Multimorbidity and healthcare service utilization in the Australian workforce: Findings from the National Health Survey

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Short Running Title

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Acknowledgments

We gratefully acknowledge the Australian Bureau of Statistics for conducting the survey.

Competing interests

The authors, Lili Wang, Andrew J Palmer, Petr Otahal, Fiona Cocker and Kristy Sanderson, declare that they have no competing interests.

Funding

Lili Wang was funded by a University of Tasmania/Anhui Medical University PhD Scholarship.

ABSTRACT

Objectives: To understand the patterns of healthcare service utilization in employees with multimorbidity.

Methods: Data were obtained from the 2011-2012 cross-sectional Australian National Health Survey. Past-month healthcare service utilization was collected for each chronic conditions from a pre-specified list. Descriptive, logistic, and Poisson regression analyses were used. The data were weighted to produce nationally representative estimates.

Results: Multimorbid employees with arthritis had higher adjusted arthritis-specific GP visit rates (RR=1.7, 95% CI=1.1-2.2, $p<0.001$) than employees with arthritis alone. Similarly, multimorbid employees with CVD had higher adjusted CVD-specific specialist visit rates (RR=1.6, 95% CI=1.1-2.5, $p<0.05$) and 2.5 times (95% CI=1.5-4.0, $p<0.001$) more CVD-specific other health professional visits than employees with CVD alone.

Conclusions: Given the increasing number of employees managing work and chronic illnesses, these findings have implications for health services and employers.

INTRODUCTION

Multimorbidity, or the presence of multiple chronic conditions in one individual, is a major public health concern[1-3] due to its increasing prevalence, associated cost, and often complex medical management.[4] Multimorbidity is more common in older age groups[2 5]. However, more than half of individuals with multimorbidity are younger than 65 years of age (i.e., of working age)[6]. The earlier onset of chronic conditions also implies younger persons

are more likely to experience subsequent chronic conditions[3 7]. Most direct healthcare costs in health systems are spent on treating multimorbidity[4 8]. In addition employees, who represent 63.4% of the global population, are working longer than before, even though have reached their retirement age[9]. For example, the Australian labour force participation rate for individuals aged 55+ years rose from 23% in 1984 to 35% in 2014,[10] and one fifth of Australian adults had multimorbidity[10]. Therefore, multimorbidity has become a substantial and challenging health and economic issue for the current workforce.

People with multimorbidity have higher overall health service utilization, including more frequent and longer hospitalizations, readmissions, and physician visits, than people with a single condition[1 2 5 11-13]. However, healthcare service utilization is multifactorial and potentially subject to measurement error[14]. The more health conditions a person experiences, the higher the risk of measurement error. As healthcare is still predominately delivered according to the individual diseases[2], it is useful to understand healthcare service utilisation patterns for diseases when they are multimorbid versus not. Additionally, most studies have focused on higher risk populations, such as patients who frequently use healthcare services and the elderly, who are more likely to present with multimorbidity[15]. As a productive workforce is central to the economic well-being of a country, understanding how employees use healthcare services for single diseases in the context of multimorbidity is essential. Particularly to gain the insights into their healthcare demands and reduce the consequences of multimorbidity on the workforce, including absenteeism, presenteeism and the related lost productive time. However, we were unable to locate any studies that reported the associations between multimorbidity and disease-specific healthcare service utilization, which referred to a series of single-disease evaluations, particularly in the workforce.

Until recently, the definition of multimorbidity and the included number of health conditions studies varied across the studies as no agreed definition existed[3]. Some

international institutes, such as the Academy of Medical Sciences[16] are calling for evidence to progress a consistent definition of multimorbidity. The consequence of no unique definition makes the comparison between studies challenging. Therefore, it is critical to specify the definition of multimorbidity and the included number of health conditions in the studies focusing on multimorbidity.

The aim of this study was to examine the association of multimorbidity with disease-specific healthcare service utilization in a working population. Specifically, we sought to: i) characterize employees with a specific chronic condition in terms of their health statuses (with or without multimorbidity); and ii) determine the associations between the presence of multimorbidity and disease-specific healthcare service utilization among employees.

METHODS

Data were derived from the nationally representative, cross-sectional Australian National Health Survey (NHS), which was conducted from March 2011 to March 2012.[17] Initially, 21,108 private dwellings were selected in the sample. This number was reduced to 18,355 due to sample loss in the field stage[17]. Of these dwellings, 15,565 (84.8%) were fully or adequately responding households, including 20,426 persons aged 0 years and over[17]. Under or over-representation of particular demographic groups, such as working people (under-represented as the survey was conducted in private dwellings), was adjusted to ensure sample representativeness[17].

The NHS dataset contains self-reported information on the labour force status and healthcare service utilization for each current chronic disease in the 12 months prior to the face-to-face interviews conducted among respondents aged 15 years and over[17]. Respondents were classified as employed, unemployed, or not in the labour force using the reduced set of the questions from the Australian Bureau of Statistics (ABS) Monthly Labour Force Survey[17].

Employed respondents were identified when they had worked in a job, for a business, or on a farm in the past week, or had a job but were absent during that week[17]. However, respondents whose usual work time was less than one hour, unpaid voluntary work, and those who were away from work due to workers' compensation but were unsure whether they would return to work for their employers were excluded[17]. Therefore, for the purpose of this study, respondents aged 15 years and older who were currently employed at the time of interview were included.

Multimorbidity was defined as the concurrent presence of two or more diagnosed chronic conditions[18-20]. Eight diagnosed chronic conditions that had lasted, or were expected to last, six months or more based on a computer-based coding system developed by the ABS were collected, including asthma, cancer, cardiovascular disease (CVD), arthritis, osteoporosis, diabetes (type 2, type 1 and unspecified type-excluding diabetes which was not current, long-term and diagnosed, such as gestational diabetes and diabetes insipidus), kidney disease, and mental well-being; these conditions were the most commonly experienced and were relevant to policy planning in the Australian community. The aforementioned conditions were identified as chronic medical conditions by asking whether the patient had "ever been told by a doctor or nurse, still current and long-term" and then by asking whether "had lasted at least six months or the respondent expected the condition to last six months or longer". There were exceptions for some conditions (e.g., asthma was considered even if the respondent reported that asthma was not a current condition but had either experienced symptoms/treatment in the past 12 months or answered 'yes' to whether they still had asthma attacks).

Information on healthcare service utilization for consultations, including the frequency of visits in the past 12 months, was collected for each respondent and each chronic condition mentioned above. Self-reported information was collected concerning visits to

some health professionals [GPs (general practitioners) and specialists (e.g., a cardiologist for CVD)], whereas other health professionals (e.g., nurses and social workers) were grouped into one category with binary answers reporting whether they had been visited at least once in the past 12 months. Information for each HSU was recorded only once for each condition group per respondent. However, because the respondent might visit a health professional for several different conditions during one visit, the number of visits for different conditions could not be summed to estimate total number of visits for a given individual. For example, a respondent who reported having visited a GP five times for CVD and two times for diabetes might have a total number of GP visits ranging from five to seven.

Univariate analyses with a 0.25 p-value cut-off were performed to identify covariates before the second round of screening, which involved multivariate analyses. A cut-off of a 10% change in the exposure variable's coefficient estimate in the multivariate model was adopted to identify "important" variables that influenced the association between the outcome and the exposure[21]. Covariates that remained after these procedures were utilized in all subsequent analyses conducted in this study. The following covariates were included in this study: age, gender, non-school qualification (having a non-school qualification, including a postgraduate degree, graduate diploma/graduate certificate, bachelor degree, advanced diploma/diploma, certificate III/IV, or certificate I/II, having a certificate that was not further defined, and not having a non-school qualification), and body mass index (BMI=self-reported weight/self-reported height^2).

Means, frequencies, and percentages were used in the descriptive analyses. To explore the associations of multimorbidity and disease-specific healthcare service utilization, logistic and Poisson regression models were used to compare individuals who had only one specific chronic condition to multimorbid individuals who had that specific chronic condition. Odds ratios were estimated from the logistic regression models for visits with other health

professionals (excluding GPs and specialists), and relative rates were estimated from the Poisson regression models for GP and specialist visits.

To account for non-responses, national representativeness, and confidentiality, all analyses were weighted using replicate weights to infer the results for the total in-scope Australian population[17]. All standard errors (SEs) of the estimates were generated by the delete-A-group jack-knife technique[17]. The significance level was set at α=0.05. Multiple testing was not adjusted[22], as this study is an exploratory study, which is mainly for hypothesis generating. The analyses were performed in STATA version 10, special edition (StataCorp, College Station, TX, USA)[23].

RESULTS

We analysed data from 10,363 employed participants from a nationally representative database. Almost one-quarter of the workforce (23.4%, 95% CI 22.3-24.7) had multimorbidity. Of the workforce reporting multimorbidity, 15.2% (95% CI 14.3-16.1) had two chronic conditions and 8.2% (95% CI 7.5-8.9) had three or more chronic conditions. The most prevalent chronic conditions were CVD at 29.1% (95% CI 27.9-30.4), followed by asthma (20.0%, 95% CI 18.9-21.2) and mental disorders (12.5%, 95% CI 11.7-13.2) (Table 1).

Compared to employees with single conditions, the employees with multimorbidity were more likely to be females for the majority of conditions, relatively older, more likely to be educated, less likely to be current smokers, more likely to have a higher BMI, and less likely to be white-collar workers. Moreover, the prevalence of multimorbidity increased with age but was highest in the 45 to 64-year-old age group. The prevalence also increased with the income level, except for cases including mental disorders, which were highest amongst those in the middle-income quintile. There were too few cases of osteoporosis and kidney

disease (21 and 22, respectively) to estimate accurately (the 95% CI ranges were quite large) and apply a regression model (Table 2).

The percentage of employees, who reported visiting a GP at least once in the previous 12 months prior to the survey interview was higher in most disease groups when multimorbidity was present, compared to when only a single condition was present. In particular, the employees with multimorbidity were more likely to have a higher number of visits. For instance, the employees who visited GPs four times or more times were more likely to suffer from multimorbidity for all listed conditions. The percentage of multimorbid employees who reported visiting any other health professional at least once in the prior 12 months was higher for the employees with cancer, arthritis, osteoporosis, CVD, and kidney disease than for the employees with only one condition in each condition group (Table 3).

After controlling for age and gender, multimorbid employees with arthritis had 1.7-fold (95% CI=1.1-2.2, $p<0.001$) greater odds of arthritis-specific healthcare service utilization of GP visits than employees with arthritis alone. Compared with employees with CVD alone, multimorbid employees with CVD had 1.6-fold (95% CI=1.1-2.5, $P<0.05$) greater odds of CVD-specific specialist visits and 2.5-fold (95% CI=1.5-4.0, $P<0.001$) greater odds of CVD-specific visits with other healthcare professionals (Table 4). Overall, our results suggested that the pattern of disease-specific healthcare service utilization varied by condition.

DISCUSSION

The descriptive analyses from this nationally representative survey revealed that the majority of multimorbid employees reported higher utilization of disease-specific healthcare than the employees with one condition alone, which was consistent with previous studies in different populations[2]. While a strong association between multimorbidity and total

healthcare service utilization is well recognized, this study found that multimorbidity does not always increase the healthcare service utilization for a given disease. The association of multimorbidity with healthcare service utilization in employees therefore varies by disease type. Examination of these nationally representative data is an important part of understanding the further healthcare needs of the multimorbid working population, but whether these varying healthcare service patterns represent under- or over-utilization of particular services cannot be answered from this cross-sectional survey.

In this study, multimorbid employees with arthritis had more arthritis-specific GP visits than employees with arthritis alone, whereas multimorbid employees with CVD were not more likely to visit GPs but were more likely to visit CVD specialists than employees with CVD alone. Multiple factors can explain these findings. For example, because arthritis in itself is inflammatory and its main symptoms are joint pain and stiffness, these symptoms may impair a person's ability to perform routine tasks[24 25]. Therefore, adults with multimorbid arthritis are more likely to have adverse outcomes, such as mental distress, and work disability than adults without arthritis[24]. Subsequently, these employees may experience greater and more frequent pain, which motivates them to use primary healthcare services more often than employees with arthritis alone.

Multimorbid employees with CVD were more likely to visit healthcare professionals (excluding GPs) than employees with CVD alone. One explanation could be that CVD, which is the global leading cause of death[26], typically manifests in acute events, such as heart attacks and strokes[27]. Therefore, adults with CVD who routinely visit their GPs, especially those who are asymptomatic, do not change their service-use models unless they experience an emergency. When acute events do occur, these individuals may require tertiary healthcare, and the odds of an acute event occurring are compounded when CVD is multimorbid. Alternatively, because GPs are considered the “gatekeepers” in the Australian healthcare

system, people with multimorbid CVD are referred to specialists according to the GP's professional knowledge and opinion even if they are initially asymptomatic and do not actively require more healthcare services.

Coexisting mental-physical disorders lead to higher healthcare service utilization[28]. However, in this study, multimorbid employees with mental and other chronic disorders did not report a higher utilization of any healthcare service. This finding could be explained by an increase in the utilization of healthcare for physical disorders. In other words, mental disorders themselves are already associated with increased healthcare service utilization[29], and their coexistence with other physical disorders(s) may not further influence the mental disorder-specific healthcare needs. However, the presence of mental disorders could aggravate a person's coexisting physical disorders and thus lead to a corresponding increase in healthcare service utilization. Because most coexisting physical-mental disorders occur in the working-age population[6 30], the presence of a mental disorder could increase total healthcare service utilization rates by exacerbating a person's symptoms or perceptions of a poor health status even though mental disorder-specific healthcare service utilization did not increase due to multimorbidity. Further, pooling all mental disorder types into one category may have mediated healthcare service utilization for severe mental disorders, such as major depression. Healthcare service utilization for the other conditions did not differ between employees with multimorbidity and with single conditions alone.

In Australia, employees with multimorbid conditions that include arthritis or CVD require more attention because their additional needs may lead to new diagnoses, prescriptions, and lifestyle changes. Moreover, in the Australian, and other similar healthcare systems, GPs are the gatekeepers of healthcare delivery and play an important role in managing multimorbidity. Therefore, specialists may be unwilling to share their expertise with those outside of their area. Subsequently, to plan for the healthcare of the growing

number of employees who juggle both employment and chronic conditions, the provision of integrated and appropriate services by GPs who closely coordinate their patient's care should remain an area of emphasis for future studies.

In contrast to the certainty of single diseases, multimorbidity is more changeable and there is no "one-size-fits-all" method to address all issues arising from it. Unfortunately, health professionals receive no explicit medical education or training in how to prioritize care for persons experiencing multimorbidity. Further, the more chronic conditions employees have, the more diseases they want to address at each consultation, which makes the health professional's ability to make treatment decisions more difficult. However, the length of a standard consultation (5-25 minutes) may not be sufficient for even one disease, and this discrepancy may lead to the under-treatment of some conditions, particularly when they co-exist with others[31 32].

For employees with multimorbidity, setting disease priorities is unavoidable. The most important step is to determine whether to identify these diseases explicitly and rationally. The needs of an individual with multimorbidity may vary substantially over their life course. Therefore, individuals with CVD or arthritis of working age need more attention and may gain greater health improvements if being managed appropriately. Moreover, the Australian National Health Survey used in this study measured healthcare use for each health conditions, which prohibit the use of "normal" count-based or cluster-based methods of defining multimorbidity[33]. As such, current national population data collection may not address the identified gap. As Tinetti et al (2012) suggest "healthcare should but not shift its current focus from a disease orientation to a patient goal orientation"[34] and must be updated to align with the clinical reality of multimorbidity.

This study also revealed the prevalence of multimorbidity in the workforce was consistent with previous studies[35] and, whilst it increased with age, was highest in the 45 to

64-year-old age group. This result may have occurred because the employees in this age group are more likely to consent to early retirement when experiencing from multimorbidity. However, the pension they receive may not be sufficient to support their heavy health and economic burdens due to multimorbidity. This could lead to multimorbid employees remaining in the workforce in order to cover the costs associated with their diseases in the very near future[36].

Given no agreed definition, using the other methods to define multimorbidity may have produced different results. For example, using the higher cut-off may strengthen the negative association of multimorbidity with HSU, and it is possible that more health conditions would be identified in addition to arthritis and CVD in this study. However, the three cut-off requires more included health conditions and is more appropriate to older populations whereas the two cut-off is more appropriate in populations with a broader age scope[37]. Another popular method is questionnaire-based, such as the Cumulative Illness Rating Scale[38] and Charlson Index[39] which require additional mapping of diagnoses from the classification system[37]. So it is impossible to access these scales if the survey like the NHS 2011-12 does not incorporate them.

A notable limitation of this study was the use of cross-sectional data which meant neither directionality nor temporality could be attributed to the associations between variables, and causal relationships could not be determined. Further, this study was based on self-reported data. That is, diagnoses and healthcare service utilization were not clinically verified by professionals, and the participants were asked only about main conditions to reduce recall bias[17]. However, some conditions were likely under-reported due to stigma (e.g., mental disorders) and the presence of "silent" conditions (e.g., mental/behavioural disorders or diabetes)[40]. Finally, due to the confidential purpose and the complex multistage cluster sampling of the NHS 2011-12 data, some statistical processing such as the differences test

between two groups was not allowed within the ABS on-line data query environment, which may lead to interpretation difficulty to some extent. However, we provided the 95% CI of each estimate to present the magnitude of difference.

The strengths of this study included the use of nationally representative data, which covered approximately 97% of the people living in Australia at the time of the NHS[17]. This broad coverage increases the generalizability of the findings. In contrast to other studies[40 41], this study explored multimorbidity not only in the working-age population but also in a population who were actually employed at the time of survey completion. This distinction could exclude working-age people who were not in the workforce, who likely had different healthcare service utilization needs, and who were not influenced by work-related factors.

CONCLUSION

This study is the first to examine the associations between multimorbidity and disease-specific healthcare service utilization using a nationally representative sample of employees and a series of chronic conditions. Multimorbidity was common in this population. Compared with individuals with other diseases, employees with multimorbid conditions including arthritis or CVD required more attention in understanding the associations between multimorbidity and health service use. Guidelines for the management of multimorbidity are urgently needed, especially with the inevitable economic burden imposed by the ageing workforce. Longitudinal studies are recommended to understand the progression and impact of multimorbidity on healthcare resource utilization over time. However, the very first and most important step is updating the way of data collection to align with the clinical reality of multimorbidity.

Table 1. Distribution of socio-demographic characteristics and health conditions in the Australian working population (2011-12).

	n	% (95% CI)
Total	10,363	
Male (vs. female)	5,344	54.4 (53.7-55.1)
Age		
Mean (years old)		39
15-24 yrs.	1,274	16.5 (15.9-17.1)
25-34 yrs.	2,224	22.4 (21.9-22.9)
35-44 yrs.	2,464	22.1 (21.7-22.5)
45-54 yrs.	2,370	21.4 (21.1-21.8)
55-64 yrs.	1,625	14.2 (13.7-14.6)
65+ yrs.	406	3.4 (3.0-3.8)
Married (vs. unmarried)	4,908	52.3 (51.0-53.6)
Has educational attainment (vs. do not has)	7,016	67.6 (66.4-68.8)
Current smoker (vs. non-smoker)	2,038	18.5 (17.6-19.4)
BMI		
Thin (>=18.5)	96	1.3 (0.9-1.6)
Normal (18.5-24.99)	3,135	36.8 (35.5-38.1)
Overweight (25-29.99)	3,160	35.4 (34.1-36.6)
Obesity (>=30)	2,336	26.5 (25.5-27.6)
White-collar (vs. blue-collar)	7,377	69.3 (68.0-70.5)
Gross weekly income level		
1st-lowest	780	9.5 (8.7-10.3)
2nd	995	12.3 (11.5-13.1)
3rd	2,059	23.7 (22.5-24.9)
4th	2,613	26.8 (25.4-28.2)
5th-highest	2,787	27.8 (26.6-28.9)
Chronic Conditions		
CVD	3,175	29.1 (27.9-30.4)
Asthma	2,150	20.0 (18.9-21.2)
Mental disorder	1,386	12.5 (11.7-13.2)
Arthritis	1,295	11.4 (10.7-12.2)
Cancer	1,070	9.1 (8.4-9.8)
Diabetes	808	7.1 (6.5-7.7)
Osteoporosis	204	1.5 (1.2-1.8)
Kidney disease	148	1.3 (1.0-1.6)
Number of chronic conditions		
0	4,163	42.4 (41.2-43.7)
1	3,506	34.1 (32.9-35.3)
2	1,726	15.2 (14.3-16.1)
3+	968	8.2 (7.5-8.9)

CVD=cardiovascular disease. Sample size (n) are showed with crude data, percentage of chronic conditions are estimated with weighting strategy. The sample size of working participants was 10,363.

Table 2 Distribution of socio-demographic characteristics by morbidity category in a national working population

	Asthma		Cancer		CVD		Arthritis	
	Only	**In MM**	**Only**	**In MM**	**Only**	**In MM**	**Only**	**In MM**
	n=975	**n=1175**	**n=304**	**n=766**	**n=1,258**	**n=1917**	**n=325**	**n=970**
Male (vs. female)	58.2 (54.0-62.5)	44.1 (41.2-47.1)	54.8 (47.9-61.8)	50.4 (45.8-54.9)	54.3 (51.1-57.5)	49.0 (46.3-51.8)	56.2 (49.4-63.1)	44.3 (40.2-48.4)
Age								
15-24 yrs.	28.6 (25.0-32.2)	11.2 (8.4-14.1)	2.6 (0-5.4)	1.3 (0.1-2.5)	5.9 (3.7-8.0)	4.4 (2.8-6.1)	4.0 (0.4-7.7)	1.0 (0.3-1.6)
25-34 yrs.	33.6 (29.9-37.4)	20.8 (18.1-23.6)	6.8 (3.3-10.4)	7.1 (5.0-9.3)	18.7 (15.6-21.7)	9.8 (8.4-11.3)	8.9 (4.9-13.0)	7.0 (5.1-8.9)
35-44 yrs.	19.5 (16.2-22.8)	22.3 (19.3-25.4)	28.9 (22.2-35.6)	13.0 (9.8-16.2)	23.9 (21.0-26.8)	18.0 (16.2-19.9)	16.6 (10.5-22.8)	11.0 (8.4-13.6)
45-54 yrs.	12.7 (10.0-15.4)	22.1 (19.8-24.5)	32.9 (27.0-38.8)	24.4 (20.7-28.1)	28.3 (26.2-30.5)	28.4 (26.2-30.5)	33.8 (26.2-41.3)	29.4 (25.9-32.9)
55-64 yrs.	5.2 (3.7-6.8)	18.9 (16.1-21.6)	23.1 (16.9-29.3)	40.2 (35.9-44.5)	18.9 (16.6-21.2)	30.5 (28.3-32.8)	27.6 (21.3-33.9)	39.4 (35.8-42.9)
65+ yrs.	0.3 (0-0.6)	4.6 (3.2-6.0)	5.7 (2.7-8.6)	13.9 (10.2-17.6)	4.3 (3.2-5.4)	8.8 (7.2-10.3)	9.0 (4.5-13.6)	12.3 (9.7-14.9)
Married (vs. unmarried)	39.6 (35.9-43.3)	49.2 (45.1-53.3)	67.7 (61.9-73.5)	65.5 (61.0-70.0)	64.8 (60.9-68.7)	61.8 (58.6-65.0)	67.0 (60.1-74.0)	64.0 (59.7-68.3)
Has educational attainment (vs. do not has)	65.9 (62.2-69.6)	72,2 (68.9-75.8)	70.3 (64.4-76.2)	73.1 (69.2-77.1)	71.3 (68.3-74.3)	69.3 (66.6-72.0)	57.8 (49.1-66.4)	69.1 (65.5-72.6)
Current smoker (vs. non-smoker)	19.3 (15.8-22.7)	20.9 (17.9-23.9)	17.2 (12.5-22.0)	15.6 (11.9-19.3)	16.7 (14.0-19.4)	16.1 (14.2-18.0)	20.6 (14.1-27.0)	16.4 (13.1-19.6)
BMI								
Thin (>=18.5)	1.7 (0.5-2.9)	1.3 (0.2-2.3)	1.6 (0-4.6)	0.1 (0-0.2)	0.6 (0-1.2)	0.6 (0-1.1)	0.6 (0-1.3)	0.3 (0-0.8)
Normal (18.5-24.99)	40.5 (35.4-45.7)	29.6 (25.7-33.6)	35.1 (27.3-42.9)	26.3 (21.5-31.1)	29.9 (26.6-33.1)	23.1 (20.3-25.9)	23.5 (17.3-29.8)	21.4 (17.7-25.1)
Overweight (25-29.99)	37.3 (32.9-41.7)	34.2 (30.1-38.3)	40.8 (33.4-48.1)	36.7 (31.6-41.8)	38.9 (35.5-42.3)	35.6 (32.0-39.2)	44.5 (36.0-53.0)	33.1 (28.3-38.0)
Obesity (>=30)	20.4 (17.1-23.8)	34.8 (30.9-38.8)	22.5 (16.5-28.5)	36.9 (32.5-41.4)	30.6 (27.4-33.8)	40.7 (37.9-43.5)	31.4 (24.4-38.5)	45.1 (40.7-49.5)
White-collar (vs. blue-collar)	30.8 (26.6-35.0)	24.4 (21.6-27.2)	25.9 (19.8-32.0)	28.8 (24.5-33.1)	31.1 (27.5-34.6)	25.9 (23.5-28.3)	39.3 (30.8-47.8)	28.8 (25.2-32.3)
Gross weekly income level								
1st-lowest	12.7 (9.9-15.5)	7.2 (5.1-9.2)	6.9 (2.7-11.1)	4.7 (2.7-6.7)	6.3 (4.3-8.3)	5.5 (4.0-6.9)	8.7 (4.6-12.7)	6.2 (4.4-7.9)
2nd	13.1 (10.1-16.0)	13.1 (10.6-15.7)	8.9 (4.5-13.2)	14.1 (10.7-17.4)	10.0 (7.7-12.3)	13.3 (11.2-15.4)	16.0 (9.1-22.9)	15.7 (12.2-19.1)
3rd	22.1 (18.4-25.7)	24.6 (21.2-28.1)	20.9 (14.1-27.8)	22.4 (18.0-26.7)	22.3 (18.8-25.8)	21.8 (18.6-25.1)	19.9 (14.3-25.6)	25.0 (20.5-29.6)
4th	30.9 (27.1-34.7)	27.9 (24.5-31.2)	30.6 (22.7-38.4)	25.6 (21.1-30.0)	28.0 (23.2-32.8)	26.9 (24.1-29.7)	27.6 (19.8-35.4)	27.0 (22.7-31.4)
5th-highest	21.2 (18.1-24.3)	27.2 (23.7-30.7)	32.8 (25.5-40.0)	33.3 (28.8-37.9)	33.4 (29.3-37.5)	32.5 (29.5-35.4)	27.8 (21.2-34.4)	26.1 (22.3-30.0)

MM=multimorbidity. CVD=cardiovascular disease. BMI=Body mass index. Values are % (95%CI). Sample size (n) are showed with crude data, percentage and mean times of visits are estimated with weighting strategy. The sample size of working participants was 10,363.

Table 2 (continue)

	Osteoporosis		Diabetes		Kidney		Mental	
	Only	In MM	Only	In MM	Only	In MM	Only	In MM
	n=21	n=183	n=191	n=617	n=22	n=126	n=410	n=976
Male (vs. female)	36.2 (10.2-62.2)	26.4 (18.1-34.6)	47.6 (38.2-57.1)	54.8 (50.1-59.5)	40.6 (8.9-72.2)	43.5 (31.8-55.3)	53.2 (47.0-59.5)	43.0 (39.0-47.0)
Age								
15-24 yrs.	6.8 (0-20.9)	0.1 (0-0.3)	8.2 (2.3-14.2)	6.0 (2.8-9.3)	23.9 (0-60.6)	3.8 (0.3-7.3)	25.6 (18.9-32.4)	9.6 (6.8-12.3)
25-34 yrs.	-	4.4 (0-9.4)	20.5 (13.9-27.0)	8.0 (5.1-11.0)	9.9 (0-29.0)	7.7 (2.9-12.5)	24.2 (18.6-29.8)	17.9 (15.1-20.8)
35-44 yrs.	40.0 (0-66.3)	8.1 (2.0-14.2)	26.9 (18.1-35.6)	19.5 (15.1-23.9)	28.0 (0.6-55.4)	12.3 (4.9-19.7)	26.6 (20.6-32.6)	23.3 (19.9-26.7)
45-54 yrs.	15.6 (0-32.7)	27.4 (19.0-35.8)	24.4 (15.9-32.8)	29.6 (25.4-33.8)	23.3 (0-51.1)	43.8 (31.7-55.9)	14.1 (10.0-18.3)	27.2 (23.2-31.1)
55-64 yrs.	25.4 (0.9-49.9)	48.4 (38.4-58.4)	17.4 (8.6-26.2)	28.3 (23.9-32.7)	15.0 (0-33.9)	21.6 (13.7-29.6)	8.2 (5.1-11.4)	17.7 (14.5-20.8)
65+ yrs.	12.2 (0-28.9)	11.6 (6.4-16.9)	2.7 (0.6-4.7)	8.5 (6.1-11.0)	-	10.8 (4.3-17.3)	1.2 (0-2.5)	4.3 (2.5-6.2)
Married (vs. unmarried)	33.5 (8.4-58.6)	62.8 (55.4-70.3)	65.7 (57.3-74.1)	58.7 (53.3-64.1)	34.3 (3.8-64.7)	60.4 (49.2-71.7)	33.3 (27.4-39.1)	49.6 (45.1-54.1)
Has educational attainment (vs. do not has)	53.1 (24.8-81.5)	71.8 (63.0-80.6)	72.1 (64.3-80.0)	69.7 (64.4-75.1)	82.3 (57.7-100)	73.8 (63.6-84.1)	65.3 (58.9-71.8)	70.7 (66.6-74.8)
Current smoker (vs. non-smoker)	3.9 (0-12.0)	16.4 (10.1-22.7)	21.7 (14.2-29.1)	15.9 (12.3-19.4)	17.4 (0-42.7)	12.8 (5.7-19.9)	30.0 (24.2-35.7)	26.4 (22.5-30.3)
BMI								
Thin (>=18.5)	-	1.7 (0-5.2)	-	0.4 (0-1.2)	-	-	2.1 (0.2-3.9)	1.0 (0.1-1.8)
Normal (18.5-24.99)	64.0 (29.2-98.7)	35.1 (24.2-45.9)	31.1 (22.3-40.0)	11.2 (7.6-14.8)	51.5 (12.2-90.9)	25.3 (14.5-36.1)	41.4 (34.5-48.2)	28.0 (23.8-32.3)
Overweight (25-29.99)	36.0 (1.3-70.8)	38.6 (26.2-51.1)	34.3 (24.7-43.9)	34.2 (28.5-39.9)	14.1 (0-31.5)	34.9 (23.7-46.0)	27.6 (22.3-32.9)	34.1 (29.1-39.1)
Obesity (>=30)	-	24.6 (15.3-33.9)	34.6 (25.0-44.2)	54.3 (48.7-59.9)	34.4 (0-70.4)	39.8 (26.9-52.8)	29.0 (22.1-35.8)	36.9 (32.3-41.5)
White-collar (vs. blue-collar)	20.2 (0.5-40.0)	16.4 (8.8-24.0)	28.5 (20.7-36.4)	28.0 (23.5-32.5)	24.0 (0-53.2)	28.4 (19.8-36.9)	30.8 (23.6-38.0)	26.8 (23.4-30.2)
Gross weekly income level								
1st-lowest	3.8 (0-11.7)	7.8 (2.1-13.6)	10.7 (2.8-18.5)	8.4 (5.0-11.8)	16.0 (0-42.0)	7.7 (1.4-14.0)	13.4 (7.9-18.8)	7.2 (5.0-9.5)
2nd	4.9 (0-15.3)	17.2 (10.4-24.0)	10.3 (4.2-16.3)	12.8 (8.9-16.7)	46.7 (3.2-90.2)	16.3 (6.9-25.8)	14.3 (8.8-19.7)	14.1 (10.8-17.4)
3rd	32.6 (3.1-62.1)	23.4 (14.2-32.6)	25.5 (16.1-34.9)	23.8 (18.6-28.9)	5.9 (0-16.7)	27.0 (16.4-37.7)	27.3 (20.7-33.9)	30.1 (26.3-33.8)
4th	42.9 (10.7-75.1)	27.3 (18.9-35.7)	28.0 (18.8-37.1)	27.7 (23.0-32.3)	22.6 (0-49.8)	15.2 (8.1-22.2)	25.2 (19.3-31.0)	25.6 (21.9-29.3)
5th-highest	15.8 (0-37.7)	24.2 (16.2-32.3)	25.6 (18.1-33.1)	27.4 (22.5-32.3)	8.7 (0-22.4)	33.7 (21.3-46.2)	19.9 (14.6-25.2)	23.0 (19.6-26.5)

MM=multimorbidity. CVD=cardiovascular disease. BMI=Body mass index. Values are % (95%CI). Sample size (n) are showed with crude data, percentage and mean times of visits are estimated with weighting strategy. The sample size of working participants was 10,363.

Table 3 12-month disease-specific healthcare service utilization of GPs, specialists and other health professionals by disease status (alone and coexisting with other conditions)

	Asthma		Cancer		CVD		Arthritis	
	Only	**In MM**	**Only**	**In MM**	**Only**	**In MM**	**Only**	**In MM**
	n=975	**n=1175**	**n=304**	**n=766**	**n=1258**	**n=1917**	**n=325**	**n=970**
Disease-specific								
GP visits								
0 visit	59.0 (52.6-65.4)	56.0 (50.2-61.8)	36.7 (3.1-70.2)	31.3 (17.0-45.7)	37.4 (32.3-42.5)	36.0 (31.1-40.9)	62.7 (53.2-72.2)	57.8 (52.6-63.1)
1 visit	24.4 (18.4-30.3)	22.1 (17.7-26.4)	23.3 (3.8-42.9)	32.9 (18.8-47.1)	20.0 (15.8-24.1)	19.7 (16.5-22.9)	27.5 (18.0-36.9)	21.2 (16.8-25.5)
2 visits	7.5 (4.5-10.5)	11.7 (8.3-15.1)	8.6 (0-27.3)	21.0 (7.6-34.4)	25.0 (20.5-29.5)	20.0 (16.1-23.8)	6.4 (2.2-10.5)	9.8 (6.8-12.7)
3 visits	6.2 (3.3-9.1)	4.2 (2.1-6.3)	0.6 (0-2.0)	5.0 (0-11.1)	6.3 (3.6-9.0)	6.9 (4.6-9.2)	1.8 (0-3.7)	4.5 (2.7-6.3)
4+ visits	2.9 (1.1-4.7)	6.0 (3.5-8.6)	30.8 (0-65.9)	9.8 (1.2-18.4)	11.4 (7.9-14.9)	17.4 (14.1-20.6)	1.7 (0.1-3.3)	6.8 (4.9-8.7)
Specialist visits								
0 visit	98.0 (96.7-99.3)	96.6 (94.8-98.3)	45.9 (13.3-78.6)	42.9 (24.9-61.0)	87.3 (84.0-90.6)	85.0 (81.9-88.1)	80.2 (71.9-88.6)	85.8 (82.8-88.9)
1 visit	1.2 (0.1-2.2)	1.8 (0.6-3.0)	19.4 (0-39.6)	17.2 (1.2-33.2)	7.9 (5.5-10.3)	8.8 (6.2-11.4)	6.4 (1.8-10.9)	7.3 (5.0-9.6)
2+ visits	0.8 (0-1.7)	1.6 (0.3-3.0)	34.7 (7.9-61.5)	39.8 (24.0-55.7)	4.8 (2.3-7.3)	6.2 (4.2-8.2)	13.4 (6.4-20.4)	6.9 (4.6-9.1)
Visit other HP at least once	10.1 (6.1-14.1)	6.1 (3.9-8.3)	24.2 (0-53.0)	26.6 (13.0-40.2)	4.4 (2.4-6.3)	9.9 (7.9-12.0)	17.4 (10.6-24.3)	20.1 (16.4-23.8)
	Osteoporosis		**Diabetes**		**Kidney**		**Mental**	
	Only	**In MM**	**Only**	**In MM**	**Only**	**In MM**	**Only**	**In MM**
	n=21	**n=183**	**n=191**	**n=617**	**n=22**	**n=126**	**n=410**	**n=976**
Disease-specific HSU								
GP visits								
0 visit	57.3 (29.3-85.3)	45.5 (36.2-54.8)	19.9 (5.2-34.5)	18.1 (9.9-26.3)	42.1 (0-100)	62.1 (40.4-83.8)	37.3 (28.5-46.0)	38.6 (33.5-43.7)
1 visit	33.2 (6.4-60.1)	28.6 (19.6-37.5)	19.0 (6.5-31.5)	17.9 (11.7-24.2)	33.4 (0-89.3)	12.8 (0-26.2)	24.6 (15.2-33.9)	18.9 (14.5-23.3)
2 visits	9.4 (0-29.3)	16.7 (6.8-26.6)	23.3 (7.6-38.9)	26.2 (17.3-35.1)	-	9.6 (0-22.5)	16.6 (9.9-23.4)	14.6 (10.7-18.5)
3 visits	-	3.6 (0-7.3)	11.7 (0-25.4)	10.0 (5.0-14.9)	24.5 (0-81.5)	1.8 (0-5.5)	8.7 (5.0-16.8)	9.9 (6.8-13.0)
4+ visits	-	5.6 (1.0-10.3)	26.1 (8.9-43.3)	27.8 (20.3-35.3)	-	13.7 (1.3-26.1)	12.9 (6.7-19.0)	18.0 (14.7-21.2)
Specialist visits								
0 visit	100 (100-100)	86.5 (79.2-93.8)	60.7 (44.4-76.9)	76.7 (68.7-84.8)	59.2 (0-100)	49.4 (30.9-68.0)	80.4 (73.3-87.4)	80.0 (76.2-83.6)
1 visit	-	6.1 (1.8-10.4)	17.1 (2.2-32.0)	7.2 (2.8-11.5)	40.8 (0-100)	20.1 (0.4-39.9)	4.3 (0.9-7.6)	3.9 (2.3-5.6)
2+ visits	-	7.4 (1.8-12.9)	22.2 (9.1-35.3)	16.1 (9.1-23.1)	-	30.4 (14.2-46.6)	15.3 (9.0-21.7)	16.2 (12.4-19.9)
Visit other HP at least once	10.4 (0-22.3)	13.4 (6.6-20.2)	42.8 (26.2-59.3)	38.1 (30.0-46.3)	-	2.5 (0-5.8)	28.5 (20.9-36.1)	26.5 (22.8-30.3)

GP=general practitioner. HP=health professional. MM=multimorbidity. CVD=cardiovascular disease.
HSU=healthcare service utilization. Values are % (95%CI). The sample size of working participants was 10,363.

Table 4 Multivariate analysis of disease-specific healthcare service utilization of GPs, specialists and other health professionals associated with employees with specific condition only compared to those with specific condition coexisting with other chronic conditions

	GPs		**specialists**		**Other HPs**	
	RR (95% CI)	***p***	**RR (95% CI)**	***p***	**OR (95% CI)**	***p***
Asthma	N=1087		N=1166		N=1171	
Only	1.0		1.0		1.0	
In MM	1.0 (0.7,1.2)	0.823	0.7 (0.2,2.6)	0.634	0.7 (0.4,1.2)	0.160
Cancer	N=89		N=90		N=112	
Only	1.0		1.0		1.0	
In MM	0.7 (0.1,1.3)	0.365	1.2 (0.5,2.9)	0.749	1.4 (0.1,14.0)	0.796
CVD[a]	N=1302		N=1718		N=1750	
Only	1.0		1.0		1.0	
In MM	1.1 (0.8,1.2)	0.680	**1.6 (1.1,2.5)**	***0.03***	**2.5 (1.5,4.0)**	***<0.001***
Arthritis[b]	N=835		N=1031		N=1056	
Only	1.0		1.0		1.0	
In MM	**1.7 (1.1,2.2)**	***<0.001***	0.9 (0.4,1.8)	0.728	1.2 (0.7,2.1)	0.453
Diabetes	N=268		N=317		N=329	
Only	1.0		1.0		1.0	
In MM	0.9 (0.5,1.2)	0.540	1.0 (0.4,2.3)	0.999	0.9 (0.4,2.0)	0.796
Mental disorder	N=814		N=873		N=935	
Only	1.0		1.0		1.0	
In MM	1.2 (0.9,1.5)	0.262	0.5 (0.8,2.8)	0.163	1.0 (0.7,1.4)	0.839

GP=general practitioner. HP=health professional. MM=multimorbidity. CVD=cardiovascular disease. Poisson regression models were used for the relationship between the number of visits with GP, specialists and the multimorbidity status. Logistic regression models were used for the relationship between the number of visits with other HP and the multimorbidity status. Significant estimates are typed in bold font ($p<0.05$). Sample size (n) are showed with crude data, rate ratios (RR) and odds ratios (OR) are estimated with weighting strategy. The sample size of working participants was 10,363.

All models adjusted for age and sex, models additionally adjusted for: a: BMI; b: educational attainment and BMI.

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