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Review Article

Multimorbidity among the Indigenous population: A systematic review and meta-analysis

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ABSTRACT

Background: Multimorbidity, the concurrent presence of multiple chronic health conditions in an individual, represents a mounting public health challenge. Chronic illnesses are prevalent in the Indigenous populations, which contributes to multimorbidity. However, the epidemiology of multimorbidity in this population is not well studied. This review aimed to elucidate the extent, determinants, consequences, and prevention of multimorbidity within Indigenous populations globally, contrasting findings with non-Indigenous populations.

Methods: Adhering to the PRISMA guidelines, this systematic review assimilated peer-reviewed articles and grey literature, focusing on the prevalence, determinants, implications, and preventive strategies of multimorbidity in global Indigenous populations. Emphasis was given to original, English-language, full-text articles, excluding editorials, and conference abstracts.

Findings: Of the 444 articles identified, 13 met the inclusion criteria. Five studies are from Australia, and the rest are from the USA, Canada, New Zealand, and India. The study indicated a higher multimorbidity prevalence among Indigenous populations, with consistent disparities observed across various age groups. Particularly, Indigenous individuals exhibited a 2-times higher likelihood of multimorbidity compared to non-Indigenous populations. Noteworthy findings underscored the elevated severity of certain comorbid conditions, especially strokes, within Indigenous groups, with further revelations highlighting their significant pairing with conditions such as heart diseases and diabetes.

Interpretation: The findings affirm the elevated burden of multimorbidity among Indigenous populations. Prevalence and risk of developing multimorbidity are significantly higher in this population compared to their non-Indigenous counterparts. Future research should prioritize harmonized research methodologies, fostering insights into the multimorbidity landscape, and promoting strategies to address health disparities in Indigenous populations.

Introduction

Even though there has not been a global consensus on the most appropriate way to define and quantify it, multimorbidity is recognised by the World Health Organization as the simultaneous presence of two or more chronic health conditions in a person [1,2]. It is a global public health concern, with several adverse health outcomes, including poor health-related quality of life and disability, increased healthcare utilisation and expenditure, polypharmacy, decreased work productivity, and premature mortality [3–5]. The prevalence of multimorbidity has been increasing in the general population across the globe in the last two decades. According to a recent systematic review and meta-analysis of community-based surveys conducted in 54 countries worldwide, approximately 37 % of adults aged 18 years and older have multimorbidity, regardless of age group, sex or geographic location [6]. More so, for those 60 years and older, the global prevalence exceeds 50 % [6].

While the phenomenon is a global health issue [6], certain populations, such as the Indigenous populations with socioeconomic

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disadvantages such as poverty, inadequate housing, limited access to quality and culturally appropriate healthcare and lower levels of education bear a disproportionate burden, both in terms of prevalence and adverse outcomes. However, this phenomenon is less studied in Indigenous populations nationally and globally. With the onset of globalisation and urbanisation, traditional lifestyles such as hunter-gatherers-based traditional diets rich in lean meats and plant-based foods and associated physical activities in Indigenous populations have been replaced by the so-called modern lifestyles characterised by unhealthy diets, smoking, substance abuse, and physical inactivity. Such transitions in lifestyles, coupled with ongoing experiences of discrimination and marginalisation from the mainstream services provided by the public sectors such as health and education sectors, led to a significant rise in obesity and the incidence of chronic health conditions in Indigenous populations [7]. Epidemiologic studies have consistently found that Indigenous populations experience a higher risk of these chronic conditions, including cardiovascular disease, diabetes, respiratory disorders, and certain types of cancers that are now more common in Indigenous populations than in non-Indigenous populations [8–11]. The intersection of higher socio-economic disadvantages, limited access to quality healthcare, and historical traumas, including forced relocations, cultural suppression, loss of land and resources and subsequent chronic stress further exacerbates these conditions in Indigenous populations [9,12–14].

However, despite the apparent health inequities faced by the Indigenous populations there remains limited quantifiable national data on the multimorbidity for Indigenous populations. The available evidence, [15–20] but not all [21], shows multimorbidity is more common in Indigenous populations than in non-Indigenous populations in different parts of the world. However, whether the global prevalence of multimorbidity is higher in Indigenous populations than in non-Indigenous populations using pooled data through meta-analysis of evidence from various countries worldwide is currently unknown. Previous systematic reviews and meta-analyses that examined various epidemiologic studies of multimorbidity, including its definition, prevalence, determinants, and intervention strategies have primarily focused on the non-Indigenous populations [22–24]. At present, there has been no comprehensive review or meta-analysis conducted to estimate the global prevalence of multimorbidity, its determinants, and preventative strategies in Indigenous communities. Identifying the drivers of multimorbidity among Indigenous populations and addressing them is crucial not only for promoting equity but also for developing more effective and inclusive healthcare policies that benefit the entire population.

This review seeks to bridge this knowledge gap, providing a comparative analysis of the prevalence of multimorbidity between Indigenous and non-Indigenous populations. Moreover, it endeavours to explore available evidence concerning the determinants, implications, and preventive approaches of multimorbidity among Indigenous groups within varied geographical and socio-cultural environments.

Methods

For this review, we followed procedures in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [25]. All procedures and subsequent reporting were in strict accordance with these guidelines. We registered this systematic review protocol under registration ID: CRD42024505729 in PROSPERO (https://www.crd.york.ac.uk/prospero/) to avoid the duplication of this work [26].

Data sources and search strategy

To collate the relevant articles, we utilized various search platforms including PubMed, Embase, CINAHL, Medline, Scopus, Informit, PsycINFO, and Australian Indigenous HealthInfoNet. The search was undertaken in July 2023, with no imposed limitations on the publication dates for each article. A combination of pertinent keywords, enhanced by 'Boolean Operators', was employed as presented in supplemental table ST1. Search strategies were meticulously constructed in collaboration with an experienced librarian and were subsequently refined following team deliberations. References were systematically managed utilizing Endnote 20 (Clarivate Analytics, Boston, USA), Microsoft Excel for Office 365 (Microsoft Corporation, Redmond, WA, USA), and Covidence 2020 (Veritas Health Innovation Ltd, Melbourne, Australia). A PRISMA flowchart delineating the study's selection process is referenced in the results section.

Eligibility criteria

For inclusion in this review, articles were required to provide insights on the prevalence, determinants, consequences, and/or prevention approaches related to multimorbidity in global Indigenous populations. We have searched both peer-reviewed articles and grey literature, provided they addressed any facets of multimorbidity (2 or more chronic health conditions in a person) as described earlier. We only considered articles that were accessible in full text and written in English. Review articles, editorials, and conference abstracts were excluded from our selection.

Target population selection

The systematic review focused on Indigenous people globally, classified as Indigenous within their respective countries. As per the World Bank description, Indigenous Peoples are characterized as distinct sociocultural entities maintaining ancestral ties to the lands and natural resources they reside in, occupy, or have been displaced from [27].

Article selection and data extraction

To ascertain the articles to be included in the review, two autonomous reviewers, KMS and AAM, screened the articles. Any disagreements that emerged were discussed and resolved during team meetings. Both reviewers (KMS and AAM) collaboratively devised a data-charting form to pinpoint relevant variables for extraction. Post this, the same reviewers proceeded to individually chart the data, compared their results, and iteratively enhanced the data-charting form as needed.

Quality assessment

In evaluating the quality of evidence in cross-sectional studies, we employed the US National Heart, Lung, and Blood Institute checklist [28] designed for assessing observational cohort and cross-sectional studies (supplemental table ST2). This tool, developed by the National Institutes of Health (NIH), consists of 14 items that evaluate aspects such as selection bias, measurement bias, and analysis bias (internal validity). This tool was previously used for quality assessment of the studies in a review article dealing with Indigenous people [29]. Two independent reviewers (KMS, TWU) assessed the risk of bias, and in cases of disagreement, consensus was reached or consultations with another reviewer (AAM) were sought for resolution. Based on this assessment tool, studies were rated as good, fair, and poor methodological quality (supplemental table ST2).

Data analysis and presentation

Descriptive statistics were computed and represented in an assortment of tables and graphs. This encompassed an evaluation of the overall prevalence of multimorbidity worldwide and its progression through different life stages among Indigenous populations and compared these findings with non-Indigenous populations. Additionally, a pooled analysis focusing on the risk of developing multimorbidity in Indigenous populations compared to non-Indigenous populations was executed and their pooled odds ratio (OR) and 95 % confidence intervals

(95 % CI) have been presented. We elaborated on the forest plot and estimated weighted overall association (OR and their 95 % CI following the random effects (RE) model [30]. Efforts were made to synthesize the findings from various studies. All analyses have been conducted by using Stata software [31].

Results

Search outcome

Our search identified a total of 444 studies after removing duplicates from six search engines. After conducting a systematic screening and eligibility checking, we could include only 13 articles. The detailed process of article selection has been summarised in the PRISMA format and is presented in Fig. 1.

Characteristics of the included studies

This review included 13 population-based studies: five from Australia, [16,17,19,20,32] three from India, [33–35] one from New Zealand [18], and two each from Canada [15,21] and USA [36,37]. There were five cohort studies [13,16–18,20] and the rest were cross-sectional [15,19,21,33–37] (Table 1). While three studies focused on the Indigenous population, [33,34,36] the remaining 10 studies compared Indigenous and non-Indigenous populations (Table 1). Moreover, of the five studies from Australia, two of them were based on the street sample patients as part of street-based clinics providing healthcare services for Indigenous Australians living on the street [16, 17] (Table 1).

Based on the quality assessment (Table ST2), all studies followed the standard methodological criteria regarding research questions and objectives, selecting samples, and assessing outcomes and exposures (where applicable). Details of the studies' methodological quality have been described in supplementary table ST2.

Heterogenicity of the studies

Four studies [18,32–34,36] evaluated multimorbidity relatively in older age groups, however, all other studies included in this review assessed the prevalence of multimorbidity among adults irrespective of age. John et al [36]. assessed the prevalence among those above 60 years, while Aminisani et al [18]. assessed this for people aged 55–70 years. Two Indian studies also assessed multimorbidity among Indigenous people after the age of 45 [33] and 50 [34] years. Twelve studies defined multimorbidity as having two or more health conditions. Only one study [37] defined this as having three or more conditions. There are subtle differences in defining the health conditions among the studies. It could be some index diseases, chronic conditions, chronic diseases, chronic health conditions or even only non-communicable diseases that the studies considered. However, the studies vary in the

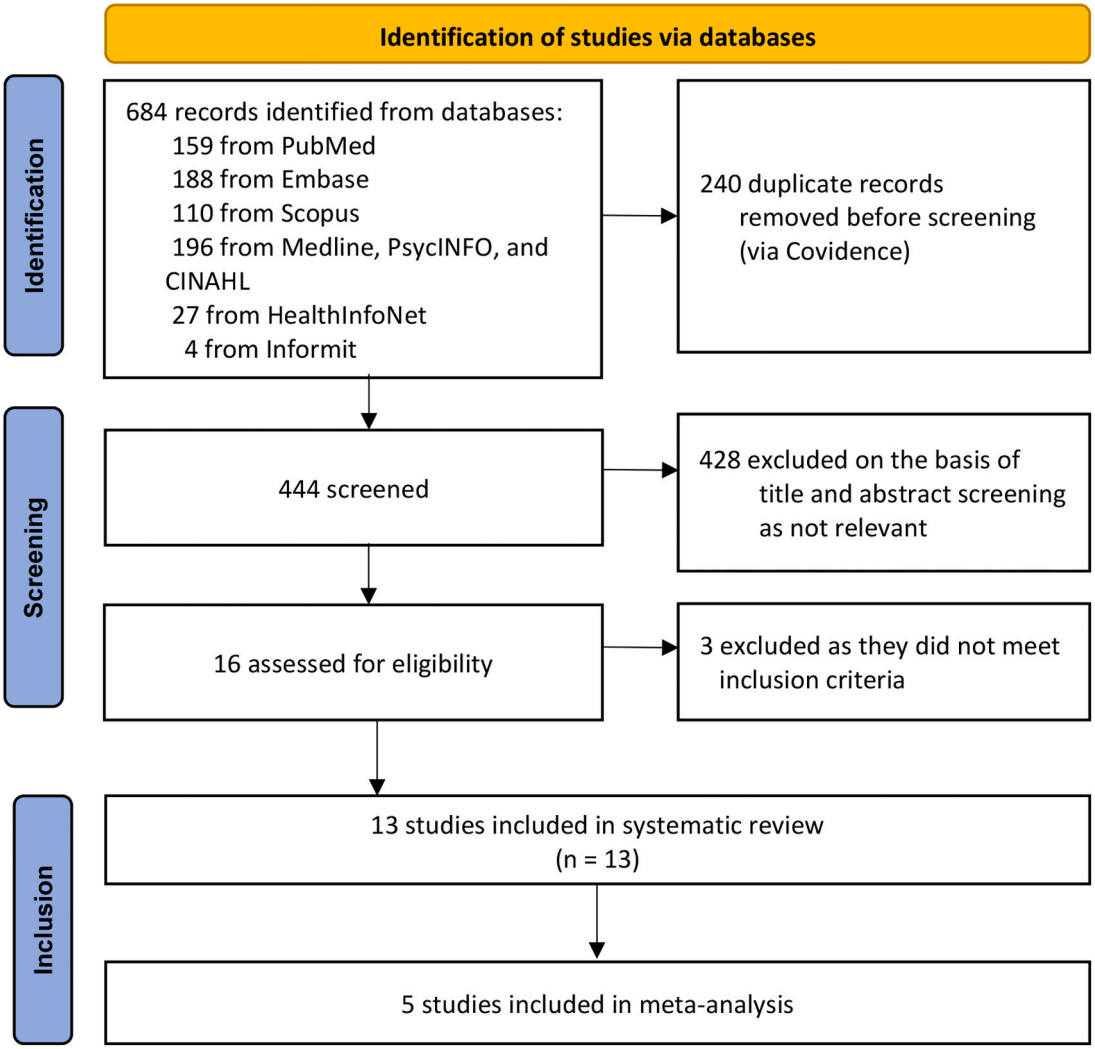

Fig. 1. Study selection.

Table 1
Characteristics of the reviewed articles.

SL	Author & publication year	Country	Population	Age group	Design, Sample	Operational definition of multimorbidity	Number and types of health conditions were considered	Results
1	John R et al. [36]	USA	American Indian	> 60 years	Cross-sectional, N = 1039	Co-occurrence of two or more diseases within one person, without defining an index-disease	11 chronic health problems: arthritis or rheumatism, difficulty seeing, tuberculosis, high blood pressure, heart diseases, diabetes, oral health problems, urinary tract disorders, stroke, depression, and hearing problems.	Most respondents (73·9 %) reported 2 or more of 11 chronic conditions. Cluster analysis revealed a four-cluster comorbidity structure: cardiopulmonary, sensory-motor, depression, and arthritis.
2	Kuwornu JP et al. [15]	Canada	Aboriginal and non-Aboriginal	≥ 18 years)	Cross-sectional, N = 3284	The presence of two or more of chronic diseases	15 chronic diseases: asthma, arthritis or rheumatism, anxiety or mental disorders, back problems, bowel disease, cataracts, diabetes, emphysema or bronchitis or chronic obstructive pulmonary disease (COPD), food allergies, heart disease, high blood pressure, urinary incontinence, migraine, thyroid conditions, and peptic ulcers	The Aboriginal population had a higher prevalence of multimorbidity than the non-Aboriginal Caucasian population (38·9 vs 30·7 %).
3	Arnold-Reed D et al. [16]	Australia	Aboriginal and non-Aboriginal	All	Retrospective cohort, N = 4285	Presence of chronic (>6 months) and deteriorating conditions affecting ≥ 2 domains	43 health conditions under 14 domains as: musculoskeletal, psychiatric, respiratory, vascular, endocrine, Eye and ENT, genitourinary, lower gastrointestinal, upper gastrointestinal, haematological, neurological, cardiac, hepatic/pancreatic, renal	Aboriginal patients had higher rates of multimorbidity than non-Aboriginal patients (58·0 % vs 50·6 %).
4	Brett T et al. [17]	Australia	Aboriginal and non-Aboriginal	All	Retrospective cohort, N = 4583	Co-occurrence of conditions across two or more (2 +) domains in individual patients	42 health conditions under 14 domains as: musculoskeletal, psychiatric, respiratory, vascular, endocrine, Eye and ENT, genitourinary, lower gastrointestinal, upper gastrointestinal, haematological, neurological, cardiac, hepatic/pancreatic, renal	Fifty percent of street health Aboriginal patients had multimorbidity compared with 45 % for non-Aboriginal patients
5	Aminisani N et al. [18]	New Zealand	Māori and non-Māori people	55 –70 years	Cohort, N = 1673	A positive diagnosis for 2 or more groups of chronic diseases.	Nine groups of diseases: heart diseases, stroke, other neurologic diseases (epilepsy, Parkinson disease, migraine headache, Alzheimer disease/dementia), musculoskeletal (arthritis, osteoporosis, hip/knee replacement), diabetes mellitus, respiratory diseases (chronic obstructive pulmonary disease, asthma), chronic liver conditions (cirrhosis), cancer, and mental disorders (depression, anxiety, and other mental diseases).	There was a significant higher rate (76·4 % vs 63·9 %) of multimorbidity among Māori people than non-Māori-people
6	Randall DA et al. [20]	Australia	Aboriginal and non-Aboriginal	All	Cohort, N = 5437,018	Having two or more morbidities	30 target morbidities, classified as physical or mental, were selected from the Elixhauser and Charlson Comorbidity Indices.	Although the prevalence rates (16·1 % vs 12·1 %) of multimorbidity were higher for Aboriginal than non-Aboriginal patients in all broad age groups, it is much higher (49·7 % vs 29·1 %) in older age group (55 or more years)
7	Carman W et al. [19]	Australia	Aboriginal and non-Aboriginal	All	Cross-sectional, N = 16,749	Having two or more health conditions (physical or mental)	10 NCDs: nine physical health conditions (arthritis/osteoporosis,asthma, cancer, chronic bronchitis/emphysema, type 1 diabetes, type 2 diabetes, heart diseases, high blood pressure/	Aboriginal respondents reported a higher prevalence of multimorbidity (24·2 %) compared with non-Indigenous Australians (20·7 %). It is much higher in older age groups (60 + years)

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Table 1 (*continued*)

SL	Author & publication year	Country	Population	Age group	Design, Sample	Operational definition of multimorbidity	Number and types of health conditions were considered	Results
							hypertension, any other serious circulatory condition) and mental health condition.	
8	Mohamud MA et al. [37]	USA	Indigenous and non-Indigenous	≥ 18 years	Cross-sectional, N = 123,613,970	Presence of 3 or more conditions based on the Elixhauser comorbidity index	30 individual chronic conditions as per Elixhauser comorbidity index.	Native American populations exhibited the largest overall increase in multimorbidity (32 %). The most contributions came from cardiovascular and metabolic diseases.
9	Geda NR et al. [21]	Canada	Aboriginal and non-Aboriginal	> 12 years	Cross-sectional, N = 109,659	Co-occurrence of two or more chronic diseases within a person	14 diseases: joint pain, asthma,chronic obstructive pulmonary disease, sleep apnoea, scoliosis, fibromyalgia, arthritis, osteoporosis, high blood pressure, heart disease, stroke, diabetes, cancer and mood disorder	Aboriginal people had 13 % less odds for multimorbidity compared to White people in Canada.
10	Puri P et al. [33]	India	Aboriginal	> 45 years	Cross-sectional, N = 11,365	Simultaneous occurrence of two or more non-communicable diseases.	16 chronic conditions or diseases: asthma, cancer, chronic bronchitis, chronic renal failure, chronic obstructive pulmonary disease, diabetes mellitus, gastrointestinal disorder, Chronic heart disease, high cholesterol, Hypertension, musculoskeletal disorders, neurological and psychiatric disorder, skin disease, stroke, thyroid disease, urinary incontinence.	The findings suggest that 14·5 % of the Aboriginal population lived with multiple diseases. Higher age, Muslim religion, higher education, unemployment, and affluent background were the major correlates of multimorbidity.
11	Sinha A et al. [34]	India	Indigenous	≥ 50 years	Cross-sectional, N = 522	Two or more chronic conditions in an individual	10 chronic conditions: arthritis, stroke, diabetes, chronic lung disease, asthma, depression, hypertension, cataract, edentulism, obesity	The overall prevalence of multimorbidity was about 23 %; and a higher likelihood of having this multimorbidity among respondents aged ≥ 80 years than the younger age groups; and among the most affluent group than the most deprived class.
12	Pati S et al. [35]	India	Indigenous and non-Indigenous	≥ 18 years	Cross-sectional, N = 1649	Presence of two or more cooccurring chronic or long-term diseases or conditions	20 chronic diseases: acid peptic disorder, hypertension, arthritis, chronic back pain, vision problem/blindness, diabetes, chronic lung disease, tuberculosis, deafness, hypotension, thyroid disease, depression, heart disease, filariasis,eczema, dementia, psoriasis,kidney disease, alcohol disorder,stroke,	The overall prevalence of multimorbidity was 28.3 %. Aboriginal people had a slightly lower prevalence than non-aboriginal (27.7 % vs 28.5 %). Non-aboriginals had 56 % higher odds of developing multimorbidity compared to Aboriginals.
13	Hussain MA et al. [32]	Australia	Aboriginal and non-Aboriginal	25 –59 years	Cohort, N = 18,194	Presence of two or more chronic conditions in addition to a cardiovascular disease	18 chronic conditions: hypertension, alcohol abuse disorders, diabetes, acid peptic disease, chronic kidney disease, substance abuse disorder,heart failure, COPD, depression, asthma, atrial fibrillation, valvular heart disease, vision loss or visual disturbances, rheumatoid arthritis, low back pain, non-skin cancer, endocrine disorders (ex. diabetes), osteoarthritis,	Within a cardiac disease (atherothrombotic disease) group, 46 % had multimorbidity. Among all Aboriginal people having atherothrombotic disease, 72.2 % had multimorbidity which is almost double compared to their non-Aboriginal (39.3 %) counterparts.

total number of conditions, categorization approaches, and introduce unique health factors. Despite these differences, commonalities including the presence of cardiovascular conditions (e.g., heart diseases, high blood pressure), respiratory issues (e.g., asthma, COPD), and a focus on mental health were found across the studies. Hussain MA et al [32], followed a different approach than other studies. They assessed multimorbidity only in a specific group of people who had a cardiovascular disease.

Comparison of multimorbidity prevalence in Indigenous and non-Indigenous populations

Six out of nine studies in this review consistently reported that the prevalence of multimorbidity was higher in Indigenous than non-Indigenous groups. John et al [36]. analysed the prevalence according to the number of chronic conditions based on a cross-sectional sample of Indigenous elders aged 60 years and above and found 73·9 % of the participants had multimorbidity (presence of 2 or more chronic conditions). Kuwornu et al [15], found that the prevalence was about 8 % higher in the Indigenous compared to non-Indigenous group (38·9 vs 30·7 %). Two retrospective cohort studies in Australia that were based on clients attending the street-based general practice clinics specially designed for marginalised and homeless persons including Indigenous people also found a higher prevalence of multimorbidity among the Indigenous than in non-Indigenous groups and the findings were consistent across all ages and over time [16,17]. Among the 2006–2011 cohort, the prevalence of multimorbidity in Indigenous patients was 50 %, compared to 45 % in non-Indigenous patients [17]. The difference was further increased (58·0 % vs 50·6) over time in the 2012–2015 cohort [16]. Similarly, another cohort study using hospital link data [20], and a cross-sectional study based on national survey data [19] in Australia reported a higher prevalence of multimorbidity in Indigenous than in non-Indigenous patients. In both of these studies, the prevalence observed for the general population was markedly lower compared to other studies [16,17] in Australia. However, the prevalence in older age groups in these studies [19,20] was comparably as high as that observed in other studies [16,17]. Contrary to the above findings, the two studies conducted in North America have found a lower prevalence of multimorbidity in Indigenous than in non-Indigenous populations [21,37]. Three Indian studies [33–35] showed that the prevalence of multimorbidity among the Indigenous people is much less than three Australian [16,17,19] and three North American studies [15,36,37]. One Indian study showed that the prevalence of multimorbidity in Indigenous people is almost similar to non-indigenous people. Different prevalence rates of multimorbidity in Indigenous and non-Indigenous populations across different populations or geographic regions have been illustrated in Fig. 2.

Four studies showed the prevalence of multimorbidity in sex-stratified analyses. Regardless of Indigenous background, women consistently exhibited a higher prevalence of multimorbidity compared to men, with the excess prevalence ranging from 3 % to 16 % [21,32,34,35]. However, an Indian study reported the opposite trend that men had a higher prevalence of multimorbidity than women [33]. Within the Indigenous group only, this difference in multimorbidity prevalence between men and women was more prominent compared to their non-Indigenous counterparts, and women showed a higher rate than men.[32]In this systematic review, we did a pooled analysis to assess the prevalence of multimorbidity in different age groups and assessed its life-course trajectory (Fig. 3). It showed the prevalence trajectory has an increasing trend with age for both Indigenous and non-Indigenous populations. However, higher prevalence has been observed in the Indigenous group compared to the non-Indigenous group in all ages. Moreover, this difference between Indigenous and non-Indigenous groups gradually increased over time. At younger ages (<25 years), the prevalence gap is small. However, such a gap increased gradually with age through middle age (50–60 years), reaching approximately 20 %. This disparity becomes more pronounced after 70 years of age, where the prevalence of multimorbidity is more than 25 % higher in Indigenous elderly people compared to their non-Indigenous peers.

Multimorbidity risk for the Indigenous population

Studies not only reported the higher prevalence of multimorbidity among the Indigenous population, but they also showed that the odds of having multimorbidity are significantly higher in this population compared to their non-Indigenous counterparts [16,18,20]. The highest risk was shown by two Australian studies [16,20] where the odds of having multimorbidity in Indigenous people were more than double (OR: 2.10 and 2.59) compared to non-Indigenous people. Another study in New Zealand also showed a significantly higher risk (OR: 1.21) of multimorbidity for Indigenous people [18]. Although a Canadian study showed that the odds of having multimorbidity among Indigenous people was 13 % less compared to White Canadians, and an Indian study showed that the prevalence is 36 % less in Indigenous than non-Indigenous Indian [35], the pooled analysis showed the OR of having multimorbidity was about two times higher in Indigenous population than non-Indigenous population (Fig. 4).

Disease severity and clustering of the comorbidities

Among the different types of co-morbidity, the disease severity score (represented how much they got in the way of daily activities) was higher for stroke or cerebrovascular accidents. Similarly, stroke had a higher odds of pairing with heart diseases (OR:11.2), diabetes (OR: 10.2) and urinary problems (OR: 16.9) than with arthritis (OR: 3.5) [36]. Arnold-Reed et al., 2018 showed that there was a significantly higher proportion of people with severe and extremely severe conditions of multimorbidity in Indigenous people compared to non-Indigenous, especially in those aged 45 years and older [16]. Within a group of people with a cardiac disease (atherothrombotic disease), 46 % had multimorbidity. And this situation was much worse in Indigenous people compared to non-Indigenous people (72.2 % vs 39.3 %).

Sociodemographic and health predictors for multimorbidity

A limited number of studies have investigated the sociodemographic

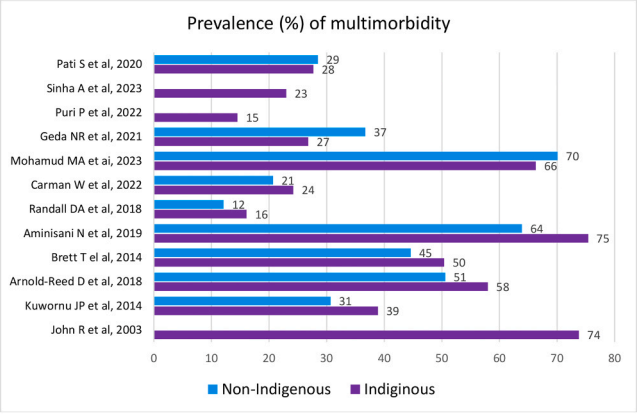

Fig. 2. Overall prevalence of multimorbidity among Indigenous and non-Indigenous people across the reviewed studies.

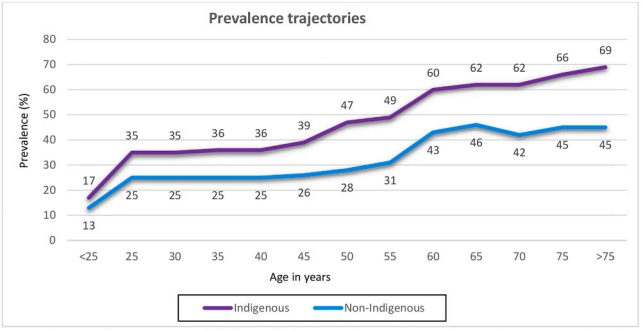

Fig. 3. Prevalence trajectories of multimorbidity among Indigenous and non-Indigenous people in different ages of life.

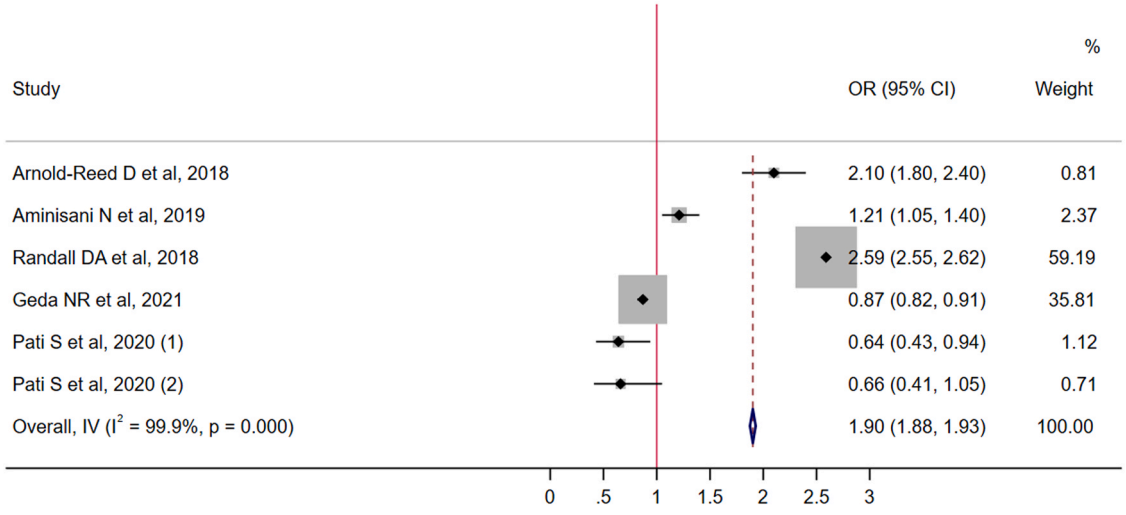

Fig. 4. Forest plot showing the odds ratio of multimorbidity among Indigenous people compared to non-Indigenous people.

and health predictors of multimorbidity [18,21,32]. These studies indicated that individuals with higher levels of education, greater income, regular engagement in physical activity, non-smoking habits, and abstinence from alcohol had a lower likelihood of developing multimorbidity compared to their counterparts [18,21]. Conversely, individuals of relatively older age, those who were widowed, divorced, or separated, unemployed in the past 12 months, leading a sedentary lifestyle, and classified as overweight or obese exhibited a significantly higher risk of multimorbidity [18,21]. It is important to note that these predictors were evaluated in the general population, without considering ethnic backgrounds. Nevertheless, our review identified two Indian studies [33,34] that examined sociodemographic predictors for multimorbidity within the Indigenous population. These studies revealed that Indigenous individuals who were relatively older age, Muslim religion had a higher likelihood of developing multimorbidity compared to their counterparts. These studies also found the risk of multimorbidity among the Indigenous population in the most affluent wealth conditions compared to the most deprived [34] which were found in opposite direction to the findings from studies based on non-Indigenous populations [18,21].

Discussion

The objective of this systematic review was to collate and synthesize the existing evidence regarding multimorbidity prevalence and determinants among Indigenous populations worldwide, and where possible, compare this to their non-Indigenous counterparts. We also aimed to identify the preventive approaches to multimorbidity in this population. Although existing literature specifically addressing multimorbidity in Indigenous populations is generally scarce, most of the existing evidence indicates that multimorbidity is more prevalent in Indigenous than in non-Indigenous populations. The variance in multimorbidity prevalence rates across the existing studies can be attributed to multiple factors, including distinct study designs, target populations, methods and the number of chronic health conditions used to define multimorbidity, and geographic regions. Notably, cohort and cross-sectional designs offered different glimpses into the prevalence patterns, suggesting the need for a more standardized approach for future research in this domain.

Our review, for the first time, elucidates these inconsistent findings by synthesising existing evidence from observational studies showing that Indigenous people in the populations covered by this review are twice as likely as non-Indigenous people to experience multimorbidity. This review underscores a significantly higher prevalence of multimorbidity in Indigenous compared to non-Indigenous people across all age groups, with such discrepancies becoming broader with increasing age. Indigenous people generally exhibit higher rates of chronic health conditions that likely cluster in each person over time, [38,39] which may explain the findings observed in this systematic review. Health is shaped by both social determinants and individual health risk factors, influenced by circumstances like birth, growing up, work, and ageing. Indigenous people experience a wide range of hardships resulting in substantial health inequalities in this population [40].

In this review, we have found there are five out of 13 studies are from Australia. In Australia, the health disparities between Indigenous and non-Indigenous populations were attributable predominantly to socioeconomic factors, particularly household income and employment, individual health risk factors, such as smoking and overweight/obesity, and limited access to affordable health services [41]. However, such inequalities in healthcare services are deeply rooted in a plethora of social, economic, and historical factors, complicating the health landscape for these communities [9]. In addition to health disparities, the Indigenous population in Australia experiences lower social and emotional well-being compared to their non-Indigenous peers [42]. Rooted in Australian history, the forced removal of Aboriginal and Torres Strait Islander children from their families from the late 1800s to 1969- 'the Stolen Generations' has had lasting impacts [43]. Survivors of the 'Stolen Generations,' without the opportunity to heal from trauma, may endure intergenerational trauma and can contribute to poor health and well-being [43]. This connection likely plays a significant role in the higher rates of adverse mental and physical conditions eventually contributing to a higher rate of multimorbidity observed among Indigenous Australians.

However, three of the reviewed articles [21,33,34] presented conflicting findings concerning the prevalence and odds of multimorbidity in Indigenous populations compared to non-Indigenous populations, as observed in other studies. While the reasons for the lower prevalence and odds of developing multimorbidity among Indigenous Canadians compared to White Canadians are unclear [21], insights from two Indian studies [33,34] may offer some explanations. The relatively lower prevalence of multimorbidity among Indigenous Indians, compared to Indigenous populations in North America and Oceania, is likely attributed to distinct sociodemographic characteristics and social determinants of health among Indian Indigenous communities. Many Indian tribes, classified as Indigenous, reside in rural or hilly areas and engage in more physical activities [44]. Despite an increasing trend of overweight and obesity among tribal groups in India, the prevalence remains considerably lower [45] than the national average [46].

Furthermore, the prevalence of overweight and obesity among Indigenous Indians [45] is notably lower than that of Indigenous populations in developed countries such as Australia [47]. Upadhyay RP et al. reported diabetes mellitus prevalence in tribal populations of India ranging from 0.7 % to 10.1 %, indicating a relatively low prevalence in some tribal groups [48]. These factors may collectively contribute to the observed lower prevalence of multimorbidity among Indigenous Indians compared to non-Indigenous Indians and other Indigenous populations across North America and Oceania.

The higher prevalence of multimorbidity in Indigenous populations than in non-Indigenous populations across all ages in this review is in line with the increasing prevalence observed in the general populations across all ages, geographical regions and over time [6,22,24,49]. While increasing age is undeniably associated with a rising prevalence of multimorbidity, [19,50] the consistent and widening disparity between Indigenous and non-Indigenous groups across age brackets is alarming. Especially, older Indigenous people (70 + years) have had a much higher prevalence of multimorbidity. In an Australian study, the authors reported that the prevalence of multimorbidity among Indigenous elders (age >70 years) was about 16 % higher compared to their non-Indigenous peers in the same age range. However, our pooled analysis considering all age-points prevalence of multimorbidity shows that the prevalence in this age group among the Indigenous people is about 20–25 % higher () compared to non-Indigenous people. This suggests that age may not be the sole factor driving these disparities; for instance, systemic and structural challenges faced by the Indigenous populations may play a considerable role. Of note, special attention should be given to older Indigenous people to reduce multimorbidity-related health complications, particularly the higher-risk age group. Our findings emphasize a crucial point: the burden of multimorbidity among Indigenous populations is not merely about higher prevalence rates. The severity of comorbid conditions, particularly in the realm of stroke or cerebrovascular accidents, is distinctly elevated [36]. The propensity of stroke to pair more significantly with conditions like heart disease and diabetes underscores the interconnectedness of chronic ailments, reinforcing the need for holistic and comprehensive health interventions. The fact that Indigenous populations experienced two folds substantially higher likelihood of multimorbidity compared to non-Indigenous populations further underscores the severity of the issue and the urgent need to address this to promote the health and well-being of the Indigenous populations. Indeed, such pronounced disparities demand an in-depth examination of the underlying determinants that exacerbate health inequities.

In this review, we have found a few of the studies examined the sociodemographic and health predictors of multimorbidity and found several factors are significantly associated with multimorbidity [18,21,32]. Although several factors increase the risk, some also act as protective factors for developing multimorbidity. Several preceding studies have also supported these conclusions [51–55]. Studies have been conducted to identify the socioeconomic, psychosocial and behavioural determinants of multimorbidity [51–55]. Socioeconomic factors such as lower household income, lower education level, and living in urban areas increase the prevalence of multimorbidity, with those in deprivation often being at a higher risk [52]. Furthermore, adverse childhood experiences (ACEs) may lead to greater multimorbidity severity, possibly due to chronic stress and its associated physiological responses [55]. However, most of these studies were conducted among non-Indigenous population. Hence, further study solely on Indigenous population can refute the findings of the existing studies conducted in the overall population.

Despite a wide range of factors associated with multimorbidity, having a higher prevalence of several social determinants of adverse health conditions [56], and bearing different cultures and understanding of health, only a few studies have been conducted so far to identify the socioeconomic, psychosocial and behavioural determinants of multimorbidity in the Indigenous population. Two Indian studies conducted only in the Indigenous populations, [33,34] indicated a higher risk of multimorbidity in relatively older age groups, which aligns with findings observed in non-Indigenous populations. However, a higher risk for multimorbidity was identified in individuals in the most affluent wealth conditions compared to the most deprived [34], contradicting findings from non-Indigenous studies [18,21]. Perhaps, the demographic and health characteristics of the Indigenous population in a developing country such as India differ from those of people in developed countries (e.g. Australia or North America). Considering the broad spectrum of risk and protective factors for multimorbidity and the variability in population characteristics, there is a paucity of stratified analyses aimed at identifying specific risks associated with these potential factors for the development of multimorbidity within the Indigenous population. This gap underscores the imperative for further research in this area.

Over recent years, global initiatives to address and reduce multimorbidity have taken a central stage in healthcare planning and public health strategies. Recognising that the coexistence of multiple chronic conditions in a single individual often leads to reduced quality of life, increased healthcare costs, and greater mortality risks. Thus, international bodies such as the World Health Organization (WHO) and many funding bodies have prioritized research and intervention strategies for multimorbidity. The WHO has developed a monograph that provides an overview of the issues and some potential solutions for multimorbidity to be considered by the WHO Member States [57]. The Global Alliance for Chronic Diseases (GACD) brings together major international research funding agencies specifically to address the growing burden of Non-communicable Diseases (NCDs) in low-and-middle-income countries (LMICs) and vulnerable populations like Indigenous people in high-income countries. The GACD is currently funding 30 life course interventions across 39 countries, tackling a wide range of NCDs in the LMICs and Indigenous populations in high-income countries. This innovative approach focuses on interventions throughout a person's life, aiming to prevent the development of NCDs or delay their onset [58]. The National Institute for Health and Care Research also sets its strategic focus and ambition to fund high-quality research to prevent, treat and manage multiple long-term conditions in LMICs [59]. All these efforts focus on the integration of health services, the promotion of preventive measures, and the development of tailored clinical guidelines that can address the complex needs of those with multiple health conditions [60].

Like LMICs and socially disadvantaged populations, there are no tailored comprehensive prevention strategies for multimorbidity for Indigenous populations. Indigenous populations have unique health needs rooted in historical traumas, colonization, cultural beliefs, and societal challenges that adversely affect their access to quality healthcare services [56,61,62]. Indigenous-led and culturally tailored healthcare respects traditional healing practices; overcomes communication barriers; and builds trust, acknowledging the deep significance of community and land to Indigenous well-being [63–65]. Thus, studies are warranted to co-develop culturally sensitive and appropriate preventive strategies for multimorbidity among the Indigenous population to combat these complex health needs.

Our review also has some limitations. We aimed to conduct a global review, but the published articles only cover the USA, Canada, Australia, New Zealand, and India. The search criteria, limited to English-language articles only, might have hindered the inclusion of articles published in other languages. The reviewed articles exhibited heterogeneity. Variability in health conditions defining multimorbidity, age groups of participants, and modes of data collection (e.g., self-reported, hospital electronic records) pose significant challenges to the synthesis of findings. Although the objectives of this systematic review included identifying potential sociodemographic and health predictors for multimorbidity among the Indigenous population, as well as effective prevention strategies, we did not find sufficient existing literature on these topics. Particularly, there is a complete absence of any literature on interventions for Indigenous multimorbidity among the Indigenous population.

In conclusion, the global prevalence of multimorbidity in Indigenous populations is higher than in non-Indigenous populations and the observed disparities in prevalence of multimorbidity between the two groups increase with age. These findings imply while multimorbidity is a global public health challenge, the condition disproportionately affects Indigenous populations, and Indigenous elders are at a particularly higher risk of developing the condition compared to their non-Indigenous peers. Addressing multimorbidity in Indigenous populations requires a comprehensive, culturally appropriate strategy co-designed with the First Nations peoples that acknowledges and respects the unique history, cultures, and community needs. This may include improving access to quality healthcare services, addressing social determinants of health, incorporating Indigenous knowledge and practices into healthcare strategies, and above all addressing social determinants of health which are the biggest drivers for developing chronic diseases. Thus, future research should strive for a more harmonized methodology, ensuring comprehensive and comparative insights into the multimorbidity landscape, and developing effective prevention strategies to reduce the health disparity inequity and improve the overall health of Indigenous populations.

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CRediT authorship contribution statement

Abdullah A. Mamun: Writing – review & editing, Supervision, Methodology, Conceptualization. **Mohammad Akhtar Hussain:** Writing – review & editing. **Sanghamitra Pati:** Writing – review & editing. **KM Shahunja:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Tolassa Wakayo Ushula:** Writing – review & editing, Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors contributors

KMS, and AAM contributed to study design, literature search and review, data extraction, data analysis, figure creation, and manuscript writing. TWU, JS, SP and MAH contributed to the study design and manuscript writing. All authors had access to the data for this study. KMS and TWU independently accessed and verified all data. All authors have read and approved the final version of this manuscript and had final responsibility for the submission of the manuscript.

Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.annepidem.2024.07.047.

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