Multiple chronic conditions: patient characteristics and impacts on quality of life and health expenditures

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ABSTRACT

BACKGROUND: While analyses of health status often focus on a single disease, comprehensive studies of people with multiple chronic conditions – ie comorbidities - are relatively rare. This paper reports on a study of comorbidities carried out under an Australian Research Council grant.

METHODS: We used unit record cross sectional data from national surveys to examine patterns associated with comorbidities (demographic/social characteristics; quality of life; risk factors; severity of activity limitation). Methods used included microdata analysis and statistical techniques (survey non-response, statistical significance, regression analyses).

RESULTS: Comorbidities gradually build up as people age. Over 80% of 60+ year old Australians have three or more chronic conditions. Among these, 83% have at least one National Health Priority Area disease; 33% *less* report being 'delighted' with their life and 160% *more* report feeling 'terrible' than other 60+ year olds. Also, a higher proportion of adults with 3 or more chronic conditions suffer from psychological distress (Kessler score).

Key risk factors affecting comorbidities were age, smoking and obesity; comorbidities limited everyday activities in terms of ability to work, earning capacity and to live independently; and the health care cost of treating people with serious comorbidities was found by earlier researchers to be five times that of other Australians.

CONCLUSIONS: Improved chronic disease prevention - and treatment that slowed the progression of such diseases – have the potential to reduce the incidence and prevalence of comorbidities and thus lead to better quality of life and to lower health care expenditures.

1. Background and Aims

The older people are, the more likely they are to have not only one chronic disease – such as heart disease, cancer, diabetes, arthritis or dementia – but several of these simultaneously. Multiple chronic conditions have been found in the US to be correlated with functional impairments - Oldridge and Stump (2004).[1] They are thus likely to have a major impact on quality of life.

In the literature focus on a single disease is the common practice, with studies considering several of these being relatively rare. While such studies are useful in tracking disease progression and related costs, they are not well suited to analysis of health as it impacts on functionality and quality of life – including people's ability to stay in the labour market, or to live independently. Among the relatively rare studies on comorbidities, it is common to focus on one major chronic disease and study whether or not the patient also has another specific chronic disease at that particular time.

In this paper we define 'comorbidity' as the number of serious chronic diseases a person suffers from at one point in time. Our key aim is to report on a study of comorbidities carried out under an ARC grant (no DP0559650). We first search for a meaningful way to measure the extent of comorbidities, given the publicly availably data. Next we study the characteristics of people with comorbidities, given their age, sex, socioeconomic status and health risk factors and report on their perceived quality of life and psychological stress levels. Finally, refer to estimates in an earlier study of the health care costs of comorbidities.

2. Data and Methods

2.1 Data

We used unit record cross sectional data from national surveys by the Australian Bureau of Statistic's (ABS) to examine patterns associated with comorbidities in terms of demographic/social characteristics; quality of life; risk factors; and severity of activity limitation.

The two main data sources were: the 2001 National Health Survey (NHS01) and the 2003 Survey of Disability, Ageing and Carers (SDAC03). We used the Confidentialised Unit Record Files (CURF) associated with each of these surveys. These are available in either Basic or Extended formats. The Basic form, which we obtained from the ABS on a CD_ROM, focuses on key variables but often with

[1] Based on two major US surveys - the Health and Retirement Survey (HRS; respondents aged 51 to 60 years) and the Assets and Health Dynamics of the Oldest Old study (AHEAD; respondents aged 70 years and older). These authors found that, having heart disease as well as comorbid conditions and poor self assessed health, was significantly correlated with limitations in functionality (such as mobility and activities of daily living).

limited number of sub-classes. On the Extended files there are more variables and some common variables are broken down into a greater number of sub-classes. Extended files can only be queried through the ABS's Remote Access Data Laboratory (RADL). While we examined both formats, for purposes of this paper we mainly used the Basic versions. However, if required at a later date, greater detail could be made available on several of the charts/tables presented in this paper through use of the Extended files. All software prepared for this project was written in the SAS programming language.

National Health Survey, 2001

The NHS01 is a *household* survey, with information obtained by trained interviewers about the health status of Australians, their use of health services and health-related aspects of their lifestyle. It was conducted in 17,918 private dwellings throughout non-sparsely settled areas of Australia, with 26,863 persons fully responding to the survey. The variables of particular relevance to this project included long-term medical conditions (including the National Health Priority Areas), quality of life indicators and lifestyle aspects that may affect health (eg weight, exercise, smoking, alcohol consumption).

Survey of Disability, Ageing and Carers, 2003

SDAC03 surveyed households – with 36,241 responding persons - as well as cared accommodation establishments such as nursing homes - 5,145 responding persons. The survey has detailed information on people with disabilities; older people and carers. Disability is defined – in line with a World Health Organisation classifications – in terms of loss of functionality and the severity of that loss.

SDAC03 variables of particular relevance to this project are whether a person is classified as disabled and the extent to which it involves core activity restrictions (mild, moderate, severe, profound). For example 'mild' disability involves: inability to easily walk 200 metres; or walk up and down stairs without a handrail; or easily bend and pick up an object from the floor; or use public transport. Other variables of interest are the number of long-term conditions the disabled have.

2.2 *Methods*

The main study methods used were microdata analysis and statistical techniques (including survey non-response, statistical significance and regression analyses). Details of each of these techniques are provided in the sections where they are used.

3 Measuring the extent of comorbidities

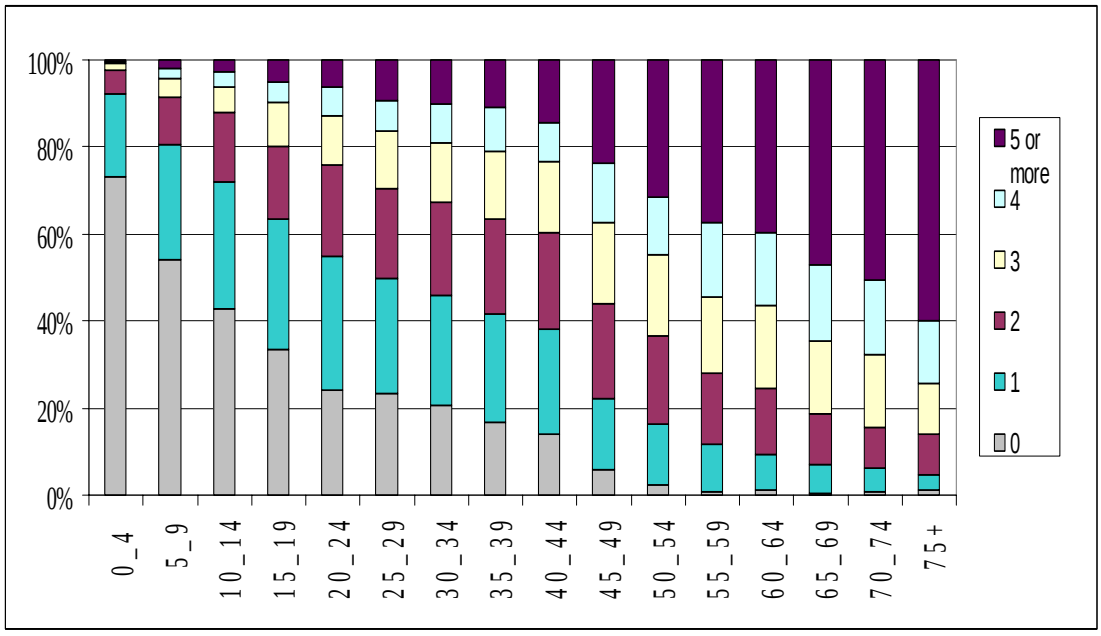
3.1 *Using NHS 2001*

As noted in section 1, for purposes of this project we defined 'comorbidity' as the number of serious chronic conditions a person suffers from at any one point in time.

The NHS01 variable chosen for this study was the number of long-term (LT) conditions. In that survey long term conditions were defined (ABS 2003c) as medical conditions (*illness, injury or disability*) current at the time of the survey which *have lasted at least six months*, or were expected by the respondent to last for six months or more. Although LT conditions were self-reported, ABS 2003c concluded that there was a reasonable likelihood that medical diagnosis would have been made in most cases.

Figure 1 shows that health, measured by the number of LT conditions, deteriorates gradually with age. For example, while in 2001 over half of children aged under 14 had zero LT conditions, nearly all Australians aged 50 years or more had at least one such condition. At the other end of the spectrum, 60% of 75+ year olds had 5 or more LT conditions, compared with only 30% of those aged 50 years or over.

Figure 1: **Per cent of the population by age and number of LT conditions, 2001**



Source: ABS (2003a), Basic version 2.

ABS 2003c states that long term conditions include:

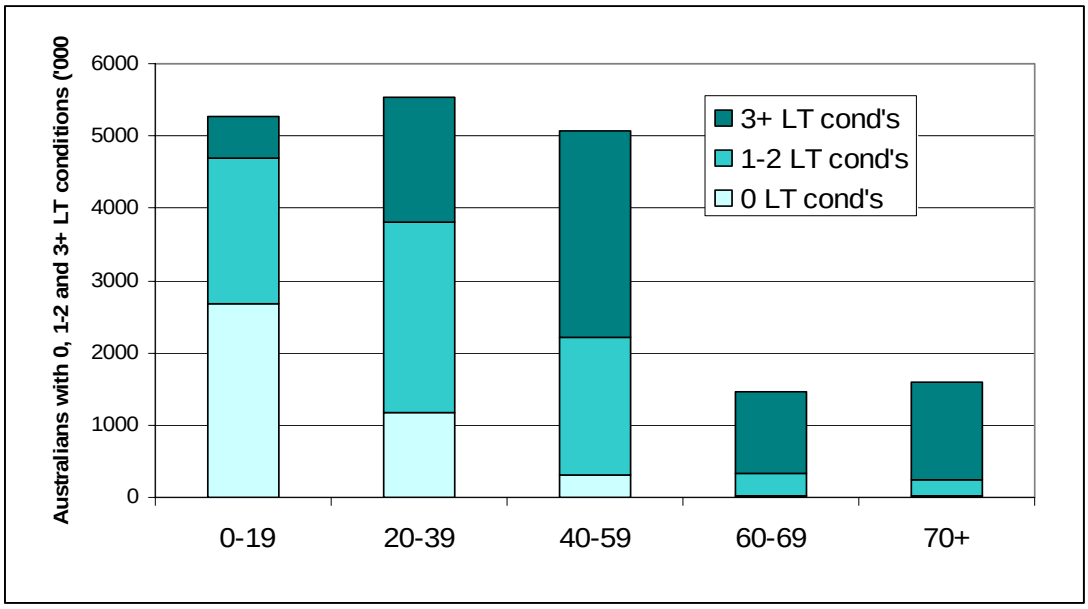
- conditions which may be under control (eg through use of medication);
- conditions which may not be considered 'illness' (e.g. reduced sight); and
- long-term or permanent impairments or disability.

This indicates that, while the focus of this project is on serious chronic diseases, the LT conditions data contains both severe and trivial items (eg cancer versus short-sightedness). We were thus faced with the task of finding some way of separating these two groups. Although attempts are now being made by the ABS to develop a generally agreed list of *serious* long term items (using the World Health Organisation's International Classification of Diseases, ICD10), in the absence of such a list we searched for an alternative solution.

First we examined the LT condition patterns by groupings these into people who had 0 or 1-2 conditions and those with 3+ LT conditions. The hypothesis to be tested was that the 0-2 group would mainly have trivial conditions, while serious illnesses would be prominent in the 3+ group. Because of the gradual deterioration of health over the life course, in Figure 2 we disaggregated these patterns by broad age groups - children (0-19), younger working aged (20-39); older working aged (40-59); the younger retired (60-69); and the older retired (70+). Across all ages 60% of Australians were found to have 0-2 LT conditions and 40% three or more such conditions.

Figure 2 shows – as did Figure 1 - that the older people are, the more likely they are to have three or more LT conditions. In particular, the vast majority of 60+ year olds were found to have at least three LT conditions (70% of 60-69 year olds and 85% of 70+ year olds).

Figure 2: **Number of persons with none, 1--2 and 3+ LT conditions by age, 2001** (‘000)



Source: ABS (2003a), Basic version 2.

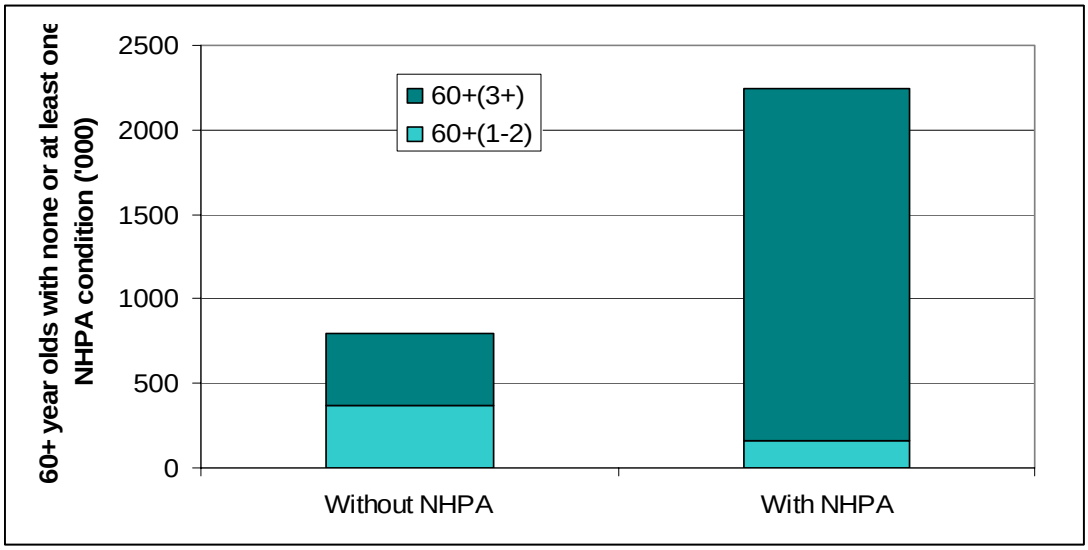
This suggested that, at least initially, it was worth focussing on the 60+ age group in our examination of serious chronic conditions.

As a second step, taking the 60+ group, we searched for a relationship between the number of LT conditions and the diseases listed under the National Health Priority Areas (NHPAs) – which, as at May 2005 were Arthritis and musculoskeletal conditions; Asthma; Cancer; Cardiovascular health; Diabetes mellitus; Injury prevention and control; and Mental health.[2] Because these have been selected for NHPA status, these conditions are generally seen as being ‘serious’.

[2] In the NHS 2001 the ABS has made an effort to separately identify each NHPA. Identification was not clear-cut because (a) the government’s NHPA documents did not define ICD10 codes for the NHPAs and (b) the NHS data were self-reported – with connection to ICD codes being made by the ABS after the survey interviews.

Figure 3 charts the number of persons with NHPA diseases among 60+ year olds with 1-2 LT conditions (as those with zero LT conditions would clearly also have zero NHPA conditions) and with 3+ LT conditions. The key finding from that Figure is that the vast majority (83%) of 60+ year olds with 3+ LT conditions have at least one NHPA disease – and thus can be considered to be seriously ill. Among 60+ year olds with 1-2 LT conditions this proportion is much lower (31%).

Figure 3: **Number of 60+ year olds with none or at least one NHPA disease: 1-2* and 3+ LT conditions, 2001** ('000 persons)



* 60+ year olds with zero LT conditions were not they account for < 1% of all 60+ yo-s
Source: ABS (2003a), Basic version 2.

Two main *conclusions* can be drawn from these NHS01-based analyses:

- comorbidities gradually develop and progress to more serious stages as people age, becoming a concern for the majority of 60+ year olds; and
- the 'number of LT conditions' variable in NHS01 can not only be used to measure the prevalence of comorbidities within age groups but, for 60+ year olds, it can also be used to separate those with mostly serious LT conditions from those with mainly trivial LT conditions.

Based on these analyses, we conclude that it is appropriate to use the NHS-s 'LT conditions' variable to indicate comorbidities – with those groups that have 3 or more LT conditions on average to be classified as having several non-trivial chronic diseases.

3.2 *Using SDAC 2003*

An additional approach re the question of severity is to focus on those 20% of Australians who have a disability (ABS 2004c). In SDAC 2003 the definition of 'LT conditions' is the same as in NHS 2001 (ABS, 2004b), except that it is only collected for the disabled (advice to author by ABS SDAC staff). By definition, disability impairs functionality, with the impairment having been classified into mild, moderate, severe and profound groupings. Because among older Australians disability tends to be due to chronic diseases (Walker and Becker 2005), additional insights into the

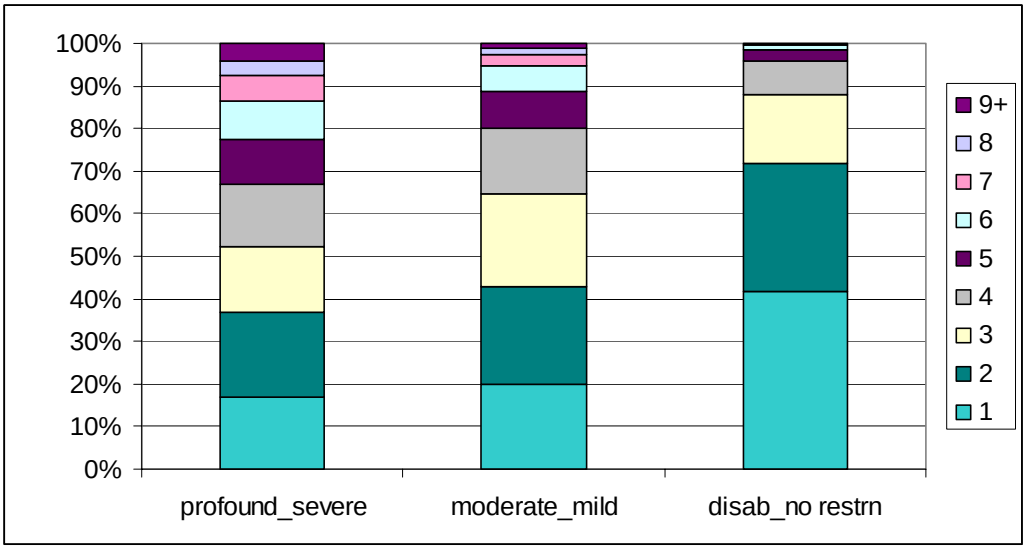
severe end of the comorbidity spectrum could be gained by studying the number of LT conditions in disabled groups at various stages of severity.

Figure 4 charts proportions among three disabled groups by 1 to 9 or more LT conditions:

- those with severe or profound restrictions in everyday activities (very few of whom are able participate in the labour force);
- those with mild or moderate restrictions (eg cannot easily walk 200 metres or go up-down stairs); and
- those disabled but not restricted in everyday activities.

Figure 4 shows a strong association between comorbidity (measured as number of LT conditions) and severity of disability (measured as loss of functionality). While over 70% of the disabled who were not restricted in everyday activities only had 1 or 2 LT conditions, this proportion fell to around 40% among those experiencing restrictions. At the other end of the spectrum, while nearly all of the disabled without restrictions had four or less LT conditions, over 20% of those with severe or profound restriction have 6, 7, 8 or 9+ such conditions.

Figure 4: **Per cent disabled with 1 to 9 or more LT conditions, 2003**



Source: ABS (2004a), Basic version.

The main ***conclusions*** from this analysis are that comorbidities are strongly associated with loss of functionality (eg ability to participate in the labour force or to live independently), and that the greater the extent of comorbidities, the greater is the loss of functionality.

4 Impact of comorbidities on quality of life

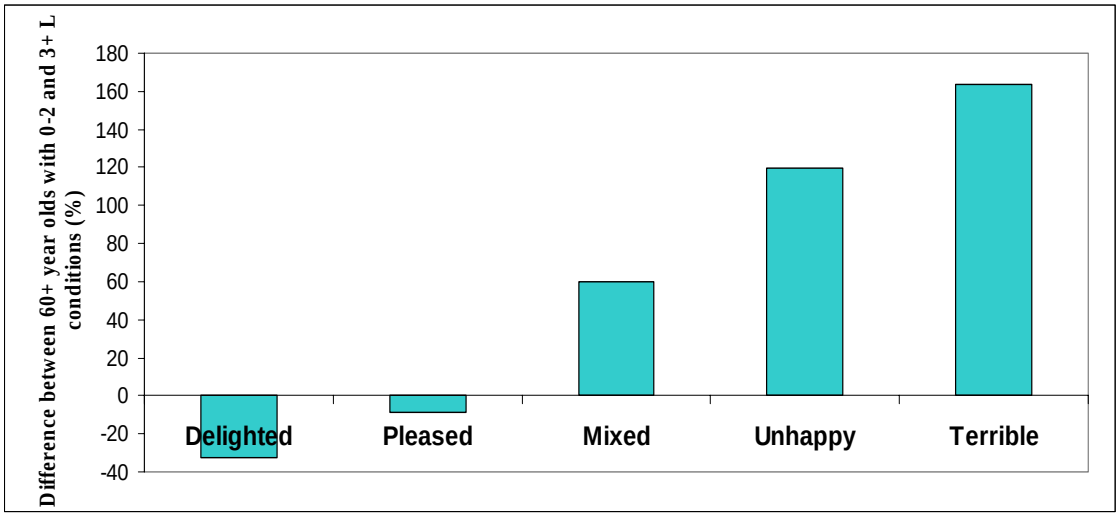
Based on the above findings it is likely that in Australia – as in the US (section 1) - comorbidity is also associated with lower quality of life.

This possibility was examined using NHS 2001. That year's NHS was exceptional in that it contained two indicators of quality of life:

- one which asked respondents aged 18 years or over whether they felt 'Delighted'; 'Pleased or mostly satisfied'; 'Mixed'; 'Mostly dissatisfied or unhappy'; or 'Terrible' about their lives;[3] and
- the Kessler score of psychological distress (K10), also for persons aged 18 years or over.

Using the first of the above quality of life indicators we found that, in general, the higher the number of LT conditions an individual had, the less satisfied he/she was with life. This is illustrated in Figure 5 for 60+ year olds. The chart shows that among those with three or more LT conditions 33% less said they were 'delighted' with their lives, and 160% more said they felt 'terrible', than amongst 60+ year olds with two or less such conditions. A striking feature of the chart is that the differences in life satisfaction between the 0-2 and 3+ groups are very much greater at the 'feeling terrible' end of the spectrum than at the delighted/pleased end. This suggests that comorbidities tend to have a negative impact on quality of life.

Figure 5: **Difference between 60+ year olds with 0-2 and with 3+ LT conditions by quality of life indicator, 2001** (%)



Source: ABS (2003a), Basic version 2.
NOTE: the smallest data cell was for those with 0-2 LT conditions who said they felt 'terrible' (2,956 weighted observations).

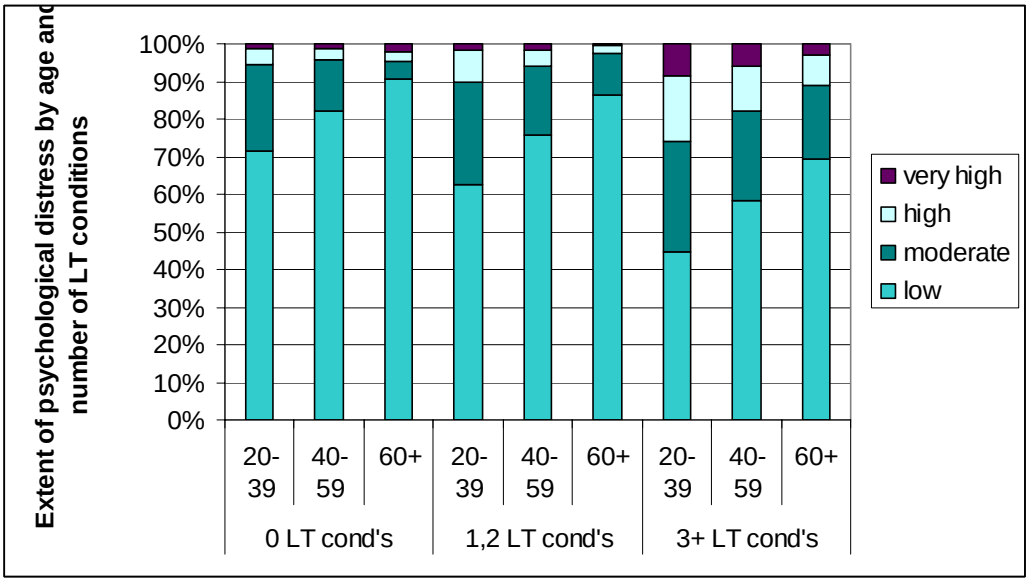
The second indicator, the *K10* score, was constructed from responses to questions about negative emotional states. We re-grouped these the same way as the Bureau did in ABS (2002):

- *low* (scores of 10 to 15 indicating little or no psychological distress);
- *moderate* (scores of 16 to 21);
- *high* (scores of 22 to 29);
- *very high* (scores of 30 to 50 – with this group likely to need professional help).

[3] The question asked was: "How do you feel about your life as a whole, taking into account what has happened in the last year, and what you expect to happen in the future?"

Figure 6 charts these K10 groupings by age and by 0, 1-2 and 3+ LT conditions. It shows that, within each age group, the higher the number of LT conditions, the greater the level of psychological distress. Taking as an example the 60+ age group (which was the subject of Figure 5), It also shows that 90% of those with no LT condition had low psychological distress, with this proportion declining to 86% for 60+year olds with 1-2 conditions and to 70% for those with 3+ conditions.

Figure 6: **Extent of psychological distress (K10) by age and 0, 1-2 or 3+ LT conditions, 2001** (%)



Source: ABS (2003a), Basic version 2.

As expected, at the other end of the spectrum the chart shows an increase for the 3+ group in the proportions with very high distress. This pattern is particularly pronounced for 20-39 year olds, no doubt because of the much greater importance of 'ability to work' to younger people than to 60+ year olds - many of the latter no longer having dependent children, having the option to retire and to rely financially on the assets they accumulated during their working lives.

5 Comorbidities and health risk factors

In this section we use NHS01 data to assess the relative importance of the various risk factors that have an influence on the number of chronic diseases an individual has. Data on risk factors have only been collected for persons aged 18 years or more. As usual with these types of cross sectional studies, the analyses concern statistical associations only and cannot be interpreted as causation. That is we cannot tell, for example, whether it was obesity that caused the disabling chronic condition, or whether it was loss of ability to exercise - due to the chronic disease - that caused the obesity.

For people aged 20 years or above, we expressed, , the number of LT conditions as a function of age, body mass index (BMI), alcohol consumption, tobacco smoking and socioeceonomic status (SES).

We estimated the following multiple regression equation using the PROC REG function of the SAS programming language:

NUMLTC = constant + a***AGE** + b***BMIr** + c***ALC** + d***SMOKE** + e***SES**

with:

NUMLTC: the NHS01 'number of LT conditions' variable (0,1,2,3,4 or 5+ LT conditions)

AGE: the NHS01 age variable at 5-year intervals between 20 and 74 years, and then 75+

BMIr: the NHS01 body mass index variable ('Thin1' (BMI <15.99), 'Thin2' (16.00 to 16.99) and 'Thin3' (17.00 to18.49); 'Normal1' (18.50 to 19.99) and 'Normal2' (20.00 to 24.99); 'Overweight 1' (25.00 to 29.99); 'Overweight 2 ' (30.00 to 39.99) and 'Overweight 3'(BMI>=40) – (1,2,3,4,5,6,7,8)

ALC: the NHS01 ALCRISK2 (new) variable which measures alcohol risk levels over 7 days, re-grouped into 'No risk', 'Low risk', 'Medium risk' and 'High risk' categories (1,2,3,4)

SMOKE: the NHS01 SMOKSTAT variable re-grouped into 'never smoked regularly' and 'regular current or ex smoker' (1,2)

SES: SEIFA quintiles (1,2,3,4,5, with SES 1 being the most disadvantaged quintile)

We examined the possibility of survey non-response, and found that it was a problem for only the BMI variable and for income-based indicators of SES. To overcome the problem of considerable non-response for the NHS01 income variables, we used the geographic area-based Socioeconomic Index for Areas (SEIFA) as indicator of SES. Among the SEIFAs, we chose the Index of Relative Socioeconomic Disadvantage, because it is the one developed for studying socioeconomic inequalities. However, geographic area-based indicators have been shown to considerably flatten the inequality gradient and thus underestimate relative to income-based indicators the extent of health inequalities by socio-economic status (Walker and Becker 2005).

Regarding the 7% of the population aged 20+ years or over with BMI "not stated", we first noted that close to half of that sub-population had 'normal1 or 2' BMI (46.5%) and 37% had an 'Overweight 1' BMI. So that we could keep these "not stated" records in the micro-dataset without introducing excessive bias, we then randomly allocated 'normal' BMI to half of the "not stated" records (in equal proportions to 'normal'-s 1 and 2), and Overweight 1' BMI to the other half.

Regression outputs for the above equation are presented in Table 1 for men and for women. Most results weare highly significant statistically (at the 0.001 level), which is expected given the large sample size (just over 17,450 non-weighted records for 20+ year olds).

Although we experimented with other model specifications and variable sub-groupings, we chose the above equation because it provided the best fit in terms of R-square values and statistical significance. Even with this best fit specification the R-square values were low, suggesting that there were other important variables affecting comorbidities. One important and obvious such factor is heredity. It could not be accounted for in the regression equation because there is no quantifiable information on it in the NHS01.

For both men and women the overall model fit and the coefficients for age, BMI, and smoking were significant at the 0.001 level (with the coefficients for alcohol consumption and socioeconomic status not statistically significant).

Table 1**: Multiple regressions of the 'number of LT conditions' for persons aged 20 years or over, 2001**

	Coefficients – MEN*			**Coefficients – WOMEN***		
Intercept	-2.88*	(0.150)	[0.277]	-2.12*	(0.127)	[0.215]
AGE -a	0.27*	(0.005)		0.23*	(0.005)	
BMIr -b	0.12*	(0.020)		0.15*	(0.015)	
Alcohol consumption-c	0.014	(0.021)		0.040	(0.023)	
Smoking -d	0.17*	(0.034)		0.18*	(0.032)	
SEIFA quintile -e	-0.008	(0.007)		-0.011	(0.007)	

NOTE: Coefficients marked with * are significant at the 0.001 level. Figures in brackets are standard errors and figures in square brackets R-square values.

Based on the magnitude of the related coefficient, the three *most important risk factors* affecting the extent of comorbidities in 20+ year old men and women were '*age*', '*smoking*' and '*BMrI*', in that order. The magnitudes of the coefficients were similar for both sexes, with age somewhat more important for men than for women (no doubt reflecting men's lower life expectancies), and BMIr being somewhat more important for women than for men. By comparison, the effects of alcohol consumption and of socioeconomic status were very small (and, as seen earlier, not statistically significant). As expected, the sign of the SES coefficient was negative because in our database better-off Australians have higher values of SES, and thus less comobidities, than the lower value more disadvantaged SES groups. As noted earlier, had it been possible to indicate SES using an income-based measure, the contribution of socio-economic status would have been somewhat greater.

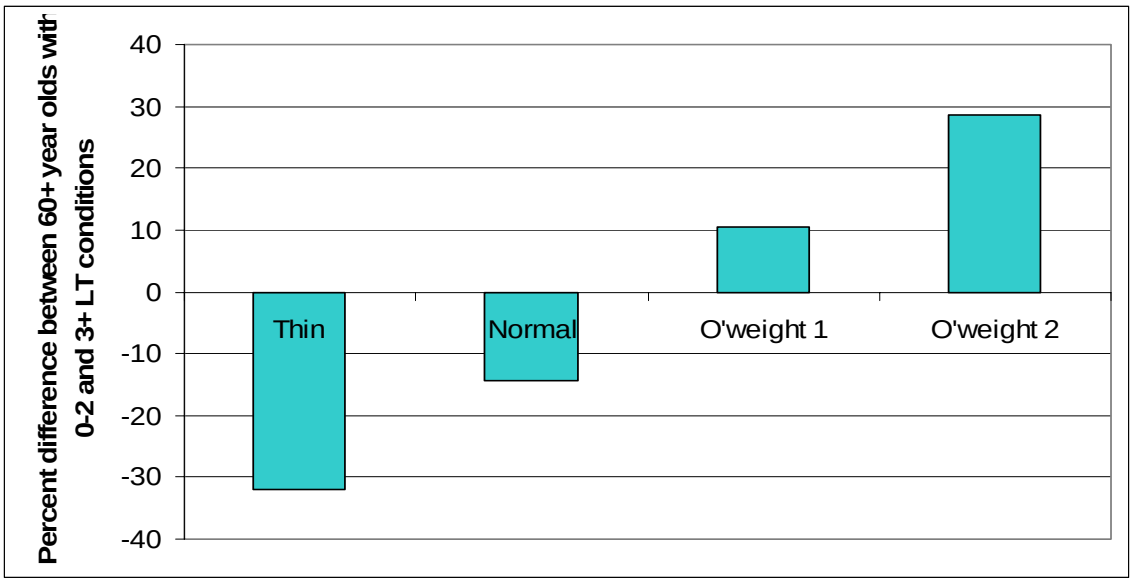
Regarding risk factors, it is important to note that while their impact on health is known to be cumulative over the life course, it is only for smoking that the NHS01 as data on past risk factor status (ie ex regular smoker). Thus the ranking for smoking in Table 1 is higher than what it would have been had data on respondents' BMI and drinking histories been also available. In view of this, and the rapidly increasing prevalence obesity, the findings for BMI are probably the ones with greatese policy relevance.

Because high BMI is more prevalent amongst the old than the young, in Figure 7 we charted its impact among 60+ year olds. For the BMI variable used in this Figure we merged the original two 'thin' and two 'normal' categories (described above for the regression BMIr variable) into one, and combined the 'Overweight 2 and 3' variables into a single O'weight 2' category.

Figure 7 shows that comorbidities are more likely to be a problem for overweight 60+ year olds than for others in the same age group. While a *lower* proportion of 'Thin' and 'Normal' BMI 60+ year olds had 3+ LT conditions relative to those with 0-2 conditions (32%), the direction of this difference was reversed for overweight people in that age group - with 10% *more* with 3+ LT than with 0-2 LT conditions for the O'weight1 group, and 29% *more* for the O'weight2 group. Thus, the more overweight

people were, the greater was the proportion with 3+ LT conditions relative to the proportion with 0-2 conditions.

Figure 7: **Difference between the proportions of 60+ year olds with 0-2 and with 3+ LT conditions by BMI** (%)



Source: 2001 NHS CURF (Basic version 2)

6 Comorbidities and health care costs

Most data on the costs of treating people with chronic diseases focus on a single disease – more commonly one that is part of the government's National Health Priority Areas (NHPAs). To obtain some estimates of health care costs for people with multiple chronic diseases, linked administrative data was required – such linking having been found to be highly complex and time-consuming.

Using such a linked dataset, earlier researchers found that the health care *cost of treating people with comorbidities was five times that of other Australians* - Department of Health and Aged Care (2002). They also found that the cost of treating people with an NHPA condition was nearly six times the cost of treating people with other medical problems. This indicates the importance of serious chronic diseases in health expenditure terms.

At the single chronic disease level, these researchers found that in the late 1990s the most costly NHPA area was cardiovascular disease ($4,006 per person on average) followed by cancer ($2,478 per person), asthma ($1,502 per person) and diabetes ($1,289 per person).

The same document also considered comorbidity involving two NHPA conditions. For those with cancer and cardiovascular disease they estimated the health care cost to be $8,526 per person on average, and for diabetes and mental health $2,738 per person.

In terms of comorbidity involving more than two NHPA conditions, the most expensive combination of three conditions was cancer, cardiovascular disease and mental health with a cost of $10,090 per person on average. The costs for people with four and five NHPA conditions were $12,405 and $14,337 per person on average respectively.

Overall, initiatives to reduce the number of LT conditions people have, or to slow the rate at which they accumulate, has the potential to significantly reduce the health care costs being spent on people with multiple chronic diseases.

3. Conclusions/Discussion

In this paper we used two national unit record datasets – NHS01 and SDAC03 – to analyse the characteristics of persons with multiple chronic diseases (ie with comorbidities). We found that:

- in both surveys the number of long-term conditions people had was a useful indicator of the extent of comorbidities, with distinct differences between persons with none, 1 or 2, and 3 or more of such conditions;
- the older people were, the more likely they were to have three or more LT conditions (70% of 60-69 year olds and 85% of 70+ year olds in 2001);
- the vast majority (83%) of 60+ year olds with 3+ LT conditions have at least one NHPA disease – and thus can be considered to be seriously ill;
- comorbidities tended to have a strong negative impact on quality of life – with 33% less 60+ year olds with three or more LT conditions saying that they were 'delighted' with their lives, and 160% more saying that they felt 'terrible', than 60+ year olds with two or less such conditions;
- comorbidities were found to be strongly associated with loss of functionality (eg ability to participate in the labour force or to live independently);
- body mass index – ie the effect of diet and exercise combined – and cigarette smoking were found to be important risk factors for having multiple chronic diseases; and
- the average per person health cost increased considerably with the number of serious chronic conditions people had (from $4006 in the late 1990s for a person with cardiovascular disease (CVD) only; to $10,090 for those with CVD, cancer and mental illness; and to $14,337 for people with five NHPA conditions).

Our efforts to develop an income-based socio-economic status did not provide satisfactory results due to survey non-response. However, this area is worth further consideration in future, should data quality improve. The comorbidity related results obtained from the household-based NHS01 are likely to be underestimates because in household surveys people in institutions (eg the really sick in nursing homes) are not surveyed. Also, our regression analyses re the relative importance of health risk factors could be improved in future if comparable data on *past* patterns of obesity and of alcohol consumption became available. If feasible, consideration of a quantifiable index of heredity is also likely to lead to considerable improvements.

Overall, improved chronic disease prevention, and treatment that slowed the progression of such diseases, have the potential to reduce the incidence and prevalence of comorbidities and thus lead to significantly improved quality of life and lower health care expenditures.

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