Chronic Health Conditions: Changing Prevalence in an Aging Population and Some Implications for the Delivery of Health Care Services*

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RÉSUMÉ

Parce que la prévalence de nombreuses conditions de santé chroniques augmente avec l'âge, nous pourrions anticiper que la proportion montrant une ou plusieurs de ces conditions, ainsi que les frais de traitement, augmenterait comme le vieillissement de la population. Combien la prévalence globale des affections chroniques augmenteraient en un quart de siècle si l'âge spécifiques des taux de prévalence n'ont pas changé? Les taux de prévalence globaux pour presque toutes les conditions qui découlent principalement de la vieillesse augmenteraient de plus de 25 pour cent, et les exigences en matière de santé auraient cru plus rapidement que la population – plus de deux fois plus rapidement dans le cas des séjours hospitaliers – si les taux pour chaque groupe d'âge sont restés constants. Combien serait requise pour l'augmentation des ressources de santé? Quelle différence rendrait-il à ces exigences si les gens avaient moins de maladies chroniques? Même de réductions modestes dans le nombre moyen de conditions à chaque âge pourraient entraîner des économies importantes.

ABSTRACT

Since the prevalence of many chronic health conditions increases with age, we might anticipate that as the population ages the proportion with one or more such conditions, and the cost of treatment, would rise. How much would the overall prevalence of chronic conditions increase in a quarter century if age-specific rates of prevalence did not change? How much would the requirements for health care resources increase? How much difference would it make to those requirements if people had fewer chronic conditions? The overall prevalence rates for almost all conditions associated mostly with old age would rise by more than 25 per cent, and health care requirements would grow more rapidly than the population – more than twice as rapidly in the case of hospital stays – if the rates for each age group remained constant. Even modest reductions in the average number of conditions at each age could result in substantial savings.

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Introduction

The World Health Organization (WHO, n.d.) projected that chronic diseases would account for 89 per cent of all deaths in Canada in 2005. Since the prevalence of many chronic health conditions increases with age, we might anticipate that as the population ages there will be a rise in the proportion with one or more such conditions, and that their treatment will make increasing

demands on the health care system. In the words of Epping-Jordan, Pruitt, Bengoa, and Wagner (2004, p. 299), "Chronic conditions are increasingly the primary concern of health care systems". Such considerations led us to ask three questions: How much would the overall prevalence of chronic conditions increase in the next quarter century if age-specific rates of prevalence did not change? How much would the requirements for health care resources increase in those circumstances? And, finally, how much difference would it make to those requirements if people had fewer chronic conditions?

In this article, we note that there is no generally accepted definition of the term *chronic condition* and that measures of prevalence vary widely. We present measures based on one recent survey to show how prevalence varies by age for a wide variety of conditions that are defined as *chronic* in that survey. We also consider how the population-wide prevalence rates for those conditions will change over the next quarter century in consequence of projected changes in age distribution, all other things being equal.

As people age, it is not uncommon for them to have more than one chronic condition, and, as we have documented, the use of health care resources tends to increase not only with age but also with number of conditions. In the work we report on here, we explored that relationship further, providing projections of future requirements for selected health care services, and assessing the impact that a hypothetical reduction in the number of chronic conditions per capita would have on the use of health care resources.

Prevalence of Chronic Conditions

Many definitions of *chronic conditions* appear in the literature. For example,

> "A chronic condition is … one that lasts or is expected to last a year or longer, limits what one can do, and may require ongoing care. …" (John Hopkins Bloomberg School of Public Health; http://www.partnershipforsolutions.org/problem/index.html

> "one lasting 3 months or more" … adding that "Chronic diseases generally cannot be prevented by vaccines or cured by medication, nor do they just disappear." (MedicineNet website; http://www.medicinenet.com/script/main/art.asp?articlekey=2728, quoting the U.S. National Center for Health Statistics)

> "[any] long-term health conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional." (Gilmour & Park, 2005, p. 26)

Such proliferation of definitions has led O'Halloran, Miller, and Britt (2004) to observe that "With the in-

creasing prevalence of chronic conditions, there is need for a standardized definition of chronicity for use in research, to evaluate the population prevalence and general practice management of chronic conditions" (p. 381). That conclusion was echoed by van der Lee, Mokkink, Grootenhuis, Heymans, and Offringa (2007) who reported "… wide variability in reported prevalence rates, surprisingly enough, from *0.2 to 44.0 percent*" [italics added] for chronic conditions in childhood, and conclude that "… international consensus about the conceptual definition of chronic health conditions … is needed" (p. 2741).

It is thus evident that definitions vary widely and that reported prevalence rates are extremely sensitive to what is measured and how the measurement is taken. Researchers are at the mercy of (and limited by) available survey data. Not withstanding the concerns, we found it informative to use the Statistics Canada *Canadian Community Health Survey* (CCHS) to investigate age prevalence patterns for a range of chronic conditions and to explore the implications for health care utilization. We used the confidential master file for CCHS cycle 3, which relates to the year 2005. The survey sampled approximately 130,000 individuals in the period January to December of 2005. The target population was persons aged 12 years or older living in private dwellings in the 10 provinces and three territories. Persons living on Indian Reserves or Crown lands, residents of institutions, full-time members of the Canadian Armed Forces and residents of certain remote regions were excluded from the survey. The CCHS covered approximately 98 per cent of the Canadian population aged 12 or older. Both personal and telephone interviews were conducted, using computer-assisted interviewing software.[1] The questionnaire presented to respondents contained the following statement:

> Now I'd like to ask about certain chronic health conditions which you may have. We are interested in "long-term conditions" which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional.

The questionnaire then proceeded through a checklist of conditions which Statistics Canada defined as *chronic*. The conditions were generally similar to those identified in population health surveys elsewhere, but we note that the checklist itself has varied somewhat, even from one Statistics Canada survey to another, and that the choice of what to include appeared to reflect the result of interdepartmental negotiations as much as a set of coherent principles. Nonetheless, in the work described in this article we worked with the conditions defined as chronic in CCHS cycle 3.

Table 1 shows prevalence rates in broad age groups for each of 32 conditions identified as chronic in the

Table 1: Prevalence of chronic conditions by age group, 2005

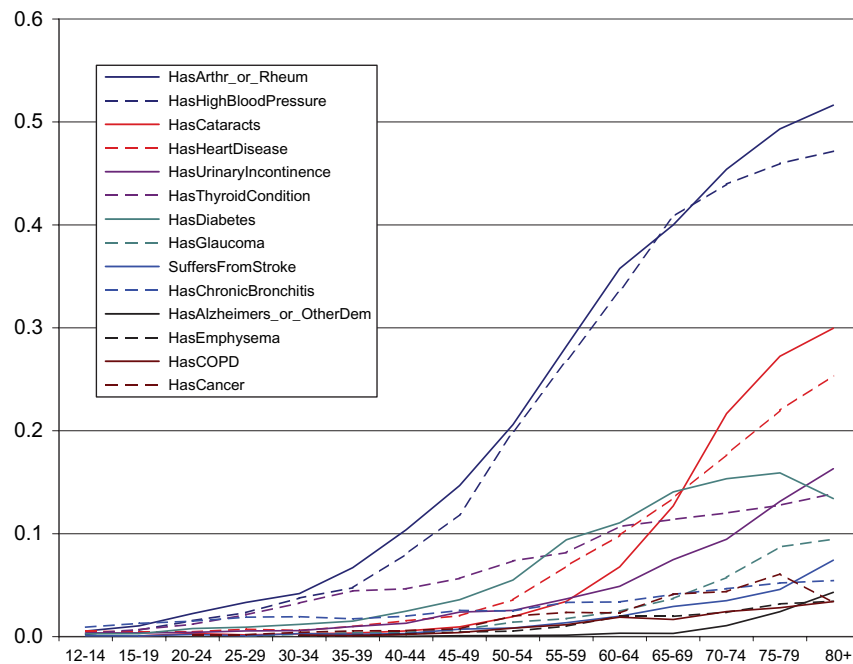| Condition	Prevalence Rate (%)						Relative Prevalence				
	12–29	30–49	50–64	65–79	80+	All ages	12–29	30–49	50–64	65–79	80+
Has Alzheimer's or other dementia	0.0	0.1	0.2	1.1	4.3	0.3	0.3	1.0	3.2	19.4	74.3
Has cataracts	0.2	0.5	3.8	19.6	30.0	4.2	0.3	1.0	6.9	35.7	54.6
Has glaucoma	0.0	0.4	1.8	5.7	9.5	1.5	0.1	1.0	4.1	13.1	21.7
Has heart disease	0.5	1.3	6.4	17.1	25.3	4.7	0.4	1.0	4.8	12.8	18.9
Suffers from stroke	0.1	0.4	1.3	3.6	7.4	1.1	0.3	1.0	3.3	9.0	18.8
Has COPD	0.0	0.2	1.2	2.2	3.4	0.7	0.0	1.0	5.5	10.0	15.2
Has emphysema	0.0	0.2	1.1	2.4	3.4	0.7	0.0	1.0	4.6	10.3	14.6
Has urinary incontinence	0.4	1.4	3.6	9.6	16.3	3.0	0.3	1.0	2.6	7.1	12.0
Has cancer	0.1	0.5	2.1	4.6	5.7	1.4	0.2	1.0	4.2	9.3	11.4
Has high blood pressure	1.3	7.3	26.0	43.2	47.2	14.9	0.2	1.0	3.5	5.9	6.4
Has diabetes	0.6	2.3	8.3	15.0	13.4	4.9	0.3	1.0	3.7	6.6	5.9
Has arthritis or rheumatism	1.9	9.3	27.3	44.3	51.6	16.4	0.2	1.0	2.9	4.8	5.5
Has thyroid condition	1.2	4.6	8.5	12.0	13.9	5.6	0.3	1.0	1.9	2.6	3.0
Has chronic bronchitis	1.5	2.1	3.0	4.6	5.4	2.5	0.7	1.0	1.5	2.2	2.6
Has bowel disorder	1.9	4.1	4.9	5.2	6.6	3.9	0.5	1.0	1.2	1.2	1.6
Has stomach or intestinal ulcers	1.6	3.1	4.1	4.7	4.8	3.1	0.5	1.0	1.3	1.5	1.5
Other long-term condition	7.1	12.1	17.0	17.9	17.9	12.6	0.6	1.0	1.4	1.5	1.5
Has chronic fatigue syndrome	0.4	1.2	1.9	1.8	1.6	1.2	0.3	1.0	1.6	1.5	1.3
Has back problems	10.6	19.9	24.7	23.1	23.6	18.8	0.5	1.0	1.2	1.2	1.2
Has fibromyalgia	0.2	1.4	2.8	2.1	1.5	1.4	0.1	1.0	2.1	1.6	1.1
Has food allergies	7.4	7.4	7.3	6.6	6.5	7.2	1.0	1.0	1.0	0.9	0.9
Suffers from multiple chemical sensitivities	1.0	2.2	3.5	3.1	1.9	2.2	0.4	1.0	1.6	1.4	0.9
Has autism or other developmental diseases	0.6	0.2	0.1	0.1	0.2	0.3	3.6	1.0	0.5	0.3	0.9
Has asthma	10.6	7.5	7.2	7.7	6.4	8.3	1.4	1.0	1.0	1.0	0.9
Has non-food allergies	28.4	27.2	26.5	23.0	19.1	26.6	1.0	1.0	1.0	0.8	0.7
Has epilepsy	0.5	0.6	0.7	0.5	0.4	0.6	0.8	1.0	1.0	0.8	0.7
Has mood disorder	4.2	6.5	6.8	4.3	4.0	5.6	0.7	1.0	1.1	0.7	0.6
Has eating disorder	0.7	0.4	0.3	0.2	0.2	0.4	1.8	1.0	0.7	0.7	0.6
Has anxiety disorder	3.9	4.8	5.1	3.6	2.2	4.4	0.8	1.0	1.1	0.7	0.5
Has schizophrenia	0.1	0.4	0.4	0.1	0.1	0.3	0.3	1.0	1.1	0.3	0.3
Has learning disability	5.5	2.1	1.5	0.9	0.6	2.8	2.6	1.0	0.7	0.4	0.3
Has migraine headaches	10.7	13.3	10.0	4.6	3.0	10.5	0.8	1.0	0.8	0.3	0.2
Has chronic condition	54.5	64.8	79.3	90.0	93.3	68.7	0.8	1.0	1.2	1.4	1.4

Note. **This tabulation was prepared in the Statistics Canada Research Data Centre at McMaster University. It is based on the master file of the Canadian Community Health Survey, Cycle 3.1. Observations have been weighted to provide estimates for the target population for the Survey.**

survey. They are ordered in terms of prevalence in the oldest age group (80 and older) relative to those in the age group 30 to 49. For the 14 conditions in the upper panel, the relative prevalence rates exceed two; it is evident from the table and from Figure 1 that these are conditions whose prevalence increases strongly with age. In the lower panel are 18 conditions less strongly associated with age.[2] In cases such as autism and learning disability, the age relationship is reversed. We might speculate that relative prevalence rates less than 1.0 are the result of lower survival rates for some such cases.[3]

The overall prevalence rates are reported in the bottom line of the table ("has chronic condition"). They may seem high – more than two thirds of the population over the age of 12 reported having a chronic condition, and more than 90 per cent of those over the age of 65. However, similar numbers have been reported in various studies in the U.S.,[4] although the set of conditions included differed from one study to another. (As one example, "hearing impairment" was included as a chronic condition in the U.S. survey referred to in Note 5, but not in CCHS cycle 3.)

The overall prevalence rates were affected by the age distribution of the population as it was in 2005. Given that distribution, the highest all-age rates were for non-food allergies (26.6% of the population) and back problems (18.8%), two chronic conditions that were not

Figure 1: Prevalence rates for chronic conditions associated with old age, 2005

concentrated at older ages but instead occurred in about the same proportions at most ages. Next in line were arthritis or rheumatism (16.4%) and high blood pressure (14.9%), both of which were about six times more likely to be present among those 80 and older than those 30 to 49. Most of the other conditions affected much smaller proportions of the population.

Of the 14 that were concentrated at older ages, arthritis/rheumatism and high blood pressure each affected about half the population aged 80 and older, cataracts and heart disease more than a quarter each, and urinary incontinence, thyroid problems, and diabetes more than an eighth. There were nine conditions for which the *relative* prevalence rates for the age group 80 and older exceeded 10. Each of the first nine conditions listed in Table 1 was more than 10 times as prevalent among those in the oldest age group as among those aged 30 to 49 and more than seven times more prevalent even among those aged 65 to 79. Overall, and not surprisingly, chronic conditions thus exhibited very strong age patterns.

Two general observations of a qualifying nature are in order. First, the prevalence rates related to the survey target population rather than to the entire population. Of particular importance for measuring the prevalence of chronic conditions was the exclusion of residents of institutions. Since such institutions include nursing homes and other long-term care facilities, the exclusion related to a segment of the population especially likely to experience multiple chronic conditions. This restric-

tion of our analysis is regrettable because it means that the prevalence rates reported in Table 1 no doubt under-estimate the rates for the population as a whole and especially for older age groups. As an important example, the prevalence rate of 4.3 per cent for Alzheimer's disease or other dementia for those 80 and older would undoubtedly be much higher if residents of long-term care facilities were included. Without appropriate survey information, we were unable to estimate how much higher.[5]

The second qualifying observation is that the classification itself provided no indication of the severity of the conditions identified.[6] Thus, for example, while 30 per cent of the population 80 and older reported having cataracts at the time of the survey, we might expect that many of them could benefit from surgery and, in time, would not continue to have the problem. As a further example, a few months after the survey some of those who reported having cancer might have been free of symptoms, and possibly cured, while others would have died from the disease. Persons 80 and older are of course those who survived to that age, and their prevalence rates do not reflect the fact that chronic disease may have caused others to die at younger ages.

Projection of Prevalence Rates for Chronic Conditions

We turn now to the future. The expectation is that, as the large baby boom cohort moves into older age categories, the overall proportion of the population with

chronic conditions will increase. The question we want to answer is how much – how much, that is, if the age-specific prevalence rates remain the same and only the population age distribution changes?[7]

Table 2 shows the projected population to 2030 on which our calculations were based. The projection relates to the "target population" as defined in the CCHS; it was derived from a MEDS projection,[8] but adjusted to the target population of the survey by assuming that the fractions of the population at each age in the CCHS excluded categories remain fixed. Fertility and mortality rates were held constant in the projection. We might expect mortality rates to fall and, in consequence, life expectancy to increase somewhat over the projection period. However, keeping mortality rates fixed is a natural concomitant of the assumption that prevalence rates are constant. Mortality and disease prevalence obviously are not independent; we would expect a positive correlation between mortality rates and the prevalence of chronic conditions. Holding mortality rates constant allows us to focus strictly on the effects of changes in the population age distribution.[9]

Table 2 shows projected growth in the overall population of 20 per cent between 2005 and 2030. However, consistent with population aging and constant fertility rates (and in spite of high levels of immigration), the rate of growth declines from 5.7 per cent in the first five-year period to 2.2 per cent in the final one. Proportionate declines are observed in the age groups under age 50 and proportionate increases in those over age 65.

The projected overall prevalence rates for each of the 32 chronic conditions are shown in Table 3. Note that if the population *in each age group* had increased by 20 per cent, with unchanged age-specific prevalence rates, the number with each condition would also have increased by 20 per cent and the overall prevalence rates would have remained the same. However, with the projected shift in age distribution we would anticipate changes in prevalence.

That is of course what we find. In consequence of changes in the age distribution alone, the overall chronic condition prevalence rate ("has chronic condition") increases by 4.7 per cent (from 68.7 to 71.9%) over the 25-year period. At the same time, substantial increases (more than 10%) occur in the prevalence rates of conditions associated mostly with old age (those in the upper panel of Table 3) and modest increases or decreases in other conditions (those in the lower panel). The increase exceeds one quarter for 12 of the 14 conditions in the upper panel, including the two that are most common in old age, arthritis/rheumatism and high blood pressure, and exceeds 10 per cent in all 14. There is a decrease in the prevalence rates for 11 of the 18 conditions in the lower panel.

Use of Health Care Resources

Table 4 shows how the number of chronic conditions varies by age. While almost three quarters of the youngest group had either no such condition or only one, more than three quarters of the oldest group (80+) had two or more. In what follows, we investigate the relationship between the use of health care resources on the one hand and the number of chronic conditions and age on the other. In doing so, we ignore which chronic conditions apply and consider only the total number, as reported by respondents.[10]

Survey respondents were asked to recall how many nights in the past 12 months they had spent in hospitals or other in-patient institutions and the number of visits to family physicians, eye specialists, and other physician specialists during that period.[11] Their responses are tabulated in Table 5. Those with more chronic conditions spent longer in hospitals or other health care institutions and had more consultations. The differences were pronounced: the 17 per cent with two chronic conditions spent nearly four times as long in institutions and had twice as many physician visits, on average, as the 31 per cent with no such conditions.

Table 2: Projected population size and percentage distribution by age group, 2005–2030

Year	Percentage distribution					Total Size (' 000)
	12–29	30–49	50–64	65–79	80+	
2005	28.4	35.8	21.4	11.3	3.2	27,132
2010	27.2	33.6	23.8	11.8	3.5	28,673
2015	25.5	32.0	25.2	13.7	3.7	29,873
2020	24.1	31.6	24.8	15.8	3.8	30,929
2025	22.9	31.6	23.5	17.9	4.1	31,846
2030	22.6	30.9	22.3	19.2	4.9	32,549

Note. The 2005 values show the population targeted in the CCHS. The projected population holds fertility and mortality rates constant at 2005 levels, immigration at 240,000 per year, and emigration at 0.13% of the population.

Table 3: Population with chronic conditions, 2005, and projected prevalence rates to 2030

Condition	Population (' 000)	Prevalence Rate (%)					
		2005	2010	2015	2020	2025	2030
Has Alzheimer's or other dementia	90	0.3	0.3	0.4	0.4	0.4	0.5
Has cataracts	1,144	4.2	4.5	4.9	5.4	5.9	6.3
Has glaucoma	407	1.5	1.6	1.7	1.8	2.0	2.1
Has heart disease	1,288	4.7	5.0	5.4	5.8	6.2	6.6
Suffers from stroke	299	1.1	1.2	1.2	1.3	1.4	1.5
Has COPD	191	0.7	0.8	0.8	0.9	0.9	0.9
Has emphysema	190	0.7	0.8	0.8	0.9	0.9	1.0
Has urinary incontinence	809	3.0	3.1	3.3	3.5	3.8	4.0
Has cancer	371	1.4	1.4	1.5	1.6	1.7	1.8
Has high blood pressure	4,053	14.9	15.8	16.9	17.8	18.6	19.1
Has diabetes	1,325	4.9	5.2	5.5	5.9	6.1	6.3
Has arthritis or rheumatism	4,443	16.4	17.3	18.3	19.2	20.0	20.6
Has thyroid condition	1,516	5.6	5.8	6.1	6.3	6.5	6.6
Has chronic bronchitis	675	2.5	2.5	2.6	2.7	2.7	2.8
Has bowel disorder	1,047	3.9	3.9	4.0	4.0	4.1	4.1
Has stomach or intestinal ulcers	847	3.1	3.2	3.3	3.3	3.4	3.4
Other long-term condition	3,417	12.6	12.8	13.1	13.3	13.4	13.5
Has chronic fatigue syndrome	334	1.2	1.3	1.3	1.3	1.3	1.3
Has back problems	5,091	18.8	19.0	19.3	19.5	19.6	19.6
Has fibromyalgia	390	1.4	1.5	1.5	1.6	1.6	1.6
Has food allergies	1,965	7.2	7.2	7.2	7.2	7.2	7.2
Suffers from multiple chemical sensitivities	599	2.2	2.3	2.3	2.3	2.4	2.4
Has autism or other developmental diseases	76	0.3	0.3	0.3	0.2	0.2	0.2
Has asthma	2,250	8.3	8.2	8.2	8.1	8.1	8.1
Has non-food allergies	7,223	26.6	26.6	26.5	26.3	26.2	26.1
Has epilepsy	160	0.6	0.6	0.6	0.6	0.6	0.6
Has mood disorder	1,514	5.6	5.6	5.6	5.6	5.5	5.5
Has eating disorder	110	0.4	0.4	0.4	0.4	0.4	0.4
Has anxiety disorder	1,187	4.4	4.4	4.4	4.4	4.3	4.3
Has schizophrenia	69	0.3	0.3	0.3	0.3	0.3	0.2
Has learning disability	753	2.8	2.7	2.6	2.5	2.5	2.5
Has migraine headaches	2,861	10.5	10.4	10.3	10.1	9.9	9.8
Has chronic condition	18,644	68.7	69.4	70.3	70.9	71.5	71.9

Note. **See note to Table 1.**

What are the implications for future health care needs as the population ages? A considerable body of evidence suggests that there is room for improvement in the ways in which health care resources are used. In the words of Kane, Priester, and Totten (2005), "we live in a health care system that is out of step with current demographic realities" (p. xvii). The authors argued that the "... health care system [in the U.S.] ... is world class in trauma, transplantation, and other high-tech care. But the majority of people who use the system ... come with chronic illnesses that require on-going, long-term attention and management" (p. xvii). A similar conclusion is

Table 4: Percentage of distribution of the population by number of chronic conditions and age group, 2005

Age Group	Number of Chronic Conditions								
	0	1	2	3	4	5	6	7+	All
					– percentage distribution –				
12–29	45.5	27.7	15.0	6.4	3.0	1.3	0.5	0.6	100.0
30–49	35.2	28.4	16.6	8.9	5.0	2.7	1.2	1.9	100.0
50–64	20.7	24.7	20.3	13.5	8.6	5.0	2.9	4.4	100.0
65–79	10.0	18.6	20.3	17.4	13.0	8.8	4.6	7.3	100.0
80+	6.7	14.9	18.1	18.2	14.9	10.4	6.9	9.9	100.0
All ages	31.3	25.9	17.4	10.4	6.4	3.7	2.0	2.9	100.0

Table 5: Use of health care resources in previous 12 months by number of chronic conditions and age group, 2005

Age Group	Number of Chronic Conditions								
	0	1	2	3	4	5	6	7+	All
Number of nights as patient in hospital, nursing home or convalescent home									
12–29	0.1	0.2	0.5	0.8	1.2	3.6	1.6	1.7	0.3
30–49	0.1	0.2	0.3	0.8	0.8	0.9	1.6	2.3	0.4
50–64	0.2	0.3	0.4	0.6	1.0	1.5	1.6	3.6	0.6
65–79	0.5	0.6	1.0	1.3	1.4	1.9	2.9	4.7	1.4
80+	0.9	1.2	2.3	2.0	2.8	3.7	4.2	6.4	2.7
All ages	0.1	0.3	0.5	0.9	1.2	1.8	2.3	3.8	0.6
Number of family physician consultations									
12–29	1.8	2.4	3.2	4.2	5.7	6.5	7.8	11.8	2.6
30–49	1.6	2.4	3.4	4.0	5.2	7.4	7.7	10.6	2.9
50–64	1.4	2.1	3.1	4.0	4.5	5.9	6.4	8.7	3.2
65–79	1.6	2.8	3.5	4.3	4.6	5.5	5.9	7.0	4.0
80+	3.0	3.6	4.9	4.5	5.4	6.3	5.9	8.0	5.1
All ages	1.7	2.4	3.3	4.1	4.9	6.3	6.6	8.8	3.1
Number of eye specialist consultations									
12–29	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
30–49	0.3	0.4	0.4	0.5	0.5	0.6	0.5	0.6	0.4
50–64	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.9	0.6
65–79	0.6	0.6	0.8	0.9	1.0	1.0	1.4	1.3	0.9
80+	0.6	0.8	1.0	1.1	1.1	1.4	1.2	1.3	1.1
All ages	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1.0	0.5
Number of other medical doctor consultations									
12–29	0.3	0.6	0.8	1.3	1.6	3.9	4.1	4.4	0.7
30–49	0.4	0.7	1.0	1.4	1.8	2.5	2.4	4.2	0.9
50–64	0.3	0.6	0.9	1.1	1.4	1.9	2.7	3.6	1.0
65–79	0.3	0.6	0.8	0.9	1.1	1.4	1.6	1.9	1.0
80+	0.4	0.5	0.7	0.8	1.0	1.1	1.3	1.9	0.9
All ages	0.4	0.7	0.9	1.2	1.4	2.0	2.3	3.1	0.9

reached by Dorland and McColl (2007) in the Canadian context: "... a system designed to respond to acute illness, however well-funded, well-staffed, and efficient, cannot deliver adequate results in managing chronic disease" (p. xvi). Speaking of the situation more broadly, the WHO (2002) made the same point differently: "Health care systems have evolved around the concept of infectious disease, and they perform best when addressing patients' episodic and urgent concerns. However, the acute care paradigm is no longer adequate" (p. 6).

While there is considerable agreement on the diagnosed mismatch between health care needs and the services that health care systems are best able to deliver, progress in remedying the situation, according to Kane et al. (2007), "... has been agonizingly slow. The generally conservative health care industry presents formidable barriers to the changes in infrastructure needed to provide better chronic care" (p. xx). Even today, medical schools do little to prepare future physicians, the gatekeepers to the system, to deal with chronic conditions.[12] At the same time, it is not clear whether the benefits that would flow from a system

better designed to meet the health care needs of those with chronic conditions would result in a net increase or decrease in resource use. As a reference case, we investigated the implications that population aging would have for the requirements for health care services on the assumption that current patterns of use continue to apply.

Table 6 shows what would happen if people in each age group had the same number and combination of chronic conditions in the future as in 2005, and if the treatment of those conditions involved the same use of resources as shown in Table 5. The number of patient nights would increase more than twice as rapidly as the population between 2005 and 2030 (45%) compared with population growth of 20 per cent, consultations with eye specialists would increase by 30 per cent, and consultations with family practitioners and other medical specialists by 25 and 22 per cent respectively.

What if people had fewer chronic conditions; what savings might then result? Many conditions result from lifestyle choices. Broemeling, Watson, and Prebtani (2008) referred to "... proven strategies to delay or

Table 6: Projected effects of population change on the use of health care resources with prevalence rates held constant, 2005–2030

Resource	2005	2010	2015	2020	2025	2030
			(Indexes, 2005 = 100.0)			
Nights as patient	100.0	109.1	118.5	127.0	135.9	144.7
Family Physician Consultations	100.0	106.5	112.1	117.0	121.6	125.4
Eye Specialist Consultations	100.0	107.2	113.7	119.5	125.0	129.9
Other Medical Doctor Consultations	100.0	106.4	111.6	116.0	119.8	122.5

prevent the onset of chronic conditions and to improve the quality of primary health care to prevent complications, reduce the need for more expensive health services and secure a better quality of life for Canadians" (p. 71). The World Health Organization claimed that the "most cost-effective interventions to reduce [the associated] risk factors are population-wide programmes to: (1) reduce salt in processed foods, cut dietary fat, particularly saturated fats; (2) encourage more physical activity; (3) encourage higher consumption of fruits and vegetables; and (4) cease smoking".[13] That suggests that successful initiatives to reduce the proportion of the population that is obese, smokes, and is physically inactive would reduce the numbers with chronic conditions and the associated need for health care services. Indeed, a number of U.S. studies have found substantial reductions in the prevalence rates in the past decade and more.[14] That led us to consider hypothetical situations in which the population observed in the survey had fewer chronic conditions (perhaps as a result of changes in lifestyle or policy initiatives taken many years earlier), and to infer the impact that would have had on the use of health care resources.[15]

Table 7 shows the percentage reductions in selected health care services that would have resulted in 2005 if, within each age group in Table 4, a fraction of those with one chronic condition shifted to having none, of those with two shifted to having only one, and so on. The fractions assumed to be shifted are one quarter,

one half, three quarters, and one. There is, of course, wide variation in chronic conditions. Some are highly debilitating, others not; some are costly to treat in terms of the health care resources that they use while others are not. Implicit in the calculations that follow, those remaining in each age category have the same combination of chronic conditions as before the assumed shift, and the same health care resources are used in their treatment. In similar fashion, those that are shifted down a category are assumed to have the same combination of conditions as those already in that category, and their care is assumed to involve the same health care resources.[16]

It is evident that the savings from even a modest reduction in the prevalence of chronic conditions would be substantial. For example, patient nights are reduced by about 16 per cent and consultations with family physicians by 10 per cent if only half of those with the specified number of chronic conditions are moved to the next lowest category. As an indication of magnitudes, those amounts are equivalent to *more than a third* of the projected increase in requirements for the same services by 2030 with prevalence rates held constant (see Table 6). The potential savings are somewhat smaller for eye specialists, larger for other physician specialists, but nonetheless significant.

Not all (perhaps not even most) chronic conditions are preventable, but Table 7 is indicative of the potential reduction in resource requirements that could result over the longer term if fewer people were subject to the risk factors associated with chronic conditions.

Concluding Remarks

Health costs continue to grow more rapidly than most other components of public budgets. How much of those budgets, and the increases in them, are accounted for by the treatment of chronic conditions is hard to answer, especially given the uncertainty about what conditions should be included in the chronic category. However, by any reasonable definition the share is large.

Working with a somewhat arbitrarily defined set of 32 chronic conditions drawn from a large household survey, we find that the prevalence rates for almost half of

Table 7: The effects of hypothetical reductions in the prevalence of chronic conditions on the use of health care resources, 2005

Resource	Percent reduction in proportion with 1, 2, …, CCs			
	25	50	75	100
		% change		
Nights as patient	−7.8	−15.6	−23.4	−31.2
Family Physician Consultations	−4.9	−9.7	−14.6	−19.5
Eye Specialist Consultations	−2.0	−4.0	−5.9	−7.9
Other Medical Doctor Consultations	−6.4	−12.8	−19.3	−25.7

the conditions increase with age and that the age patterns are strong. For example, there are nine conditions for which the prevalence rates are more than 10 times greater for the oldest age group (those 80+) than for those aged 30 to 49. We ask how the overall population prevalence rates would change over a quarter century, as the population ages, if the rates for each age group remained constant. Consistent with recent demographic trends, we project that the rates for almost all conditions that are associated mostly with old age would rise by more than 25 per cent.

Recent survey data show that resource use increases strongly with age and number of chronic conditions. If the number of conditions were to be maintained, our projection indicates that health care requirements would grow more rapidly than the population – more than twice as rapidly in the case of hospital stays.

The age patterns of both chronic conditions and resource usage will, of course, change, as will the relationship between them. What form those changes will take is uncertain, but we have explored the implications of hypothetical reductions in the average number of conditions at each age. We find that even modest reductions could result in substantial savings.

Notes

1 Further information about the survey is provided on the Statistics Canada website – http://www.statcan.ca/english/concepts/health/cycle3_1/overview.htm

2 No information was available about what specific conditions were included in the category "other long-term conditions". It was based on respondents' answers to a question about whether they "have any other long-term physical or mental health condition that has been diagnosed by a health professional".

3 Alternatively, it might be a cohort effect: autism and learning disabilities are usually diagnosed at a young age, and health professionals might have been less likely to have diagnosed a learning disability among those now in the older age groups than among those now in middle age or younger. We are grateful to a referee for this observation.

4 "Eighty-eight percent of Americans over 65 years of age have at least one chronic health condition (as of 1998)"; http://www.medicinenet.com/script/main/art.asp?articlekey=33490 – as one example.

5 Although we did not have information about their health characteristics, based on comparisons with Statistics Canada comprehensive population estimates for 2005, it appears that the survey missed about 20 per cent of those aged 80 and older, the largest proportion of whom would be in long-term care facilities.

6 The survey did provide information relating to functional abilities, an aspect taken into account by Gilmour and Park (2005).

7 Changes in the overall age distribution will be accompanied by changes also in the visible minority and urban/rural composition as well as in other dimensions. A referee has observed, quite correctly, that such changes could, in principle, affect the projected proportions with various chronic differences. To address the concern, we compared the "white" and "visible minority" proportions with heart disease, high blood pressure, and chronic obstructive pulmonary disease. After controlling for age, the differences were quite small in most cases; less than 1 percentage point in half of the age-group-chronic-condition cells. Larger differences, when they arose, often changed sign from one age group to another, an outcome that resulted from the small sample of visible minority individuals with specified chronic conditions in particular age groups. We concluded that although there were undoubtedly differences across various population groupings in the prevalence of at least some chronic conditions, we did not have sufficient information to take them into account in the projections that follow.

8 MEDS stands for Models of the Economic-Demographic System. For a description of MEDS, see Denton, Feaver, and Spencer (1994, 2005).

9 In what follows, we report results based on only one population projection. As explained, mortality rates were held constant for analytical reasons. The effects of alternative rates of fertility and immigration are not reported in detail, in order to avoid a proliferation of tables, but a few comments are in order. The projection as reported extends to 2030, or just over two decades. Higher fertility rates would increase the size of the population under the age of 20, and hence the proportion in that age group. Since young people have very few chronic conditions, that would reduce the overall prevalence rates, but have no effect on the rates for age groups older than age 20. Sustained higher immigration would have very little effect on the age distribution of the population, and hence little effect on the overall prevalence rates.

10 The survey itself provides no information about the extent to which the use of health resources is associated with each chronic condition. In future work, we intend to estimate the resource use associated with the treatment of specific chronic conditions rather than simply the number of them, but the present approach is informative, we think.

11 No further information about specialist visits was collected in the survey and hence we are limited to the categories noted. In related work, we were concerned with the impact of population aging on the need for the services of the full range of physician specialties. We found, for example, that in Ontario aging alone would suggest especially large increases in the need for thoracic/cardiovascular surgeons, ophthalmologists, and urologists combined with only small increases in the case of paediatricians, obstetricians/gynaecologists, and psychiatrists. See Denton, Gafni, and Spencer (2001, 2002, 2003).

12 For example, "Only three of the ... 145 medical schools [in the US] have a full-scale department of geriatrics that requires a mandatory rotation in geriatrics for students and

residents, and less than 3 percent of all medical students take even one course in geriatrics." (O'Neill & Barry, 2003, p. 17).

13 The quotation is from the World Health Organization website http://www.who.int/dietphysicalactivity/publications/facts/riskfactors/en/index.html

14 For example, Manton and Gu (2001) found an increasing rate of decline in chronic disability, ranging from 0.26 per cent per year in 1982–1989 to 0.56 per cent in 1994–1999. Specific chronic conditions, perhaps including heart disease, cancer, and high blood pressure, are likely to respond even more to lifestyle changes of the sort identified. But even in the case of conditions that may be less responsive to possible changes in lifestyle, Langa, Larson, Karlawish, Cutler, Kabeto, Kim et al. (2008) found that among Americans aged 70 and older the prevalence of cognitive impairment (a term used to describe a range of conditions ranging from memory loss to dementia and Alzheimer's disease) dropped 3.5 percentage points (from 12.2 to 8.7) between 1993 and 2002. For the population aged 65 and older, Manton, Gu, and Ukraintseva (2005) found an average annual rate of decline in dementia prevalence over the period 1982–1999 between 5.7 and 2.9 per cent, depending on the definition used.

15 We note also the recent study by Légaré and Décarie (2008), which used LifePaths, a detailed microsimulation model, to project the population 75 and older with moderate or severe physical or mental disabilities (described by the authors as being in "poor health"). Their projections assumed either constant morbidity rates at each age (the "base scenario") or else that additional years gained in life expectancy are in good health (the "healthy scenario"). The healthy scenario projected 19 per cent fewer males and 16 per cent fewer females in poor health by 2031, as compared to the base scenario.

16 In practice, of course, a decline in the overall prevalence of chronic conditions would not be uniform: the prevalence of some conditions would decline more rapidly, others less rapidly, and some might even increase. We abstracted from such complications by assuming a uniform decline.

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