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The association between chronic illness, multimorbidity and depressive symptoms in an Australian primary care cohort

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Abstract

Purpose To assess the link between multimorbidity, type of chronic physical health problems and depressive symptoms

Method The study was a cross-sectional postal survey conducted in 30 General Practices in Victoria, Australia as part of the diamond longitudinal study. Participants included 7,620 primary care attendees; 66% were females; age range from 18 to 76 years (mean = 51years SD = 14); 81% were born in Australia; 64% were married and 67% lived in an urban area. The main outcome measures include the Centre for Epidemiologic Studies Depression Scale (CES-D) and a study-specific self-report check list of 12 common chronic physical health problems.

Results The prevalence of probable depression increased with increasing number of chronic physical conditions (1 condition: 23%; 2 conditions: 27%; 3 conditions: 30%; 4 conditions: 31%; 5 or more conditions: 41%). Only 16% of those with no listed physical conditions recorded CES-D scores of 16 or above. Across the listed physical conditions the prevalence of 'probable depression' ranged from 24% for hypertension; 35% for emphysema; 35% for dermatitis to 36% for stroke. The dose–response relationship is reduced when functional limitations and self-rated health are taken into account, suggesting that these factors mediate the relationship.

Conclusions A clear dose–response relationship exists between the number of chronic physical problems and depressive symptoms. The relationship between multimorbidity and depression appears to be mediated via self-perceived health related quality of life. Primary care practitioners will identify more cases of depression if they focus on those with more than one chronic health problem, no matter what the problems may be, being especially aware in the group who rate their health as poor/fair.

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Introduction

Depression and physical illness commonly co-occur and depression is commoner in those with a chronic condition,

as found in the large, worldwide WHO study [1]. There is growing interest in understanding the links between depression and physical illness, which are thought to be bi-directional [2, 3]; depression can increase the risk of the development of other health conditions through mechanisms such as lifestyle factors, poor health behaviours, delayed help-seeking and treatment non-compliance [4], and depression can develop subsequent to the diagnosis of a chronic health condition through physiological, pharmacological or psychological mechanisms [5–8] .

Studies are emerging which investigate the links between, for example, diabetes and depression [9] and asthma and depression [10, 11]. However, questions remain around whether the observed link is due to a particular condition (hence some common underlying biological pathway), the number of conditions, a particular combination of conditions or a common pathway through functional limitations. An analysis of a subsample of the European Study of the Epidemiology of Mental Disorders (ESEMeD) reported by Stegmann and Ormel et al. (2010) [2] suggests that previous studies may have overestimated the association between individual physical conditions and depression. They postulate that the association between physical conditions (which included arthritis, allergy, heart disease, hypertension, asthma, diabetes and stomach/duodenal ulcer) and depression can be explained by functional disability (which they measure as 'days out of role'). Their finding, however, is limited to major depressive disorder and they were not able to account for the possible effect of antidepressant use.

Nevertheless, their finding is important and calls into question the current health policy focus in many countries on co-morbidity (a single condition such as diabetes or heart disease with depression). Added to this is the growing recognition and interest in the number of individuals experiencing multimorbidity, defined as any co-occurrence of two or more chronic medical conditions [12–15]. A recent systematic review reported a prevalence rate of 60% for multimorbidity, compared with rates for individual conditions of 6.5% for asthma, 29.6% for hypertension and 8.7% for diabetes [16] and a Dutch study reported that rates of multimorbidity doubled between 1985 and 2005 [13].

Multimorbidity complicates appropriate diagnosis and treatment and has been linked to greater utilization of health care services, reduced life expectancy and poorer health outcomes [13], yet our health care systems fail to address the needs of these patients [17]. From the patients' perspective multimorbidity can have profound, detrimental effects on their ability to function physically, socially and psychologically [18], resulting in a reduction in quality of life [16, 19] and an increased risk of depression [19]. Depression and psychological distress in patients with multiple physical conditions may further increase the negative impact of those conditions by increasing pain and

disability, and reducing compliance with treatment recommendations concerning medication and lifestyle changes. Multimorbidity is especially relevant in primary care where people attend for comprehensive health care and often present with a mix of undifferentiated physical and mental health symptoms and disabilities. Understanding the interplay between multimorbidity, functional limitations and self-rated health and depressive disorders in the primary care setting is crucial to developing more effective interventions for the growing number of people experiencing multiple physical and mental health conditions.

The aims of this study were to assess, in primary care attendees, the link between the number and type of chronic physical health problems and depressive symptoms and how this link might interact with functional limitations and self-rated health, taking into account the important potential confounder of antidepressant use.

Methods

Participant selection and screening procedures

The data reported here are from the *diamond* study; a large longitudinal study approved by The University of Melbourne's Human Research Ethics Committee, conducted in Victoria, Australia, which focuses on depression in general practice. Full details have been reported earlier [20, 21]. Eligible GPs were approached from a randomised list generated by the Health Insurance Commission [22] until 30 agreed to take part. Practice staff, supported by a research assistant, searched the GPs' computerised records to randomly sample 600 eligible patients from each of the 30 practices. Each eligible patient was sent a screening postal survey with a covering letter from their GP. A total of 7,667 (43.1%) patients returned their survey and form the sample for this study. A de-identified record of age and sex was available to determine the representativeness of the survey responders.

Measures

The Centre for Epidemiologic Studies Depression Scale (CES-D) is a 20-item scale designed to measure depressive symptoms experienced in the past week using a four point response scale [23]. Scores range from 0 to 60 with high scores indicating higher depressive symptoms. A cut-point of 16, indicating 'probable clinical depression' was used [23].

The survey also included a list of 12 common chronic physical conditions seen in Australian general practice and the National health priority areas [24, 25]: asthma, emphysema or other chronic lung problem, diabetes (high

blood sugar), arthritis or any kind of rheumatism, back problems, chronic back pain or sciatica, hypertension (high blood pressure), chronic sinusitis, lipid disorder (high cholesterol), heart disease (angina, heart failure, heart attack), cancer (includes melanoma but not other skin cancer), stroke, and dermatitis. Respondents were asked to tick any listed chronic physical condition that they had experienced in the past 12 months. They then responded 'Yes' or 'No' to the following question: "Do you have any long-term illness, health problem or disability, which limits your daily activities or the work you can do (including problems that are due to old age)?"; and rated their health by answering the question: "In general, would you say your health is; Excellent, Very good, Good, Fair or Poor?" as self-rated health and functional limitations give an indication of perceived health-related quality of life. Participants were also asked whether they had experienced depression/and or anxiety in the past 12 months.

Statistical analysis

All analyses were conducted using STATA version 11 [26]. Data were summarised using frequencies and percentages for categorical data, and means and standard deviations (SD) for continuous data. Co-morbidity was defined as the total number of physical conditions experienced in the past 12 months across the 12 listed chronic physical conditions. The numbers of comorbid physical conditions experienced for each of the 12 listed conditions were summarised using quantiles. Multimorbidity was created using the total number of the 12 listed specific physical conditions. Logistic regression using generalised estimating equations with robust standard errors was used to examine the association between chronic physical conditions and depressive symptoms, allowing for the clustering effect due to recruiting participants from the same general practice, and controlling for the effects of age, sex, general practice location and additionally whether they were taking antidepressant medication. Results are reported as unadjusted and adjusted odds ratios (ORs) with 95% confidence intervals (CI) and p values (p). The Likelihood-ratio test was used to compare the logistic model treating the number of chronic conditions as a continuous variable against the logistic model treating the number of conditions as a categorical variable using dummy variables to look for evidence against linearity.

Results

Sample characteristics

The sample consisted of 7,620 participants, with 47 excluded from the analysis due to missing data on the chronic physical

Table 1 Demographic characteristics of the sample ($n = 7,620$)

Characteristic	Mean (SD)	No. (%)
Age in years	50.89	(14.22)
Female	5,047	(66.41)
Marital status		
Never married	1,348	(17.89)
Widowed/divorced/separated	1,350	(17.92)
Married	4,836	(64.19)
Lives alone	1,028	(13.55)
English first language	7,187	(94.79)
Born in Australia	6,153	(81)
Highest level of education		
Left school before year 10	1,293	(17.07)
Completed year 10 or 12	2,993	(39.51)
Certificate or diploma	1,572	(20.75)
Bachelor degree or higher	1,718	(22.68)
Pension/benefit main source of income	1,968	(26.17)
Has health care card	2,707	(35.73)
Unemployed looking for work	112	(1.47)
Unable to work due to sickness/disability	415	(5.46)
Long-term illness/health problem/disability, which limits daily activities or work	2,424	(32.61)
Currently taking depression medication	1,052	(13.94)
Location of general practice		
Urban	5,136	(67.40)
Rural	2,484	(32.60)

Denominators vary due to missing data

conditions. The majority of the sample were female (66% compared with 61% sent a survey) and ages ranged from 18 to 76 years (mean age of responders was 51 years (SD, 14.2) compared with the mean age of participants sent a survey 46.2 (SD, 15.3)). The majority of survey responders were born in Australia (81%) with 95% indicating that English was their first language. The majority were married (64%), without post-secondary education (57%), with two-thirds (67%) living in an urban area (Table 1).

Prevalence of chronic health conditions

Table 2 shows the number and percentage of participants that reported experiencing any of the 12 listed chronic physical conditions in the past 12 months, the percentage with multimorbidity, the median number of comorbid chronic physical conditions, proportion of females and mean age for each condition. The most commonly reported chronic physical condition was back problems (28%) followed by arthritis (18%) and hypertension (17%). Almost one-quarter (24%) reported depression and/or anxiety in the past 12 months.

Table 2 Prevalence, number of comorbidities, gender and age breakdown for participants reporting each of the 12 listed physical conditions

Condition[a]	Prevalence N = 6,864 n (%)	No co-morbidity n (%)	Number of co-morbid physical conditions[b]		Female n (%)	Age Mean (SD)
			Median	IQR		
Stroke	59 (0.77)	4 (6.78)	6	4–10	31 (52.54)	58.17 (13.75)
Emphysema	167 (2.19)	26 (15.57)	4	3–6	87 (52.1)	58.36 (13.24)
Cancer	192 (2.52)	59 (30.73)	3	2–5	105 (54.97)	59.65 (11.53)
Heart disease	239 (3.14)	27 (11.3)	4	3–5	95 (39.92)	61.62 (10.95)
Diabetes	400 (5.25)	81 (20.25)	3	3–5	206 (51.5)	58.65 (12.02)
Chronic sinusitis	401 (5.26)	70 (17.46)	3	2–4	310 (77.31)	51.33 (13.16)
Dermatitis	521 (6.84)	149 (28.6)	3	2–4	378 (72.83)	47.19 (13.85)
Asthma	774 (10.16)	237 (30.62)	3	2–4	555 (71.8)	48.62 (14.79)
Lipid disorder	820 (10.76)	136 (16.59)	3	2–4	488 (59.58)	58.58 (10.44)
Hypertension	1,258 (16.51)	323 (25.68)	3	2–4	755 (60.16)	58.94 (10.83)
Arthritis	1,357 (17.81)	297 (21.89)	3	2–4	903 (66.74)	59.49 (10.66)
Back problems	2,125 (27.89)	810 (38.12)	3	2–4	1,385 (65.24)	51.08 (13.34)

IQR Inter-quartile range (25th–75th percentile)

[a] Individual conditions are not mutually exclusive

[b] Total co-morbidities include nominated physical condition

Measuring multimorbidity

Figure 1 shows how we sampled participant data for this paper. Overall, 42.6% of respondents (3,247/7,620) did not experience any of the 12 listed chronic physical conditions in the past 12 months. Of these 3,247 participants, 679 reported having a long-term illness or disability limiting their activity, yet we were not able to discern the nature or number of long-term conditions they were experiencing. In addition, 77 participants who did not experience any of the 12 listed chronic physical conditions did not record a response to the question about long-term illness or disability limiting their activity. Hence, these participants were not included in the analysis of multimorbidity reported in Tables 3, 4 and 5 which is based only upon the responses from the remaining 6,864 participants (Fig. 1).

31% (2,154/6,864) reported two or more chronic physical conditions, with 2.4% reporting five or more of the listed conditions. Of the participants reporting at least one condition (n = 4,373), 49% (n = 2,154) were

Fig. 1 Flowchart of participant response to questions about chronic physical conditions and limits to daily activity. [a]Analysis reported in Tables 3, 4 and 5 of this paper are based on responses from these participants
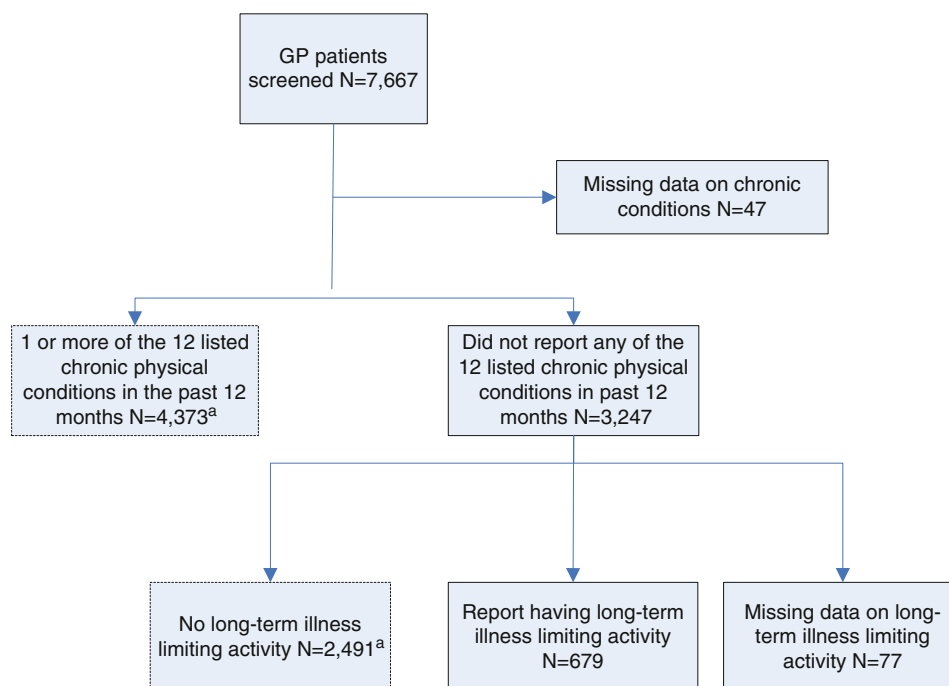
Table 3 Prevalence of multimorbidity of physical health conditions, across gender and age group (N = 6,864)

Condition	Prevalence	Aged 18–44 years		Aged 45–64 years		Aged 65+ years	
	Total sample n (%)	Males n (%)	Females n (%)	Males n (%)	Females n (%)	Males n (%)	Females n (%)
No condition[a]	2,491 (36.29)	254 (46.61)	967 (50.68)	312 (27.61)	655 (32.55)	123 (23.47)	149 (22.04)
1 condition	2,219 (32.33)	203 (37.25)	631 (33.07)	374 (33.10)	652 (32.41)	156 (29.77)	186 (27.51)
2 conditions	1,148 (16.72)	56 (10.28)	228 (11.95)	223 (19.73)	372 (18.49)	116 (22.14)	140 (20.71)
3 conditions	585 (8.52)	21 (3.85)	58 (3.04)	127 (11.24)	181 (9.00)	71 (13.55)	122 (18.05)
4 conditions	257 (3.74)	6 (1.10)	14 (0.73)	53 (4.69)	95 (4.72)	35 (6.68)	52 (7.69)
5+ conditions	164 (2.39)	5 (0.92)	10 (0.52)	41 (3.63)	57 (2.83)	23 (4.39)	27 (3.99)

Denominators vary due to missing data for age or sex of participant

[a] No listed chronic physical conditions or long-term illness or disability, 77 respondents with missing responses and 679 respondents that said "Yes" to "Long-term illness, health problem or disability" were coded as missing (see Fig. 1)

multimorbid. The multimorbidity rates were higher among the older age group (65+ years), with 47% (245/524) of males and 50% (341/676) of females reporting two or more chronic physical conditions (Table 3). 4% of this older age group reported five or more conditions, compared with less than 1% among the youngest age group (18–44 years). Among the older age group with at least one chronic condition, 61% (245/401) of males and 65% (341/527) of females were multimorbid.

Depressive symptoms across physical conditions and multimorbidity

The percentage of participants recording CES-D scores ≥16 (indicating probable depression) was identified for the 12 listed chronic physical conditions (Table 6). For respondents reporting a chronic physical condition, the prevalence of 'probable depression' ranged from a low of 24% (hypertension) to a high of 36% (stroke). Participants reporting dermatitis and emphysema (35%) also recorded high levels of depressive symptoms.

The results of the logistic regression model comparing the odds of probable depression for participants with and without each of the listed chronic physical conditions are shown in Table 6. Adjusted analyses show strong evidence for an association between depressive symptoms and each chronic physical condition (p value < 0.001), except for cancer (p value = 0.16) and hypertension (p = 0.08).

Multimorbidity was also associated with higher odds of probable depression. For participants classified within the group 'no chronic physical condition', only 16% recorded CES-D scores ≥16. While 23% of respondents reporting one chronic physical condition recorded CES-D scores ≥16, over 40% of respondents reporting five or more chronic physical conditions recorded CES-D scores indicating probable depression. There was a strong association between depressive symptoms and the number of chronic

physical conditions reported (Table 4 and Fig. 2). As the likelihood-ratio test showed weak evidence against linearity (p = 0.02 for the unadjusted analysis and p = 0.01 for the adjusted analysis) odds ratios are reported for each of the multimorbidity levels compared with the reference group participants who did not list any chronic physical condition or functional limitation. With each increase in the number of reported chronic physical conditions, the odds of experiencing depressive symptoms became more likely, up to four times in cases where five or more physical conditions were reported compared with none. When we additionally adjusted multimorbidity for the functional limitations or self-rated health, substantial decreases in the associations (odds ratios) with depressive symptoms were observed. However, statistically significant associations of multimorbidity with depressive symptoms remained (Table 4), indicating that condition count is independently associated with depressive symptoms, yet suggesting that it is also mediated via functional limitations and self-rated health.

Depressive symptoms across chronic physical conditions limited to one organ system

We also investigated whether there was a link between conditions grouped by 'organ system' and depressive symptoms. We combined chronic physical conditions into the appropriate organ system groups. The cardiovascular system groups together stroke, heart disease, lipid disorder and hypertension. The musculoskeletal system groups together back problems and arthritis. Chronic physical conditions related to the respiratory system includes emphysema, chronic sinusitis and asthma. Skin as an organ system only comprised of dermatitis and diabetes the only condition related to the endocrine system. All of the organ system types were independently and significantly related to depressive symptoms. Statistically significant adjusted

Table 4 Number (%) of cases with probable depression across multimorbidity levels (N = 6,738)

Condition	CES-D ≥16			Unadjusted		Adjusted[a]		Adjusted[b]		Adjusted[c]		Adjusted[d]	
	N	n	%	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
No condition	2,463	405	16.44	Ref	<0.001	Ref	<0.001	Ref	<0.001	Ref	<0.001	Ref	<0.001
1 condition	2,176	510	23.44	1.53 (1.61, 2.27)		1.69 (1.45, 1.98)		1.59 (1.37, 1.83)		1.38 (1.18, 1.61)		1.23 (1.37, 1.83)	
2 conditions	1,121	308	27.48	1.91 (1.61, 2.27)		2.4 (2, 2.88)		2.20 (1.83, 2.64)		1.85 (1.54, 2.22)		1.56 (1.83, 2.64)	
3 conditions	570	172	30.18	2.18 (1.61, 2.27)		3.12 (2.54, 3.84)		2.67 (2.15, 3.31)		1.74 (1.37, 2.21)		1.62 (2.15, 3.31)	
4 conditions	249	78	31.33	2.33 (1.61, 2.27)		3.43 (2.52, 4.66)		2.94 (2.12, 4.09)		1.65 (1.16, 2.36)		1.54 (2.12, 4.09)	
5+ conditions	159	65	40.88	3.45 (1.61, 2.27)		5.01 (3.55, 7.06)		4.15 (2.87, 5.99)		2.03 (1.36, 3.04)		2.25 (2.87, 5.99)	

Respondents who had completed CES-D scale

N = Number of respondents with the individual number of condition

n (%) = Number and percentage of respondents with conditions scoring CESD-D scores ≥16

Ref Reference group, OR odds ratio, CI 95% confidence interval, p p value

Adjusted estimates using multivariable logistic regression with robust standard errors and:

[a] Adjusted for sex and age group of respondent and general practice location

[b] Adjusted for sex, age group of respondent, general practice location, reported use of antidepressants

[c] Adjusted for sex, age group of respondent, general practice location, reported use of antidepressants and health rate

[d] Adjusted for sex, age group of respondent, general practice location, reported use of antidepressants and daily activities limitation

odds ratios for all organ systems linked conditions ranged from 1.28 (cardiovascular) to 1.84 (endocrine). (Tables available on request).

We additionally adjusted for the presence of each 'organ system' group condition. No substantial decreases in the association with depressive symptoms were observed, except for cardiovascular system (OR = 1.10, $p = 0.94$). When controlling for functional limitations and self-rated health there was a decrease in all odds ratios; most striking was the decrease in the odds of association for the cardiovascular conditions. The only organ systems that remained statistically significant were musculoskeletal (adjusted OR = 1.25, $p < 0.001$, 95% CI (1.10–1.42)) and skin (adjusted OR = 1.41, $p < 0.001$, 95% CI (1.17–1.69)).

Health rate and long-term illness or disability limiting activity and its effect on depressive symptoms

Table 5 shows the proportion of participants with each number of chronic physical conditions who reported long-term illness or disability limiting their daily activities. Almost 72% of participants with four chronic conditions and over 71% of respondents with five chronic conditions reported long-term illness or disability limiting their daily activities. These groups also recorded the highest proportion of participants with a 'poor' or 'fair' health rating (42 and 54% respectively).

Figure 3 details the proportion of cases with health rated as 'poor' and long-term illness or disability limiting activity across each of the number of chronic physical conditions. Among the participants with five or more chronic conditions, approximately 75% experienced long-term illness or disability limiting activity and 17% rated their health as 'poor'.

Self-rated health was strongly associated with depressive symptoms (adjusted OR = 4.80; 95% CI 4.12–5.59; $p < 0.001$). Also, there was a strong association between functional limitations and depressive symptoms (adjusted OR = 2.74, 95% CI (2.38–3.15) $p < 0.001$). As presented in the previous section multimorbidity was strongly associated with depressive symptoms and this relationship was statistically significant. However, controlling for functional limitations or self-rated health reduced the observed odds ratios and the associations with depressive symptoms substantially decreased. As depressive symptoms were strongly and statistically significantly associated with self-rated health and functional limitations, it appears that self-rated health and functional limitations may play a mediating role in the relationship between multimorbidity and depressive symptoms (Fig. 4) suggesting that the number of co-occurring conditions also affects depressive symptoms indirectly through the impact on perceived health-related quality of life [27].

Table 5 Proportion of participants reporting limitations in daily activity and poor-fair health (N = 6,864)

| Condition | Prevalence total sample n (%) | Daily activities limited | | Poor-fair health rating n (%) | Good–excellent health rating n (%) |
		Yes n (%)	No n (%)		
No condition[a]	2,491 (36.29)	0 (0)	2,491 (100)	100 (4.01)	2,378 (95.46)
1 condition	2,219 (32.33)	634 (28.57)	1,540 (69.40)	291 (13.11)	1,905 (85.85)
2 conditions	1,148 (16.72)	462 (40.24)	653 (56.88)	207 (18.03)	922 (80.31)
3 conditions	585 (8.52)	347 (59.32)	224 (38.29)	187 (31.97)	383 (65.47)
4 conditions	257 (3.74)	185 (71.98)	60 (23.35)	107 (41.63)	144 (56.03)
5+ conditions	164 (2.39)	117 (71.34)	41 (25.00)	89 (54.27)	72 (43.90)

Denominators vary due to missing data for health rate and functional limitation. Conditions sorted by percentage of cases with limited daily activities. Conditions are not mutually exclusive—participants may report ≥1 condition

[a] No listed chronic physical conditions or long-term illness or disability, 77 respondents with missing responses and 679 respondents that said "Yes" to "Long-term illness, health problem or disability" were coded as missing (see Fig. 1)

Table 6 Proportion of participants with the health condition with CES-D scores ≥16 (N = 7,467)

| Condition | N | CES-D ≥16 n (%) | Unadjusted | | Adjusted[a] | | Adjusted[b] | |
			OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Stroke	56	20 (35.71)	1.76 (1.14, 2.72)	0.01	2.03 (1.31, 3.16)	0.002	1.04 (0.47, 2.3)	0.92
Dermatitis	514	181 (35.21)	1.77 (1.51, 2.09)	<0.001	1.68 (1.42, 1.98)	<0.001	1.39 (1.18, 1.65)	<0.001
Emphysema	165	58 (35.15)	1.70 (1.25, 2.33)	0.001	1.97 (1.42, 2.71)	<0.001	1.38 (0.95, 2.01)	0.09
Diabetes	382	122 (31.94)	1.54 (1.30, 1.82)	<0.001	1.81 (1.52, 2.15)	<0.001	1.57 (1.3, 1.89)	<0.001
Chronic sinusitis	393	125 (31.81)	1.50 (1.26, 1.79)	<0.001	1.5 (1.26, 1.78)	<0.001	1.16 (0.97, 1.38)	0.11
Back problems	2,088	634 (30.36)	1.58 (1.42, 1.75)	<0.001	1.58 (1.43, 1.74)	<0.001	1.42 (1.27, 1.58)	<0.001
Asthma	765	232 (30.33)	1.42 (1.20, 1.68)	<0.001	1.37 (1.16, 1.62)	<0.001	1.09 (0.92, 1.28)	0.31
Heart disease	224	65 (29.02)	1.32 (0.98, 1.78)	0.07	1.69 (1.23, 2.33)	0.001	1.19 (0.79, 1.81)	0.41
Arthritis	1,321	357 (27.02)	1.24 (1.06, 1.44)	0.006	1.49 (1.28, 1.72)	<0.001	1.15 (0.98, 1.35)	0.09
Lipid disorder	801	216 (26.97)	1.20 (1.04, 1.38)	0.01	1.39 (1.19, 1.61)	<0.001	1.05 (0.87, 1.26)	0.60
Cancer	183	48 (26.23)	1.16 (0.79, 1.70)	0.44	1.32 (0.90, 1.93)	0.16	0.92 (0.58, 1.47)	0.74
Hypertension	1,221	293 (24.00)	1.01 (0.86, 1.19)	0.89	1.18 (0.98, 1.42)	0.08	1.00 (0.82, 1.22)	0.99

Respondents who had completed CES-D scale

N = Number of respondents with the individual condition

n (%) = Number and percentage of respondents with condition scoring ≥16 on CES-D

OR odds ratio, CI 95% confidence interval, p p value

[a] Adjusted estimates using multivariable logistic regression with robust standard errors and adjusted for sex and age group of respondent and general practice location

[b] Additionally adjusted for reported use of antidepressants

Discussion

In this paper we have shown a clear dose–response relationship between the number of chronic physical health problems (multimorbidity) and depressive symptoms, and we have shown how this link may also be mediated via perceived health-related quality of life. This is the largest scale study to our knowledge that reports such a dose–response relationship across a wide range of chronic physical conditions and our findings build upon those previously reported [1, 2]. The finding that probable depression is as much linked to problems such as dermatitis, as it is to diabetes and heart disease, calls into question the usefulness of the current strong focus on a particular disease association such as diabetes and depression in the primary care setting. The clear dose–response relationship suggests that primary care practitioners will identify more cases of depression if they focus on those with more than one chronic health problem, no matter what the problems may be.

We have also examined the way in which multimorbidity, specific organ system conditions, functional limitations and self-rated health are associated with depressive
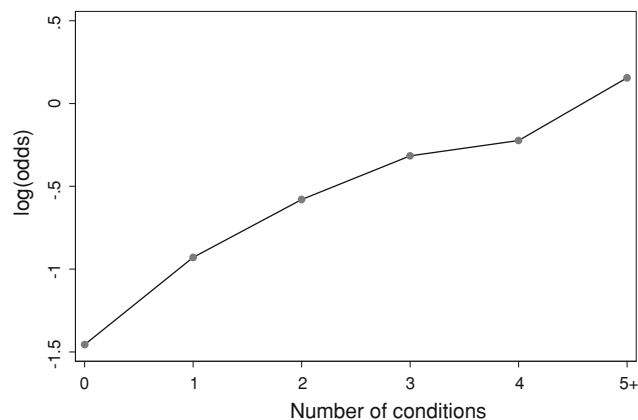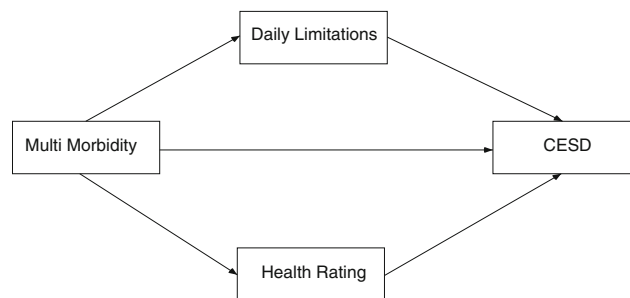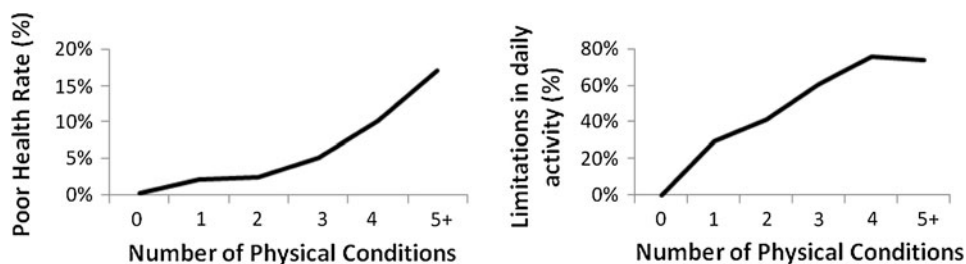
Fig. 2 Adjusted log of the odds of probable depression by number of physical conditions ($N = 6,681$)

Fig. 4 Mediation diagram for probable depression for multimorbidity, health rate and daily limitations

symptoms. Although our regression analysis shows that the dose–response relationship loses robustness when adjustment is made for either functional limitations or self-rated health, we have clearly demonstrated that multimorbidity and depressive symptoms are strongly linked to functional limitations and self-rated health. This suggests that multimorbidity and depressive symptoms are partially mediated by health-related quality of life: functional limitations and self-rated health. We put forward that this is a more clinically useful way of thinking about the link between multiple chronic health conditions and depression, rather than postulating that one of these factors is more important than the other. The next step will be to explore this possible partial mediation using more sophisticated statistical analysis techniques such as structural equation modelling or logistic regression with binary mediation using the product of coefficients approach allowing for computing the direct and indirect effects.

The strengths of this study are the large and representative sample size, the focus on 12 common and chronic physical conditions that form a large component of disease burden and our use of a well validated measure for depressive symptoms. The response rate of 43.1% to the initial mail-out survey may be seen as a study limitation; yet it is consistent with responses rates from other well conducted large-scale primary care studies investigating

depression [28], including the international PREDICT study being conducted in six European countries [29].

Both the chronic physical conditions checklist and the depression scale (CES-D) used in this study are self-report measures, introducing the potential for inaccuracies due to either under- or over-reporting of conditions. Self-report measures are, however, used extensively in the health and medical literature and a number of studies have suggested reasonable concordance between patient self-report and physician diagnoses or laboratory reports [30, 31]. Whilst medical records are a source for patient data on encounters/diagnoses, information recorded often differs from patient self-reported conditions due to differences in illness behaviour and practice variation of the GP [32]. We have measured multimorbidity using a simple count of the number of chronic physical conditions reported by our participants from a specified list of 12 common physical conditions. The use of counts may be seen as a limitation by some [19] who advocate for the use of sophisticated scales to assess multimorbidity, taking into account the severity of the health condition (e.g. Cumulative Illness Rating Scale [33]). We argue that these more complex and time-consuming measures have a place in research settings but are limited in the way the findings can be applied in the routine clinical encounter.

More research is clearly needed into the prevalence and impact of multimorbidity, recognizing the complexity of the issue and identifying factors that may serve to either increase or decrease its detrimental effects.

Fig. 3 Poor health rating and daily activities limited by number of physical conditions ($N = 6,864$)

Conclusion

A substantial proportion of patients attending primary care health settings have at least one chronic physical condition, with many being multimorbid. Primary care practitioners should have a raised awareness for depression in any patient that reports a common chronic physical condition and be especially aware in those who report two or more, and particularly so for those whom also report functional limitations or poor/fair self-rated health.

Ethical approval: Ethical approval for the study was obtained from The University of Melbourne Human Research Ethics Committee (Ethics ID: 030613).

Conflict of interest All authors declare that the answer to the questions on competing interest form are all 'No' and therefore have nothing to declare.

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