* .ab. OR Educational Status.ab. OR Educational Achievement*.ab. OR Ethnic* .ab. OR Race* .ab. OR Raci* .ab. OR Sexis* .ab. OR Gender* .ab. OR Social Capital* .ab. OR Neomaterial* .ab. OR Social Cohesi* .ab. OR	

	Materalis* .ab. OR Neomaterial* .ab.	

WEB OF SCIENCE

Outcome	Exposure	Phenomenon
TS = (multimorb* OR multi-morb* OR "multiple chronic condition*" OR "multiple chronic disease*")	TS = ("Psychosocial Deprivation*" OR "Family characteristics" OR "Social Hierarch*" OR "Minority Group*" OR "Social Class" OR "Social Mobilit*" OR Caste* OR "Social Condition*" OR Sociology OR Poverty. OR "Socioeconomic Factors" OR Socioeconomic* OR Salary OR Salaries OR Income* OR Wage* OR Remuneration* OR Occupation* OR Unemploy* OR Labour* OR Labor* OR Employment* OR Employment* OR "Educational Status" OR	TS = (Inequalit* OR Unequal* OR Disparit* OR Inequit* OR Difference* OR Different* OR Discriminat* OR Marginali* OR Depriv* OR Disadvantage* OR Vulnerab*)

	"Educational Achievement*" OR "Educational level*" OR "Educational attainment" OR "Ethnic Groups" OR Ethnic* OR Race* OR Raci* OR Sexism OR Sexis* OR "Gender Identity" OR Gender* OR "Social Capital*" OR "Social Cohesi*" OR Materalis* OR Neomaterial* OR Materalis* OR Neomaterial*)	

PUBMED

Outcome	Exposure	Phenomenon
multimorb*[TIAB] OR multimorbidity[MH] OR multi-morb*[TIAB] OR multiple chronic condition*[TIAB] OR multiple chronic disease*[TIAB] OR multiple chronic disease [MH]	Psychosocial Deprivation*[TIAB] OR Family characteristics [TIAB] OR Social Hierarch*[TIAB] OR Minority Group*[TIAB] OR Social Class[TIAB] OR Social Mobilit*[TIAB] OR Caste*[TIAB] OR Social Condition*[TIAB] OR Sociology[TIAB] OR Poverty [TIAB] OR Socioeconomic Factors[TIAB] OR Socioeconomic*[TIAB] OR Salary[TIAB] OR Salaries[TIAB] OR Income*[TIAB] OR Wage*[TIAB] OR Remuneration*[TIAB] OR Occupation*[TIAB] OR Unemploy*[TIAB] OR Labour*[TIAB] OR Labor*[TIAB] OR Employment*[TIAB] OR Educational Status [TIAB] OR	Inequalit*[TIAB] OR Unequal*[TIAB] OR Disparit*[TIAB] OR Inequit*[TIAB] OR Difference*[TIAB] OR Different*[TIAB] OR Discriminat*[TIAB] OR Marginali*[TIAB] OR Depriv*[TIAB] OR Disadvantage*[TIAB] OR Vulnerab*[TIAB]

	Educational Achievement*[TIAB] OR Educational level*[TIAB] OR Educational attainment [TIAB] OR Ethnic Groups[TIAB] OR Ethnic*[TIAB] OR Race*[TIAB] OR Raci*[TIAB] OR Sexism[TIAB] OR Sexis*[TIAB] OR "Gender Identity"[TIAB] OR Gender*[TIAB] OR Social Capital*[TIAB] OR Social Cohesi*[TIAB] OR Materalis*[TIAB] OR Neomaterial*[TIAB] OR Materalis*[TIAB] OR Neomaterial*[TIAB]	

PROQUEST (Applied Social Sciences/ERIC/Humanities Index/ProQuest Central/ProQuest dissertation and Thesis Global/Sociological Abstracts)

multimorb* OR multi-morb* OR "multiple chronic condition*" OR "multiple chronic diseases*"

AND

"Psychosocial Deprivation*" OR "Family characteristics" OR "Social Hierarch*" OR "Minority Group*" OR "Social Class" OR "Social Mobilit*" OR Caste* OR "Social Condition*" OR Sociology OR Poverty. OR "Socioeconomic Factors" OR Socioeconomic* OR Salary OR Salaries OR Income* OR Wage* OR Remuneration* OR Occupation* OR

Unemploy* OR Labour* OR Labor* OR Employment* OR Employment* OR "Educational Status" OR "Educational Achievement*" OR "Educational level*" OR "Educational attainment" OR "Ethnic Groups" OR Ethnic* OR Race* OR Raci* OR Sexism OR Sexis* OR "Gender Identity" OR Gender* OR "Social Capital*" OR "Social Cohesi*" OR Materalis* OR Neomaterial* OR Materalis* OR Neomaterial*

AND

Inequalit* OR Unequal* OR Disparit* OR Inequit* OR Difference* OR Different* OR Discriminat* OR Marginali* OR Depriv* OR Disadvantage* ORVulnerab*

Appendix 2. Reasons for exclusion of studies after full-text review

Comorbidity Barnett, Mercer (1), Gallacher, McQueenie (2), Alonso-Moran, Orueta (3)

Unclear definition of multimorbidity Chau, Baumann (4), Reis-Santos, Gomes (5)

Did not explore the association between socioeconomic disadvantage and multimorbidity Charlton, Rudisill (6), Galenkamp, Gagliardi (7), Golinowska, Sowa (8), Jessen, Pallesen (9), Koroukian, Schiltz (10), Mujica-Mota, Roberts (11), Orueta, Garcia-Alvarez (12), Phaswana-Mafuya, Peltzer (13), Rodrigues, Gregorio (14), Thavorn, Maxwell (15), Tran, Kiran (16), van den Akker, Buntinx (17), Wang, Wang (18), Ward (19), Woo and Leung (20), Cassell, Edwards (21), Brinda, Attermann (22), Kone, Mondor (23)

Absence of comparative group Eakin, Bull (24), Frakes, Brownie (25), Kangovi, Mitra (26), Leiser, Deruaz-Luyetl (27), Smith, Ferede (28), von dem Knesebeck, Bickel (29)

Full-text unavailable Jantz (30), Pati and Swain (31), Russel, Grant (32), Cezard, Keenan (33), Zou, Wang (34)

Duplicate Myung, Yo Han (35), Srinivasa Vittal, Skivington (36), Aminisani, Stephens (37), Chamberlain, Rutten (38), Pati, Swain (39)

Use of the same sample Ahmadi, Alimohammadian (40), Ataguba (41), Kunna, Miguel San (42), Nunes, Thume (43), Habib, Mikati (44)

No primary data Shadmi (45)

Not in English Melo and Lima (46)

Not peer-reviewed Korea National Health & Nutrition Survey (47)

Wrong exposure Basham (48), Douglas, Vinjerui (49), Guimaraes and Andrade (50), Harrison, Britt (51)

Wrong outcome Kivimaki, Batty (52)

Wrong population Calderon-Larranaga, Marengoni (53), Carrilero, Dalmau-Bueno (54), Shang, Peng (55), Vinjerui, Boeckxstaens (56)

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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.	
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.	
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.	
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.	
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.	
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.	
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.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
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.	
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.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
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.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
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.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
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.	
Limitations	20	Discuss the limitations of the scoping review process.	
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.	
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.	

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.