ABSTRACT

Objective To document socioepidemiological 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, Sclio, Applied Social Sciences, ERIC, Humanities Index and Sociological Abstracts. After the selection of studies, data were extracted using a data charting plan. The last search was performed on the 28 September 2021. Extracted data included: study design, country, population subgroups, 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, 16 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) theories 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.

INTRODUCTION

Multimorbidity is a societal challenge and an increasingly recognised public health concern. It is described as the co-occurrence of two or more chronic conditions in an individual. 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. There is an emerging threat of increased multimorbidity worldwide, primarily due to population ageing and the epidemiological transition from communicable to non-communicable diseases. 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. Furthermore, multiple studies have reported socioeconomic inequalities in multimorbidity within countries regardless of their level of economic development.

A meta-analysis of 24 cross-sectional studies reported that low education compared with high education was associated with 64% higher odds of multimorbidity. 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. A clear causal relationship between socioeconomic conditions and multimorbidity has also been argued based on empirical evidence, however, pathways through which socioeconomic disadvantage leads to multimorbidity are not well studied.

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 (eg, socioeconomic position) leads to a health outcome, and as such, they are particularly helpful in informing intervention designs. Since the release of the Black Report in 1982, several categories of theories have been proposed to explain associations between social inequalities and health outcomes, although in the context of single diseases or health measure. These include:

1. 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. As a result, poor health outcomes are commonly clustered at the lower end of the socioeconomic scale. Behavioural theory can be extended to apply to multimorbidity from a common risk factor approach, as a behavioural risk factor can cause multiple diseases (eg, smoking can cause cancer, asthma and cardiovascular diseases).

2. Psychosocial: this theory postulates that the emotions that arise due to social inequality can directly affect biological health. 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. 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 neuroendocrine mechanisms, and in doing so, may affect multiple body systems and lead to multimorbidity.

3. 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 with their more advantaged counterparts. Socioeconomically deprived individuals are also more likely to be exposed to hazardous working environments. The materialist theory proposes these explanations as pathways between socioeconomic deprivation and health inequalities.

4. Social support: this theory holds that positive social support mitigates the detrimental effect of socioeconomic deprivation in health. 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.

5. 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. 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. 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 above-mentioned theories, a life course framework examines the effect of early life socioeconomic exposures on later health outcomes. 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. 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 socioepidemiological 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.
indicate the differences in disease levels between people. We use the term socioeconomic inequalities in health to describe area level measures (deprivation, socioeconomic scores). Educational attainment, income, occupation, wealth and the position in which an individual or a group is located are displayed in table 1. We applied a strict inclusion and exclusion criteria; these were focused on an index condition (e.g., diabetes). 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. 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.

### Methods

We conducted a scoping review to examine epidemiological theories applied to explain the association between socioeconomic disadvantage and multimorbidity 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.

**Stage I: identifying the research question**

Our research 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 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 on, 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 online supplemental 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 25 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, socioeconomic 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.

We excluded studies on ‘comorbidity’ as such studies are focused on an index condition (e.g., diabetes). 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. 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.

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

---

Fleitas Alfonzo L, et al. BMJ Open 2022;12:e055264. doi:10.1136/bmjopen-2021-055264
theories. When directly mentioned, types of theories were recorded verbatim. This follows the approach previously applied in a published study examining the application of socioepidemiological theories in studies on the relationship between social inequality and oral health.31

Stage V: collating, summarising 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 conducting 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. Online supplemental 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 flow chart of this process is shown in figure 1.

Summary characteristics of included studies
Twenty studies were from low-income and middle-income countries12 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 data9 10 42 54 56–76 (table 2).

Table 2

| Type of Study | Number of Studies |
|---------------|-------------------|
| Cross-sectional | 38 |
| Longitudinal | 26 |

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 multimorbidity9 40 41 45 47 53 55 67–70 72 75 77 78 (table 2).

Types of theories
Overall, nearly half of studies (33/64) referred to at least one socioepidemiological theory. Therefore, 31 studies can be considered largely atheoretical, without any emphasis on pathways through which socioeconomic disadvantage leads to multimorbidity. In the 33 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 materialist38 41 42 45 46 48 50 52 71 72 74 79 82–85 and psychosocial.34 42 51 52 57 72 73 74 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 capital51 and social support,57 which are widely considered as

Figure 1 Flow chart of the study selection process.

Fleitas Alfonzo L, et al. BMJ Open 2022;12:e055264. doi:10.1136/bmjopen-2021-055264
| Study                  | Study design | Location          | Population focus               | Assessement of multimorbidity (presence/nature/extent/both) | List of chronic conditions                                                                 | Measure of socioeconomic disadvantage                      |
|-----------------------|--------------|-------------------|---------------------------------|-------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Andersen et al.       | Cross-sectional | Finland           | Adults aged 20–69 years          | Presence of multimorbidity. Out-of-two 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.          | Longitudinal  | USA               | 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.          | 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.           | Longitudinal  | England           | Adults aged 18 years and over     | Presence of multimorbidity. Out-of two and three conditions. | 211 conditions listed elsewhere.62                                                                      | Area-level deprivation.                                     |
| Hernández et al.      | Cross-sectional | 4 high income     | Adults aged 52–85 years           | Patterns of multimorbidity.                                  | 10 conditions including cardiovascular diseases, diabetes, arthritis, cancer, lung disease, osteoporosis and psychological disorders. | Education, household income and employment.                |
| Hone et al.           | Cross-sectional | Brazil            | Individuals of any age            | Presence of multimorbidity. Count of chronic conditions.    | 53 chronic conditions.                                                                                       | Education.                                                 |
| Khanolkar et al.      | Longitudinal  | UK                | Adults aged 36–69 years           | Presence of multimorbity. 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.            | Longitudinal  | South Korea       | Adults aged 45 years and over      | Multimorbidity clusters. Out-of two 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.           | Cross-sectional | Canada            | Adults aged 22–95 years           | Presence of multimorbity. Out-of two and three conditions.   | 18 chronic diseases including cardiovascular diseases, respiratory conditions, diabetes, mental illness, musculoskeletal conditions, renal failure, inflammatory bowel failure and cancers. | Household income and education.                            |
| Zacarias-Pons et al.  | 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, catarracts, dementia, other affective or emotional disorders, rheumatoid arthritis, osteoarthritis and osteoporosis | Education, employment and material deprivation index.       |
| Vidyasheer et al.     | Cross-sectional | India             | People aged 60 years and above     | Presence of multimorbidity (cut-off unclear).               | Unclear.                                                                                                  | Economic dependency.                                       |
| Sharma and Maurya et al | Cross-sectional | India         | People aged 60 years and above     | Presence and patterns of multimorbity. Out-of two 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, catarract, loss of all-natural teeth, accidental injury in the past year, injury due to fall, skin disease and paralysis. | Educational attainment, working status and wealth quintile. |
| Singh et al.          | Longitudinal  | Australia         | People aged 15 years and above     | Presence of multimorbidity. Out-of two conditions.           | Arthritis, cancer, type 1 diabetes mellitus, type 2 diabetes mellitus, hypertension, heart disease, asthma, bronchitis or depression. | Financial hardship.                                         |
| Aminisani et al.      | Longitudinal  | New Zealand       | Adults aged 55–70 years           | Presence of multimorbity. Out-of two conditions.             | Nine groups of chronic diseases: cardiovascular diseases, neurological diseases, musculoskeletal conditions, diabetes mellitus, respiratory diseases, chronic liver conditions, cancer and mental disorders. | Education and income.                                     |
| Study             | Study design | Location     | Population focus          | Assessment of multimorbidity (presence/ nature/ extent/ both) | List of chronic conditions                                                                 | Measure of socioeconomic disadvantage                                      |
|-------------------|--------------|--------------|---------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Chamberlain et al  | Cross-sectional | USA          | Adults aged 20 years and over | Presence of multimorbidity. Cut-off of two conditions.         | 21 conditions including cardiovascular diseases, metabolic conditions, respiratory diseases, arthritis, osteoporosis, chronic kidney disease, autism spectrum disorder,  | Area level deprivation.                                                        |
| Costa et al       | Cross-sectional | Brazil       | Adults aged 20-59 years    | Presence of multimorbidity. Cut-off of two 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         | Longitudinal  | South Korea  | Adults aged 19 years and over | Presence of multimorbidity. Cut-off of two conditions.         | 28 chronic conditions as listed elsewhere.                                                              | Household income and education.                                               |
| Møller et al      | Longitudinal  | Denmark      | People aged 16 years and over | Multimorbidity patterns or classes (Latent Class Analysis).    | 47 diseases.                                                                                           | Education and employment.                                                     |
| Odland et al      | Cross-sectional | Burkina Faso | Adults aged 40 years and older | Presence and patterns of multimorbidity. Cut-off of two conditions. | 11 conditions including: cancer, HIV, chronic respiratory disease, stroke heart disease, hypertension, diabetes, anxiety, depression and dementia/cognitive decline. | Education and wealth.                                                          |
| Pati et al        | Cross-sectional | India        | Adults aged 18 years and older | Presence of multimorbidity. Cut-off of two conditions.         | 21 chronic conditions.                                                                                  | Poverty level and education.                                                  |
| Zhao et al        | Longitudinal  | China        | People aged 50 years and older | Presence of multimorbidity. Cut-off of two conditions.         | Diagnosed.                                                                                             | Annual per-capita household consumption.                                     |
| Yildiz et al      | Cross-sectional | The Netherlands | People aged 18–64 years | Presence of multimorbidity. Cut-off of two conditions.         | List of most prevalent chronic diseases (cardiovascular diseases, psychological disorders, inflammatory conditions and respiratory diseases). | Employment status and education.                                             |
| Wister et al      | Cross-sectional | Canada       | People aged 45–85 years    | Presence of multimorbidity. Cut-off of two 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 ischaemic attack, kidney disease, rheumatoid arthritis, bowel incontinence, stroke, multiple sclerosis, epilepsy, Parkinson’s disease, as well as dementia and Alzheimer’s disease. | Vancouver.                                                                  |
| Vinjeru et al     | 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          | Cross-sectional | Vietnam      | Individuals aged 15 years and over | Presence of multimorbidity. Cut-off of two 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.                                   |
| Dugravot et al    | Longitudinal  | UK           | Adults aged 35–55 years    | Presence of multimorbidity. Cut-off of two and five conditions. | 9 conditions including diabetes, coronary heart disease, stroke, COPD, depression, arthritis, cancer, dementia and Parkinson’s disease. | Occupational position, education.                                             |
| Johnston et al    | Longitudinal  | Scotland     | Adults aged 45–51 years    | Presence of multimorbidity. Cut-off of two conditions.         | Six conditions. List not provided.                                                                     | Father’s occupation during childhood. Educational attainment in adulthood.  |
| Park et al        | Longitudinal  | South Korea  | Adults aged 50 years and older | Presence and patterns of multimorbidity (LCA). Cut-off of two conditions. | 10 chronic diseases: hypertension, dyslipidaemia, stroke, osteoarthritis, tuberculosis, asthma and allergies. | Household income, educational level and occupation.                         |
| Study | Design | Location | Population | Age | Presence of multimorbidity | Cut-off of two conditions | Measure of socioeconomic disadvantage | Type of employment and income |
|-------|--------|----------|------------|-----|---------------------------|----------------------------|--------------------------------|-------------------------------|
| Russell et al | Cross-sectional | New Zealand | Adults aged 60 years and over | Presence of multimorbidity | cuts-off of two conditions | Educational level and income per capita | Socioeconomic status | Education and household income |
| Seo et al | Cross-sectional | South Korea | Working age adults | Presence of multimorbidity | cuts-off of two conditions | Household income and educational level | Area-based measure of socioeconomic deprivation | Monthly household income and years of schooling |
| Alimohammadian et al | Cross-sectional | Iran | Adults aged 40–75 | Presence of multimorbidity | cuts-off of two conditions | Socioeconomic status and household income | Education and household income | Area-based deprivation level |
| Canizares et al | Cross-sectional | Colombia | Adults aged 21 years and over | Presence of multimorbidity | cuts-off of two conditions | Area-based measure of socioeconomic deprivation | Education and household income | Area-based measure of socioeconomic deprivation |
| Katikireddi et al | Cross-sectional | New Zealand | Adults aged 35–75 | Presence of multimorbidity | cuts-off of two conditions | Area-based measure of socioeconomic deprivation | Education and household income | Area-based measure of socioeconomic deprivation |
| Nielsen et al | Cross-sectional | Brazil | Adults aged 50 years and over | Presence of multimorbidity | cuts-off of two conditions | Area-based measure of socioeconomic deprivation | Education and household income | Area-based measure of socioeconomic deprivation |
| Nunes et al | Cross-sectional | Brazil | Adults aged 18 years | Presence of multimorbidity | cuts-off of two conditions | Area-based measure of socioeconomic deprivation | Education and household income | Area-based measure of socioeconomic deprivation |

*Note: The table continues with additional studies and data.*
### Table 2 Continued

| Study                  | Study design | Location                  | Population focus                  | Assessment of multimorbidity (presence/ nature/extent/ both) | List of chronic conditions                                                                 | Measure of socioeconomic disadvantage                                      |
|------------------------|--------------|----------------------------|-----------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Puth et al[^8]         | Cross-sectional | Germany                  | Adults aged 18 years and older     | Presence of multimorbidity. Cut-off of two conditions.      | 15 chronic diseases: hypertension, coronary heart disease, myocardial infarction, chronic heart failure, stroke, diabetes mellitus, bronchial asthma, any type of cancer, hypercholesterolaemia, chronic bronchitis, chronic liver disease, arthritis, osteoporosis, arthritis and depression. | Level of education.                                                        |
| Congdon[^9]            | Cross-sectional | London, UK               | Adults aged between 65 and 75 years | Presence of multimorbidity. Cut-off of two conditions.      | A list of 15 chronic conditions were assessed: cardiovascular diseases, diabetes, asthma, COPD, dementia, depression, serious mental illness (psychosis or bipolar disorder), cancer and chronic kidney disease. | Area-level socioeconomic deprivation.                                      |
| Garin et al[^10]       | Cross-sectional | 9 low to upper middle-income countries | Adults aged 50 years of age        | Presence of multimorbidity. Cut-off of two conditions.      | 9 conditions explored: arthritis, asthma, cataract, COPD, depression, diabetes, edentulism, hypertension, cognitive impairment, obesity and stroke.                                                                 | Household income and education.                                             |
| Jackson et al[^11]     | Longitudinal  | Australia                 | Women aged 45–50 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 and chronic fatigue syndrome. | Education, occupation and income management.                               |
| Tomasdottir et al[^12] | Longitudinal  | Norway                    | Adults aged 20–59 years            | Presence of multimorbidity. Cut-off of two conditions.      | 17 chronic conditions.                                                                                                                                  | Financial hardship (worries).                                               |
| Afshar et al[^13]      | Cross-sectional | 28 low-income to middle-income countries | Adults aged 18 years and over      | Presence of multimorbidity. Cut-off of two conditions.      | Seven chronic conditions including: arthritis, angina pectoris, asthma, depression, schizophrenia or psychosis and diabetes.                                                                                        | Level of education.                                                        |
| Chung et al[^14]       | Cross-sectional | China                     | Adults aged 15 years and older     | Presence and extent of multimorbidity. Cut-off of two conditions. | List not provided.                                                                                                                                      | Household income, educational attainment, employment status and type of housing. |
| Diaz et al[^15]        | Cross-sectional | Norway                    | Immigrants aged 15 years and over  | Presence of multimorbidity. Cut-off of two conditions.      | List not provided.                                                                                                                                      | Personal income level, Reason for migration.                                |
| Prazeres and Santiago[^16] | Cross-sectional | Portugal                   | Adults aged 18 years and older     | Extent and presence of multimorbidity. Cut-off of two and three conditions. | List not provided.                                                                                                                                      | Years of educations, professional status and self-perceived socioeconomic status. |
| Roberts et al[^17]     | Cross-sectional | Canada                    | Adults aged 20 years and older     | Presence and extent of multimorbidity. Cut-off of two or three conditions. | A list of nine conditions including arthritis, mood disorder and/or anxiety, asthma, diabetes mellitus, heart disease, COPD, cancer, stroke, and Alzheimer’s disease. | Educational level and household income.                                    |
| Banjare and Pradhan[^18] | 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 and skin disease. | Education, state of economic independence, quintiles of wealth, living arrangement and caste. |
| Habib et al[^19]       | Cross-sectional | Lebanon                    | Palestinian refugees aged between 14 and 87 years old | Presence and extent of multimorbidity. Cut-off of two conditions. | List not provided.                                                                                                                                      | Educational attainment and wealth index.                                    |

[^8]: Fleitas Alfonzo L, et al. BMJ Open 2022;12:e055264. doi:10.1136/bmjopen-2021-055264
[^9]: Puth et al.
[^10]: Garin et al.
[^11]: Jackson et al.
[^12]: Tomasdottir et al.
[^13]: Afshar et al.
[^14]: Chung et al.
[^15]: Diaz et al.
[^16]: Prazeres and Santiago
[^17]: Roberts et al.
[^18]: Banjare and Pradhan
[^19]: Habib et al.
## Table 2

| Study                        | Study design | Location       | Population focus       | Assessment of multimorbidity (presence/ nature/extent/ both)                                                                 | List of chronic conditions                                                                 | Measure of socioeconomic disadvantage                                                        |
|------------------------------|--------------|----------------|------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| McLean et al<sup>78</sup>    | 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 two conditions. | A list of 35 physical and eight mental conditions were included but not specified on the paper. | Area-based deprivation.                                                                     |
| Violán et al<sup>97</sup>    | Cross-sectional | Spain         | Adults aged 19 years and older | Presence of multimorbidity. Cut-off of two conditions.                                                                       | 31 chronic conditions.                                                                       | Area-level of deprivation.                                                                  |
| Alaba and Chola<sup>67</sup> | Cross-sectional | South Africa  | Adults aged 18 years and over | Presence or absence of multimorbidity. Cut-off of two conditions.                                                              | 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 and employment.                      |
| Cornish et al<sup>84</sup>   | Longitudinal  | Bristol, UK    | Children aged 0–18 years     | Presence and extent of multimorbidity. Cut-off of two conditions.                                                              | As listed in the Johns Hopkins University Adjusted Clinical Groups System.                   | Parent’s educational level. Occupational social class. Housing tenure. Family adversity index during pregnancy. Area socioeconomic deprivation. |
| Demirchyan et al<sup>42</sup> | Longitudinal  | Armenia       | Adults aged 37–90 years     | Presence of multimorbidity. Cut-off of two conditions.                                                                       | List not provided.                                                                          | Education, perceived low affordability of healthcare services and perceived living standards.|
| Weiman et al<sup>98</sup>    | Cross-sectional | South Africa  | People aged 15 years and older | Presence of multimorbidity. Cut-off of two conditions.                                                                       | List not provided.                                                                          | Multidimensional poverty index.                                                             |
| Agborsangaya et al<sup>28</sup> | Cross-sectional | Canada        | Adults aged 18 years and over | Presence of multimorbidity. Cut-off of two 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<sup>93</sup>   | Cross-sectional | UK            | Individuals from all ages   | Presence of multimorbidity Cut-off of two conditions.                                                                       | 40 chronic conditions.                                                                       | Area-level deprivation.                                                                     |
| Schäfer et al<sup>70</sup>   | Longitudinal  | Germany       | Adults aged 65 years and older | Presence and patterns of multimorbidity (cardiometabolic disorders and anxiety, depression, somatoform disorders and pain) Cut-off of three conditions. | 29 chronic conditions.                                                                       | Education, autonomy on former occupation and household income.                               |
| Tucker-Seeley et al<sup>74</sup> | Longitudinal  | USA           | 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 socioeconomic status. |

COPD, chronic obstructive pulmonary disease.
psychosocial assets (table 3). Five studies used a life-course framework. Collectively, behavioural theory was the most referred to among studies.

**Context of application of theories**

Of the papers using theories, 15 explicitly stated those theories, and the other 21 studies were inferred to be consistent with a presumed theoretical pathway, based on definitions from existing literature.

**Testing the explanatory potential of theories**

Only five studies tested variables consistent with theoretical pathways as mediators between socioeconomic disadvantage and multimorbidity. Applying material theory, Chung et al. examine 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.

Drawing on behavioural theory as well as a life course framework, Katikireddi et al. quantified mediation by five behavioural risk factors (diet, smoking, physical activity, alcohol and body mass index (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. 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. 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. 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; 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’. 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, is difficult to establish cross-sectionally. Second, there is a paucity of evidence regarding pathways (eg, behavioural, material and psychosocial) between the shared causal factor (exposure to socioeconomic disadvantage) and multiple conditions that co-occur in multimorbidity. The lack of evidence precludes policymakers from intervening on causal mechanisms that can prevent or mitigate observed socioeconomic inequalities in multimorbidity. 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. 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 (eg, age) and contextual characteristics (eg, 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. A key limitation is that
| Study*                        | Theoretical application | Materialist | Behavioural | Psychosocial | Social capital | Life course | Neoliberal |
|------------------------------|-------------------------|-------------|-------------|--------------|----------------|-------------|------------|
| Vidyashree et al 2021†48     | ✓                       | ✓           | ✓           | ✓            |                |             |            |
| Singh et al 2021†72          | Theory tested           | ✓           | ✓           | ✓            |                |             |            |
| Hone et al 2021†52           | ✓                       | ✓           | ✓           |              |                |             |            |
| Herández et al 2021†77       | ✓                       |             |             |              |                |             |            |
| Khanolkar et al 2021†74      | ✓                       |             |             |              |                |             |            |
| Craig et al 2021‡41          | ✓                       | ✓           |             |              |                |             |            |
| Anderén et al 2021†79        | ✓                       |             |             |              |                |             |            |
| Zhao et al 2020†80           | ✓                       |             |             |              |                |             |            |
| Yidiz et al 2020$^55$        | ✓                       | ✓           | ✓           | ✓            |                |             |            |
| Wister et al 2020$^82$       | ✓                       | ✓           | ✓           |              |                |             |            |
| Vinjerui et al 2020$^54$     | ✓                       |             |             |              |                |             |            |
| Chamberlain 2020†83          | ✓                       |             |             |              |                |             |            |
| Odland et al 2020†45         | ✓                       |             |             |              |                |             |            |
| Pati et al 2020†46           | ✓                       | ✓           |             |              |                |             |            |
| Russell et al 2019†65        | ✓                       |             |             |              |                |             |            |
| Seo 2019†71                  | ✓                       | ✓           |             |              |                |             |            |
| Johnston et al 2019‡63       | Theory tested           | ✓           |             |              |                |             |            |
| Calderón-Larrañaga et al 2018†57 | ✓                     |             |             |              |                |             |            |
| Mondor et al 2018‡30         | Theory tested           | ✓           |             |              |                |             |            |
| Alimohammadian et al 2017‡35 | ✓                       |             |             |              |                |             |            |
| Katikireddi et al 2017‡70    | Theory tested           | ✓           |             |              |                |             |            |
| Tomasdottir et al 2016‡73    | ✓                       |             |             |              |                |             |            |
| Chung et al 2015‡53          | Theory tested           | ✓           | ✓           |              |                |             |            |
| Barnett et al 2012‡53        | ✓                       |             |             |              |                |             |            |
| Agborsangaya et al 2012‡86   | ✓                       |             |             |              |                |             |            |
| Tucker-Seeley et al 2011‡74  | ✓                       |             |             |              |                |             |            |
| Costa et al 2018‡60          | ✓                       |             |             |              |                |             |            |
| Canizares et al 2017‡59      | ✓                       |             |             |              |                |             |            |
| Puth et al 2017‡81           | ✓                       |             |             |              |                |             |            |
| Afshar et al 2015‡34         | ✓                       | ✓           |             |              |                |             |            |

Continued
open access 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.

Contributors

LF A 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 DC-S contributed towards the development of search strategy and manuscript preparation. SZ contributed towards manuscript preparation. LFA and AS are the guarantors.

Funding

TK is also supported by an Australian Research Council Discovery Early Career Research Award (DE200100607).

Competing interests

None declared.

Patient consent for publication

Not applicable.

Ethics approval

This study does not involve human participants.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data availability statement

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

Supplemental material

This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any errors and/or omissions arising from translation and adaptation or otherwise.

Open access

This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial.

ORCID iDs

Ludmila Fleitas Alfonzo http://orcid.org/0000-0001-6988-5036
Ankur Singh http://orcid.org/0000-0003-1335-6493

Table 3  Continued

| Study* | Theoretical application | Materialist | Behavioural | Psychosocial | Social capital | Life course | Neoliberal |
|--------|-------------------------|------------|-------------|--------------|---------------|------------|------------|
| Banjare and Pradhan 2014†ı37 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Alaba and Chola 2013†51 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Demirchyan et al 2013‡42 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

*Restricted to studies with identified use of theories.
†Theory was identified and inferred by the reviewers.
‡Specific theory was explicitly mentioned by the authors.
§One or more theories were explicitly mentioned but one or more identified and inferred by the reviewers.
REFERENCES

1. Xu X, Mishra GD, Dobson AJ, et al. Progression of diabetes, heart disease, and stroke multimorbidity in middle-aged women: a 20-year cohort study. *PLoS Med* 2018;15:e1002516.

2. Tran J, Norton R, Conrad N, et al. Patterns and temporal trends of comorbidity among adult patients with incident cardiovascular disease in the UK between 2000 and 2014: a population-based cohort study. *PLoS Med* 2018;15:e1002513.

3. Stanley J, Semper K, Millar E, et al. Epidemiology of multimorbidity in New Zealand: a cross-sectional study using national-level hospital and pharmaceutical data. *BMJ Open* 2018;8:e019889.

4. The Academy of Medical Sciences. Multimorbidity: a priority for global health research. London: The Academy of Medical Sciences, 2018.

5. Wallace E, Salisbury C, Guthrie B, et al. Managing patients with multimorbidity in primary care. *BMJ* 2016;353:i21176.

6. Kingston A, Robinson L, Booth H, et al. Projections of multimorbidity in the older population in England to 2035: estimates from the population ageing and care simulation (PACSim) model. *Age Ageing* 2018;47:374–80.

7. Iaccarino G, Tommasi M, Boffa L, et al. Age and multimorbidity predict death among COVID-19 patients. *Hypertension* 2020;76:366–72.

8. Ataguba JE-O. Inequalities in multimorbidity in South Africa. *Int J Equity Health* 2013;12:84.

9. Jackson CA, Dobson AJ, Tooth LR, et al. Lifestyle and socioeconomic determinants of multimorbidity patterns among mid-aged women: a longitudinal study. *PLoS One* 2016;11:e0156804.

10. Katikireddi SV, Skivngton K, Leyland AH, et al. The contribution of risk factors to socioeconomic inequalities in multimorbidity across the lifecycle: a longitudinal analysis of the Twenty-07 cohort. *BMJ Med* 2017;15:192.

11. Kunna R, San Sebastian M, Stewart Williams J. Measurement and decomposition of socioeconomic inequality in single and multimorbidity in older adults in China and Ghana: results from the WHO study on global ageing and adult health (SAGE). *Int J Equity Health* 2017;16:79.

12. Nunes BP, Chiavegatto Filho ADP, Pati S, et al. Contextual and individual inequalities of multimorbidity in Brazilian adults: a cross-sectional national-based study. *BMJ Open* 2017;7:e015885.

13. Palthina Th, Jackson CA. Socioeconomic status and multimorbidity: a systematic review and meta-analysis. *Aust NZ J Public Health* 2018;42:186–94.

14. Ingram E, Ledden S, Beardon S, et al. Household and area-level social determinants of multimorbidity: a systematic review. *J Epidemiol Community Health* 2016;70:142–51.

15. Arcaya MC, Arcaya AL, Subramanian SV. Inequalities in health: definitions, concepts, and theories. *Glob Health Action* 2015;8:27106.

16. Townsend P, Davidson N, Black DS, et al. Determinants of multimorbidity among mid-aged women: a longitudinal study. *PLoS One* 2016;11:e0156804.

17. Bartley M. Health inequality : an introduction to theories, concepts, and methods. Cambridge, UK: Polity Press, 2004.

18. Ball K, Timperio A, Salmon J, and methods. Cambridge, UK: Polity Press, 2004.

19. Paan A, Wang Y, Talaei M, et al. Relation of smoking with total multimorbidity in the older population in England to 2035: estimates from the population ageing and care simulation (PACSim) model. *Age Ageing* 2018;47:374–80.

20. Iaccarino G, Tommasi M, Boffa L, et al. Age and multimorbidity predict death among COVID-19 patients. *Hypertension* 2020;76:366–72.

21. Kunna R, San Sebastian M, Stewart Williams J. Measurement and decomposition of socioeconomic inequality in single and multimorbidity in older adults in China and Ghana: results from the WHO study on global ageing and adult health (SAGE). *Int J Equity Health* 2017;16:79.

22. Ataguba JE-O. Inequalities in multimorbidity in South Africa. *Int J Equity Health* 2013;12:84.

23. Jackson CA, Dobson AJ, Tooth LR, et al. Lifestyle and socioeconomic determinants of multimorbidity patterns among mid-aged women: a longitudinal study. *PLoS One* 2016;11:e0156804.

24. Katikireddi SV, Skivngton K, Leyland AH, et al. The contribution of risk factors to socioeconomic inequalities in multimorbidity across the lifecycle: a longitudinal analysis of the Twenty-07 cohort. *BMJ Med* 2017;15:192.

25. Kunna R, San Sebastian M, Stewart Williams J. Measurement and decomposition of socioeconomic inequality in single and multimorbidity in older adults in China and Ghana; results from the WHO study on global ageing and adult health (SAGE). *Int J Equity Health* 2017;16:79.

26. Nunes BP, Chiavegatto Filho ADP, Pati S, et al. Contextual and individual inequalities of multimorbidity in Brazilian adults: a cross-sectional national-based study. *BMJ Open* 2017;7:e015885.

27. Palthina Th, Jackson CA. Socioeconomic status and multimorbidity: a systematic review and meta-analysis. *Aust NZ J Public Health* 2018;42:186–94.

28. Ingram E, Ledden S, Beardon S, et al. Household and area-level social determinants of multimorbidity: a systematic review. *J Epidemiol Community Health* 2016;70:142–51.

29. Arcaya MC, Arcaya AL, Subramanian SV. Inequalities in health: definitions, concepts, and theories. *Glob Health Action* 2015;8:27106.

30. Townsend P, Davidson N, Black DS, et al. Determinants of multimorbidity among mid-aged women: a longitudinal study. *PLoS One* 2016;11:e0156804.

31. Bartley M. Health inequality : an introduction to theories, concepts, and methods. Cambridge, UK: Polity Press, 2004.

32. Ball K, Timperio A, Salmon J, et al. Personal, social and environmental determinants of educational inequalities in walking: a multilevel study. *J Epidemiol Community Health* 2007;61:108–14.

33. Pan A, Wang Y, Talaei M, et al. Relation of smoking with total multimorbidity in the older population in England to 2035: estimates from the population ageing and care simulation (PACSim) model. *Age Ageing* 2018;47:374–80.

34. Iaccarino G, Tommasi M, Boffa L, et al. Age and multimorbidity predict death among COVID-19 patients. *Hypertension* 2020;76:366–72.

35. Kunna R, San Sebastian M, Stewart Williams J. Measurement and decomposition of socioeconomic inequality in single and multimorbidity in older adults in China and Ghana; results from the WHO study on global ageing and adult health (SAGE). *Int J Equity Health* 2017;16:79.

36. Ataguba JE-O. Inequalities in multimorbidity in South Africa. *Int J Equity Health* 2013;12:84.

37. Jackson CA, Dobson AJ, Tooth LR, et al. Lifestyle and socioeconomic determinants of multimorbidity patterns among mid-aged women: a longitudinal study. *PLoS One* 2016;11:e0156804.

38. Katikireddi SV, Skivngton K, Leyland AH, et al. The contribution of risk factors to socioeconomic inequalities in multimorbidity across the lifecycle: a longitudinal analysis of the Twenty-07 cohort. *BMJ Med* 2017;15:192.

39. Kunna R, San Sebastian M, Stewart Williams J. Measurement and decomposition of socioeconomic inequality in single and multimorbidity in older adults in China and Ghana; results from the WHO study on global ageing and adult health (SAGE). *Int J Equity Health* 2017;16:79.

40. Nunes BP, Chiavegatto Filho ADP, Pati S, et al. Contextual and individual inequalities of multimorbidity in Brazilian adults: a cross-sectional national-based study. *BMJ Open* 2017;7:e015885.

41. Palthina Th, Jackson CA. Socioeconomic status and multimorbidity: a systematic review and meta-analysis. *Aust NZ J Public Health* 2018;42:186–94.

42. Ingram E, Ledden S, Beardon S, et al. Household and area-level social determinants of multimorbidity: a systematic review. *J Epidemiol Community Health* 2016;70:142–51.

43. Arcaya MC, Arcaya AL, Subramanian SV. Inequalities in health: definitions, concepts, and theories. *Glob Health Action* 2015;8:27106.

44. Townsend P, Davidson N, Black DS, et al. Determinants of multimorbidity among mid-aged women: a longitudinal study. *PLoS One* 2016;11:e0156804.

45. Bartley M. Health inequality : an introduction to theories, concepts, and methods. Cambridge, UK: Polity Press, 2004.

46. Ball K, Timperio A, Salmon J, et al. Personal, social and environmental determinants of educational inequalities in walking: a multilevel study. *J Epidemiol Community Health* 2007;61:108–14.

47. Pan A, Wang Y, Talaei M, et al. Relation of smoking with total multimorbidity in the older population in England to 2035: estimates from the population ageing and care simulation (PACSim) model. *Age Ageing* 2018;47:374–80.

48. Iaccarino G, Tommasi M, Boffa L, et al. Age and multimorbidity predict death among COVID-19 patients. *Hypertension* 2020;76:366–72.

49. Kunna R, San Sebastian M, Stewart Williams J. Measurement and decomposition of socioeconomic inequality in single and multimorbidity in older adults in China and Ghana; results from the WHO study on global ageing and adult health (SAGE). *Int J Equity Health* 2017;16:79.

50. Ataguba JE-O. Inequalities in multimorbidity in South Africa. *Int J Equity Health* 2013;12:84.
Multimorbidity in early childhood and socioeconomic disadvantage: findings from a large New Zealand child cohort. *Acad Pediatr* 2020;20:619–27.

Aminisani N, Stephens C, Allen J, et al. Socio-Demographic and lifestyle factors associated with multimorbidity in New Zealand. *Epidemiol Health* 2020;42:e2020001.

Calderón-Larrañaga A, Santoni G, Wang HK, et al. Rapidly developing multimorbidity and disability in older adults: does social background matter? *J Intern Med* 2018;283:489–99.

Carvlo E, Azar A, Shura R, et al. A new path of address multimorbidity? longitudinal analyses of retirement sequences and chronic diseases in old age. *J Appl Gerontol* 2021;37:1233–43.

Carizares M, Hogg-Johnson S, Gignac MAM, et al. Increasing trajectories of multimorbidity over time: birth cohort differences and the role of changes in obesity and income. *J Gerontol B Psychol Sci Soc Sci* 2018;73:1303–14.

Dugravot A, Fayosse A, Dumurgier J, et al. Social inequalities in multimorbidity, frailty, disability, and transitions to mortality: a 24-year follow-up of the Whitehall II cohort study. *Lancet Public Health* 2020;5:e42–50.

Hayek S, Ifrah A, Enav T, et al. Prevalence, correlates, and time trends of multiple chronic conditions among Israeli adults: estimates from the Israeli national health interview survey, 2014–2015. *Prev Chronic Dis* 2017;14:E64.

Hayek S, Rishal I, Toker O. Multimorbidity and its patterns according to immigrant origin. A nationwide register-based study in Norway. *BMJ Open* 2020;10:e0237375.

Kim J, Keshavjee S, Atun R. The consequences of multimorbidity among South Korea adults: analysis in the context of multimorbidity: a Korean panel study. *BMJ Open* 2020;10:e035037.

Khanolkar AR, Chaturvedi N, Kuan V et al. Examining the association between social class at birth and multimorbidity in middle age in the Aberdeen children of the 1950s cohort study. *BMJ Open* 2019;9:e024048.

Khanolkar AR, Chaturvedi N, Kuan V, et al. Socioeconomic inequalities in multimorbidity across adulthood: a longitudinal analysis of the MRC 1946 national survey of health and development in the UK. *PLOS Med* 2021;18:e1003775.

Kim M, Lee YH, Kim Y-S, et al. Socioeconomic inequalities in health in the context of multimorbidity: a Korean panel study. *PLOS One* 2017;12:e0173703.

Kim J, Keshavjee S, Atun R. Trends, patterns and health consequences of multimorbidity among South Korea adults: analysis of national representative survey data 2007–2016. *J Glob Health* 2020;10:e020426.

Lee SA, Joo S, Chai HW, et al. Patterns of multimorbidity trajectories and their correlates among Korean older adults. *Age Ageing* 2021;50:1336–41.

Moller SP, Laursen B, Johannesen CK, et al. Patterns of multimorbidity and its patterns according to immigrant origin. A nationwide register-based study in Norway. *PLoS One* 2020;15:e0237375.

Park B, Lee HA, Park H. Use of latent class analysis to identify multimorbidity patterns and associated factors in Korean adults aged 50 years and older. *PLoS One* 2019;14:e0216259.

Schäfer I, Hansen H, Schön G, et al. The influence of educational attainment on the association between social class at birth and multimorbidity in middle age in the Aberdeen children of the 1950s cohort study. *BMJ Open* 2019;9:e024048.

Dugravot A, Fayosse A, Dumurgier J, et al. Social inequalities in multimorbidity, frailty, disability, and transitions to mortality: a 24-year follow-up of the Whitehall II cohort study. *Lancet Public Health* 2020;5:e42–50.

Hayek S, Ifrah A, Enav T, et al. Prevalence, correlates, and time trends of multiple chronic conditions among Israeli adults: estimates from the Israeli national health interview survey, 2014–2015. *Prev Chronic Dis* 2017;14:E64.

Head A, Fleming K, Kypridemos C, et al. Incidences in prevalent and prevalent multimorbidity in England, 2004–19: a population-based, descriptive study. *The Lancet Healthy Longevity* 2021;2:e489–97.

Johnston MC, Black C, Mercer SW, et al. Impact of educational attainment on the association between social class at birth and multimorbidity in middle age in the Aberdeen children of the 1950s cohort study. *BMJ Open* 2019;9:e024048.

Khanolkar AR, Chaturvedi N, Kuan V, et al. Socioeconomic inequalities in multimorbidity across adulthood: a longitudinal analysis of the MRC 1946 national survey of health and development in the UK. *PLOS Med* 2021;18:e1003775.

Kim M, Lee YH, Kim Y-S, et al. Socioeconomic inequalities in health in the context of multimorbidity: a Korean panel study. *PLOS One* 2017;12:e0173703.

Kim J, Keshavjee S, Atun R. Trends, patterns and health consequences of multimorbidity among South Korea adults: analysis of national representative survey data 2007–2016. *J Glob Health* 2020;10:e020426.

Lee SA, Joo S, Chai HW, et al. Patterns of multimorbidity trajectories and their correlates among Korean older adults. *Age Ageing* 2021;50:1336–41.

Moller SP, Laursen B, Johannesen CK, et al. Patterns of multimorbidity and its patterns according to immigrant origin. A nationwide register-based study in a Danish population—A register-based study. *PLoS One* 2020;15:e0237375.

Park B, Lee HA, Park H. Use of latent class analysis to identify multimorbidity patterns and associated factors in Korean adults aged 50 years and older. *PLoS One* 2019;14:e0216259.

Schäfer I, Hansen H, Schön G, et al. The influence of age, gender and socio-economic status on multimorbidity patterns in primary care. First results from the multicare cohort study. *BMJ Health Serv Res* 2012;12:89.

Seo S. Multimorbidity development in working people. *Int J Environ Res Public Health* 2019;16:4749.

Singh A, Contreras Suarez D, You E, et al. Role of social support in the relationship between financial hardship and multimorbidity—a causal mediation analysis. *Eur J Public Health* 2021;31:482–7.

Tomasdottir MO, Sigurdsson JA, Petunsson H, et al. Does ‘existential unease’ predict adult multimorbidity? Analytical cohort study on embodiment based on the Norwegian HUNT population. *BMJ Open* 2016;6:e012602.

Tucker-Seeley RD, Li Y, Sorensen G, et al. Lifecourse socioeconomic circumstances and multimorbidity among older adults. *BMJ Public Health* 2011;11:313.

Zacarias-Pons L, Villalta-Franch J, Turro-Garriga O, et al. Multimorbidity patterns and their related characteristics in European older adults: a longitudinal perspective. *Arch Gerontol Geriatr* 2021;95:104428.