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Changing definitions altered multimorbidity prevalence, but not burden associations, in a musculoskeletal population

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Abstract

Objectives: The inclusion of musculoskeletal conditions within multimorbidity research is inconsistent, and working-age populations are largely ignored. We aimed to: (1) estimate multimorbidity prevalence among working-age individuals with a range of musculoskeletal conditions; and (2) better understand the implications of decisions about the number and range of conditions constituting multimorbidity on the strength of associations between multimorbidity and burden (e.g., health status and health care utilization).

Study Design and Setting: Using data from the Australian National Health Survey 2007–08, the associations between burden measures and three ways of operationalizing multimorbidity (survey, policy, and research based) within the working-age (18–64 years) musculoskeletal population were estimated using multiple logistic regression (age and gender adjusted).

Results: Depending on definition, from 20.2% to 75.4% of working-age individuals with musculoskeletal conditions have multimorbidity. Irrespective of definition, multimorbidity was associated with increased likelihood of subjective health burden, pain or musculoskeletal medicines use, nonmusculoskeletal specialist and pharmacist (advice only) consultations, and reduced likelihood of not consulting health professionals. A group with intermediate health outcomes was considered multimorbid by some, but not all definitions. With the restrictive policy and research multimorbidity definitions, this intermediate group is included within the reference population (i.e., are considered nonmultimorbid). This worsens the reference group's apparent health status thereby leveling the comparative burden between those with and without multimorbidity. Consequently, dichotomous cut points lead to similar associations with burden measures despite the increasingly restrictive multimorbidity definitions used.

Conclusions: All multimorbidity definitions were associated with burden among the working-age musculoskeletal population. However, dichotomous cut points obscure the gradient of increased burden associated with restrictive definitions.

Keywords: Multimorbidity; Musculoskeletal conditions; Quality of life; Health care utilization; Burden of disease; Self-rated health; Health status

1. Introduction

The importance of coexisting chronic conditions (termed multimorbidity [1], or in the context of an index condition, comorbidity [2]) is increasingly recognized because multimorbidity magnifies health care expenditure [3], health care service usage [4,5], polypharmacy, and mortality rates [6]; reduces functional status and quality of life [7–12]; and contributes to adverse events [12]. Multimorbidity prevalence varies substantially across studies, ranging from 12% to 95% [3,7,13–22]. Factors contributing to this variation include differences in geographical settings, populations sampled, and data collection methods [17,23].

There is currently no "gold standard" definition for multimorbidity (or comorbidity). The definition selected depends on its suitability for the sample population, outcome of interest, or the data available [7,11,22,24]. Complex scale–based measures of coexistent conditions that include weightings of severity [25–28] or physical

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What is new?

Key findings

- The estimate of prevalence of multimorbidity in the working-age Australian population with musculoskeletal conditions varies greatly with how multimorbidity is defined (i.e., with the survey, policy, and research definitions).
- Irrespective of definition, multimorbidity adds to subjective health burden and health care utilization.

What this adds to what was known?

- The strength of associations between multimorbidity and burden is relatively consistent with these different multimorbidity operational definitions (establishing convergent validity).
- However, an inherent limitation of dichotomous cut points is that they "level associations" and obscure the gradient of increased burden associated with the more restrictive definitions.
- The degree of burden added by multimorbidity escalates with each increasingly restrictive operational definition; however, this is illustrated only when the reference group is fixed to those considered not multimorbid by any definition (examined here).

What is the implication and what should change now?

- It is important to be aware of this "leveling of association" with burden measures when comparing different definitions of multimorbidity based on simple counts.

functioning [29,30] potentially require intensive training time or labor to implement, access to clinical notes [24], and researcher decisions about presence of conditions are still partly subjective [7]. Data on duration, time-course, or severity of disease are often limited, which precludes weighting on these factors [23]. Therefore, multimorbidity is often pragmatically operationalized by simply summing the number of coexisting chronic diseases [11,31,32]. In addition, the minimum number (nominal threshold) and range (operational definition) of conditions that constitute multimorbidity contribute to the heterogeneity in prevalence observed across study populations [11,18,23,33–35].

Multimorbidity operationalized by condition count can include all conditions reported individually [11,36] or categorized by affected organs or systems [17,23]; the range of chronic conditions reported may be unlimited, or limited to a prespecified list of conditions. Even within a single data set, the definition used ("survey" [37], "policy" [38], and "research based" [35]) to operationalize multimorbidity greatly influences prevalence estimates (Lowe et al. submitted and [34]). However, it is unclear whether the strength of associations between these multimorbidity operational definitions and burden (e.g., health status and health care utilization) similarly varies. Examination of how well multimorbidity based on simple counts encapsulate associated health burden is needed to establish convergent validity of these multimorbidity definitions and to better understand the implications of decisions about the range of conditions included.

Working-age people with musculoskeletal (MSK) conditions are an appropriate policy-relevant and clinically important population to determine the additional subjective health and health care utilization burden that can be attributed to the presence of multimorbidity. MSK are highly prevalent and therefore a likely component of multimorbidity [7,21,39]. MSK are demonstrably burdensome; they impact on quality of life [40], complexity of medication regimens [41], and ability to continue paid employment [16,42]. Problematically, multimorbidity research tends to include MSK in an inconsistent and selective manner (e.g., restricted to osteoarthritis [43]; fibromyalgia and rheumatic conditions [21,44]) or within vaguely described or broadly encapsulating categories (e.g., inclusive of arthritis, joint disorders, or painful conditions not otherwise described [7,12]). Furthermore, multimorbidity research typically focuses on older people; however, similar to MSK, multimorbidity is not simply a process of aging [7,19,22]. Consequently, little is known about the additional subjective burden of multimorbidity among working-age people with MSK [10].

To address this, we used data from the Australian National Health Survey, to answer the following questions. Among working-age (18–64 years) people with any MSK:

1. Is each multimorbidity definition associated with additional burden across a range of subjective health and health care utilization measures? (i.e., establish convergent validity)
2. Do these observed associations vary according to the multimorbidity definition used?

2. Materials and methods

Data were sourced from the Australian Bureau of Statistics (ABS) National Health Survey 2007-08 [National Health Survey (NHS) 07-08] [37]. The ABS conducts NHS on a regular, approximately triennial basis. This secondary analysis uses data from a survey that took place during the period of August 2007 to June 2008. Previous surveys were conducted in 1977–78, 1983, 1989–90, 1995, 2001 and 2004–05. Confidentialized unit record files, released by the ABS since 2001, enable researchers to conduct detailed analysis of the survey data. For this

nationally representative survey, the ABS sampled people from all Australian states and territories and across all age groups. The overall response rate for the NHS 07-08 was 91%. In total, 20,788 persons from 15,792 households provided completed questionnaires. The NHS 07-08 questionnaire sought data on a broad range of health factors including self-reports of conditions diagnosed, health status, use of health services, health-related lifestyle risk factors, and sociodemographic characteristics. Information was collected through trained interviewers using prompt cards and where possible, with validated measures. Further details on survey design, sampling strategy, questionnaire, and response rate are available elsewhere [37].

For the present study, the sample population was drawn from working-age (18–64 years) NHS 07-08 respondents (n = 12,604) who self-reported the presence of any chronic (i.e., current and present for 6 months or more) MSK condition(s) (n = 4,555; 36.1% of working-age sample). MSK comprised any of: osteoarthritis (n = 933; 7.9%), inflammatory arthritis (n = 317; 2.5%), other arthritis or arthropathies (n = 1,022; 8.1%), soft-tissue disorders (n = 404; 3.2%), gout (n = 589; 4.7%), back pain (n = 2,493; 19.8%), osteoporosis (n = 292; 2.3%), or other MSK (n = 117; 0.9%).

The multimorbidity operational definitions compared were drawn from "survey-" [37], "policy-" [38] and "research-based" [35] contexts. The survey definition included all chronic conditions reported within the NHS 07-08. The policy definition included Australian National Health Priority Area chronic condition categories: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorders [38]. By collating conditions into categories, the definition counts two or more conditions (e.g., osteoporosis and rheumatoid arthritis) affecting a single body system only once (e.g., MSK). The research definition included: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis [35]. Details on specific diagnoses included in each condition category are described in more detail elsewhere ([35,37,38] and Lowe et al. submitted).

The nominal threshold (minimum number of conditions constituting multimorbidity) varied between definitions. For the policy and research definitions of multimorbidity, it was two or more (2+) chronic condition categories. For the survey definition, with the 2+ threshold, multimorbidity prevalence within the working-age MSK population was very high, resulting in small cell counts in many instances and therefore associations could not be estimated. Therefore, the multimorbidity threshold for the survey definition was set at 3+ conditions (as recommended in Lowe et al. submitted). This higher threshold was required as the survey definition includes all reported chronic conditions, some with potentially insubstantial burden (e.g., myopia).

Subjective health burden (during 4 weeks before interview) included NHS 07-08 measures of: fair to poor self-rated health status [45], high psychological distress [46], moderate to severe pain rating, and pain interfering with work (see Table 1).

MSK-related medicines use and health care utilization data were collected only for respondents with current long-term osteoporosis, osteopenia, arthritis [gout, rheumatism or arthritis - osteoarthritis, rheumatoid arthritis, and/or other type (specified)]. General health care utilization data were collected from all respondents. Health utilization measures were based on the following NHS 07-08 data:

- Pain and MSK-related medicines use in the previous 2 weeks. MSK-related medicines use included self-reports of up to three arthritis-related, self-reported main pharmaceuticals used. This included vitamins and mineral supplements such as vitamin D, calcium, glucosamine, and various marine-based products, natural, or herbal treatments;
- MSK-related general practitioner (GP) and specialist consultations during the previous 2 weeks (e.g., for arthritis or osteoporosis);
- General health care utilization during the previous 12 months including consulting a specialist, physiotherapist(s), chiropractor(s), or pharmacist(s) for advice, as well as, not consulting a health professional.

All statistical analyses were performed using Stata (release 10.1, College Station, TX, USA). The associations between multimorbidity and the various outcomes among the MSK population were estimated using multiple logistic regression models. Analyses were adjusted for age and gender as potential confounders. To account for the survey design, the ABS generated replicant weights were applied. Based on weights provided in the confidentialized unit record file, population prevalence estimates of multimorbidity for each of the operational multimorbidity definitions were derived for the total working-age MSK population, as well as age- and gender-specific subgroups.

Previously (Lowe et al. submitted), we demonstrated the survey definition is the most inclusive and the research definition, by including only conditions purported to be severely problematic to health, the most restrictive. With dichotomous multimorbidity measures, the more restrictive the definition is, the more people—including individuals with potentially burdensome health (see intermediate group in Fig. 1)—are placed into the nonmultimorbid reference group. We explored the effects of these dichotomous cut points further by identifying the group considered universally by the three definitions as "nonmultimorbid," as a stable reference group. To achieve this, we created four mutually exclusive groups: (1) "nonmultimorbid" according to any definition, (2) "multimorbid with the survey definition only," (3) "multimorbid with both the policy and survey definition," and (4) "multimorbid with all three definitions."

Table 1. Description of self-reported health measures

Health measure	Description	Timeframe
Fair to poor self-rated health status	A response of either "fair" or "poor" to the question "In general would you say that [your/(proxy name)] health is excellent, very good, good, fair, or poor"	During 4 weeks before interview
High psychological distress	A Kessler Psychological Distress Scale-10 (K10) grouped score indicating high (>22 points) or very high severity of distress (30–50 points)	During 4 weeks before interview
Moderate to severe pain	A rating of "moderate," "severe," or "very severe" to the extent of bodily pain felt	During 4 weeks before interview
Pain interfering with work	A response of "moderately" or "extremely" to the extent of bodily pain interfering on normal work activities	During 4 weeks before interview

3. Results

3.1. Characteristics of MSK population and prevalence of multimorbidity

Prevalence of most demographic characteristics, multimorbidity, subjective health, and health care utilization measures varied between working-age respondents with or without MSK (Table 2). Among the working-age population, people with MSK were older and had lower household income than those without MSK: the prevalence of multimorbidity was as low as 20.2% with the research definition, 38.3% with the policy definition, and as high as 75.4% with the survey definition. Ratings of all subjective health and health utilization measures were higher for those with MSK than the working-age population without (see Table 2).

For each multimorbidity definition, the proportion of the MSK population considered multimorbid increases with age and differs slightly by gender (see Fig. 2). To determine if reporting strata-specific estimates were warranted, we formally tested whether either gender or age modified the associations between multimorbidity and self-reported health outcomes, using interaction analyses. These analyses revealed no clinically important effect modification by either gender or age. For example, while women are more likely to report psychological distress than males, the association between multimorbidity and psychological distress is nonetheless similar for both males and females. Where effect modification was observed, associations were stronger in some subgroups, but the direction of effects was the same (results available on request).

3.2. Associations between multimorbidity and subjective health measures

In the working-age population with any MSK condition (here onward termed the MSK population), the presence of multimorbidity with each definition was associated with increased likelihood of poorer ratings for all subjective health measures, compared to the MSK population without

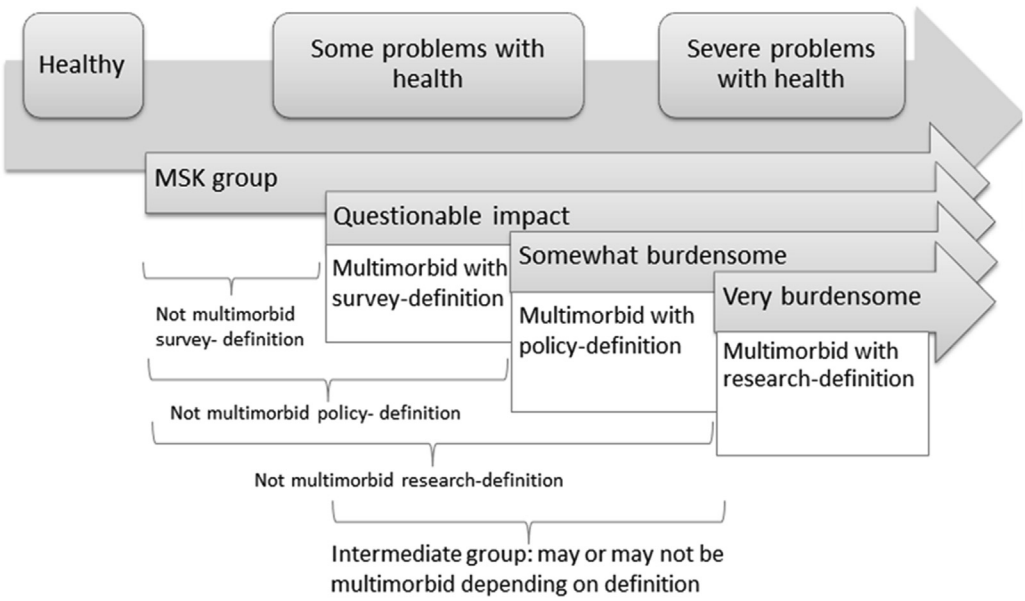


Fig. 1. Illustration of dichotomous population cut points for those considered to have multimorbidity with each definition and hypothesized burden on health along a continuum. MSK, musculoskeletal.

Table 2. Prevalence of demographic characteristics, multimorbidity, subjective health, and health care utilization measures within the working-age (18 to 64 years) respondents with or without MSK (adjusted for survey design)

Characteristic	Working-age population with MSK (n = 4,555); prevalence % (95% CI)	Working-age population without MSK (n = 8,049); prevalence % (95% CI)
Gender		
Female	50.3 (48.6, 52.1)	50.0 (49.0, 51.0)
Male	49.7 (47.9, 51.4)	50.0 (49.0, 51.0)
Age group		
18–34	21.5 (20.0, 23.1)	45.0 (44.1, 45.9)
35–49	34.8 (33.5, 36.2)	34.5 (33.7, 35.2)
50–64	43.7 (42.1, 45.2)	20.5 (19.7, 21.3)
Income group		
First quintile	13.6 (12.2, 15.1)	7.5 (6.9, 8.1)
Second quintile	14.9 (13.5, 16.5)	14.1 (13.0, 15.4)
Third quintile	19.6 (18.2, 21.1)	19.2 (18.0, 20.4)
Fourth quintile	19.1 (17.2, 21.1)	21.6 (20.4, 22.9)
Fifth quintile	17.9 (16.5, 19.5)	22.0 (20.6, 23.5)
Not stated	14.8 (13.5, 16.4)	15.6 (14.3, 16.9)
Multimorbidity		
Survey definition[a]	75.4 (73.6, 77.0)	24.8 (23.5, 26.2)
Policy definition[b]	38.3 (36.5, 40.1)	3.5 (3.0, 4.1)
Research definition[c]	20.2 (18.9, 21.6)	1.7 (1.4, 2.0)
Subjective health measures during previous month		
Fair to poor health status	22.2 (20.6, 23.8)	7.5 (6.8, 8.2)
High psychological distress	19.0 (17.5, 20.7)	9.1 (8.2, 10.1)
Moderate to severe pain rating	46.1 (44.5, 47.8)	16.7 (15.6, 17.9)
Pain interfering with work	36.0 (34.0, 37.9)	12.6 (11.7, 13.7)
Health care utilization measures (MSK related) within last 2 weeks		
Consulting an MSK specialist	2.2 (1.7, 2.8)	Not applicable
Consulting GP for MSK condition	4.4 (3.7, 5.3)	Not applicable
Pain medication use	4.9 (4.0, 5.8)	0.7 (0.5, 1.0)
MSK medication use	24.4 (22.7, 26.2)	0.7 (0.5, 0.9)
Health care utilization measures during previous 12 months (general)		
Consulting a specialist	32.6 (30.9, 34.4)	18.9 (17.9, 20.90)
Consulting a physiotherapist	14.0 (12.7, 15.4)	7.5 (6.7, 8.4)
Did not consult health professional	31.8 (30.0, 33.6)	50.8 (49.2, 52.5)
Consulting a pharmacist (advice only)	16.6 (15.4, 17.9)	12.4 (11.3, 13.6)
Consulting a chiropractor	15.2 (13.7, 16.8)	7.5 (6.8, 8.2)

Abbreviations: MSK, musculoskeletal; CI, confidence interval; GP, general practitioner.

[a] The survey definition includes the presence of three or more conditions reported within the NHS 07-08.

[b] The policy definition includes the presence of two or more Australian National Health Priority Area conditions: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorder.

[c] The research definition suggested by Diederichs et al. includes two or more of the following conditions: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis.

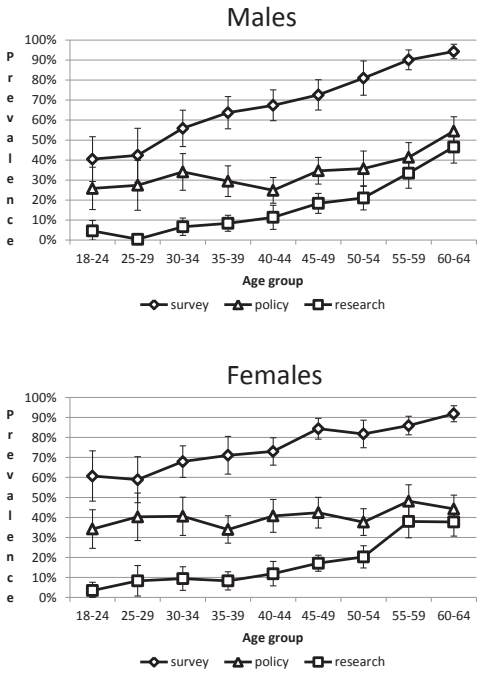
multimorbidity (Table 3). Specifically, the MSK population with multimorbidity were 2.8-fold to 3.9-fold more likely to report fair to poor health status, and twice as likely to report higher ratings of pain, or pain interfering with work, than the MSK population without multimorbidity. The strongest association was observed for psychological distress: the MSK population with multimorbidity was 3.0-fold to 6.6-fold more likely to report high psychological distress than those without multimorbidity (see Table 3).

Associations between multimorbidity and subjective health measures were similar, regardless of the definition used (Table 3), with most confidence intervals (CIs) overlapping. Two possible exceptions to this were: (1) the likelihood of high psychological distress was greater with the policy definition; and (2) the association with poor to fair health status was slightly weaker with the survey definition (see Table 3).

As it is questionable if nonlower back pain is truly an MSK [47], we conducted analyses excluding those participants with only back pain and no other form of MSK. The results were substantively similar, with the exception that the associations with psychological distress were marginally weaker (analyses available on request).

3.3. Associations between multimorbidity and self-reported MSK-related health care utilization

Among the MSK population, the presence of multimorbidity was associated with increased likelihood of using pain or MSK medications, compared to the MSK



[a] The survey definition includes all conditions reported within the NHS 07-08.

[b] The policy definition includes Australian National Health Priority Area conditions: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorder.

[c] The research definition suggested by Diederichs et al. includes: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis.

Fig. 2. Age- and gender-specific prevalence rates of multimorbidity among the working-age MSK population obtained with the survey[a], policy[b], and research[c] multimorbidity definitions, respectively. [a]The survey definition includes all conditions reported within the NHS 07-08. [b]The policy definition includes Australian National Health Priority Area conditions: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorder. [c]The research definition suggested by Diederichs et al. includes: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis. MSK, musculoskeletal.

population without multimorbidity. Multimorbidity was not associated with increases in associations with MSK-related GP or MSK specialist consultations in the previous 2 weeks among the MSK population (see Table 4).

The point estimates for associations between multimorbidity and MSK-related health care utilization were fairly similar (and CIs overlap) regardless of definition used. Within the MSK population, the association with pain medication use was strongest with multimorbidity using the policy definition, whereas association with MSK medication use was strongest with multimorbidity using the survey definition (see Table 4).

3.4. Associations between multimorbidity and self-reported general health care utilization

Within the MSK population, the presence of multimorbidity was associated with a twofold increase in consulting "other" specialists (i.e., non-MSK related), pharmacists for advice only (i.e., not for prescription refill), and a reduced likelihood of not consulting a health professional during the last 12 months. Presence of multimorbidity was not consistently associated with consulting either a chiropractor or physiotherapist among the MSK population (Table 5).

The associations with general health care utilization did not vary substantially with the multimorbidity definition used (see Table 5). One exception was consulting with a chiropractor. This was associated with a slightly increased likelihood with the survey definition, whereas for the research definition, the associations were reduced and the policy definition was not associated with consulting a chiropractor.

3.5. The effect of shifting "nonmultimorbid" reference groups on associations with burden measures

There was a clear gradient of increasing burden associated with the restrictiveness (i.e., decreased prevalence) of the multimorbidity definition when compared to those who were "nonmultimorbid" according to all three definitions (Table 6). Within Tables 3–5, as the multimorbidity definition becomes more restricted, more people, including individuals with progressively poorer health status (as illustrated by the shaded cells in Table 6), were placed into the reference ("nonmultimorbid") group. This shifting intermediate group (Fig. 1) has the effect of worsening the reference group's apparent health status, leveling the associations between multimorbidity and burden measures, consequently resulting in estimates that appear mostly uniform across definitions. However, when the reference group is fixed to those considered "nonmultimorbid" by all three definitions, the gradient in burden associated with each mutually exclusive multimorbidity group is clear, as indicated by the point estimates and CIs no longer overlapping (Table 6). Compared with those considered "nonmultimorbid" with any definition, those who were considered multimorbid by all three definitions had an 8.5-fold higher odds of reporting fair to poor health, 8.9-fold increased odds of high psychological distress, 3.4-fold increased odds of pain interfering with work, and 4.0-fold increased odds of reporting a moderate to severe pain rating.

4. Discussion

For the sample population of working-age Australians with any MSK, multimorbidity (however defined) was associated with higher subjective health burden (fair to poor health status, high psychological distress, moderate to severe pain ratings, and pain interfering with work) when compared to people with MSK but without multimorbidity. Similarly, irrespective of definition used, multimorbidity was associated with health care utilization measures including increased likelihood of consulting "other" specialists and pharmacist for advice only and pain or MSK

Table 3. Associations between multimorbidity and subjective health burden measures among the working-age musculoskeletal population

Multimorbidity definition (condition threshold)	Fair to poor health status; OR (95% CI)	High psychological distress; OR (95% CI)	Pain interfering with work; OR (95% CI)	Moderate to severe pain rating; OR (95% CI)
Survey[a] (3+)	2.8 (2.1, 3.7)	3.3 (2.4, 4.5)	2.1 (1.6, 2.6)	2.4 (1.9, 2.9)
Policy[b] (2+)	3.9 (3.1, 4.8)	6.6 (5.4, 8.1)	2.2 (1.8, 2.7)	2.1 (1.7, 2.5)
Research[c] (2+)	3.9 (3.0, 4.9)	3.0 (2.3, 3.9)	1.8 (1.4, 2.3)	2.1 (1.7, 2.6)

Abbreviations: OR, odds ratio; CI, confidence interval; MSK, musculoskeletal.

The reference group is the MSK working-age population without multimorbidity (as classified per the definition in the row). Associations are adjusted for age and gender.

[a] The survey definition includes all conditions reported within the NHS 07-08.

[b] The policy definition includes Australian National Health Priority Area conditions: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorder.

[c] The research definition suggested by Diederichs et al. includes: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis.

medications use. Among the MSK population, the presence of multimorbidity did not generally alter likelihood of consulting a specialist or GP for MSK-related issues, or consulting physiotherapist or chiropractor. This is an expected finding because multimorbities are not usually treated by those professionals, but by ''other specialists.''

Each definition used here ''counts'' conditions differently, and this has important implications. For the policy definition, the ''nonmultimorbid'' reference population potentially includes people with more than one condition because this definition groups some individual conditions into affected organ categories. This is done because the number of body systems affected may be a better indicator of severity of burden related to multimorbidity than summing individual conditions [17]. For the survey definition, although all individual conditions reported were summed, the three-condition threshold was used, so the ''nonmultimorbid'' reference population again potentially includes people with two conditions. Yet, all three multimorbidity definitions compared here predicted almost equivalently increased likelihood of subjective health burden and health care utilization, even with organ domain–based classification of conditions or when restricting to conditions with a known burden, as with the policy and research definitions. Our hypothesis was that as populations classified with multimorbidity become more restricted with each definition, the impact of multimorbidity would become more burdensome (see Fig. 1). Therefore, this finding was unexpected, especially given the very different estimates of multimorbidity prevalence generated by these same definitions (range: 20.2% to 75.4%).

However, further analyses revealed that although all three definitions predict similar additional health burden associated with multimorbidity within the MSK population, this is only the case when compared with those considered ''nonmultimorbid'' by the particular definition forming the analysis. It is therefore misleading to conclude that the burden associated with multimorbidity is uniform irrespective of conditions included, as there is a gradient of increased burden with the increasingly restrictive nature of these definitions. However, this gradient in severity is identified only when the reference population is fixed to those uniformly classed as ''nonmultimorbid'' by all three definitions. This is an inherent limitation of dichotomous cut points used when operationalizing multimorbidity with counts of conditions. The inclusion of the intermediate group (i.e., the shifting group who are considered to be multimorbid by some definitions but not by others) in the reference population worsens the reference group's apparent health status thereby leveling the comparative burden between those with and without multimorbidity.

Table 4. The association between the presence of multimorbidity and musculoskeletal (MSK)–related health care utilization and medicines use in the previous 2 weeks, among the working-age MSK population

Multimorbidity definition (condition threshold)	MSK-related specialist consultations; OR (95% CI)	MSK-related GP consultations; OR (95% CI)	Pain medication use; OR (95% CI)	MSK[a] medication use; OR (95% CI)
Survey[a] (3+)	3.4 (0.7, 17.8)	2.1 (0.7, 6.0)	2.9 (1.5, 5.6)	2.1 (1.5, 2.9)
Policy[b] (2+)	1.5 (0.8, 3.0)	1.5 (1.0, 2.2)	3.3 (2.2, 5.0)	1.4 (1.1, 1.7)
Research[c] (2+)	1.7 (0.9, 3.6)	0.9 (0.6, 1.5)	2.5 (1.6, 3.9)	1.8 (1.5, 2.3)

Abbreviations: OR, odds ratio; CI, confidence interval; GP, general practitioner.

The reference group is the MSK working-age population without multimorbidity (as classified per the definition in the row). Associations are adjusted for age and gender.

[a] The survey definition includes all conditions reported within the NHS 07-08.

[b] The policy definition includes Australian National Health Priority Area conditions: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorder.

[c] The research definition suggested by Diederichs et al. includes: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis.

Table 5. The association between the presence of multimorbidity and general health care utilization during the previous 12 months, among the working-age musculoskeletal population

Multimorbidity definition (condition threshold)	Consulting a specialist; OR (95% CI)	Consulting a physiotherapist; OR (95% CI)	Did not consult health professional; OR (95% CI)	Consulting a pharmacist (advice only); OR (95% CI)	Consulting a chiropractor; OR (95% CI)
Survey[a] (3+)	2.1 (1.6, 2.7)	1.3 (0.9, 1.9)	0.5 (0.4, 0.6)	2.3 (1.6, 3.2)	1.2 (1.0, 1.6)
Policy[b] (2+)	2.3 (1.9, 2.7)	1.0 (0.8, 1.4)	0.4 (0.4, 0.5)	2.0 (1.7, 2.5)	0.9 (0.7, 1.1)
Research[c] (2+)	2.0 (1.6, 2.6)	1.0 (0.7, 1.5)	0.5 (0.4, 0.7)	2.1 (1.6, 2.7)	0.6 (0.4, 0.9)

Abbreviations: OR, odds ratio; CI, confidence interval; MSK, musculoskeletal.

The reference group is the MSK working-age population without multimorbidity (as classified per the definition in the row). Associations are adjusted for age and gender.

[a] The survey definition includes all conditions reported within the NHS 07-08.

[b] The policy definition includes Australian National Health Priority Area conditions: MSK, diabetes, cancer, cardiovascular disease, asthma, chronic obstructive pulmonary disease, and mental health disorder.

[c] The research definition suggested by Diederichs et al. includes: cancer, diabetes mellitus, depression, hypertension, myocardial infarction, chronic ischemic heart disease, heart arrhythmias, heart insufficiency, stroke, chronic obstructive pulmonary disease, and arthritis.

This results in associations between multimorbidity and burden that are relatively similar despite the greater severity of conditions included in the more restrictive research definition compared to the policy definition and in both these definitions compared to the survey definition. As such, although the convergent validity of each operational definition is relatively similar, it is important to be aware of this "leveling of association" with burden measures when using different definitions of multimorbidity.

The present study demonstrates that there are possibly some specific instances where it does matter how multimorbidity is defined. With the policy definition multimorbidity

Table 6. Among the working-age population with MSK, the proportions with, and associations for, subjective health burden measures when multimorbidity is classed in distinct groups

	Multimorbidity classed in distinct groups (% of MSK working-age sample population)[a]			
Health measure[b]	Nonmultimorbid by all three definitions (24.7%)	Multimorbid by survey definition only (36.1%)	Multimorbid by policy and survey definitions (22.1%)	Multimorbid by research, policy and survey definitions (17.0%)
Fair to poor health status	9.5%	13.9%	27.7%	50.6%
OR (95% CI)	1[c]	1.4 (1.0, 2.0)	3.5 (2.5, 5.0)	8.5 (5.9, 12.1)
OR for survey definition	1		2.9 (2.1, 4.0)	
OR for policy definition		1		4.2 (3.4, 5.1)
OR for research definition			1	4.7 (3.7, 6.1)
High psychological distress	8.5%	8.5%	36.1%	37.7%
OR (95% CI)	1	1.1 (0.7. 1.7)	6.4 (4.5, 9.3)	8.9 (5.9, 13.0)
OR for survey definition	1		3.6 (2.5, 5.0)	
OR for policy definition		1		6.8 (5.6, 8.1)
OR for research definition			1	4.0 (3.1, 5.2)
Mod-severe pain ratings	30.1%	42.9%	55.0%	63.3%
OR (95% CI)	1	1.7 (1.4, 2.1)	2.7 (2.1, 3.5)	4.0 (3.0, 5.3)
OR for survey definition	1		2.3 (1.8, 2.8)	
OR for policy definition		1		2.3 (1.8, 2.8)
OR for research definition			1	2.3 (1.8, 2.9)
Pain interfering with work	23.9%	31.9%	45.0%	51.5%
OR (95% CI)	1	1.5 (1.1, 1.9)	2.6 (1.9, 3.4)	3.4 (2.4, 5.0)
OR for survey definition	1		2.1 (1.6, 2.7)	
OR for policy definition		1		2.2 (1.8, 2.7)
OR for research definition			1	2.1 (1.6, 2.8)

[a] The groups are: "non-multimorbid" with all three definitions (fixed reference population); classed as multimorbid with the survey definition only; classed as multimorbid with both the policy and survey definition; and classed as multimorbid with all three (survey, policy and research definitions). Participants were excluded if they (1) met the policy definition but not the survey definition ($n = 48$), (2) met the research definition, but not the survey definition ($n = 8$), or (3) met the policy definition but not the research definition ($n = 178$). Associations are adjusted for age and gender.

[b] The data from Table 2 are reanalysed here to highlight how the shifting reference group impacts the estimates of burden for each of the definitions in contrast with the estimates produced by each definition when the reference group is stable (fixed). The actual effect sizes are slightly different to Table 2, due to the exclusion of participants outlined above.

[c] Shaded cells indicate nonmultimorbid reference group used in analysis for each row.

was more strongly related to specialist consultations and pain medication, whereas the survey definition was more strongly related to MSK medicine use, seeking advice only from pharmacist (i.e., not to fill scripts) and visits to chiropractor. MSK-related GP consults also varied according with multimorbidity definitions. Furthermore, the policy definition was a better predictor of distress than the survey and research definitions. This association does not appear to be an artifact due to mental health being part of the multimorbidity definition because all three definitions included chronic depression. Specifically, the survey and policy definitions include all chronic mental health conditions reported by respondents, whereas the research definition includes depression only.

The strength of this study was the use of a large nationally representative data set, with a comprehensive range of data on subjective health burden, health care and medicines use, and chronic conditions available. By directly comparing different operationalizations of multimorbidity within a single sample population, we have shown that the choice of definition directly affects burden estimates, eliminating other explanatory factors including geographical setting, recruitment, and data collection methods. Limitations of the data include that it is self-reported, which may be subject to recall bias, and cross-sectional, which does not allow for examination of temporality of associations between variables. In addition, given the inability to rate clinical severity, we measured multimorbidity by conditions counts.

The focus on the working-age, community dwelling population extends multimorbidity research to illustrate that multimorbidity is associated with additional impact within this largely overlooked population [15,33]. Furthermore, by applying the definitions of multimorbidity with a population with existing disease (people with any MSK), we determined the additional burden associated with three definitions of multimorbidity. The general consensus is that when an index condition is applied, the term is comorbidity [1,2]; however, here, we use the term multimorbidity although we are also considering MSK. This is because although the sample population is people with any MSK, the exposure is the presence of multimorbidity; thus, here, MSK is not an index condition. Instead, those with MSK are the population within which the subjective burden of multimorbid is compared to the subjective burden of those considered nonmultimorbid, for each definition.

Despite focusing on the community dwelling, working-age population, the prevalence of MSK observed here (36%) is fairly similar to (32% [3,48]; and 39% [14]) or higher than (18% [20]; 23% [21]; and 25% [33]) studies primarily focused on older and/or clinical populations. This may be explained by our broader inclusion of MSK compared with the selective inclusion within other studies, as well as differences between countries of origin. The range of multimorbidity prevalence in this study (20.2−75.4%) encompasses the multimorbidity prevalence range observed within other MSK populations: 64% and 67% among those with rheumatoid arthritis and fibromyalgia, respectively [21], whereas among those with painful conditions, 21% had one other condition, 21% had 2 other conditions, and 47% had 3+ other conditions [7].

Our findings contrast with previous studies which suggest competing demands of conditions may be associated with lower likelihood of prescribing for MSK conditions [16,49]. The counterintuitive increased likelihood of MSK medicines use among those with multimorbidity may suggest greater MSK disease progression or symptom severity for those with multimorbidity. Alternatively, one of the additional conditions might include another MSK (such as coexisting osteoporosis and osteoarthritis), thereby increasing likelihood of using MSK medicines.

Previous studies, two within UK primary care populations [39,43] of 3,145 patients aged 39−79 years [39] and one in a random population-based survey of 2,192 adults conducted in Spain [44], also identified additional subjective health burden associated with multimorbidity among people with subsets of MSK (arthritis [39], rheumatic conditions [44], and osteoarthritis [43]). Specifically, greater association between multimorbidity and poor quality of life (HRQoL) was observed: for multimorbidity that included rheumatic conditions compared to those that did not [44], and associations with poor HRQoL increased with increasing number of conditions among those with arthritis [arthritis plus one condition odds ratio (OR) = 1.5 (95% CI: 1.3−1.7), and plus two additional conditions OR = 3.0 (95% CI: 2.1−4.1)] [39]. However, effect sizes were lower compared to here. This may be due to differences in the range of conditions contributing to multimorbidity [39]. The third study found among those with osteoarthritis, associations with poor physical function increased with increasing number of conditions [2−3 conditions: OR = 2.0 (95% CI: 1.0−4.2), 4−5 conditions OR = 2.8 (95% CI: 1.4−5.6), and 6+ conditions: OR = 3.7 (95% CI: 1.8−7.4)] [43].

Although not specifically focused on MSK populations, studies limited to primary care and elderly populations have also compared associations between multimorbidity and health status or HRQoL [8,32,50], physical functioning [51], and distress [9] sometimes using a range of definitions within the same population. Within a UK study, associations with poor physical function increased with increasing number of conditions [2−3 conditions (OR = 1.5; 95% CI: 1.4−1.7), 4−5 conditions (OR = 2.7; 95% CI: 2.4−3.1), and 6+ conditions (OR = 4.4; 95% CI: 3.9−5.1)] [51]. A study of Canadian primary care practices (n = 238 adults) found that although simple counts of chronic conditions were associated with HRQoL, scale-based measures outperformed simple counts [8]. Conversely, multimorbidity measured by simple condition counts was not related to psychological distress (OR = 1.12; 95% CI: 0.97−1.29), whereas multimorbidity measured by the

Cumulative Illness Rating Scale (CIRS) was (OR = 1.67; 95% CI: 1.19−2.37) and the likelihood of psychological distress increased with each CIRS multimorbidity quintile [9].

Similar to other studies, we combine a broad range of MSK despite the clinical heterogeneity of these conditions [17,19]. This extends multimorbidity research which examines subgroups of arthritis conditions [39], osteoarthritis [43], and rheumatic conditions [44]. However, there is a lack of understanding of whether health burden associated with multimorbidity varies for specific subcategories of MSK (particularly soft-tissue disorders, back pain, gout, and osteoporosis). To aid prioritization efforts, this focus is required in future research to identify subgroups of MSK for which the burden of multimorbidity is particularly problematic and whether there is an operationalization of multimorbidity counts that best captures this burden.

5. Conclusion

Three in four working-age individuals with any MSK reported living with at least two other co-occurring conditions (survey definition), more than one in three reported at least two somewhat burdensome health priority area conditions (policy definition), whereas one in five reported at least two very burdensome conditions (research definition). Among working-age Australians with MSK, those with multimorbidity had increased likelihood of subjective health burden, consulting (non-MSK) specialists and taking pain and MSK medicines compared to those who do not have multimorbidity, irrespective of multimorbidity definition used. These analyses highlight the level of additional subjective health and health care utilization burden associated with multimorbidity within the MSK population. However, the use of dichotomous cut points obscures the gradient of burden severity produced by multimorbidity definitions that exclude potentially less burdensome conditions. It is yet to be established if the additional subjective health burden associated with different ways of operationalizing multimorbidity is similar among other disease-specific (e.g., diabetes) populations and whether associations differ within particular subgroups of MSK conditions.

References

[1] van den Akker M, Buntinx F, Knottnerus JA. Comorbidity or multimorbidity what's in a name? A review of literature. Eur J Gen Pract 1996;2:65−70.

[2] Feinstein A. The pre-therapeutic classification of co-morbidity in chronic disease. J Chronic Dis 1970;23:455−68.

[3] McRae I, Yen L, Jeon YH, Herath PM, Essue B. Multimorbidity is associated with higher out-of-pocket spending: a study of older Australians with multiple chronic conditions. Aust J Prim Health 2013;19:144−9.

[4] Librero J, Peiro S, Ordinana R. Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. J Clin Epidemiol 1999;52:171−9.

[5] Glynn LG, Valderas JM, Healy P, Burke E, Newell J, Gillespie P, et al. The prevalence of multimorbidity in primary care and its effect on health care utilization and cost. Fam Pract 2011;28:516−23.

[6] Lee TA, Shields AE, Vogeli C, Gibson TB, Woong-Sohn M, Marder WD, et al. Mortality rate in veterans with multiple chronic conditions. J Gen Intern Med 2007;22:403−7.

[7] Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet 2012;380:37−43.

[8] Fortin M, Bravo G, Hudon C, Lapointe L, Almirall J, Dubois MF, et al. Relationship between multimorbidity and health-related quality of life of patients in primary care. Qual Life Res 2006;15:83−91.

[9] Fortin M, Bravo G, Hudon C, Lapointe L, Dubois MF, Almirall J. Psychological distress and multimorbidity in primary care. Ann Fam Med 2006;4:417−22.

[10] Radner H, Yoshida K, Smolen JS, Solomon DH. Multimorbidity and rheumatic conditions-enhancing the concept of comorbidity. Nat Rev Rheumatol 2014;10:252−6.

[11] Huntley AL, Johnson R, Purdy S, Valderas JM, Salisbury C. Measures of multimorbidity and morbidity burden for use in primary care and community settings: a systematic review and guide. Ann Fam Med 2012;10:134−41.

[12] Agborsangaya CB, Lau D, Lahtinen M, Cooke T, Johnson JA. Health-related quality of life and healthcare utilization in multimorbidity: results of a cross-sectional survey. Qual Life Res 2013;22:791−9.

[13] Stewart M, Fortin M, Britt HC, Harrison CM, Maddocks HL. Comparisons of multi-morbidity in family practice−issues and biases. Fam Pract 2013;30:473−80.

[14] Theis KA, Furner SE. Shut-in? Impact of chronic conditions on community participation restriction among older adults. J Aging Res 2011;2011:759158.

[15] Marengoni A, Rizzuto D, Wang HX, Winblad B, Fratiglioni L. Patterns of chronic multimorbidity in the elderly population. J Am Geriatr Soc 2009;57:225−30.

[16] Vogeli C, Shields AE, Lee TA, Gibson TB, Marder WD, Weiss KB, et al. Multiple chronic conditions: prevalence, health consequences, and implications for quality, care management, and costs. J Gen Intern Med 2007;22:391−5.

[17] Britt HC, Harrison CM, Miller GC, Knox SA. Prevalence and patterns of multimorbidity in Australia. Med J Aust 2008;189:72−7.

[18] Violan C, Foguet-Boreu Q, Flores-Mateo G, Salisbury C, Blom J, Freitag M, et al. Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies. PLoS One 2014;9:e102149.

[19] Taylor AW, Price K, Gill TK, Adams R, Pilkington R, Carrangis N, et al. Multimorbidity—not just an older person's issue. Results from an Australian biomedical study. BMC Public Health 2010;10:718.

[20] Gunn JM, Ayton DR, Densley K, Pallant JF, Chondros P, Herrman HE, et al. The association between chronic illness, multimorbidity and depressive symptoms in an Australian primary care cohort. Soc Psychiatry Psychiatr Epidemiol 2012;47:175−84.

[21] Loza E, Jover JA, Rodriguez-Rodriguez L, Carmona L. Observed and expected frequency of comorbid chronic diseases in rheumatic patients. Ann Rheum Dis 2008;67:418−21.

[22] Agborsangaya CB, Lau D, Lahtinen M, Cooke T, Johnson JA. Multimorbidity prevalence and patterns across socioeconomic determinants: a cross-sectional survey. BMC Public Health 2012;12:201.

[23] Fortin M, Stewart M, Poitras ME, Almirall J, Maddocks H. A systematic review of prevalence studies on multimorbidity: toward a more uniform methodology. Ann Fam Med 2012;10:142−51.

[24] Yurkovich M, Avina-Zubieta JA, Thomas J, Gorenchtein M, Lacaille D. A systematic review identifies valid comorbidity indices derived from administrative health data. J Clin Epidemiol 2015;68:3−14.

[25] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373−83.

[26] Linn BS, Linn MW, Gurel L. Cumulative illness rating scale. J Am Geriatr Soc 1968;16:622−6.
[27] Miller MD, Paradis CF, Houck PR, Mazumdar S, Stack JA, Rifai AH, et al. Rating chronic medical illness burden in geropsychiatric practice and research: application of the Cumulative Illness Rating Scale. Psychiatry Res 1992;41:237−48.
[28] Parkerson GR Jr, Broadhead WE, Tse CK. The Duke Severity of Illness Checklist (DUSOI) for measurement of severity and comorbidity. J Clin Epidemiol 1993;46:379−93.
[29] Greenfield S, Blanco DM, Elashoff RM, Ganz PA. Patterns of care related to age of breast cancer patients. JAMA 1987;257:2766−70.
[30] Greenfield S, Sullivan L, Dukes KA, Silliman R, D'Agostino R, Kaplan SH. Development and testing of a new measure of case mix for use in office practice. Med Care 1995;33:AS47−55.
[31] Valderas JM, Starfield B, Sibbald B, Salisbury C, Roland M. Defining comorbidity: implications for understanding health and health services. Ann Fam Med 2009;7:357−63.
[32] Fortin M, Hudon C, Dubois MF, Almirall J, Lapointe L, Soubhi H. Comparative assessment of three different indices of multimorbidity for studies on health-related quality of life. Health Qual Life Outcomes 2005;3:74.
[33] Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. Arch Intern Med 2002;162:2269−76.
[34] Harrison C, Britt H, Miller G, Henderson J. Examining different measures of multimorbidity, using a large prospective cross-sectional study in Australian general practice. BMJ Open 2014;4:e004694.
[35] Diederichs C, Berger K, Bartels DB. The measurement of multiple chronic diseases−a systematic review on existing multimorbidity indices. J Gerontol A Biol Sci Med Sci 2011;66:301−11.
[36] Holzer BM, Siebenhuener K, Bopp M, Minder CE. Overcoming cutoff restrictions in multimorbidity prevalence estimates. BMC Public Health 2014;14:780.
[37] ABS. Australian National Health Survey. 2007-08 [cited 21 July 2014]; 2009. Available at http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4364.0Explanatory%20Notes12007-2008%20%28Reissue%29. Accessed October 24, 2015.
[38] Dowrick C. The chronic disease strategy for Australia. Med J Aust 2006;185:61−2.
[39] Mavaddat N, Valderas JM, van der Linde R, Khaw KT, Kinmonth AL. Association of self-rated health with multimorbidity, chronic disease and psychosocial factors in a large middle-aged and older cohort from general practice: a cross-sectional study. BMC Fam Pract 2014;15:185.
[40] Alonso J, Ferrer M, Gandek B, Ware JE Jr, Aaronson NK, Mosconi P, et al. Health-related quality of life associated with chronic conditions in eight countries: results from the International Quality of Life Assessment (IQOLA) Project. Qual Life Res 2004;13:283−98.
[41] Manias E, Claydon-Platt K, McColl GJ, Bucknall TK, Brand CA. Managing complex medication regimens: perspectives of consumers with osteoarthritis and healthcare professionals. Ann Pharmacother 2007;41:764−71.
[42] Burton W, Morrison A, Maclean R, Ruderman E. Systematic review of studies of productivity loss due to rheumatoid arthritis. Occup Med (Lond) 2006;56:18−27.
[43] Kadam UT, Croft PR. Clinical comorbidity in osteoarthritis: associations with physical function in older patients in family practice. J Rheumatol 2007;34:1899−904.
[44] Loza E, Jover JA, Rodriguez L, Carmona L, EPISER Study Group. Multimorbidity: prevalence, effect on quality of life and daily functioning, and variation of this effect when one condition is a rheumatic disease. Semin Arthritis Rheum 2009;38:312−9.
[45] Sanderson K, Andrews G. The SF-12 in the Australian population: cross-validation of item selection. Aust N Z J Public Health 2002;26:343−5.
[46] Andrews G, Slade T. Interpreting scores on the Kessler Psychological Distress Scale (K10). Aust N Z J Public Health 2001;25:494−7.
[47] Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. Bull World Health Organ 2003;81:646−56.
[48] Islam MM, Valderas JM, Yen L, Dawda P, Jowsey T, McRae IS. Multimorbidity and comorbidity of chronic diseases among the senior Australians: prevalence and patterns. PLoS One 2014;9:e83783.
[49] Roberts ER, Green D, Kadam UT. Chronic condition comorbidity and multidrug therapy in general practice populations: a cross-sectional linkage study. BMJ Open 2014;4(7):e005429.
[50] Fortin M, Lapointe L, Hudon C, Vanasse A, Ntetu AL, Maltais D. Multimorbidity and quality of life in primary care: a systematic review. Health Qual Life Outcomes 2004;2:51.
[51] Kadam UT, Croft PR, North Staffordshire GP Consortium Group. Clinical multimorbidity and physical function in older adults: a record and health status linkage study in general practice. Fam Pract 2007;24:412−9.