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USERS AND SUPPLIERS OF PHYSICIAN SERVICES: A TALE OF TWO POPULATIONS

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Abstract:

Physician shortages and their implications for required increases in the physician population are matters of considerable interest in many health care systems, in light especially of the widespread phenomenon of population ageing. To determine the extent to which shortages exist one needs to study the population of users of physician services as well as that of the physicians themselves. In this paper we study both, using the province of Ontario, Canada, as an example. The user population is projected and the implications for requirements calculated, conditional on given utilization rates. On the supplier side, the age and other characteristics of the (active) physician population are examined and patterns of withdrawal investigated. The necessary future growth of supply is calculated, assuming alternative levels of present shortages. The effects of population change on requirements are found to be smaller in the future than in the decade 1981-1991, in the aggregate, not far from the effects in 1991-2001, but highly variable among different categories of physicians.

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USERS AND SUPPLIERS OF PHYSICIAN SERVICES:

A TALE OF TWO POPULATIONS [*]

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1. INTRODUCTION

This paper is concerned with demographic aspects of the "market" for physician services in Ontario. (Terms such as "market" and "demand" are convenient and we shall use them. However, they require looser definitions than usual when applied to a publicly insured health care system.) On the supply side it examines the population (labour force) of practising physicians – its size, age structure, distribution among different categories of practitioner, and other characteristics. On the demand side it looks at the characteristics of the user population. From a demographic point of view both populations are subject to processes of aging, renewal, and depletion. The user population – the general population of Ontario, that is – is fed by births and immigration, depleted by deaths and emigration. The physician population is fed by graduates of Ontario medical training programs and inflows of physicians from other provinces and countries, and is depleted by deaths, emigration, and retirements. The two populations interact with each other to determine the balance or imbalance in the "market." Whether there is a shortage of physicians by some measure, and if so what are its implications for required increases in the physician population, are questions of considerable present interest, not only in Ontario but in many other health care jurisdictions.

The paper proceeds as follows. Section 2 presents some projections of the Ontario population under alternative assumptions about fertility, mortality, and migration in order to establish a likely range of possible sizes and age distributions for the future population of health care users in the province. Section 3 reviews the growth of the physician population since 1981 and its relationship with the user population, having regard for both changes in the size of the

latter and changes in its age composition. Section 4 looks at the age composition of the physician population as of 2001, the differences between the age distributions of male and female practitioners, and the differences between general practitioners and specialists. It looks also at differences in patterns of practice, as represented by head counts vs. full-time equivalents. Section 5 makes use of physician retirement patterns inferred from comparisons of age distribution data for 1996 and 2001 to estimate cohort retention rates and likely future withdrawals from the 2001 physician population, again in terms of both head counts and full-time equivalents. Section 6 presents age-utilization profiles for different types of physician services, as calculated from data for 2001, and applies those profiles to the projected user population to calculate future increases in requirements, conditional on the assumption of constant utilization patterns. Section 7 takes note of the widespread view that there is a present shortage of physicians in Ontario and estimates the rates at which the physician population would have to be increased in order to eliminate a shortage, and at the same time allow for future growth in requirements. Section 8 explores the effects of different demographic assumptions on projections of requirements and separates the increases into population growth and population aging components. Section 9 provides a concluding statement.

2. THE USER POPULATION

We begin with Table 1, which presents a summary of changes in the population of Ontario from 1951 to 2001 and projections to 2031. Seven projections are provided, a “standard” one, as we shall call it, and six alternatives based on higher or lower fertility, mortality, and migration rates. (The projections were made using MEDS; see Denton, Feaver and Spencer,

1994.) The assumptions are as follows:

Projection 1 (standard): The total fertility rate is constant at its 2002 level of 1.474 children per woman. Mortality rates continue to decline, with life expectancy at birth rising for males from 77.4 years in 2001 to 82.8 in 2031, and for females from 81.9 to 84.7. Consistent with stated government target levels, total immigration to Canada is set at 230,000 per year in 2005 and remains at that level thereafter; Ontario's share is set at 56.9 percent, the average percentage during the period 1999 to 2004. Emigration from Ontario is held at 0.17 percent of the population. Net migration from the rest of Canada is 7,600 in 2005, declines linearly to zero by 2011, and then remains at zero. Other projections are the same as this standard one, except as noted.

Projection 2 (higher mortality): Male life expectancy rises to 80.4 in 1931, female life expectancy to 82.9.

Projection 3 (lower mortality): Male life expectancy rises to 84.8 in 1931, female life expectancy to 86.3.

Projection 4 (higher fertility): The total fertility rate rises linearly to 2.1 in 2021 and remains at that level. (2.1 is the long-run natural replacement rate, the rate required for the population to become stationary in the absence of migration and changes in mortality rates.)

Projection 5 (lower fertility): The total fertility rate declines linearly to 1.2 in 2021 and remains at that level.

Projection 6 (higher immigration): Total immigration to Canada is 280,000 in 2006 and remains at that level; Ontario's share remains at 56.9 percent.

Projection 7 (lower immigration): Total immigration to Canada is 180,000 in 2006 and remains

at that level; Ontario's share remains at 56.9 percent.

The standard projection has the population increasing from about 11.9 million in 2001 to 16.2 million in 2031, a gain of 36 percent. The alternative projections for 2031 range from 15.3 million with lower immigration to 17.4 million with higher fertility. Changes in mortality rates have much smaller effects.

The proportion of population under 20 years of age declined from 39.2 percent in 1961 to 26.2 percent in 2001 as the baby boom effects were replaced by the continuing effects of the baby bust. Concomitantly, the proportion 65 and over rose from 8.1 to 12.5 percent. In the absence of a substantial increase in fertility rates the under-20 share will continue to fall. The 65-and-over share will increase from 12.5 to more than 20 percent by 2031; all of the projections agree on that, differing only within a range of 2.4 percentage points (20.7 with higher fertility, 23.1 with lower immigration). The 85-and-over share will rise as well, although in no case will it exceed 2.7 percent of the population.

The last two columns of Table 1 show what we are calling "support ratios", ratios of population to labour force. (The labour force projections required for calculating the ratios assume future participation rates consistent with recent patterns and trends.) The overall ratio was at a peak in 1961 of about 2.5. By the 1990s it had fallen to 1.9 and a further decline is projected for the present decade. Increases are projected after that, with the 2031 ratio ranging from 1.9 to 2.0. None of the projections produces a ratio nearly as high as the ones witnessed thirty or forty years ago, when the baby boom generation was in its youth.

The projected ratios of the 65-and-over population to the labour force reflect the anticipated increases in the older population. From 0.24 in 2001 the ratio rises into the range

0.41 to 0.45 by 2031. The different projections are in close agreement on this score: by 2031 there will be about two people 65 or over for every five people in the labour force, whichever projection one uses. That is no doubt impressive from the point of view of future health care and other costs associated with the elderly. On the other hand, it is impressive also that the overall support ratio does not get as high as it was in earlier decades, and that suggests future tradeoffs: proportionately higher shares of the province's gross domestic product to cover the costs (private and public) associated with the older population, proportionately lower shares to cover the costs of education and child-rearing costs. We have explored this issue in more detail elsewhere (Denton and Spencer, 2000).

In any event, and to no one's surprise, the population of Ontario is going to grow and to age. We consider below how the demand for physician services is likely to be affected.

3. THE USER AND SUPPLIER POPULATIONS IN RELATION TO EACH OTHER

The changing relationship between the population of physicians and the population of users is shown in summary form in Table 2. The first column gives the mid-year population of Ontario for each year from 1981 to 2003. The second column shows, in index form, the effects of aging over that period. The index is calculated by holding constant the size of the population, allowing only its age distribution to change, and applying the male and female age-utilization profiles for physician services in 2001. (The derivation of the profiles is described later.) Thus the first column represents simple growth in the number of users while the second represents what the effects on the consumption of services would have been had there been only a shift in age distribution. The index is set equal to 1.00 in 2001. The third column combines the two

effects by calculating what population size would have been necessary in each year to produce the same aggregate level of consumption of services if there had been no change in age distribution. The actual population grew by 39 percent between 1981 and 2003. The population with the adjustment for aging grew by 52 percent.

The numbers of physicians are shown in the fourth column of Table 2, based on head counts from the Southam Medical Data Base and provided to us by the Canadian Institute for Health Information (CIHI). The totals include physicians in both clinical and nonclinical practice but exclude interns and residents. One could argue that only physicians in clinical practice should be included for purposes of comparison with the user population. On the other hand one can take the view that the nonclinical component of the total is a kind of overhead component: for every X clinical physicians another Y nonclinical ones are required to make the system work. That is the view that we adopt here.

The last two columns of the table show the ratios of users to suppliers, based in one case on the actual user population and in the other on the adjusted population. The ratio based on actual population fell from 629 persons per physician in 1981 to a low of 515 in 1993, and then rose to 563 by 2003. The ratio based on adjusted population fell from 581 in 1981 to a low of 495 in 1989, and then rose to 569 in 2003. (The two ratios are necessarily the same in 2001 because the age-effects index is set to 1.00 in that year.) The proportionate variations in the population/physician ratio are thus less extreme when changes in age distribution are taken into account. The 2003 ratio is only 2 percent below the level of 1981, the highest level of any year in the table. This comparison is based on head counts, though; it does not take into account changes in the average work week of physicians.

4. THE CHARACTERISTICS OF THE SUPPLIER POPULATION

We turn now to the characteristics of the physician population, using data for 2001. The data are from the National Physician Data Base and were provided to us by CIHI. They include physicians who billed OHIP on a fee-for-service basis in 2001, whether or not they billed also for other services on a different basis. Physicians who billed entirely outside the fee-for-service framework are excluded from the NPDB, and the coverage is therefore incomplete. However the coverage ratio was high in 2001. Based on OHIP payments to physicians it was about 89 percent; based on the more comprehensive head count provided by the Southam Medical Data Base it was about 94 percent.

We consider the age distributions of physicians according to two criteria, head counts and full-time equivalents. (The FTEs are as calculated and provided to us by CIHI.) The distributions of head counts are shown in Table 3 and Figure 1, the distributions of FTEs in Table 4 and Figure 2. The two sets of distributions are generally similar in shape but differ in detail in some interesting ways.

About 45 percent of all fee-for-service physicians were in the age range 40 to 54 in 2001, by head count, and 48 or 50 percent in terms of FTEs. The proportions differ only slightly between physicians in General Practice and specialists. That is true also of the median ages. Where greater differences are observable is between men and women. The median age is some seven years younger for female physicians than for male physicians, by head count, and five and a half years younger based on FTEs. The male-female differences in the shapes of the age distributions stand out in Figures 1 and 2. These differences reflect the rising proportions of women in medical school enrolment in recent decades.

Women account for 31 percent of General Practice physicians but only 23 percent of specialists, by head count; for FTEs the proportions are lower, 25 and 19 percent. These comparisons reflect male-female differences in patterns of practice within the GP and specialist categories. The pattern differences are made more explicit in Table 5, which shows full-time equivalency ratios – ratios of FTEs to head counts. The ratios are notably lower for women. In sum, women physicians are younger, more concentrated in general practice, and more likely to work fewer hours per week in their practices.

Physicians represent about a third of one percent of the total labour force of Ontario. Table 6 provides comparisons of the median ages of practising physicians with the median ages of the general labour force and population. Medians are shown for all ages combined, ages 35 and over, ages 35-74, and ages 35-64. The overall median age of 48.9 years for physicians compares with 36.7 and 38.8 for the general population and labour force. However, physicians have long periods of training before entering practice whereas the general labour force includes workers as young as teenagers. Hence the restricted age-group comparisons are more relevant. For ages 35 and over the 50.4 median for physicians compares with 51.4 for the general population and 46.0 for the general labour force. Physicians in private practice may continue to work beyond 65 (though possibly with reduced hours of work) whereas people working as employees in other types of jobs may have to retire. A comparison for ages 35 to 64 may thus have additional relevance. For that age range the overall physician median is 48.3, compared with 45.7 for the general labour force, a difference of 2.6 years. The difference is a little greater for specialists, a little smaller for GPs.

The situation is somewhat different as between male and female physicians. For women

35 and older the medians are very close to the comparable general labour force medians. That is true for both female GPs and female specialists. Male physicians, on the other hand, are a few years older than their counterparts in the general labour force for both categories of physicians.

5. THE 2001 PHYSICIAN POPULATION AS IT GROWS OLDER

The 2001 active physician population will diminish in size as it ages in consequence of retirements, mortality, and to some extent emigration. We have used age distribution data for 1996 and 2001 to calculate cohort retention rates. That is to say we compare the number of active physicians 65-69 years of age in 2001, for example, with the number 60-64 in 1996 and calculate the proportion remaining in practice. Having done this calculation for each five-year age group we apply the 1996-2001 retention rates to the 2001 physician population to estimate the number who will still be practising in 2006, then repeat the process to calculate the number in 2011, and so on. For younger age groups we assume full retention (rates equal to 1 for groups under 45); for older groups the rates are less than 1, reflecting mostly retirements and deaths.

The foregoing refers to calculations of head counts. We have also estimated the numbers of full-time equivalents remaining in practice by applying the 2001 equivalency ratios to the projected head counts in 2006, 2011, etc., age group by age group. Thus we assume that practice patterns, as represented by equivalency ratios, remain the same as they were in 2001.

Based on calculations of this kind we present, in Table 7, estimates of the future numbers remaining active from the 2001 physician population, at five-year intervals out to 2031. The head count estimates show about 91 percent of the 2001 physician population as remaining active in 2006 and about 81 percent in 2011. Withdrawals are thus calculated to be about 19

percent over the decade 2001-2011. About 31 percent still remain active in 2031. The proportions remaining active are somewhat higher for general practitioners than for specialists. Converting to full-time equivalents shows the FTEs surviving at a little higher rate in the first one or two five-year periods, but then at a lower rate thereafter. The general pattern of differences between GPs and specialists observed for head counts holds also for FTEs.

6. FUTURE REQUIREMENTS

The future requirements for physician services will depend on changes in the population, changes in technology, changes in methods of disease control and prevention, changes in the way medicine is practised, and other factors. Of these, the one that we can say something useful about is changes in population. The kind of calculation we can make is to combine observed utilization rates with anticipated population changes. That is what we now do. Specifically, we use 2001 OHIP fee-for-service data by age and sex of patient to derive age-utilization profiles and apply the profiles to our population projections. We thus obtain *conditional* projections of physician requirements – conditional on the maintenance of the 2001 utilization patterns. This allows us to see the pure effects of population growth and aging.

The profiles are derived as follows. (Similar procedures were used in earlier studies, with earlier data. See Denton, Gafni and Spencer, 2001, 2002, 2003.) Let s_i be a clinical service of type i and let I_p be the set of all services provided by physicians in category p (General Practitioners, Pediatricians, Dermatologists, etc.). One could think of aggregating the services directly but they are unequal in physician time requirements and complexity, and should be

weighted accordingly. We assume that the OHIP fee schedule reflects sufficiently accurately the differences in the characteristics of the services and use that as a source of weights. The weighted total of all services provided by fee-for-service physicians in category p to patients of sex j, age x in some year is then

$$Q_{pjx} = \sum_{i \in I_p} f_i s_{ijx}$$

where f_i is the fee for a service of type i and Q is aggregate expenditure on the services in question, but interpretable also as a weighted measure of the quantity of services. Now suppose that fee-for-service physicians are some fraction k_p of all category p clinical physicians and make the assumption that non-fee-for-service physicians provide services in the same proportions as fee-for-service physicians. (The assumption may not be strictly correct but if k_p is very large, as it is generally for our data, the assumption introduces little error.) Letting N_{jx} be the sex j, age x population in Ontario, the quantity of services per capita provided to that population by category p fee-for-service physicians is $q_{pjx} = Q_{pjx} / N_{jx}$ and the quantity of services per capita provided by all physicians in the category is q_{pjx} / k_p. Summing over both sexes and all age groups, the total quantity of service provided by category p physicians is $Q_p = \sum_j \sum_x (q_{pjx} / k_p) N_{jx}$. Adding a subscript t for year and choosing a base year t = 0 (the

year 2001 in our calculations) we can then construct an index R_p of the total quantity of services for physicians in category p:

$$R_{pt} = \left(\sum_j \sum_x q_{pjx0} N_{jxt} \right) \Big/ \left(\sum_j \sum_x q_{pjx0} N_{jx0} \right)$$

where the fee-for-service parameter k_p is the same in the numerator and denominator, and drops out. The foregoing allows us to use the OHIP fee-for-service expenditure data to construct indexes of service quantities for various categories of physicians. R is a Laspeyres-type index with base year per capita utilization weights. (To draw the analogy with price indexes, q replaces price and N replaces quantity in the Laspeyres formula.)

The age-utilization profiles on which the indexes are based are displayed in Figure 3 for General Practice, 18 specialist categories, and all physicians combined. There are separate profiles for men and women. In most cases the profiles show utilization increasing with age but there are exceptions: Obstetrics/Gynecology and Pediatrics are obvious ones, Plastic Surgery is another. The profiles for Psychiatry peak in the 40 to 50 age range and the Thoracic/Cardiology profiles in the 70 to 80 range. The profiles for most of the other specialist categories turn down at the very oldest ages, and that is true also for the all-categories-combined profiles. The General Practice profiles continue to rise until the end.

The indexes that we have calculated make use of the standard population projection (Projection 1 of Table 1). They are shown in Table 8 for the period 2001-2031 at five-year

intervals and the 2001-2031 percentage increases are displayed in Figure 4. Overall, the indexes reflect the effects of general population growth but the differences among them reflect the differential effects of changes in age distribution, and more particularly the shift toward older ages. The differences are generally consistent with the age-utilization profiles. The largest increases occur in the Thoracic/Cardiology, Ophthalmology, Urology, and Internal Medicine categories, to pick out the top four; the smallest increases are in Pediatrics, Obstetrics/Gynecology, Psychiatry, and Otolaryngology. The combined requirements for all categories of physicians are projected to increase by about 20 percent between 2001 and 2011 and by 62 percent over the full 30 years of the projection period. The increases for General Practice are a little lower, 18 percent and 55 percent, reflecting the somewhat greater growth of requirements for physician services in many of the specialist categories.

We emphasize that these projections relate to the pure effects of population change. They assume constant patterns of utilization and abstract from all influences other than demographic ones.

7.SUPPLY GROWTH NECESSARY TO SATISFY FUTURE REQUIREMENTS

The overall requirements for physician services are projected to increase by about 9 or 10 percent in each five-year period between 2001 and 2031, based on the standard population projection and the assumption of constant age-sex-specific utilization rates. The question then is how much would the supply have to grow in order to satisfy the rising level of requirements. The initial answer is, it depends. There is a widespread view that there has been in recent years, and continues to be, a shortage of physicians (Chan, 2002, Kralj, 1999, 2001, for example). How

much the supply would have to grow depends therefore on how large a shortage there is to be eliminated, in addition to allowing for changes in the population. The size of the shortage is a matter of debate. (See Chan, 2002, on possible reasons for a shortage.)

There are different ways of going about attaching a number to the present shortage, or rather the shortage as it was in 2001, our benchmark year and take-off year for projections. One way is to assume no shortage, to interpret the 2001 utilization rates as representing full satisfaction of the demand for physician services, and to view the market (if we may use that term again) as being in balance. The assumption then would be zero shortage in 2001. The projection of necessary supply growth under that assumption is straightforward: if requirements are projected to increase by X percent, then supply must also increase by X percent.

A second way of arriving at a shortage number is to go back to Table 2, compare the population/physician ratio in 2001 with the lower ratio in some earlier year when shortage was not an issue, and then calculate how much the physician supply would have to increase to reset the ratio to its earlier level. A general shortage was not an issue in the early 1990s; discussion at that time was concerned rather with a surplus, or prospective surplus. Work that we did in modelling the Ontario health care system indicated that if the situation at that time were to continue there would indeed be a surplus (Denton, Gafni, and Spencer, 1993, 1994). That finding was consistent with views expressed by others (Barer and Stoddart, 1991, for example). Against that background one might choose, say, the 1991 population/physician ratio as a hypothetical policy goal. There are in fact two 1991 ratios in Table 2, one based on the actual population, the other on the population after adjustment to incorporate the effects of age distribution on requirements. Using the first as a benchmark for calculating the shortage tells us that the number

of physicians should have been 7 percent higher in 2001 in order to balance it with requirements that went unsatisfied in that year. Using the second 1991 ratio tells us that the number should have been 10 percent higher in 2001.

A third route to a shortage figure takes us into the realm of expert opinion. The McKendry Report, as it is known, estimated the shortage in 1999 as 1000 (McKendry, 1999) and the Expert Panel on Health Professional Human Resources (2001) estimated the increase in shortage after 1999 as 250. Putting these two estimates together, Kralj (2001a) then calculated the shortage as 1250 in 2001. Taking the McKendry figure by itself the shortage would have been about 5 percent in 1999; taking Kralj's figure it would have been about 6 percent in 2001. Putting all of this together and coupling it with our calculations based on the Table 2 ratios and the no-shortage assumption we choose three alternatives to experiment with: a zero shortage in 2001, a 5 percent shortage, and a 10 percent shortage. If one takes one of the latter two as the basis for a policy of achieving demand/supply balance there is then the question of how fast the shortage should be, or could be, eliminated. For that we envisage two scenarios. In the first the percentage shortage is eliminated by 2011, linearly. That is to say, the percentage is reduced by half by 2006, and the remainder eliminated by 2011. In the second the shortage is eliminated by 2016, again linearly.

The results are shown in Table 9. Before turning to that table, though, two observations on the notion of a shortage are appropriate. The first is that requirements are not well defined. How often one should see a family physician, what tests should be prescribed, and so on, have a substantial element of judgement, or perhaps better a component determined by standards of practice that may be different at different times and in different places. And then there is the

question of whether observed demand is conditioned on supply, in the sense that if there were a surplus, "requirements" would adjust in such a way as to eliminate it. The notion of supply-determined demand is a familiar one in the literature.

Ambiguity in defining demand or requirements aside, there is also the issue of aggregate supply vs. geographic distribution. Kralj (2001b) has analyzed the inequalities in the distribution of physicians among regions of Ontario; his work quantifies the generally accepted view that some regions are substantially underserviced in relation to others. We do not deal here with the distributional aspect of the shortage concept, important as that is. Nor do we attempt to give a precise definition to aggregate requirements. What we do is simply to experiment with the three alternative definitions noted above, on the grounds that they seem to encompass roughly what people are likely to have in mind in current discussions of physician shortages. That takes us back to Table 9.

The table shows the assumed total requirements in 2001 and projected totals for 2006, 2011, and 2016, based on the standard population projection. In the no-shortage case the 2001 requirements are set equal to the actual number of active physicians (excluding interns and residents) derived from the Southam Medical Data Base. (The figure is the same as in Table 2.) The projected requirements in the later years are then obtained by applying the percentage increases of Table 8. The numbers are in terms of head counts, which of course are what matter from the point of view of training. (Medical schools train people, not full-time equivalents.) The requirements would be somewhat lower in terms of full-time equivalents, although the projected percentage increases would be the same as long as the full-time equivalency ratios remained the same. Under the no-shortage assumption the supply head count is equal to the requirements head

count in 2001, and in the subsequent years as well. The increases necessary to maintain the balance are 9 or 10 percent in each five-year period – about 2100 to 2300 physicians over the five years, or roughly 410 to 460 per year. These are of course net increases – net of withdrawals because of retirements, deaths, and emigration.

The number of first-year places for students at Ontario medical schools has been about 700 recently and is scheduled to rise to something in excess of 850, according to government announcements. Not all graduates of the province's medical schools stay in Ontario for graduate training and subsequent employment, of course; there are substantial flows of medical school graduates into and out of the province. A rough calculation suggests for the present situation a withdrawal rate of 9 or 10 percent of active physicians over a five-year period, or about 2 percent per year (largely because of retirement but the withdrawals include also deaths and emigration) . Given the current physician population that would mean some 400 to 450 annually. This would seem to imply that as of today future medical school graduates could just about cover net requirements, but that assumes that they all stay in Ontario, or that the net exchange of graduates with other jurisdictions is roughly zero. It assumes also that there is no present shortage to be eliminated.

If a nonzero shortage is assumed the requirements are reset for 2001 in Table 9 so that the observed number of physicians is either 5 percent or 10 percent below the assumed "actual" level of requirements. The 2001 supply remains the same and the 5 or 10 percent gap is closed over 10 or 15 years, depending on which scenario is chosen. To eliminate a 5 percent shortage by 2011 necessitates an increase of 12.5 percent in 2001-2006 and a 12.1 percent increase in 2006-2011, followed by an 8.8 percent increase in 2011-2016 to allow only for population

change. To eliminate the same shortage by 2016 requires somewhat lower rates of growth in the first two five-year periods but a higher rate in the final one. If a 10 percent shortage is assumed the necessary supply growth rates are of course higher – 15 or 16 percent per five-year period over ten years or 13 or 14 percent per period over fifteen. In short, to accommodate only the effects of population change would require some 9 or 10 percent growth in the physician population in each five-year period; to eliminate a shortage in the 5 or 10 percent range would require rates of growth as high as 12 to 16 percent.

These rates may be compared with actual five-year rates of change since the 1980s, based on the data in Table 2. The highest five-year rate observed since 1981 was a 26.5 percent rate of growth in 1984-1989, the lowest was a decrease, -1.3 percent in 1993-1998. The most recent five-year growth rate calculated from Table 2 was 6.2 percent in 1998-2003. The hypothetical rates in Table 9 needed to both eliminate an assumed shortage and accommodate the effects of population change are thus high by the recent standard but well within the range of observed rates over the past quarter-century. We take no position ourselves on the existence and possible size of a shortage. Table 9 simply provides some “what if” calculations.

Two further comments. First, the calculations in Table 9 assume a constant full-time equivalency ratio. In practice the ratio may in fact decline somewhat. Women have been an increasing component of the physician total and their average full-time equivalency ratio is lower than that of men: they tend to work fewer hours per week. To the extent that the female percentage of the total continues to rise this may imply that a somewhat higher head count would be necessary in the future to provide the same level of supply of services. We are painting with a broad brush in making the calculations of Table 9, though, and this consideration is likely to be

of rather small order in relation to others that underlie the calculations. Secondly, we are dealing only with the total supply of physicians, not its distribution. The shortage situation and need for increasing the supply may be quite different in different physician categories; in some there may even be surpluses, now or in the future. And of course, the situation may vary also from region to region within the province (Kralj, 2001b).

8. FUTURE REQUIREMENTS: POPULATION GROWTH VS. POPULATION AGING

We focus again on the projection of future requirements under the assumption of constant utilization rates. Under that assumption the projected increases can be factored into two components, one representing growth in the size of the population, the other the changes in its age distribution. One hears a lot about the effects of aging in discussions of the future of the health care system and it is of interest to see just how much effect aging is likely to have in the case of physician service requirements. How great the effect depends on the assumptions one makes about future fertility rates, mortality rates, and rates of migration. We go back to Table 1 therefore and make use of the seven alternative populations projections shown in that table.

The calculations are simple. Let R_t be an index of total requirements for physician services in year t (as in the earlier notation), let $G_t = N_t / N_0$ be an index of population size (and hence of the pure effects of population growth on requirements), and let D_t be an index of age distribution effects. R_t is then equal to $G_t D_t$, where D_t is defined by

$$D_t = \left(\sum_p \sum_j \sum_x w_{p0} q_{pjx0} n_{jxt} \right) \Big/ \left(\sum_p \sum_j \sum_x w_{p0} q_{pjx0} n_{jx0} \right).$$

$n_{jxt} = N_{jxt} / N_t$ is the proportion of the total population that is of sex j, age x, q_{pjx0} is the base year (2001) age-sex-specific utilization rate for the services of physicians in category p (as before), and w_{p0} is the base year proportion of physicians in that category (strictly speaking, the proportion of full-time equivalent physicians). The aggregate age-effects index is thus obtained by holding constant the population size, allowing the age distributions (male and female) to vary, and summing over all ages, both sexes, and all physician categories.

Given the foregoing, the increase in requirements, ΔR_t, can be factored into population growth and aging components, as follows:

$$\Delta R_t = (G_t + \Delta G_t)(D_t + \Delta D_t) - G_t D_t = G_t \Delta D_t + D_t \Delta G_t + \Delta G_t \Delta D_t$$

Dividing through by $R_t = G_t D_t$ and cancelling terms in numerators and denominators then yields

$$r_t = g_t + d_t + g_t d_t$$

where $r_t = \Delta R_t / R_t$, $g_t = \Delta G_t / G_t$, and $d_t = \Delta D_t / D_t$. As the time interval goes to zero the term $g_t d_t$ vanishes. For a nonzero but relatively short interval the equation with the latter term omitted holds as an approximation. The term $g_t d_t$, the error of approximation (which is small), results from the interaction of population growth and aging, and is not separately attributable to either. As a practical procedure we assign it half-and-half to each.

The decomposition thus arrived at is shown in Table 10 for intervals of ten years. As before, the calculated values are based on fee-for-service physician data. For the standard

projection the overall increases in requirements are the same as in Table 8. Comparing those with the alternative projections shows the effects of the different demographic assumptions. Higher mortality, lower fertility, and lower immigration reduce the projected increases; lower mortality, higher fertility, and higher immigration increase them, as of course would be expected.

The overall increase in requirements is 19.8 percent between 2001 and 2011, under the standard assumptions, and of that, population growth accounts for a little over two-thirds, aging for a little under one-third. The overall increases are smaller in 2011-2021 and 2021-2031and the share of aging rises to about two-fifths of the total. In none of the projections does the share of aging exceed the share of population growth. The various overall rates of increase decline over the three decades but even in 2001-2011, when the increases are greatest, they are never as large as in 1981-1991, and not hugely different from the 1991-2001 increase (21 percent at most, compared with about 18 percent in 1991-2001). All of this is dependent on the assumption of utilization rates constant at the 2001 levels of course, a point we note once again, for emphasis.

9. CONCLUSION

The population of Ontario will continue to grow in the next few decades and the proportion 65 and over will rise substantially, almost regardless of what happens to fertility, mortality and immigration rates. The requirements for physician services will increase accordingly. On the other hand, the combined population under 20 and 65+ expressed as a ratio to the Ontario labour force will fall well short of the levels seen in the 1950s, 1960s and 1970s, when those born in the baby boom era were in their youth. That suggests the possibility of a social tradeoff: an increased share of the gross domestic product going to public pensions and

health care, a decreased share going to education and the raising of children.

The population/physician ratio has varied over the past quarter-century. Concerns in the early 1990s about a surplus of physicians have been replaced by concerns about a shortage. The ratio has been higher in recent years than it was in 1991, though lower than in 1981. That is true whether or not one adjusts the population for changes in age distribution. We have done experimental calculations with assumed shortages of 0, 5 and 10 percent but choosing a precise value is clouded by the ambiguity of the term "requirements" and is not straightforward. On the assumption of no shortage we calculate the necessary net increase in the number of physicians at 9 or 10 percent every five years for the period 2001-2016, holding age-specific utilization rates constant at their 2001 levels. If a 2001 shortage of 5 or 10 percent is assumed, and is to be eliminated within ten or fifteen years (as well as allowing for population change), five-year increases in the range 12 to 16 percent may be called for.

The age patterns of utilization vary among categories of physicians. The rates for all services combined generally rise with age but turn down at the very oldest ages. That is true also of many of the individual specialist categories, although for General Practice the rising trend continues to the end. These variations of utilization patterns are reflected in the projected effects of population change: general growth of the population drives up the requirements in all categories but the differential effects of aging produce a wide range of variation among them.

Men predominate in the physician population, accounting for 70 percent in General Practice in 2001 (based on fee-for-service practitioner data) and 73 percent overall. But the proportion of women has risen in recent decades and will no doubt continue to rise. That trend is evident in the differences between male and female age distributions: women are younger, on

average, and represent a much larger fraction of the under-40 physician population. A comparison with the Ontario labour force at large shows men to be a few years older than in other occupations when allowance is made for differences in length of training period and age of entry, while women are roughly similar in average age to the nonphysician female labour force. Women in the physician population tend also to have shorter work weeks than men, as seen by comparisons of full-time equivalency numbers with corresponding head counts. Male physicians are thus closer now to normal retirement age than female physicians, on average, and their retirements may remove from practice proportionately larger shares of full-time equivalents.

We have estimated that of the population of physicians active in 2001, about 91 percent will still be active in 2006, and about 81 percent in 2011. Thus about 9 percent will retire or withdraw for other reasons in each five-year period, based on head counts. Based on full-time equivalents the retention proportions are a little higher, the proportions leaving a little lower. To bring the numbers closer to the present, a rough calculation suggests that about 9 or 10 percent of the 2005 physician population will withdraw (stop practising completely, that is) in the next five years. That is based on head counts; a similar calculation based on full-time equivalents would allow for reduced work weeks of older physicians, and would be a slightly lower.

There is much talk about the effects of population aging on future requirements. Under our standard ("best guess") demographic assumptions, and holding constant the physician services utilization rates, we estimate that aging will account for a little less than one-third of the demographically induced increase between 2001 and 2011, population growth for a little over two thirds. The projected proportion due to aging rises thereafter but in none of the seven alternatives does it exceed the proportion due to growth. Moreover, the overall projected

increase in requirements is in no case as great as the estimated demographically induced increase in 1981-1991, and never more than a little greater than the 1991-2001 increase. This provides some perspective on the increases that we have calculated, and the future role of population aging.

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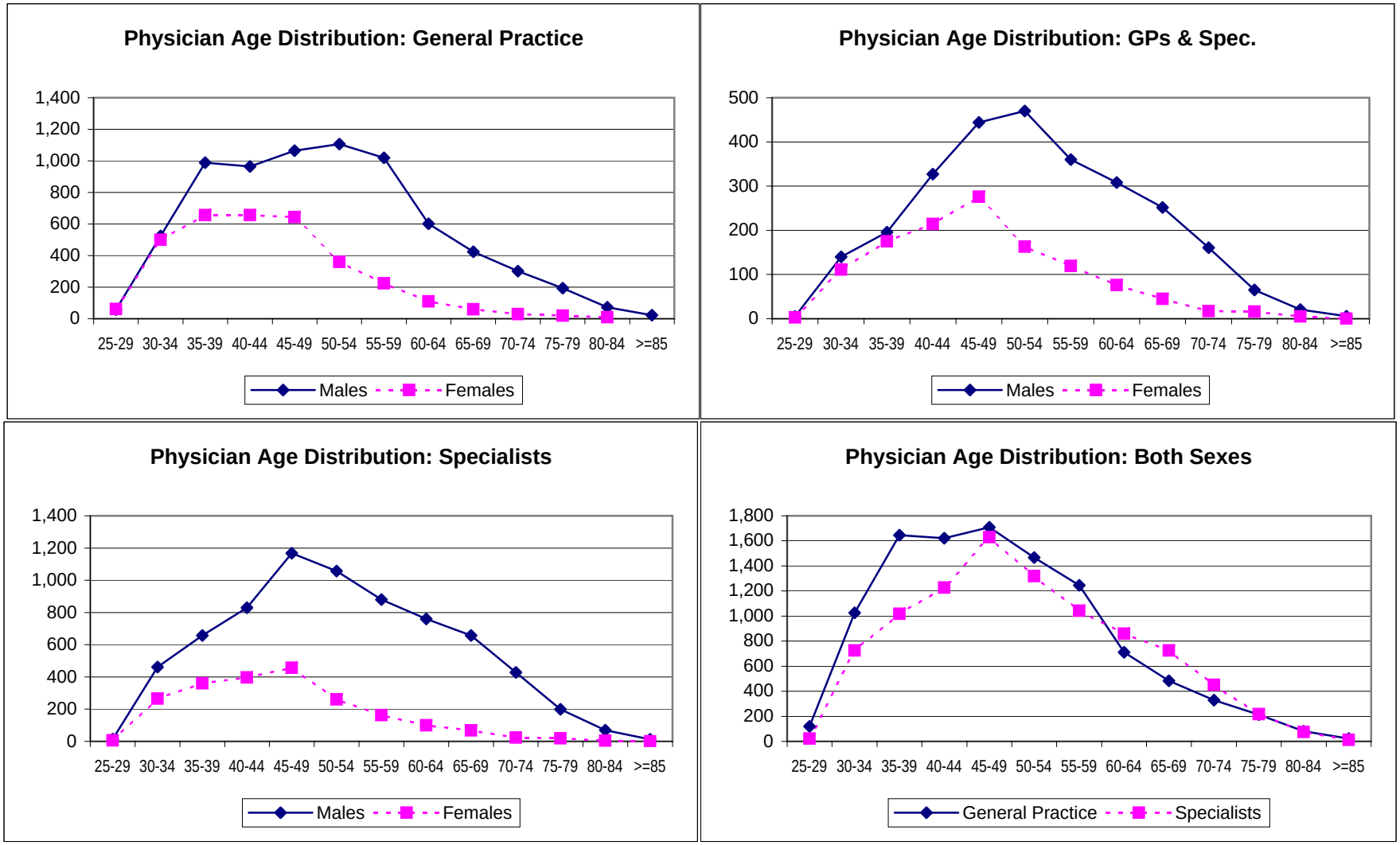
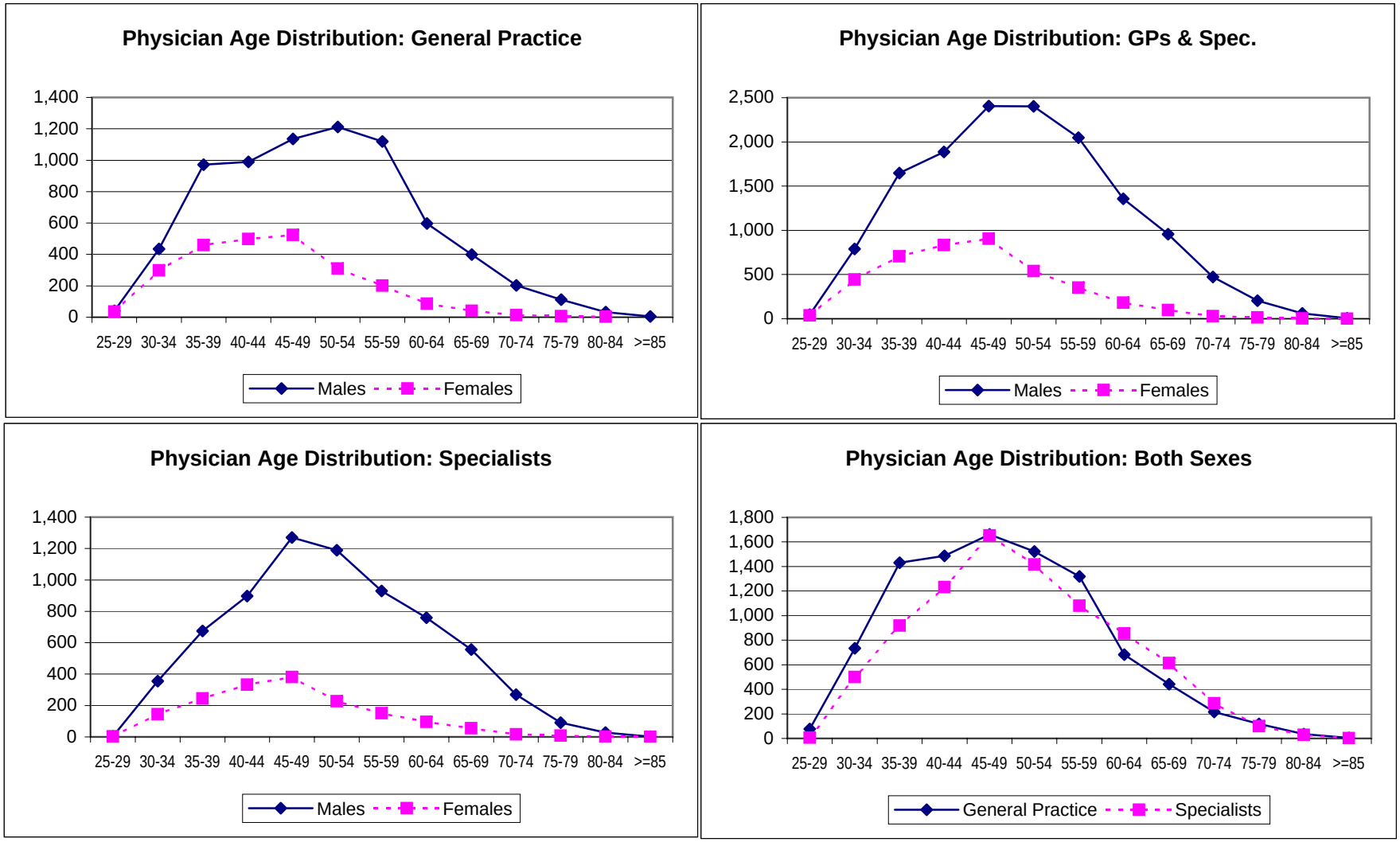
Figure 1: Age Distributions of the Active Physician Population: Head Counts



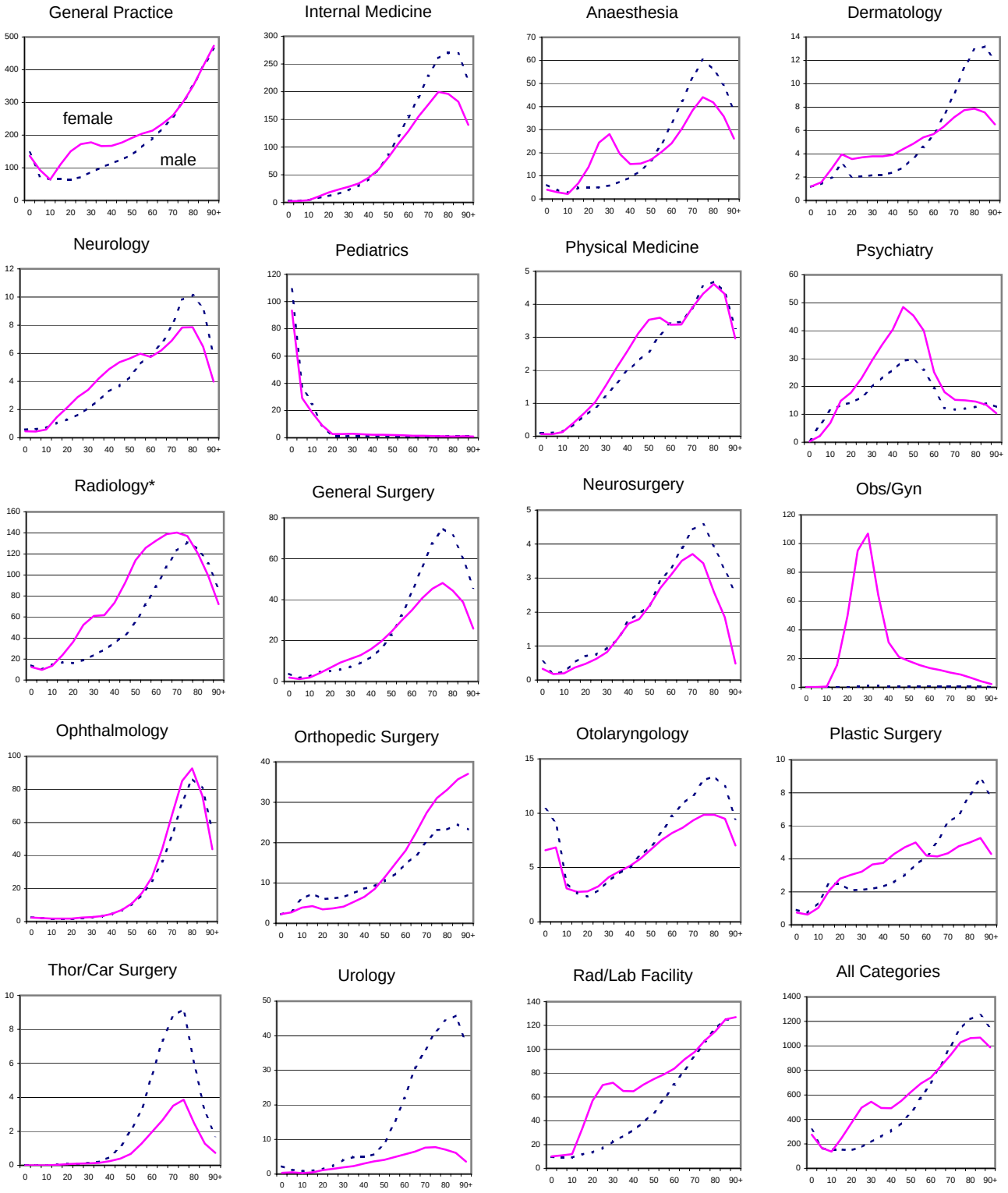
Note: See note to Table 3.

Figure 2: Age Distributions of the Active Physician Population: Full-Time Equivalents



Note: See note to Table 3.

Figure 3: Age Profiles of the Utilization of Physician Services (Fee Payments per Capita), by Category of Physician: Ontario, 2001



Note: Five-year age groups are indicated on the horizontal axis: 0 for 0-4, 5 for 5-9, etc.; the oldest group is 90+. Fee payments per capita (in dollars) are shown on the vertical axes. *To facilitate presentation, the category Radiology includes Laboratory.

Figure 4: Projected Percentage Increases in Requirements for Physician Services by Category of Physician, 2001 to 2031, Based on 2001 Utilization Profiles

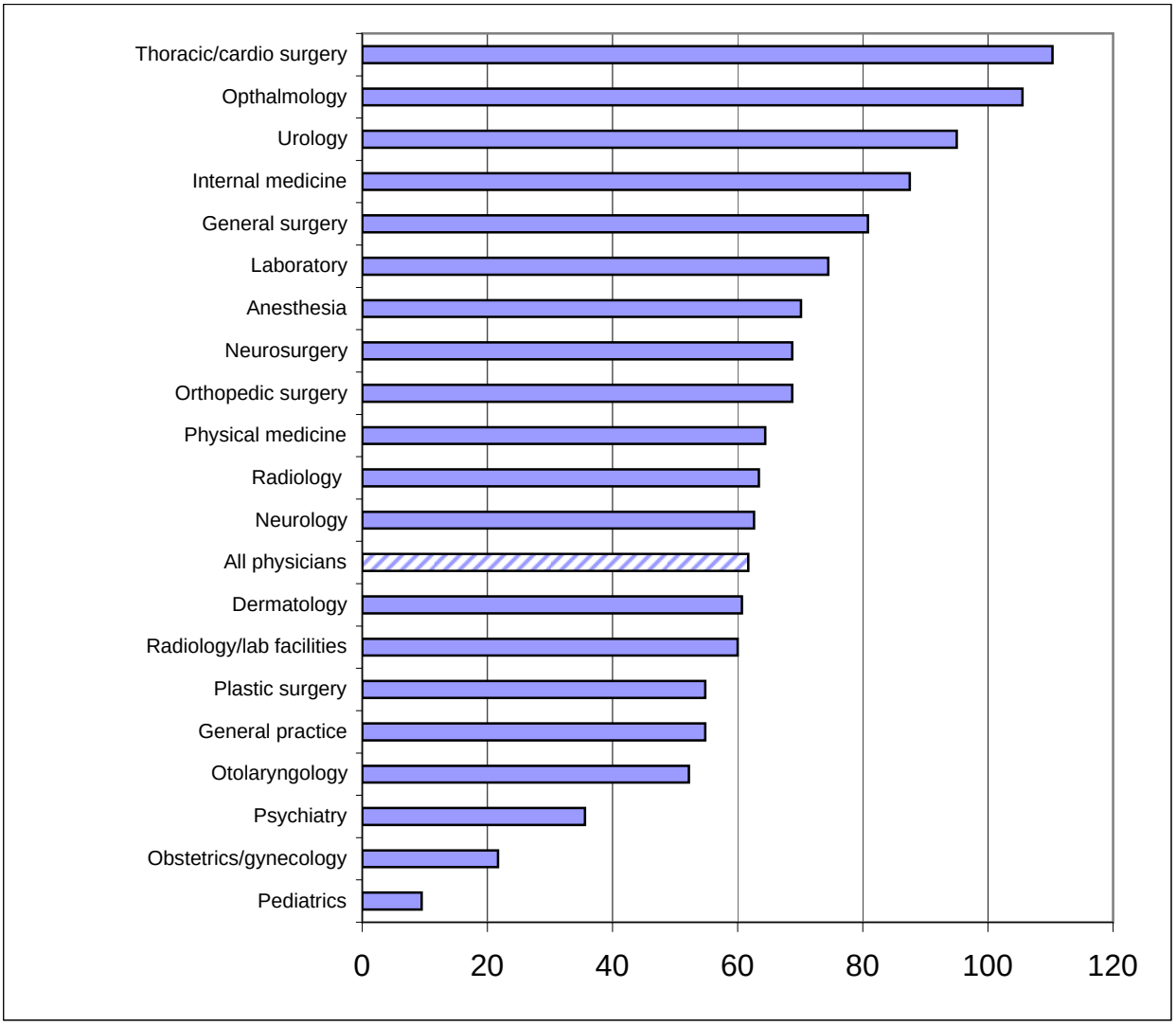


Table 1: The Population of Ontario and Selected Characteristics: Historical and Projections to 2031

	Population ('000)	% under 20	% 20-64	% 65+	% 85+	Support ratios	
						Total pop/LF	Pop 65+/LF
Actual population							
1951	4,685	33.8	57.5	8.7	0.5	2.45	0.20
1961	6,354	39.2	52.7	8.1	0.5	2.52	0.20
1971	7,849	37.7	54.0	8.3	0.6	2.31	0.19
1981	8,811	31.1	59.0	9.9	0.8	1.92	0.19
1991	10,428	26.9	61.5	11.6	1.0	1.88	0.22
2001	11,898	26.2	61.3	12.5	1.3	1.88	0.24
Projection 1 (Standard)							
2011	13,474	23.0	63.2	13.8	1.8	1.78	0.25
2021	14,934	20.8	61.6	17.6	2.0	1.83	0.32
2031	16,185	20.1	57.6	22.2	2.5	1.93	0.43
Projection 2 (Higher Mortality)							
2011	13,459	23.0	63.3	13.7	1.7	1.78	0.24
2021	14,847	20.9	61.9	17.2	1.9	1.82	0.31
2031	15,975	20.4	58.2	21.5	2.3	1.91	0.41
Projection 3 (Lower Mortality)							
2011	13,481	23.0	63.2	13.8	1.8	1.78	0.25
2021	14,982	20.7	61.5	17.8	2.1	1.83	0.32
2031	16,340	20.0	57.2	22.8	2.7	1.94	0.44
Projection 4 (Higher Fertility)							
2011	13,594	23.7	62.7	13.7	1.8	1.79	0.25
2021	15,497	23.7	59.4	16.9	2.0	1.89	0.32
2031	17,368	25.0	54.3	20.7	2.4	2.03	0.42
Projection 5 (Lower Fertility)							
2011	13,422	22.7	63.5	13.9	1.8	1.77	0.25
2021	14,688	19.4	62.7	17.9	2.1	1.80	0.32
2031	15,669	17.8	59.2	23.0	2.6	1.88	0.43
Projection 6 (Higher Immigration)							
2011	13,652	23.1	63.3	13.7	1.7	1.78	0.24
2021	15,437	21.1	61.8	17.1	2.0	1.82	0.31
2031	17,033	20.5	58.1	21.4	2.4	1.91	0.41
Projection 7 (Lower Immigration)							
2011	13,297	22.9	63.2	13.9	1.8	1.78	0.25
2021	14,432	20.5	61.5	18.1	2.1	1.84	0.33
2031	15,338	19.8	57.1	23.1	2.7	1.95	0.45

Table 2: Number of Physicians and Population/Physician Ratios, 1981 to 2003

	Population ('000)	Age effects index	Adjusted population (pop. x index)	Number of active physicians	Population/physician ratio	
					Using unadjusted Population	Using adjusted population
1981	8,811	0.923	8,133	13,999	629	581
1982	8,922	0.929	8,289	14,550	613	570
1983	9,042	0.935	8,454	15,065	600	561
1984	9,172	0.940	8,622	15,466	593	557
1985	9,298	0.945	8,786	16,241	572	541
1986	9,438	0.950	8,966	16,860	560	532
1987	9,644	0.953	9,191	17,688	545	520
1988	9,842	0.956	9,409	18,659	527	504
1989	10,108	0.958	9,683	19,568	517	495
1990	10,298	0.962	9,907	19,737	522	502
1991	10,428	0.968	10,094	20,056	520	503
1992	10,570	0.971	10,263	20,403	518	503
1993	10,688	0.975	10,421	20,738	515	503
1994	10,818	0.978	10,580	20,525	527	515
1995	10,950	0.982	10,753	20,407	537	527
1996	11,083	0.985	10,917	20,209	548	540
1997	11,228	0.988	11,094	20,194	556	549
1998	11,367	0.991	11,265	20,460	556	551
1999	11,506	0.995	11,449	20,701	556	553
2000	11,685	0.997	11,650	21,176	552	550
2001	11,898	1.000	11,898	21,482	554	554
2002	12,097	1.004	12,145	21,735	557	559
2003	12,238	1.010	12,361	21,738	563	569

Note: Physician numbers are taken from the Southam Medical Data Base and include physicians in clinical and non-clinical practice.

Table 3: The Active Physician Population in 2001, by Age Characteristics, Sex and Type of Practice: Head Counts

	Number	Median Age	Age distribution (%)			
			Under 40	40-54	55-64	65+
Both sexes						
All physicians	20,162	48.9	22.8	44.8	19.3	13.1
General practice	10,777	47.7	26.1	44.9	18.3	10.6
Specialists	9,385	50.2	18.9	44.8	20.4	15.9
Males						
All physicians	14,684	51.2	18.6	42.6	22.4	16.4
General practice	7,430	50.3	21.4	42.7	22.1	13.8
Specialists	7,254	52.2	15.7	42.5	22.8	19.0
Females						
All physicians	5,478	44.2	33.9	50.8	10.9	4.3
General practice	3,347	43.4	36.6	49.8	10.0	3.5
Specialists	2,131	45.4	29.8	52.4	12.4	5.4

Note: Physician data are taken from the National Physicians Data Base and include only fee-for-service physicians. Radiology and laboratory medicine are excluded.

Table 4: The Active Physician Population in 2001, by Age Characteristics, Sex and Type of Practice: Full-Time Equivalents

	Number	Median Age	Age distribution (%)			
			Under 40	40-54	55-64	65+
Both sexes						
All physicians	18,429	49.3	19.9	48.7	21.4	10.0
General practice	9,737	48.4	23.0	48.0	20.6	8.4
Specialists	8,693	50.1	16.4	49.5	22.3	11.9
Males						
All physicians	14,289	50.8	17.4	46.9	23.8	11.9
General practice	7,259	50.2	20.0	46.0	23.6	10.4
Specialists	7,030	51.3	14.7	47.8	24.0	13.5
Females						
All physicians	4,140	45.3	28.7	54.9	12.9	3.5
General practice	2,477	44.5	32.0	53.8	11.6	2.6
Specialists	1,663	46.4	23.7	56.6	14.8	4.9

Note: See note to Table 3.

Table 5: The Active Physician Population in 2001, by Age Characteristics, Sex and Type of Practice: Full-Time Equivalency Ratios (FTEs/Head Counts)

	All ages	Under 40	40-54	55-64	65+
Both sexes					
All physicians	0.91	0.80	0.99	1.01	0.70
General practice	0.90	0.80	0.97	1.01	0.72
Specialists	0.93	0.80	1.02	1.01	0.69
Males					
All physicians	0.97	0.91	1.07	1.03	0.71
General practice	0.98	0.91	1.05	1.05	0.74
Specialists	0.97	0.90	1.09	1.02	0.69
Females					
All physicians	0.76	0.64	0.82	0.89	0.62
General practice	0.74	0.65	0.80	0.86	0.54
Specialists	0.78	0.62	0.84	0.94	0.71

Note: See note to Table 3.

Table 6: Median Ages of Active Physicians in 2001 Compared with Median Ages of the General Population and Labour Force

	Active physician population			General population	General labour force
	All physicians	General practice	Specialists		
Both sexes					
All ages	48.9	47.7	50.2	36.7	38.8
Ages 35+	50.4	49.4	51.6	51.4	46.0
Ages 35-74	49.8	48.9	51.0	49.4	46.0
Ages 35-64	48.3	47.7	49.0	47.0	45.7
Males					
All ages	51.2	50.3	52.2	35.9	39.1
Ages 35+	52.5	51.6	53.3	50.7	46.3
Ages 35-74	51.8	51.0	52.7	49.2	46.3
Ages 35-64	49.7	49.3	50.1	46.9	45.8
Females					
All ages	44.2	43.4	45.4	37.5	38.5
Ages 35+	46.1	45.6	46.8	52.1	45.7
Ages 35-74	45.3	45.1	45.5	49.5	45.7
Ages 35-64	45.2	45.0	45.5	47.1	45.5

Note: See note to Table 3.

Table 7: Aging and Withdrawal: Projections of the 2001 Active Physician Population as It Grows Older

	Head counts			Full-time equivalents		
	Number remaining	% remaining		Number remaining	% remaining	
		From 2001	Previous 5 years		From 2001	Previous 5 years
All physicians						
2001	20,162	100.0	--	18,429	100.0	--
2006	18,295	90.7	90.7	17,037	92.4	92.4
2011	16,246	80.6	88.8	15,064	81.7	88.4
2016	13,953	69.2	85.9	12,621	68.5	83.8
2021	11,448	56.8	82.1	9,893	53.7	78.4
2026	8,831	43.8	77.1	7,088	38.5	71.6
2031	6,282	31.2	71.1	4,546	24.7	64.1
General practice						
2001	10,777	100.0	--	9,737	100.0	--
2006	9,898	91.8	91.8	9,147	93.9	93.9
2011	8,926	82.8	90.2	8,258	84.8	90.3
2016	7,784	72.2	87.2	7,044	72.3	85.3
2021	6,490	60.2	83.4	5,622	57.7	79.8
2026	5,090	47.2	78.4	4,097	42.1	72.9
2031	3,678	34.1	72.3	2,668	27.4	65.1
Specialists						
2001	9,385	100.0	--	8,693	100.0	--
2006	8,398	89.5	89.5	7,890	90.8	90.8
2011	7,321	78.0	87.2	6,806	78.3	86.3
2016	6,169	65.7	84.3	5,577	64.2	81.9
2021	4,958	52.8	80.4	4,271	49.1	76.6
2026	3,740	39.9	75.4	2,991	34.4	70.0
2031	2,604	27.7	69.6	1,879	21.6	62.8

Note: See note to Table 3.

Table 8: Indexes of Requirements for Physician Services by Category of Physician Based on 2001 Utilization Profiles: Projections to 2031

	2001	2006	2011	2016	2021	2026	2031
All physicians	100.0	109.6	119.8	130.4	141.3	151.9	161.7
General practice	100.0	108.8	117.9	127.3	136.7	146.0	154.8
Specialists	100.0	110.0	120.7	132.0	143.7	155.0	165.2
Anesthesia	100.0	109.8	120.8	133.0	146.0	158.8	170.1
Dermatology	100.0	109.6	119.4	129.4	139.8	150.5	160.7
General surgery	100.0	111.7	124.5	138.5	153.3	167.8	180.8
Internal medicine	100.0	112.5	126.3	141.2	157.1	172.9	187.5
Laboratory	100.0	112.0	125.2	139.0	152.5	164.5	174.5
Neurology	100.0	110.4	120.8	131.3	142.1	152.8	162.6
Neurosurgery	100.0	111.0	122.5	134.7	147.2	158.9	168.7
Obstetrics/gynecology	100.0	104.4	110.0	115.5	119.5	121.4	121.7
Opthalmology	100.0	112.3	126.0	142.2	161.8	183.9	205.5
Orthopedic surgery	100.0	110.5	121.3	132.7	144.7	157.0	168.7
Otolaryngology	100.0	107.8	116.3	125.5	135.1	144.3	152.2
Pediatrics	100.0	98.7	100.2	103.1	106.6	109.0	109.5
Physical medicine	100.0	111.2	122.2	133.0	143.9	154.6	164.4
Plastic surgery	100.0	109.7	119.2	128.5	137.4	146.3	154.8
Psychiatry	100.0	109.1	116.6	122.4	127.2	131.5	135.6
Radiology/lab facilities	100.0	109.9	120.2	130.5	140.8	150.8	160.0
Radiology	100.0	110.5	121.5	132.6	143.7	154.3	163.4
Thoracic/cardio surgery	100.0	113.3	129.6	149.3	171.4	192.9	210.3
Urology	100.0	112.3	126.6	142.9	160.7	178.7	195.0

Note: Projections of requirements are based on population projection 1, as summarized in Table 1. Utilization profiles are derived from 2001 census population data and data in the National Physicians Data Base.

Table 9: Requirements for Physicians and Available Supply Based on Alternative Shortage Assumptions: Projections to 2016

	2001	2006	2011	2016
If no shortage --				
Total requirements	21,482	23,544	25,735	28,013
Total supply	21,482	23,544	25,735	28,013
5-year increase -- number		2,062	2,191	2,277
-- %		9.6	9.3	8.8
If 5% shortage --				
Total requirements	22,613	24,783	27,090	29,487
Shortage eliminated by 2011				
Total supply	21,482	24,164	27,090	29,487
5-year increase -- number		2,682	2,926	2,397
-- %		12.5	12.1	8.8
Shortage eliminated by 2016				
Total supply	21,482	23,957	26,639	29,487
5-year increase -- number		2,475	2,681	2,848
-- %		11.5	11.2	10.7
If 10% shortage --				
Total requirements	23,869	26,160	28,595	31,125
Shortage eliminated by 2011				
Total supply	21,482	24,852	28,595	31,125
5-year increase -- number		3,370	3,743	2,530
-- %		15.7	15.1	8.8
Shortage eliminated by 2016				
Total supply	21,482	24,416	27,642	31,125
5-year increase -- number		2,934	3,226	3,483
-- %		13.7	13.2	12.6

Note: Elimination of a shortage takes place uniformly over the elimination period, in percentage terms. Elimination of a 5% shortage by 2011 assumes the shortage is reduced to 2.5% by 2006, for example. The number of physicians in 2001 is a head count from the Southam Medical Data Base and includes physicians in clinical and non-clinical practice.

Table 10: The Effects of Population Change on the Requirements for Physicians: Historical and Projections to 2031

	Index of requirements (2001=100)	10-Year growth rate (%)		
		Total	Resulting from	
			population growth	population aging
Actual population				
1981	68.4	--	--	--
1991	84.8	24.0	18.8	5.2
2001	100.0	17.9	14.3	3.6
Projection 1 (Standard)				
2011	119.8	19.8	13.6	6.2
2021	141.3	18.0	11.2	6.8
2031	161.7	14.4	8.6	5.8
Projection 2 (Higher Mortality)				
2011	119.5	19.5	13.5	6.0
2021	139.8	16.9	10.6	6.3
2031	157.8	12.9	7.8	5.1
Projection 3 (Lower Mortality)				
2011	119.9	19.9	13.7	6.2
2021	142.1	18.5	11.5	7.0
2031	164.6	15.8	9.3	6.4
Projection 4 (Higher Fertility)				
2011	120.5	20.5	14.6	5.8
2021	143.8	19.3	14.3	5.0
2031	166.4	15.7	12.3	3.5
Projection 5 (Lower Fertility)				
2011	119.5	19.5	13.2	6.3
2021	140.2	17.3	9.8	7.6
2031	159.6	13.8	6.9	6.9
Projection 6 (Higher Immigration)				
2011	121.0	21.0	15.1	5.8
2021	144.9	19.7	13.5	6.3
2031	168.2	16.1	10.6	5.5
Projection 7 (Lower Immigration)				
2011	118.6	18.6	12.1	6.5
2021	137.7	16.1	8.8	7.3
2031	155.2	12.7	6.5	6.2

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