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The importance of including a mental health dimension in a multimorbidity indicator: an analysis of Belgian health survey data

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Abstract

Background Multimorbidity is a rising public health concern. Indicators that address these complex health conditions are often exclusively devoted to physical diseases. Because of their high disease burden, mental health disorders ought to be considered as well. This paper aims to measure the added value of including a mental health dimension in a population-based multimorbidity indicator and identify which mental health measures are most appropriate.

Methods Secondary analyses were conducted on data from the Belgian Health Interview Survey 2018. We compared the prevalence of different multimorbidity indicators (MIs) in relation to health impact measures, such as quality of life (EQ-5D score) and activity limitation (GALI). The MIs differed as to the health conditions involved: one was based on physical conditions only; the other three included mental health dimensions that were either self-reported or assessed by a scale (GAD-7, PHQ-9, and GHQ-12). We performed linear and logistic regressions to assess the association between the MIs and the health correlates and compared the goodness of fit of the different models.

Results MI prevalence was higher when including a mental health dimension assessed with the GHQ-12 (42.0%) and with the GAD-7 or the PHQ-9 (39.4%) as compared to physical conditions only (35.0%). Associations between the MI and health correlates were consistently stronger if the MI included a mental health dimension. The regression models with MI including the GAD-7 and PHQ-9 showed the strongest association between MI and the health correlates and also had the best goodness-of-fit measures.

Conclusions MIs that only take physical conditions into account underestimate their impact on individuals' lives. Including mental ill-health in an MI is key to linking it to health correlates.

Keywords Multimorbidity, Mental health, Health interview survey, Quality of life, Activity limitation

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Introduction

According to the World Health Organization (WHO), chronic diseases account for 80–90% of all deaths and cause 10–20% of premature deaths in European countries [1]. Due to its increasing prevalence over recent decades, multimorbidity, defined as the co-existence of two or more chronic diseases in the same person [2–4], is a growing challenge for the healthcare system [5]. This trend is predicted to continue for the next 10–20 years [6], with women, elderly people and those in a lower socioeconomic position being at greater risk [7, 8]. The major consequences of multimorbidity are functional impairment, poor quality of life, as well as high healthcare use and costs [8].

There is no consensus on the operational definition of multimorbidity, which hinders comparability across studies [9] and leads to wide variations in prevalence estimates, ranging from 13.1 to 71.8% in the general population [4]. Several reasons can explain this.

First, while most studies use simple disease counts to characterize multimorbidity, others use complex measures such as the Charlson Comorbidity Index (CCI) or the Cumulative Illness Rating Scale (CIRS), which attributes different weights to the diseases [10]. Second, heterogeneity across multimorbidity studies using disease counts also relates to the type and the number of chronic conditions that are listed in each research [4]. Such lists can comprise between 4 and 102 chronic conditions, and some also include symptoms, risk factors, and acute conditions [11]. Another reason for the variability in multimorbidity estimates comes from the study design characteristics, such as the population settings, data sources and modes of data collection [12].

Finally, considering, or not mental health conditions in the multimorbidity count adds further heterogeneity. According to one systematic review of 566 studies, even though nearly 75% of the multimorbidity studies include at least one mental health condition, still 25% of them are solely based on physical conditions. In comparison, chronic conditions such as diabetes or cardiovascular and respiratory diseases are involved in more than 90% of multimorbidity studies [13]. However, chronic mental illnesses should be given as much importance as physical diseases. Worldwide, mental diseases affect approximately one in eight people at a given time, especially anxiety and depressive disorders [14]. In Belgium, according to the national health interview survey, the point prevalence of anxiety disorders was 11% in 2018, and 9% of the population aged 15 and older was experiencing depressive symptoms [15]. Moreover, mental disorders have a high impact on people's functioning, which should be a key criterion when investigating chronic conditions and their co-occurrence [16]. The burden associated with mental disorders is increasing across the world, as the global number of disability-adjusted life-years (DALYs) due to mental disorders has risen from 80.8 million to 125.3 million between 1990 and 2019 [17]. Mental diseases are also associated with poor quality of life and high healthcare use and costs [18–20]. The cost of mental health accounts for 5% of the Gross domestic product (GDP) and more than 20 billion € in Belgium [21].

Prevalence estimates of chronic conditions and multimorbidity at the population level are mainly based on two common types of data sources. Most rely on administrative and health care data, including primary care data [22], health insurance data, hospital discharge data or billing records, which contain information about diagnoses, hospital stays and care provision [23]. Although such data provide information on many people at low cost, hospital discharge information only concerns patients who are or were hospitalised, and insurance data do not provide diagnostic information. The second common source of data used to estimate chronic disease prevalence is self-reported data collected through national or regional health surveys conducted among a representative sample of the population. These surveys also include information on sociodemographic status, lifestyle, and other health determinants [24–26].

As part of this study, we decided to focus on health interview survey data. In those, mental health is operationalised in many different ways. Some surveys ask the individuals if they experienced any specific mental disorders from a list (e.g., the French Health and Social Protection Survey), while others use screening tools (e.g., GHQ) or diagnostic instruments (e.g., DISSI) to evaluate the mental health status of individuals. Moreover, studies differ in the timeframe for a given disorder, exploring past month, past year, or lifetime occurrences. Finally, a multitude of different instruments exist for assessing a given mental disorder – which can also hamper study comparisons [26–28].

Multimorbidity studies assessing its impact on patient's lives often use outcome measures such as health-related QoL and daily life functioning [29, 30]. Among those studies, multimorbidity patterns of multiple mental health conditions such as depression often had poorer health outcomes than patterns including physical conditions [31–34]. It was also shown that multimorbidity and depression cooccur [32]. The longer someone lives with multiple chronic diseases, the less this person will display positive affects, which serve to buffer the stressful impact of chronic illness on mental health [35].

Despite the diversity brought by the existing research in the era of multimorbidity and mental health, to our knowledge, the remaining questions are to which extent the integration of the mental health dimension to the multimorbidity concept enhances its comprehensiveness and how this is best operationalized in the construction

of a population-based multimorbidity indicator. The aim of this paper is thus to assess the added value of considering mental health problems in the development of a disease count multimorbidity indicator based on health interview data. More specifically we would like to assess [1] to which extent the inclusion of the mental health dimension in a multimorbidity indicator improves the association of this indicator with health-related quality of life and activity limitations and [2] which mental health measure would fit best in a multimorbidity indicator based on a health interview survey.

Methods

Data source

This study uses the data collected through the sixth Belgian Health Interview Survey (BHIS) carried out in 2018 [29].

This cross-sectional general population survey collected information about health status, health determinants and healthcare use from 11,611 individuals, selected from the national register according to a stratified multistage clustered sampling design. Data were collected through a face-to-face interview and a self-administered paper questionnaire for sensitive questions. By making use of post-stratification weights, survey results are representative of the Belgian population. Our study focussed on the population aged 15 years and older, which also included residents of nursing homes. From the total sample 1,858 participants who were younger than 15 years were removed resulting in a study sample of 9,753 individuals. Further details on methodological features can be found elsewhere [24].

Multimorbidity indicators

Physical conditions

We constructed a physical multimorbidity indicator based on chronic conditions that are retained in the majority of multimorbidity-pattern studies. These studies were identified in a systematic review by Prados-Torres et al. [36]. The most commonly counted conditions were asthma, chronic obstructive pulmonary disease (COPD), hypertension, dyslipidaemia, coronary heart disease, cardiac arrhythmia, congestive heart failure, stroke, malignancy, joint disease, osteoporosis, diabetes, thyroid disease, hearing problems, obesity, prostatic hypertrophy, anaemia, and dementia. Multimorbidity was confirmed if an individual reported at least two chronic conditions.

In the BHIS 2018, the presence of a chronic condition was assessed through the following question: "Have you had one of the following diseases or conditions in the past 12 months?". Thirty-eight chronic conditions were listed [37]. Next to these, obesity was measured by asking the respondent to report his or her height and body weight [38]. Hearing problems were assessed by a question on wearing a hearing aid and/or having hearing problems in a quiet or noisy room [39]. Anaemia and dementia, which were included in Prado-Torres' systematic review, were not included because of no available data in the BHIS. A detailed comparison between the conditions included in the review of Prado-Torres et al. (2014) and the conditions assessed in the BHIS can be found in the Supplementary material Table A1.

This physical multimorbidity indicator will hereafter be referred to as MI1 (multimorbidity indicator 1).

Mental health conditions

The BHIS 2018 collects information on various mental health dimensions. This study takes into account three specific mental health measures to assess the best candidate for the comprehensive multimorbidity index.

Depression was assessed in two different ways, which will allow us to choose the best approach. First, depression was part of the list of self-reported chronic conditions in the face-to-face questionnaire, together with the physical condition items. Respondents were asked whether they had experienced depression for over 2 weeks in the past 12 months. Second, depressive symptoms were also measured with the Patient Health Questionnaire 9 items (PHQ-9), a scale placed in the self-administered questionnaire. The respondent was asked to indicate how often she/he experienced the given symptoms in the last 2 weeks (e.g., loss of pleasure in doing things, feeling down or loss of concentration) on a 4-point Likert scale going from "not at all" to "nearly every day". The indicator of depression was confirmed if any of the "major depressive syndrome" or "other depressive syndrome" were identified based on the respective DSM-5 diagnostic algorithms for these disorders [40].

Anxiety is assessed with a screening tool built on the same model as the PHQ-9: the General Anxiety Disorder scale – 7 items (GAD-7). Here the questions concern situations like "not being able to stop or control worrying" or "trouble relaxing". The answers give values going from 0 for "not at all" to 3 for "nearly every day". The score ranges from 0 to 21, with 10 or more defining probable anxiety.

A third mental health indicator considered in this study was subjective well-being, measured with the self-administered General Health Questionnaire – 12 items (GHQ-12). Respondents reported how much more (or less) than usual they had experienced problems like "difficulty concentrating" or "feeling useless" in the past few weeks on a 4-point Likert scale. The answers [1, 2, 3, 4] were recoded [0, 0, 1, 1] (or [1,1,0,0] if positively worded) and summed across the 12 items. This bimodal scoring method leads to a distress score ranging from 0 to 12 [41]. The threshold of 2+at use in general population studies was set to identify people experiencing "psychological distress" in

comparison to the 4+threshold, used to identify people with "probable mental disorder".

For comparing the multimorbidity burden in relation to an individual's quality of life and functional limitations, the following indicators were explored:

- MI1: A physical-only multimorbidity indicator.
- MI2: A physical + self-reported depression multimorbidity indicator.
- MI3: A physical + screened anxiety (GAD) and depression (PHQ) multimorbidity indicator.
- MI4: A physical + psychological distress (GHQ 2+) multimorbidity indicator.
- MI5: A physical + possible mental illness (GHQ 4+) multimorbidity indicator.

Outcome variables for which the association with multimorbidity was evaluated

Health-related quality of life

HRQoL was assessed in the BHIS through the EQ-5D-5 L (Euroqol 5 dimensions, 5 levels). EQ-5D-5 L is a well-known multidimensional preference-based instrument, the most widely used to measure HRQoL. EQ-5D-5 L covers five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. For each dimension, the respondent can choose between five response categories (no problems, slight problems, moderate problems, severe problems, and extreme problems/unable to). The EQ-5D-5 L score ranges between 0 (death) and 1 (perfect health) [30, 42, 43].

Activity limitations

The Global Activity Limitation Indicator (GALI) is a single-item measure of functional status or level of disability taking into account the environment of people. It is the underlying measure of the European indicator "Healthy life years" (HLY). To assess these concepts the following question was asked: "For at least the past 6 months, to what extent have you been limited because of a health problem in activities people usually do?". Respondents can answer that they are "severely limited", "limited but not severely", or "not limited at all" [44, 45].

Confounders

The demographic characteristics of the respondents may be associated with either health-related quality of life or activity limitations and multimorbidity. Therefore, we included sex (male, female) and age (categories: 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, and 75 and older) as potential confounders of the association between multimorbidity and health-related quality of life [32] and the association between multimorbidity and activity limitations [46]. Income and education were also added for sensitivity analysis [8].

Statistical analysis

We conducted a complete case analysis. Missing values were not imputed. For each multimorbidity indicator (MI1-MI4), we assessed the prevalence and the correlation with health-related quality of life and activity limitations with the Pearson correlation coefficient (r).

We then performed linear regression models to assess the association between health-related quality of life (EQ-5D score - dependent variable) and the different multimorbidity indicators (independent variables). Logistic regressions were performed to assess the association between activity limitations (GALI – dependent variable) and the different multimorbidity indicators. For the purposes of the analysis, the GALI was binarized into "no limitation" versus "limitation, mild or severe". Regression models were adjusted for potential confounders (age and sex). To assess effect modification by sex, we added an interaction term between multimorbidity and sex. Coefficient estimates with 95% confidence intervals (CI) were calculated for each predictor. We also computed, for each model, goodness-of-fit measures: the Adjusted R-square, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) for the linear regressions; the AIC, the deviance (-2 log-likelihood) and the area under the curve (AUC) for the logistic regressions.

Survey settings were taken into account through the rescaling of the weights, an ad hoc approach suggested by Lumley and Scott (2015) [47].

All the statistical analyses were performed in SAS® 9.4.

Results

Descriptive statistics

Table 1 displays the sociodemographic and health characteristics of the respondents included in our analysis (n=9,753). Our sample has quite the same gender distribution as the Belgian population, with a slightly higher percentage of women represented (52.1% versus 51% in the general population), and is quite older (mean age: 49.9 versus 48.8 years in the general population, aged more than 15) and has a higher proportion of low educated people (people with maximum lower secondary education) (20.9% versus 41.5% in the general population). By making use of post stratification weights, the sample is representative of the Belgian population in terms of age and gender".

The most prevalent physical conditions reported were hearing problems (25.6%), joint diseases (including rheumatoid arthritis and osteoarthritis) (21.8%), hypertension (18.4%), dyslipidemia (18.3%), and obesity (15.8%). Among the mental health conditions, psychological distress, based on the GHQ-12, is the most prevalent

Table 1 Sociodemographic and health characteristics of the sample ($n = 9,753$), BHIS 2018

	Number	Proportion (%)
Sex		
Male	4674	47.9
Female	5079	52.1
Age, years (49.88 ± 19.08)		
15–24	1059	10.9
25–34	1338	13.7
35–44	1578	16.2
45–54	1725	17.7
55–64	1670	17.1
65–74	1289	13.2
75+	1094	11.2
Household equivalent income		
Quintile 1 (lowest income)	1927	22.2
Quintile 2	1551	17.9
Quintile 3	1660	19.1
Quintile 4	1731	19.9
Quintile 5 (highest income)	1818	20.9
Education levels		
No diploma or primary education	723	7.6
Lower secondary	1276	13.3
Higher secondary	2892	30.2
Higher education	4681	48.9
Physical health conditions		
Hearing problems	2498	25.6
Joint diseases (including rheumatoid arthritis and osteoarthritis)	2121	21.8
Hypertension	1789	18.4
Dyslipidaemia	1779	18.3
Obesity	1512	15.8
Thyroid problems	757	7.8
Diabetes	628	6.4
Asthma	580	6.0
Prostate problems (denominator = 4666: men only)	266	5.7
Chronic bronchitis, COPD, or emphysema	424	4.3
Osteoporosis	352	3.6
Serious heart diseases (except coronary heart diseases)	312	3.2
Cancer	225	2.3
Coronary heart diseases (including myocardial infarction)	185	1.9
Stroke	82	0.8
Mental health conditions		
Psychological distress (GHQ score 2+)	2600	33.0
Possible mental illness (GHQ score 4+)	1449	18.4
General anxiety disorder (GAD-7)	865	11.1
Depression (PHQ-9)	765	9.8
Self-reported depression	766	7.8
Health correlates		

COPD = chronic obstructive pulmonary disease

Table 2 Prevalence and correlation with health-related quality of life and activity limitations, for each multimorbidity indicator

	MI1	MI2	MI3	MI4	MI5
Prevalence (%)	36.16	37.77	40.77	43.63	40.43
Correlations[a]					
Health-related quality of life (EQ-5D score)	-0.34***	-0.38***	-0.43***	-0.42***	-0.41***
Activity limitations (GALI)	0.33***	0.35***	0.37***	0.36***	0.36***

[a] Pearson correlation coefficient; MI = multimorbidity indicator, MI1 = physical multimorbidity indicator, MI2 = MI1 + self-reported depression, MI3 = MI1 + PHQ&GAD, MI4 = MI1 + GHQ2+, MI5 = MI1 + GHQ4+, all p-values < 0.0001

(33.0%). Self-reported depression is the least prevalent with "only" 7.8% of the sample affected. Almost one in four in the sample (23.9%) has activity limitations.

Multimorbidity indicators

A table containing the distribution of the different multimorbidity indicators regarding sex and age can be found in the supplementary material table A3. Table 2 shows the weighted prevalence of each multimorbidity indicator and its correlation with health-related quality of life and activity limitations. The physical multimorbidity indicator (MI1) has the lowest prevalence (36%) and the lowest correlations with the EQ-5D score (r = -0.34) and the GALI (r=0.33) compared with the indicators including a mental health dimension. Among them, the multimorbidity indicator with psychological distress (MI4) has the highest prevalence (43%), while that based on screened anxiety and depressive symptoms shows the strongest correlations with health-related quality of life (r = -0.43) and long-term limitations (r=0.37). The correlations between these multimorbidity indicators and the health correlates are weak to moderate with only small differences between them [48]. Correlations with MIs are somewhat stronger for health-related quality of life than for activity limitations.

An extension of Table 2 that includes correlations between each multimorbidity indicator and each mental health indicator can be found in Supplementary material Table A3.

Association between multimorbidity and health-related quality of life

Table 3 presents the main results (coefficient estimates, Adjusted R-square, AIC, and BIC) from the linear regression models. While each multimorbidity indicator had a significant association with the health-related quality-of-life variable, it was stronger for the indicators including a mental health dimension (MI2, MI3, and MI4) than for the multimorbidity physical indicator (MI1), when adjusted for age and sex. The indicator including the screened anxiety and depressive symptoms (MI3) had

Table 3 Association between the multimorbidity indicators and health-related quality of life (EQ-5D score)

	MI1	MI2	MI3	MI4	MI5
Adjusted by age and sex					
Coefficient estimate β (95% CI)					
Multimorbidity	-0.127 (-0.138 ; -0.116)	-0.145 (-0.156 ; -0.134)	-0.165 (-0.176 ; -0.155)	-0.154 (-0.164 ; -0.144)	-0.152 (-0.162; -0.142)
Age	-0.0011 (-0.0014 ; -0.0009)	-0.0009 (-0.0012 ; -0.0007)	-0.0008 (-0.0011 ; -0.0005)	-0.0010 (-0.0013 ; -0.0008)	-0.0009 (-0.0012 ; -0.0006)
Sex	-0.044 (-0.053 ; -0.034)	-0.043 (-0.052 ; -0.033)	-0.039 (-0.048 ; -0.030)	-0.038 (-0.047 ; -0.029)	-0.040 (-0.050 ; -0.031)
Goodness-of-fit					
Adjusted R-square	0.1417	0.1655	0.1993	0.1880	0.1789
AIC	-21230,92	-21413.94	-21683.58	-21591.88	-21519.74
BIC	-21229.23	-21412.25	-21681.85	-21590.18	-21518.03
Adjusted by age, sex, and the interaction between multimorbidity and sex					
Coefficient estimate β (95% CI)					
Multimorbidity	-0.104 (-0.135 ; -0.072)	-0.122 (-0.152 ; -0.091)	-0.142 (-0.171 ; -0.112)	-0.142 (-0.172 ; -0.113)	-0.137 (-0.167; -0.107)
Age	-0.0011 (-0.0014 ; -0.0009)	-0.0009 (-0.0012 ; -0.0007)	-0.0008 (-0.0011 ; -0.0005)	-0.0010 (-0.0013 ; -0.0008)	-0.0009 ; -0.0012 ; -0.0006)
Sex	-0.038 (-0.050 ; -0.027)	-0.037 (-0.048 ; -0.025)	-0.033 (-0.044 ; -0.021)	-0.035 (-0.047 ; -0.023)	-0.036 (-0.048 ; -0.025)
Multimorbidity*sex	-0.015 (-0.035 ; 0.004)	-0.015 (-0.034 ; 0.004)	-0.016 (-0.034 ; 0.003)	-0.008 (-0.026 ; 0.011)	-0.010 (-0.029 ; 0.008)
Goodness-of-fit					
Adjusted R-square	0.1419	0.1657	0.1996	0.1879	0.1790
AIC	-21231.29	-21414.49	-21684.37	-21590.55	-21518.88
BIC	-21229.68	-21412.87	-21682.71	-21588.92	-21517.25
Adjusted by age, sex, education, income and the interaction between multimorbidity and sex					
Coefficient estimate β (95% CI)					
Multimorbidity	-0.106 (-0.136; -0.075)	-0.121 (-0.151; -0.091)	-0.141 (-0.170; -0.112)	-0.142 (-0.171; -0.113)	-0.137 (-0.167; -0.108)
Age	-0.0008 (-0.0011; -0.0005)	-0.0006 (-0.0009; -0.0003)	-0.0005 (-0.0008; -0.0002)	-0.0007 (-0.0010; -0.0004)	-0.0006 (-0.0009; -0.0003)
Sex	-0.036 (-0.048; -0.025)	-0.034 (-0.046; -0.023)	-0.031 (-0.043; -0.020)	-0.033 (-0.045; -0.021)	-0.035 (-0.046; -0.023)
Multimorbidity*sex	-0.009 (-0.028; 0.010)	-0.011 (-0.029; 0.007)	-0.010 (-0.028; 0.008)	-0.003 (-0.021; 0.015)	-0.005 (-0.023; 0.014)
Education	0.024 (0.018; 0.030)	0.023 (0.017; 0.029)	0.022 (0.016; 0.027)	0.022 (0.017; 0.028)	0.023 (0.017; 0.029)
Income	0.018 (0.015; 0.022)	0.018 (0.014; 0.021)	0.016 (0.013; 0.020)	0.017 (0.014; 0.021)	0.017 (0.014; 0.021)
Goodness-of-fit					
Adjusted R-square	0.1756	0.1980	0.2270	0.2185	0.2093
AIC	-21490.01	-21669.93	-21909.15	-21838.28	-21762.01
BIC	-21488.00	-21667.92	-21907.14	-21836.26	-21759.99

MI = multimorbidity indicator, MI1 = physical multimorbidity indicator, MI2 = MI1 + self-reported depression, MI3 = MI1 + PHQ&GAD, MI4 = MI1 + GHQ2+, MI5 = MI1 + GHQ4+, AIC = Akaike information criterion, BIC = Bayesian information criterion

the highest association (β = -0.16). Regarding the goodness-of-fit measures, the physical multimorbidity indicator had systematically the poorest values. Conversely, the MI3 model had the best goodness-of-fit with all outcomes. There were no differences between MI4 and MI5, the indicators based on GHQ, with a 2+and 4+threshold.

Regressions were also adjusted for an interaction between multimorbidity and sex. Although the interaction itself was not significant, the models showed significantly better goodness-of-fit values (apart from MI4) than the model without interaction. Coefficient estimates were slightly lower. When adding education and income as covariates, there were no huge changes in the coefficient estimates. However, goodness-of-fit measures were systematically better. Results stratified by sex can be found in the Supplementary material (Table A4).

Association between multimorbidity and activity limitations

In the logistic regression analysis with the GALI as a dependent variable (Table 4), we noted a higher odds ratio for the multimorbidity indicators including a mental health dimension (MI2, MI3, and MI4), when adjusting for age and sex. Estimates (OR = 5.2) and goodness-of-fit measures were better for the MI3, including screened anxiety and depressive symptoms.

Here again, we performed a supplementary analysis, adding an interaction between multimorbidity and sex.

Table 4 Association between the multimorbidity indicators and activity limitations (GALI score)

	M1	M2	M3	M4	M5
Adjusted by age and sex					
Odds ratio (IC95%)					
Multimorbidity	3.87 (3.38–4.43)	4.49 (3.92;5.15)	5.24 (4.56;6.02)	5.01 (4.36;5.76)	4.80 (4.18;5.50)
Age	1.02 (1.01; 1.02)	1.01 (1.01; 1.02)	1.02 (1.01; 1.02)	1.02 (1.02; 1.02)	1.02 (1.01; 1.02)
Sex – Men (ref.)	1	1	1	1	1
Sex – Women	1.25 (1.11; 1.41)	1.23 (1.10; 1.40)	1.21 (1.07; 1.37)	1.19 (1.06; 1.35)	1.22 (1.08; 1.37)
Goodness-of-fit					
AIC	6664.20	6569.35	6462.39	6496.16	6523.83
Deviance	6656.20	6561.35	6454.39	6488.16	6515.83
AUC	0.7264	0.7370	0.7471	0.7467	0.7431
Adjusted by age, sex, and the interaction between multimorbidity and sex					
Odds ratio (IC95%)					
Multimorbidity	3.16 (2.12;4.70)	3.59 (2.40;5.38)	4.93 (3.24;7.51)	4.57 (2.98;7.01)	4.63 (3.06;7.01)
Age	1.02 (1.01; 1.02)	1.01 (1.01; 1.02)	1.02 (1.01; 1.02)	1.02 (1.02; 1.02)	1.02 (1.01; 1.02)
Sex – Men (ref.)	1	1	1	1	1
Sex – Women	1.16 (0.96; 1.39)	1.13 (0.93; 1.38)	1.18 (0.95; 1.45)	1.14 (0.92; 1.43)	1.20 (0.97; 1.47)
Multimorbidity*sex	1.14 (0.89; 1.46)	1.16 (0.90; 1.48)	1.04 (0.80; 1.35)	1.06 (0.82; 1.39)	1.02 (0.79; 1.32)
Goodness-of-fit					
AIC	6665.07	6570.04	6464.30	6497.96	6525.80
Deviance	6655.07	6560.04	6454.30	6487.96	6515.80
AUC	0.7275	0.7385	0.7475	0.7470	0.7432
Adjusted by age, sex, income, education and the interaction between multimorbidity and sex					
Odds ratio (IC95%)					
Multimorbidity	3.31 (2.21;4.95)	3.66 (2.43;5.52)	5.10 (3.33;7.81)	4.72 (3.06;7.28)	4.86 (3.19;7.40)
Age	1.01 (1.01; 1.02)	1.01 (1.01; 1.02)	1.01 (1.01; 1.02)	1.02 (1.01; 1.02)	1.01 (1.01; 1.02)
Sex – Men (ref.)	1	1	1	1	1
Sex – Women	1.13 (0.94; 1.36)	1.10 (0.90; 1.33)	1.15 (0.93; 1.43)	1.12 (0.89; 1.39)	1.17 (0.95; 1.44)
Multimorbidity*sex	1.09 (0.85; 1.39)	1.12 (0.87; 1.44)	0.99 (0.76; 1.28)	1.02 (0.78; 1.33)	0.97 (0.75; 1.26)
Education – Higher (ref.)	1	1	1	1	1
Education – Higher secondary	1.41 (1.22; 1.64)	1.40 (1.21; 1.62)	1.38 (1.19; 1.60)	1.40 (1.21; 1.63)	1.41 (1.22; 1.63)
Education – Lower secondary	1.30 (1.07; 1.58)	1.29 (1.06; 1.57)	1.28 (1.05; 1.56)	1.30 (1.06; 1.58)	1.30 (1.06; 1.58)
Education – no diploma or primary education	1.69 (1.30; 2.18)	1.70 (1.31; 2.20)	1.62 (1.25; 2.10)	1.62 (1.25; 2.11)	1.65 (1.27; 2.15)
Income – quintile 5 (ref.)	1	1	1	1	1
Income – quintile 4	1.27 (1.03; 1.57)	1.28 (1.04; 1.57)	1.27 (1.03; 1.57)	1.24 (1.01; 1.53)	1.23 (1.00; 1.52)
Income – quintile 3	1.63 (1.32; 2.02)	1.64 (1.32; 2.02)	1.66 (1.34; 2.05)	1.65 (1.33; 2.05)	1.61 (1.30; 1.99)
Income – quintile 2	2.28 (1.84; 2.82)	2.27 (1.83; 2.81)	2.23 (1.79; 2.77)	2.21 (1.78; 2.74)	2.22 (1.79; 2.76)
Income – quintile 1	2.14 (1.73; 2.65)	2.15 (1.74; 2.67)	2.05 (1.65; 2.55)	2.12 (1.71; 2.63)	2.07 (1.67; 2.57)
Goodness-of-fit					
AIC	6508.96	6417.17	6328.92	6351.33	6380.39
Deviance	6484.96	6393.17	6304.92	6327.33	6356.39
AUC	0.7481	0.7588	0.7664	0.7676	0.7643

MI = multimorbidity indicator, MI1 = physical multimorbidity indicator, MI2 = MI1 + self-reported depression, MI3 = MI1 + PHQ&GAD, MI4 = MI1 + GHQ2+, MI5 = MI1 + GHQ4+, AIC = Akaike information criterion, deviance = -2log(likelihood), AUC = Area under the Curve

Odds ratios were slightly lower than in the previous models. No significant difference was noted in the goodness-of-fit measures. We also added income and education as covariates. Odds ratios were slightly higher with better goodness-of-fit measures. Results stratified by sex can be found in the Supplementary material (Table A5).

Discussion

Main results

This study aimed to investigate the added value of including a mental health dimension in a survey-based multimorbidity indicator. Analyses were performed on data from the 2018 Belgian Health Interview Survey. Results showed that [1] including a mental health dimension in a multimorbidity indicator had a better fit than an indicator solely based on physical conditions when associated

with health-related quality of life and activity limitations measures [2]. The best fit was shown when including screened anxiety and depressive symptoms measured through the PHQ-9 and GAD-7 scales.

The study's first aim was to assess the impact of including mental health in a multimorbidity indicator on health correlates. This approach is supported by Mercer et al. (2012) who stated that multimorbid patients need to be addressed by applying the idea that there is "no health without mental health" [49]. Mental health conditions, as well as physical health conditions, are relevant to consider when investigating multimorbidity. This suits to the general concept of multimorbidity which states that chronic conditions co-occur and interact mainly synergistically [30, 50]. Yokota et al. (2016) showed that the association of depression with a chronic respiratory disease is the most limiting condition among people with multimorbidity [51]. Also, people experiencing chronic pain conditions often suffer from mental health disorders [52]. Moreover, the risk of depression doubles for people with multimorbidity, and the odds rise by 45% with each additional chronic condition [53].

The second aim of the study was to identify the mental health indicator that would best be considered in a multimorbidity indicator. Among the indicators that included a mental health dimension, the one with screened anxiety and depressive symptoms based on the GAD-7 and PHQ-9 scales showed better results regarding its association with a health-related quality-of-life and activity limitation. Its correlation with the EQ-5D score and the GALI was higher than when including self-reported depression or psychological distress based on the GHQ-12. The higher correlation between anxiety and depression and the EQ-5D score may be explained by the fact that one of the five dimensions that are covered by the ED-5D score is anxiety/depression. An explanation of lower results for the multimorbidity indicator including self-reported depression is that the anxiety dimension is missing, which is a cause of poorer quality of life, and so undermining its impact [54, 55]. Although the multimorbidity indicator including psychological distress (GHQ-12≥2) scored systematically lower than that including screened anxiety and depressive symptoms, differences were very small. So, we cannot conclude that one mental health measure seems to score better than another one.

While three-quarters of multimorbidity studies already include both physical and mental health, our results highlight the importance of widening this use, a statement already made 20 years ago [13, 46]. Nowels and VanderWielen (2018) offer two explanations for the scarcity of mental health in comorbidity indices [56]. First, comorbidity and multimorbidity indexes often rely on medical records and administrative data [13]. The medical field is known to be just evolving from a paradigm where body and mind are separate entities to one where an individual is seen in a holistic way. Second, documentation and data extraction are not the same between mental health professionals and physical health providers. For example, they mention the DSM (Diagnostic and Statistical Manual of Mental Disorders) and the ICD (International Classification of Diseases) as two different ways of coding conditions. This can be a structural barrier to gathering physical and mental health data [56].

We chose to rely on two health outcomes, activity limitation and health-related quality of life, because of their strong association with multimorbidity. Multimorbidity patients are at higher risk of physical limitations, regardless of which conditions were included [29]. Further, the association between multimorbidity and health-related quality of life is established with a predicted decline of 3.88% in an EQ-5D score for each additional disease [32]. Also, mental health diseases such as depression and anxiety are among the most prevalent chronic conditions, particularly among older people [52, 57].

Strengths and limitations

To our knowledge, this is the first study to investigate the added value of integrating mental conditions in a multimorbidity indicator. One strength is that it relies on data from a representative sample of the general population. Also, comparing the effects of including different mental health measures to the MI contributed to the robustness of the results. Rather than simply adding a mental health condition to a multimorbidity indicator, we assessed how well the multimorbidity indicator models including various mental health measures predicted the quality of life and limitations outcomes.

The first set of limitations is related to the source of data. First, the data are cross-sectional, which hampers causal inference. Second, survey data are subject to recall biases and incorrect reports, with young women and more educated people being more accurate [58]. Third, selection biases are also common. Marginalized people such as migrants, older, ill, or low educated people are often left out of surveys because of difficulty to reach or willingness issues. This could impact the generalisability of the results [59–61].

A second limitation is related to the physical multimorbidity indicator. We chose to rely on a systematic review presenting the top 20 diseases included in multimorbidity studies [36]. However, we could not use every disease mentioned in the review because some of them were not available in the BHIS.

A third limitation is that important mental health problems such as dementia or schizophrenia were not captured because they were not included in the BHIS. It is also challenging to obtain valid information about these mental health problems through interview surveys.

A final limitation is that the health-related quality of life (HRQoL) outcome based on the EQ-5D for which the association with the multimorbidity indicators was assessed includes anxiety/depression as one of the five dimensions involved in the measure. This could partly explain the higher association with the multimorbidity models in which anxiety and depression were represented. However, the global EQ-5D score covers a much wider concept of life quality as a whole. Besides, the associations between the multimorbidity indicators and HRQoL were in line with the results of their associations with the GALI. This adds validity to the findings.

Impact on research

Our study highlights the importance of including mental health conditions in a multimorbidity indicator. We have argued that leaving them out from this indicator could undermine its predicting value in terms of quality of life and functional activities, as it would underestimate its relationship with and its impact on health-related outcomes. From a researcher perspective, including mental health would improve the comprehensiveness of multimorbidity impact on health correlates, but also on social and psychological outcomes. Including the mental health dimension in a clinical approach of patients with comorbidities would also be beneficial for healthcare providers. A review on general practitioners' perspectives showed that healthcare is fragmented between different medical specialities and that guidelines often target single diseases [62]. A comprehensive indicator has the advantage to give a more holistic picture of patients' needs and allow better decision-making regarding care trajectories. Lastly, for policymakers, acknowledging the cooccurrence of chronic physical and mental diseases on outcomes such as quality of life and functional health could strengthen strategies aimed at preventing chronic diseases.

Including mental health has also some disadvantages. As we already mentioned, this research showed that mental health can be assessed in many different ways (self-report, scales of depression and anxiety, scale of well-being). So, incorporating a mental health dimension into a multimorbidity indicator could further increase the already high heterogeneity in multimorbidity studies and hamper comparability across them. Also, some studies regard mental health as a core outcome of multimorbidity, to the same extent as mortality or health-related quality of life [34]. As an example, in their review and meta-analysis, Read *et* al. (2017) assess the relationship between multimorbidity and depression as this seems bidirectional: depression increases the risk of cardiovascular diseases and occurs more often after an infarct [53].

Beyond this advantages-disadvantages balance, we must keep in mind that collecting data about mental health problems is a challenge. Mental disorders are subject to stigma and are underreported due to social desirability [63]. Social desirability and stigma would mainly apply for collecting mental health data in a face-to-face survey setting. Underreporting of mental health disorders can also pertain to the respondents' inability to identify symptoms as part of a clinical syndrome. More diagnostic tools, for instance tools included in specific mental health surveys, could provide more precise indicators on mental disorders, but such surveys are costly, very demanding for participants and have less information on physical morbidity. Along these considerations, it remains unclear which data source to consider when creating a population-based multimorbidity indicator. Although administrative data would more accurately capture multimorbidity including mental health, they are either not available in all countries or available only in subpopulations [64]. Moreover, these data only account for people who have received professional mental health care, while many remain unattended [65]. Furthermore, administrative databases may be different from country to country but also within countries [64].

Future studies on multimorbidity should include as far as possible chronic mental health disorders in the development of the multimorbidity indicator. Following Diederichs et al.. (2011), the main reason to include some diseases is data availability [16], so including anxiety or depression would depend on such pragmatic reason. Some health surveys also include dementia and other mental health diseases, such as schizophrenia, obsessive compulsive disorder and bipolar disease [26, 66]. Even though the validity of self-reported information on these diseases may be limited, a critical review of the lists of diseases should be envisaged. Although challenging, further research should also try to identify and evaluate new instruments to measure mental morbidity in general health surveys. Our study did not disentangle which assessment of mental health would suit best for the understanding multimorbidity's impact on health, even if scales seemed to have quite better results. Using scales could also facilitate data collection through bypassing social desirability. Some studies suggest to weight included diseases on the basis of their health impact [67]. A weighted index could be more precise in measuring the health impact of a multimorbidity indicator. Other authors showed no clear advantage of using weighted indicators or simple diseases counts [10]. The results are thus not conclusive. In this study, we used simple counts which facilitated analyses and indicator development. Lastly, it was out of the scope of the study to compare administrative data with survey data, so we cannot conclude on the best source to use. A Canadian study showed that the prevalence was higher when using administrative data [27]. Linkages between health survey data and

administrative data may therefore yield multimorbidity indicators which better capture the mental health dimension then survey data alone. This is also a hypothesis that needs further investigation. All in all, authors should be more explicit about their choices regarding the diseases included in their multimorbidity index, the measurement tools and reference times and the data sources [68]. Finally, further research on multimorbidity and mental health could investigate how the impact of the inclusion of mental health in multimorbidity on health outcomes varies by age, as mental and physical trajectories of health can differ according to age [69].

Conclusion

Multimorbidity is a rising public health issue as it concerns a significant part of the population. Multimorbidity has long been determined based on the presence of two or more somatic chronic conditions, without reference to mental disorders. Adding a mental health dimension and seeing the individual in a more holistic way is a growing practice and in line with the conceptual definition of multimorbidity.

This paper showed that ignoring mental health when studying multimorbidity leads to an underestimation of its occurrence in the population and its influence on health correlates such as health-related quality of life and activity limitations. Our study also allowed to pick the best multimorbidity indicator in relation to these health-related outcomes, based on differential mental health measures on trial.

Further studies should investigate the impact of adding mental health in a multimorbidity indicator of the age-multimorbidity association.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-024-21028-0.

Supplementary Material 1

Author contributions

JVH and PL conceived the design of this study and performed analyses. The first draft of the manuscript was written by PL. LG, WD, RC and JVH provided intellectual content and commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability

The datasets generated and/or analysed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The BHIS 2018 sampling and survey method was carried out according to the Belgian privacy legislation and has been approved by the Privacy Commission and the Ethical Committee of the University of Ghent. Informed consent was obtained from all individual participants in the BHIS.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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