Time spent on health-related activities by senior Australians with chronic diseases: what is the role of multimorbidity and comorbidity?

M. Mofizul Islam,[1] Ian S. McRae,[1] Laurann Yen,[1] Tanisha Jowsey,[1] Jose M. Valderas[2]

Abstract

Objective: To examine the effect of various morbidity clusters of chronic diseases on health-related time use and to explore factors associated with heavy time burden (more than 30 hours/month) of health-related activities.

Methods: Using a national survey, data were collected from 2,540 senior Australians. Natural clusters were identified using cluster analysis and clinical clusters using clinical expert opinion. We undertook a set of linear regressions to model people's time use, and logistic regressions to model heavy time burden.

Results: Time use increases with the number of chronic diseases. Six of the 12 diseases are significantly associated with higher time use, with the highest effect for diabetes followed by depression; 18% reported a heavy time burden, with diabetes again being the most significant disease. Clusters and dominant comorbid groupings do not contribute to predicting time use or time burden.

Conclusions: Total number of diseases and specific diseases are useful determinants of time use and heavy time burden. Dominant groupings and disease clusters do not predict time use.

Implications: In considering time demands on patients and the need for care co-ordination, care providers need to be aware of how many and what specific diseases the patient faces.

Key words: time, multimorbidity, comorbidity, disease cluster, self-management, chronic illness, behaviour, health practice

Activities for managing health are an everyday affair for people with chronic diseases. Management of long-lasting diseases is time demanding, not only for the patient but also for health and social care service providers. The amount of time required for managing care, and any subsequent pressure from that time on the patient[1] or the provider,[2] potentially affects a patient's decision about the access to care. In addition, time is a scarce resource. With the ageing of the population and longer survival, scientific advances in medical care and public health policy, a growing proportion of the population is surviving longer with multiple chronic diseases. Thus, patient time use is increasingly becoming part of the care discourse of chronic disease.[3,4] However, there is a dearth of empirical studies examining the quantity of time used and associated factors, particularly among people with multiple chronic diseases.

Patients living with multiple chronic diseases report spending a substantial amount of time managing their health and attempting to balance the demands of their illnesses with other activities.[5] The total time required for managing multiple diseases may not be same as the sum of the times required for managing the separate diseases and may be greater or less, depending on the type and patterns of comorbid chronic diseases. Existing studies about time use have mostly been either the descriptive analysis of time use and/or the relationship between time use and the number of chronic diseases;[4,6] few have explored the impact of co-morbid combinations of diseases. There is now literature assessing the common natural cluster of chronic diseases that tend to co-occur.[7] This literature suggests that clusters can be derived by multivariate techniques like cluster analysis[8,9] or factor analysis,[9,10] or by looking at commonly occurring pairs and triplets,[11,12] and further clusters can be based on clinical factors and advice from clinicians.[13] Clinically, clusters might signal groups of conditions that would benefit from synergies in their medical management and this could in turn be reflected in a more efficient use of time by patients. However, to our knowledge, no previous study has examined this hypothesis or assessed which specific diseases are likely to account for a larger portion of time use.

This study aimed to examine (i) the effect of the total number of chronic diseases, specific chronic diseases, and various groupings of chronic diseases on time use on health-related activities; and (ii) explore the significant factors associated with a high burden of time use reflected by more than 30 hours per month being spent on health-related activities.

1. Australian Primary Health Care Research Institute, Australian National University, Australian Capital Territory
2. Health Services and Policy Research, University of Exeter Medical School, England, UK
Correspondence to: Dr M. Mofizul Islam, Australian Primary Health Care Research Institute, Australian National University, Building 63, Cnr. Mills & Eggleston Roads, Acton, ACT 2601; e-mail: mofizul.islam@anu.edu.au
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Methods

Setting and participants

A questionnaire entitled 'How much work is involved in looking after your health?' was posted to a sample of members of three national Australian organisations: National Seniors Australia (NSA), The National Diabetes Services Scheme (NDSS) and Lung Foundation Australia (LFA). The questionnaire sought information in four main areas: demographics, health, health services use and time spent by patients and informal carers on health-related activities that usually do not need hospital admission. This study does not include carer time, which is reported elsewhere.[6] The sample drawn from NSA and NDSS was stratified by state, rurality, age and gender, and all 3,062 members of LFA identified as having chronic obstructive pulmonary disease (COPD) were surveyed. To increase the proportions with chronic diseases, the older members were oversampled from NSA. The survey questionnaire was tested, piloted and revised before it was sent to participants. Full details of the survey development and data collection method have been described elsewhere.[5]

Respondents were asked: "Has a doctor ever told you that you had any of the following illnesses?" This was followed by a list of the most prevalent and common chronic diseases: cancer, heart disease, high blood pressure (HBP), stroke, diabetes, renal or kidney disease, asthma or hay fever, COPD, arthritis, osteoporosis, chronic pain (including back pain) and depression or anxiety. Participants were also asked to report other diseases (if any) under 'other chronic condition'. The survey and study were approved by the Australian National University Human Research Ethics Committee (no. 2010/468).

Time use

Participant recall was used in this study rather than diaries to limit the burden on the respondents and encourage response.[3,14] Participants were asked to recall their time use for home-based activities on most days and in the last month for clinic-related and other activities. Time for home-based activities was then converted to hours per month. Time use was defined as the time spent on different health-related activities, which are grouped into three types:

1. Clinic-related activities: these are related to use of medical and allied health services in the previous month; such as making appointments, travelling to health services, waiting in waiting rooms, attending appointments and having medical treatments.
2. Other activities: these are related to obtaining information, support or products in the previous month; including attending rehabilitation programs, education programs and support groups, shopping for special foods and looking for/reading health information.
3. Home activities: these are undertaken in domestic spaces on most days, such as time spent on exercising, preparing/consuming prescribed medications, and undertaking tests at home such as blood-glucose monitoring.

Information about time use in hours and minutes on the three multipart questions was converted to hours per month. The importance of exercise to health outcomes is acknowledged, as are the time demands of exercise; the measure of total time used here excludes exercise as the exercise times tend to dominate other activities.

With a view to examining the factors associated with the excessive time use, we defined a heavy time burden as spending more than 30 hours per month on health-related activities excluding exercise. Although this cut-off point is necessarily somewhat arbitrary, an amount of one hour per day on health-related activity is substantial, and more than 18% of the sample reported facing this burden.

Comorbid groups

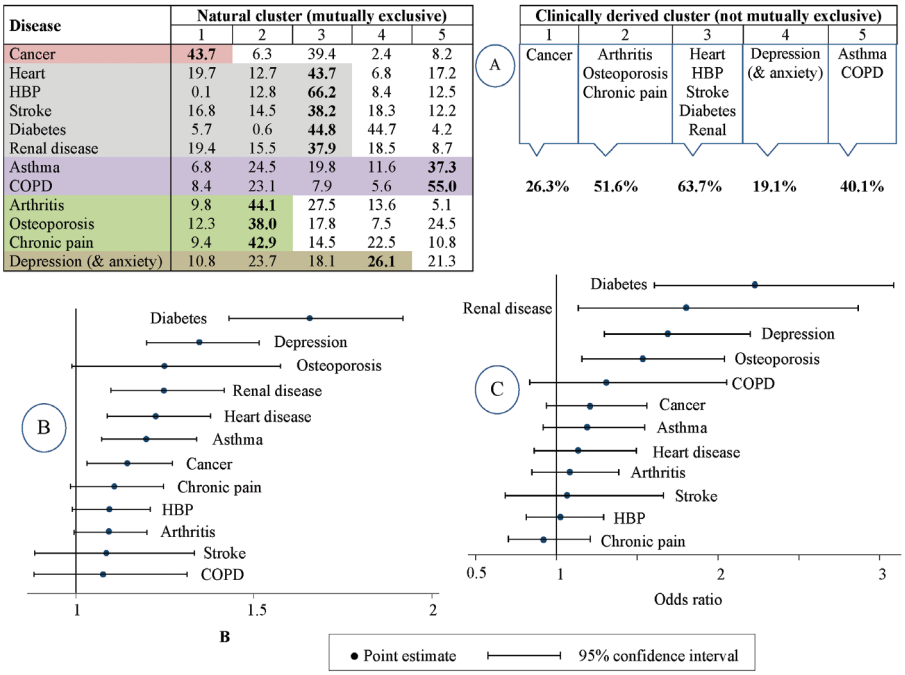
To establish natural groups of chronic diseases a cluster analysis was undertaken to classify observations into groups that are labelled by their most common components.[9] The clustering was performed with k-medoids and Yule's Q similarity measure.[15] Participants with none of the 12 diseases were classified as the reference cluster, and time use for the other clusters was estimated in relation to the reference cluster.

We also identified a set of clinical clusters (Figure 1) in which conditions shared disease management processes in clinical care practice[16] and that, unlike natural clusters, were not mutually exclusive. Thus a participant may belong to more than one clinically suggested cluster, depending on their chronic diseases.

Finally, as an alternative means of addressing co-morbidity, we created a categorical variable labelled 'multiple morbidity', following an approach used by Schoenberg et al.[17] Among those individuals with only one chronic illness, high blood pressure (HBP) and arthritis were the most frequently occurring, so we categorised people with one disease into three sub-groups: those with HBP only; those with arthritis only;

Figure 1: A: Natural and clinical clusters; B: forest plot for parameters of linear regression in model 2; C: forest plot for parameters of logistic regression in model 2.

Disease	Natural cluster (mutually exclusive)				
	1	2	3	4	5
Cancer	**43.7**	6.3	39.4	2.4	8.2
Heart	19.7	12.7	**43.7**	6.8	17.2
HBP	0.1	12.8	**66.2**	8.4	12.5
Stroke	16.8	14.5	**38.2**	18.3	12.2
Diabetes	5.7	0.6	**44.8**	44.7	4.2
Renal disease	19.4	15.5	**37.9**	18.5	8.7
Asthma	6.8	24.5	19.8	11.6	**37.3**
COPD	8.4	23.1	7.9	5.6	**55.0**
Arthritis	9.8	**44.1**	27.5	13.6	5.1
Osteoporosis	12.3	**38.0**	17.8	7.5	24.5
Chronic pain	9.4	**42.9**	14.5	22.5	10.8
Depression (& anxiety)	10.8	23.7	18.1	**26.1**	21.3



and those with only one disease but not arthritis or HBP. Participants with only two diseases were divided into two sub-groups: HBP + arthritis; and all other combinations of only two diseases. Following the same approach, we constructed all combinations of three diseases, four diseases and more than four diseases (Tables 1 and 2). Although we could have made more sub-groups with two or three-disease combinations, we did not go any further as the prevalence of such combinations increasingly became very small. Following Schoenberg et al., 'participants with HBP only' was selected as the reference group as it is the most common morbidity that tends to be associated with other diseases. (While arthritis is more prevalent, it is relatively independent of most other diseases.)

Other variables

A number of potentially confounding variables were selected from analytical domains that previous studies have shown to be associated with time use.[4,6,18] These included socio-demographic variables such as age, sex, general health status and region, and number of 'other chronic conditions'. We also included a variable to identify which of the three sub-samples the patient was selected from.

Regression analysis

For each of the two outcomes (time use as a continuous variable and heavy time burden as a binary variable) a set of five models were estimated, as given below:

- model 1 – the total number of chronic diseases
- model 2 – all the specific chronic diseases
- model 3 – 'multiple morbidity' (reference: HBP only)
- model 4 – natural clusters (reference: no chronic diseases)
- model 5 – clinically meaningful clusters (reference: participants with none of the specific diseases forming the clusters. The regression parameter of the asthma-COPD cluster, for example, signifies the effect of this cluster in reference to people who do not belong to this cluster, i.e. who do not have asthma or COPD).

The distribution of the time use variable contains 5% of respondents who reported zero time use. The dataset has a highly skewed distribution of nonzero values. We therefore undertook a linear regression with the subset who reported at least some time use, after logarithmic transformation of that subset. To examine the significant factors for time use in the whole sample, including the 5% who mentioned zero time use, we performed a Poisson regression with robust variance measure following the guidelines offered by Gould,[19] and Silva and Tenreyro;[20] however, there was minimal difference between the Poisson and log transformed regression outcomes, so only the latter is reported.

A logistic regression was undertaken to explore the significant variables associated with a heavy time burden. A backward elimination procedure was followed to determine the final model for each of the 10 equations reported, although in each case all the variables reflecting diseases and groups of diseases were retained in the model, even if an individual disease or sub-category was not significant. The reason for our using a set of 10 models is to explore comprehensively the potential conditions and/or a range of forms of groupings and clusters of chronic diseases associated with time use and heavy time burden, and to estimate their effects on these two outcomes.

Data were analysed using STATA (version 12). To make the coefficients (β) of the linear regression readily interpretable they have been exponentially transformed and reported as a value B. The interpretation is that a one unit (e.g. from zero to one) increase of independent variable would result in (B-1)*100 percentage change in time use.

Results

Response rate and participants' demographics

A total of 2,540 participants responded to the survey, with an overall response rate of 24%. Among the three sub-samples, the response rate was highest for NSA (n=1,432, response rate: 28.4%), followed by LFA (n=681, response rate: 22%) and NDSS ('Diabetes subsample' hereafter; n=427, response rate: 16.8%).

Overall, there were more female (53%) participants than male (47%), although in the Diabetes sub-sample there were more male (56%) than female (43%). Participants' mean age was 69.7 years (SD±9.01), and median age 69.0 years (interquartile range 64.0 – 76.0). More than three-quarters (77%) were born in Australia. More than half of the participants had post-school qualifications. The mean number of chronic diseases was 3.0 in the overall sample, and 85% reported having at least two chronic diseases. Among the individual diseases COPD and diabetes are present in almost all respondents within their individual sub-samples as well as across other sub-samples. HBP (46.4%), arthritis (36.6%) and cancer (26.3%) are highly represented across the whole sample, while stroke (5.2%) and renal diseases (4.1%) are less prevalent. A detailed account of prevalence of individual diseases in three sub-samples is described elsewhere.[6]

Condition Clusters

Cluster analysis identified five natural clusters depending on combinations of diseases, and we label the clusters according to the dominant diseases in each group as shown in Figure 1. For instance, 44.1 % of the participants with arthritis fell in Cluster 2 with the rest in Cluster 1 (9.8%), Cluster 3 (27.5%), Cluster 4 (13.6%) and Cluster 5 (5.1%), so for the purpose of identifying clusters participants with arthritis were labelled as belonging to Cluster 2. This group was also the dominant group for osteoporosis and chronic pain and hence we describe Cluster 2 as 'arthritis-osteoporosis-chronic pain' cluster. Clinically relevant clusters are shown in the right half of Figure 1 (A). The natural clusters we identified using the cluster analysis were very similar to the clinically relevant clusters. Both of these sets of clusters are consistent with our previous analysis on a different data set, although a previous study identified four clusters.[9]

Time spent on health-related activities and significant factors in the linear regressions

The reported median time was 5.2 (95%CI: 4.7–5.6) hours per month for the NSA sub-sample, 16.5 (95%CI: 14.7–18.3) hours per month for the LFA sub-sample, and 11.1 (95%CI: 9.3–12.8) hours per month for the Diabetes sub-sample.

Linear model 1 (2nd column of Table 1) shows that time use increased significantly with the number of chronic diseases experienced, and for an additional disease time use increases by 18%. Linear model 2 reveals all 12 conditions had estimated values of B more than '1', meaning that those with the diseases spent more than those without

them. Specific diseases including cancer, heart disease, diabetes, asthma, osteoporosis and depression were significantly associated with increased time use at 5% significance (third column of Table 1), with the highest effect for diabetes (B=1.6, 95%CI 1.4-1.9). The coefficients are displayed in a forest plot in Figure 1. The results of Linear model 3 addressing the combined multi-morbidity structure show only the non-specific combinations of one, two, three, four and more diseases are significantly different to the omitted category of HBP only. Linear model 4, which presents the adjusted regression parameter (B) across natural clusters of diseases with reference to the group that reported having no chronic disease, shows that all clusters are significantly different to those with no chronic diseases. The depression dominant cluster had the highest parameter (B=1.8) followed by heart-stroke-HBP-diabetes-renal disease (B=1.7). Similarly all clinically relevant clusters were significant, with highest effect measure for heart-stroke-HBP-diabetes-renal disease (B=1.4) followed by depression dominant cluster (B=1.3). There was no significant difference between cluster coefficients for either the natural or the clinically relevant clusters, meaning that these clusters do not facilitate predicting the time use for different comorbid groups.

Factors correlated with heavy time burden

Overall, around one-fifth of the participants reported heavy time burden (defined as more than 30 hours per month on health-related activities). Among the sub-samples, the proportion of heavy time use is highest for LFA (29.7%) followed by Diabetes subsample (22.2%) and NSA (11.3%). Results from the logistic regression (Table 2) demonstrate that with an additional chronic disease the odds of becoming a heavy time user increase by 25%. Logistic model 2 with individual diseases reveals diabetes, renal disease, osteoporosis and depression are significantly associated with heavy time burden, and this is also shown in a forest plot in Figure 1. The Logistic model 3 addressing 'multiple morbidity' shows only the non-specific combination of four and more diseases to be significant. In the model with natural clusters (Logistic model 4) none of the clusters were found to be significantly different from each other or from the group with no diseases. Among the clinical clusters, however, arthritis-osteoporosis-chronic pain and depression dominated groups were found significant, with much higher parameter (OR=1.7) for the depression cluster although this was not significantly different to other parameter estimates.

Among the confounding factors, those significantly associated with time use were predominantly self-reported general health status, the number of 'other chronic conditions', sub-sample, employment and educational status. The Diabetes and LFA sub-samples were almost always more time demanding than the NSA sub-sample, which more closely reflects the general population. In the logistic models, age (which has an inverse relation with time burden) was an additional confounding factor, and employment status was not significant in the final models. Thus, apart from the total number of chronic diseases and some specific diseases mentioned above, overall heavy time burden was likely to be reported by the participants who were relatively young within this already older population group, who were either from the Diabetes or LFA sub-sample or who reported poor health status.

Discussion

Findings of this study suggest that neither natural nor clinical clusters, nor dominant groupings, identify significant differences in time demand. However, some individual diseases do stand out from others. The best predictor of time use is the number of diseases. The multiple morbidity variable, which we developed following the approach of Schoenberg et al. (model 3),[17] shows that the non-specific combinations of two, three, four and more diseases offer predictive information more strongly than the various combinations of specific diseases, reinforcing the view that numbers of diseases most strongly influence time spent on health-related activity.

Some individual chronic diseases offer more useful information about both time use and burdensome time use than the various groupings. Time use for health care is significantly higher among those with cancer, heart disease, diabetes, asthma, osteoporosis or depression than those who did not have any of these diseases. Among the specific diseases, diabetes has the highest odds ratios both for time use (OR=1.6 CI 1.4-1.9) and for heavy time burden (OR=2.1 CI 1.6-2.8). This time burden could be due to time required for maintaining a defined daily routine for disease-specific activities such as blood sugar testing – which may need to be done several times in a day – and time needed for preparing and taking medication, foot care and buying specific foods. A literature review performed by Jowsey et al. (2012) also reported relatively excessive time use by people with diabetes compared to those with other chronic diseases.[4]

This study answers the question raised in the current literature about the combined effect of clusters and groupings on total time spent on health-related activity by people with chronic diseases, at least as it applies to this group of common diseases. It has been argued that some chronic diseases are concordant and have the same pathophysiologic risk profile; that they are more likely to share the same management and are more likely to be the focus of the same disease management plan (e.g. type 2 diabetes mellitus and hypertension). The opposite is true for diseases that are considered discordant.[16] Therefore, it could be argued that for a given level of multimorbidity, some combinations of diseases are likely to be associated with a heavy time burden of health-related activities, depending on the concordance or discordance of the diseases. Our study shows that although a cluster or a specific group may be clinically important and help design care process, it does not help predict the time spent on health-related activities.

Apart from the effect of particular comorbid groups on time use, this study also highlights the fact that disease management requires considerable time for those with multimorbidity. Whether this time is efficiently used, and how much time could be saved if it were more efficiently managed, is beyond the scope of this study. This study does not address how particular health-related activities are experienced; whether younger seniors spend unnecessary time; nor does it tell if the older seniors should spend more time on health-related activities. We suggest that these issues should be taken up in future research. Previous literature has explained that time requirements are barriers to self-care or health care more generally. One study found "not enough time" was the biggest obstacle for more than 20% of patients to effectively managing their diabetes.[21] Likewise, the economic value of time, the opportunity cost and potential loss of productivity have not been explored here but are likely to be material.

Table 1: Linear regression model reflecting correlates of time use in hours per month (without exercise).

Variable	With aggregated number of conditions (linear model 1)		With specific chronic conditions (linear model 2)		With multiple morbidity (linear model 3)		With natural clusters mutually exclusive (linear model 4)		With clinically meaningful clusters not mutually exclusive (linear model 5)	
	B[a]	95% CI	B[a]	95% CI	B[a]	95% CI	B[a]	95% CI	B[a]	95% CI
Number of chronic conditions	1.18**	1.15-1.21								
Specific chronic conditions										
Cancer			1.15*	1.03-1.27						
Heart disease			1.22**	1.09-1.38						
High blood pressure			1.09	1.00-1.20						
Stroke			1.08	0.88-1.33						
Diabetes			1.65**	1.43-1.91						
Renal disease			1.25	0.99-1.57						
Asthma			1.20**	1.07-1.34						
COPD			1.07	0.88-1.31						
Arthritis			1.09	0.99-1.21						
Osteoporosis			1.25**	1.10-1.42						
Chronic Pain			1.11	0.98-1.25						
Depression (or anxiety)			1.35**	1.20-1.51						
Multiple morbidity										
High blood pressure only					1.00	-				
None of these 12 conditions					0.80	0.59-1.08				
Arthritis only					0.83	0.55-1.26				
All others with one disease only					1.33*	1.01-1.75				
High blood pressure and arthritis only					1.19	0.80-1.77				
All others with two diseases only					1.32*	1.01-1.71				
All with three diseases only					1.72**	1.32-2.25				
All with four diseases only					2.10**	1.59-2.76				
All with >four diseases only					2.70**	2.06-3.54				
Natural Clusters										
None of 12 conditions							1.00	-		
Cancer							1.65**	1.32-2.10		
Arthritis, osteoporosis and chronic pain							1.51**	1.21-1.87		
Heart, High blood pressure , stroke, diabetes & renal disease							1.71**	1.39-2.09		
Depression[b]							1.87**	1.47-2.37		
Asthma and COPD							1.59**	1.25-2.02		
Clinically relevant clusters										
Cancer									1.18**	1.06-1.31
Arthritis, osteoporosis and chronic pain									1.24**	1.13-1.37
Heart, High blood pressure , stroke, diabetes & renal disease									1.38**	1.24-1.53
Depression[b]									1.35**	1.20-1.52
Asthma and COPD									1.14*	1.00-1.29
Number of other chronic diseases			1.19**	1.10-1.29			1.25**	1.16-1.36	1.20**	1.11-1.31
Education										
None	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Up to year 12	1.01	0.87-1.17	1.01	0.87-1.17	1.01	0.87-1.17	0.98	0.84-1.13	1.00	0.86-1.16
Trade/Certificate/Diploma	1.16	0.99-1.35	1.16	0.99-1.34	1.15	0.99-1.34	1.13	0.97-1.32	1.15	0.99-1.34
University or more	1.32**	1.12-1.56	1.32**	1.12-1.56	1.32**	1.12-1.56	1.28**	1.08-1.52	1.31**	1.11-1.56
Subsample										
NSA	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
DBT	1.37**	1.20-1.56	1.05	0.88-1.25	1.32**	1.16-1.51	1.39**	1.20-1.61	1.42**	1.24-1.63
LNG	1.36**	1.20-1.54	1.45**	1.19-1.77	1.31**	1.15-1.48	1.49**	1.29-1.73	1.44**	1.24-1.67
Employment										
Full or part-time	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Retired	1.03	0.91-1.16	1.05	0.93-1.19	1.03	0.91-1.17	1.06	0.94-1.21	1.04	0.92-1.18
Home & Other	1.25*	1.04-1.50	1.27*	1.06-1.52	1.25*	1.04-1.50	1.35**	1.12-1.63	1.28**	1.06-1.54
General health										
Excellent	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Very good	1.28*	1.01-1.61	1.28*	1.01-1.61	1.21	0.96-1.53	1.27	0.99-1.61	1.24	0.99-1.57
Good	1.98**	1.57-2.50	1.96**	1.56-2.47	1.81**	1.43-2.30	2.12**	1.67-2.69	1.99**	1.57-2.51
Fair	2.86**	2.24-3.66	2.80**	2.19-3.59	2.68**	2.09-3.44	3.40**	2.64-4.37	2.99**	2.33-3.84
Poor	3.65**	2.76-4.82	3.55**	2.68-4.69	3.49**	2.64-4.62	4.51**	3.40-5.99	3.85**	2.92-5.10
	n=2343; R-square=0.28		n=2343; R-square=0.29		n=2343; R-square=0.29		n=2343; R-square=0.26		n=2343; R-square=0.28	

*a: Exponentiated values of the coefficients estimated in the linear model of the logarithm of the time use (in hours per month); b: or anxiety; ** p<0.01, * p<0.05*

Table 2: Logistic regression model reflecting correlates of heavy time burden – reflected by 30 hours per month on health related activities (without exercise).

Variable	With aggregated number of conditions (linear model 1)		With specific chronic conditions (linear model 2)		With multiple morbidity (linear model 3)		With natural clusters (linear model 4)		With clinically meaningful clusters (linear model 5)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Number of chronic conditions	1.25**	1.18-1.32								
Specific chronic conditions										
Cancer			1.18	0.92-1.52						
Heart disease			1.12	0.85-1.47						
High blood pressure			1.02	0.81-1.29						
Stroke			1.05	0.68-1.64						
Diabetes			2.15**	1.66-2.78						
Renal disease			1.82*	1.14-2.88						
Asthma			1.19	0.92-1.54						
COPD			1.71**	1.29-2.27						
Arthritis			1.07	0.84-1.37						
Osteoporosis			1.56**	1.17-2.07						
Chronic Pain			0.90	0.70-1.19						
Depression (or anxiety)			1.82**	1.41-2.36						
Multiple morbidity										
High blood pressure only					1.00	-				
None of these 12 conditions					0.98	0.32-2.98				
Arthritis only					0.39	0.04-3.46				
All others with one disease only					1.31	0.48-3.54				
High blood pressure and arthritis only					0.67	0.12-3.61				
All others with two diseases only					1.40	0.54-3.65				
All with three diseases only					1.55	0.59-4.08				
All with four diseases only					2.33	0.89-6.14				
All with >four diseases only					3.45*	1.32-9.04				
Natural Clusters										
None of 12 conditions							1.00	-		
Cancer							1.57	0.80-3.06		
Arthritis, osteoporosis and chronic pain							1.27	0.66-2.44		
Heart, high blood pressure , stroke, diabetes & renal disease							1.45	0.77-2.72		
Depression[a]							1.72	0.87-3.38		
Asthma and COPD							1.35	0.68-2.65		
Clinically relevant clusters										
Cancer									1.25	0.97-1.59
Arthritis, osteoporosis and chronic pain									1.33*	1.05-1.69
Heart, high blood pressure , stroke, diabetes & renal disease									1.27	0.98-1.66
Depression[a]									1.72**	1.33-2.23
Asthma and COPD									1.01	0.74-1.38
Number of other chronic diseases			1.36**	1.14-1.61	1.14	0.95-1.36	1.44**	1.22-1.71	1.37**	1.15-1.62
Age	0.98**	0.97-0.99	0.98*	0.97-1.00	0.98**	0.97-0.99	0.98**	0.97-1.00	0.98*	0.97-1.00
Education										
None	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Up to year 12	0.87	0.62-1.23	0.84	0.59-1.18	0.87	0.61-1.22	0.82	0.58-1.15	0.85	0.60-1.19
Trade/Certificate/Diploma	1.18	0.84-1.67	1.12	0.80-1.58	1.15	0.82-1.61	1.10	0.78-1.53	1.14	0.81-1.60
University or more	1.32	0.90-1.95	1.26	0.85-1.86	1.32	0.90-1.94	1.24	0.85-1.82	1.31	0.89-1.93
Subsample										
NSA	1.00	-			1.00	-	1.00	-	1.00	-
DBT	1.49*	1.09-2.03			1.49*	1.09-2.04	1.58**	1.13-2.22	1.67**	1.21-2.28
LNG	1.49**	1.12-1.98			1.47**	1.10-1.96	1.73**	1.25-2.39	1.74**	1.22-2.47
General health										
Excellent	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Very good	1.30	0.57-2.97	1.31	0.57-2.99	1.31	0.57-3.02	1.38	0.60-3.16	1.28	0.56-2.92
Good	2.02	0.91-4.52	2.04	0.91-4.57	1.97	0.87-4.48	2.43*	1.08-5.45	2.09	0.94-4.67
Fair	3.50**	1.55-7.91	3.56**	1.57-8.09	3.47**	1.51-7.98	4.89**	2.16-11.06	3.95**	1.74-8.93
Poor	5.65**	2.42-13.17	5.67**	2.42-13.27	5.70**	2.40-13.44	8.17**	3.50-19.07	6.31**	2.71-14.71
	n=2444; Pseudo R^2=0.13		n=1444; Pseudo R^2=0.14		n=2444; Pseudo R^2=0.13		n=2444; Pseudo R^2=0.11		n=2444; Pseudo R^2=0.12	

*a: or anxiety; ** p<0.01, * p<0.05*

It is important that health care providers are aware of the magnitude of time spent by people with multi-morbidity, and the pressure that further health-related time demands may make of them. Processes that address, for example, better co-ordination of booking consultations, identifying methods for reducing waiting times and improving support for self-management activities can help reduce the heavy burden of time use for people with multiple chronic diseases.

Limitations

The overall sample consisted of three different sub-samples, with response rates in each sub-sample of around 20%, potentially limiting the generalisability of the study. One possible reason for this low response rate is that people with poor health may have been deterred from responding to the survey, and that may under-estimate the real time costs. However, as the analysis undertaken in this paper is essentially regression-based modelling – which includes adjustment for the sub-sample – rather than estimation of prevalence, the impact of response bias on the results should be minimal. To minimise inconvenience to respondents and to extend the period over which the time use could be explored, the study used a recall questionnaire rather than a time use diary. This is a common practice in chronic illness research.[4] Using self-report may be associated with relatively increased prevalence of symptoms-based diseases,[22] and there may have been some influence of cognitive impairment for some participants on the recall of time use.

Our study includes only the most frequently occurring chronic diseases for identifying multimorbid groups. While there were opportunities for respondents to add "other diseases", we may have found more responses about other chronic diseases such as hearing and vision loss had these been explicitly identified. The natural clusters we computed are correlational, and are affected by the number, type and prevalence of comorbid diseases, and can vary with the different set of diseases, so they are specific to a particular setting. Thus, our finding may not be generalisable to other settings with different relative prevalences of chronic diseases, or with larger sets of diseases or more narrowly defined sets of diseases. Moreover, clusters developed using the clinical information on each individual may not outperform dominant diseases in terms of time use.[23] Our study identifies participants who have ever had the identified conditions although the effects on time use of the conditions may be mitigated as some participants (e.g. some cancer patients) may not be under treatment at the time of the survey. Our study does not ask about all time spent as a consequence of the disease, but focuses on time spent to manage the disease. However, the models we have developed here could be used more generally to identify associated time burden.

Conclusions

Time spent on health-related activities by people with chronic diseases can be substantial and this study shows that time use increases with the number of chronic diseases. With the set of diseases tested in this study, neither the natural clusters nor the clinically defined clusters provide a means to identify those facing the highest time demands. However, people with diabetes, osteoporosis, depression and/or asthma are more likely than people without these diseases to report higher time use. Moreover, the first three of these four diseases are associated with a heavy time burden. Better co-ordination among the stakeholders including patients, providers and carers may help reduce the time burden from these older citizens, who face an increasing time burden in parallel with the increasing burden of chronic disease.

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