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The youth of today are sickening: Implications of age and cohort effects in health and service use for NHS planning

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Abstract

NHS workforce planners currently utilise models that apply current provider-to-population ratios to projections of future populations. This assumes that current provider-to-population ratios are appropriate and that needs per capita will not change over time. In this paper, we describe the needs-based analytical framework of Birch et al. (2007) and present our own application of the needs-based model to plan for future use of outpatient and GP services in England under different scenarios until 2033. We find that the number of people with a limiting longstanding illness is set to rise by 25% by 2033 and that there have been no changes in LLSI prevalence between cohorts post-1930. At current rates of expansion in service use this would lead to an increase of 23% in outpatient service volumes and 42% in GP consultations by 2033. This will need to be met by increasing inputs, reducing needs-adjusted service requirements and/or productivity.

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Introduction

Typically, workforce planners utilise models which express the requirement for services simply as a function of the size of the projected population (Birch et al. 2007). Sometimes this is refined by reference to projections for a particular age group such as the over-65s. The Centre for Workforce Intelligence, for example, use projected numbers of people in ‘the groups which rely most heavily’ on given specialties to forecast consultant numbers by specialty (Centre for Workforce Intelligence 2010).

This approach does not explicitly model any other potential determinants of the requirement for health care workers. There are at least three fundamental problems with this approach:

- (i) Age is used as an implicit measure of need, which does not allow for changes in need at the same age over time.
- (ii) The model does not account for planned changes to the level of service to be provided. For example, failure to take account of deliberate government policies to increase service provision will result in an underestimation of worker requirements.
- (iii) No account is taken of changes in the amount of labour input required for producing services over time.

Workforce planning requires the use of models that incorporate determinants of provider requirements above and beyond the age structure of the population. Birch et al. (2007) proposed a ‘need-based model’ for workforce planning. Their approach explicitly models important components of the future need for health care workers.

The model expresses provider requirements as a function of two elements – supply side/production and ‘demand’ side/need for services. The production of services has just one component, labour productivity, whereas the need for services has three components: demography; epidemiology; and service levels.

In this paper we focus on the need for services element of workforce planning. We begin by describing the needs-based model and contrasting it with the simple ‘constant provider-to-population ratio’ model used for the NHS in England. We then use data covering a thirty-one year period from the General Household Survey, and the methods proposed by Deaton (1997) for distinguishing age, cohort and time effects, to create projections of the number of people with a limiting longstanding illness until 2033. We find that these numbers are set to rise

substantially because the inter-cohort reductions in illness observed between 1890 and 1930 have ceased. Consequently, the cohorts that will reach the older ages over the next twenty years are just as likely to have an illness at these ages as those born in 1930. We examine whether this is due to selection caused by reduced mortality among those with illnesses compared to earlier cohorts but find a small negative effect of survival rates on illness prevalence.

The effect of the projected increases in numbers with chronic conditions on the total volume of services required depends on decisions about service provision for those with and without chronic conditions. We illustrate the effects on projected service requirements of applying service provision levels from three periods: the late-eighties; the early-nineties; and the mid-noughties. Decisions about service provision levels within these possibilities are less important than the projected rise in illness. As a final exercise, we use Deaton's method to project the volume of services based on age and cohort effects. These projections are considerably higher than would be generated by the projected illness burden because the volume of services used by later cohorts is substantially higher than earlier cohorts at the same age.

Models for Workforce Planning

The simple 'constant provider-to-population ratio' approach to workforce planning can be written algebraically as:

$$L_{t+x}^r = P_{t+x} \left(\frac{L}{P} \right)^* = P_{t+x} \left(\frac{L_{t=0}}{P_{t=0}} \right) \quad (\text{A})$$

in which: L_{t+x}^r is the required number of workers at time $t + x$; P_{t+x} is the size of the population at time $t + x$; and $\left(\frac{L}{P} \right)^*$ is the target ratio of workers to population which is usually assumed to be the current value. Changes in the projected population captures the size and age structure of the population and changes to the distribution over time as a consequence of increasing life expectancy across ages, changes in net migration and birth rates. This is the only variable that influences worker requirements.

By contrast, the needs based planning model can be expressed as:

$$L_{t+x}^r = H_{t+x} \left(\frac{Q}{H} \right)^* \left(\frac{L}{Q} \right)^* = P_{t+x} \left(\frac{H_{t+x}}{P_{t+x}} \right) \left(\frac{Q}{H} \right)^* \left(\frac{L}{Q} \right)^* \quad (\text{B})$$

where the terms on the right hand side represent separate determinants of worker requirements:

- (i) H_{t+x} represents the total volume of health at time $t + x$. As population size and demographic composition are projected separately from health levels, it is customary to express H_{t+x} as the product of P_{t+x} and average health status at time $t + x$: $\left(\frac{H_{t+x}}{P_{t+x}}\right)$.
- (ii) $\left(\frac{Q}{H}\right)^*$ represent the level of services that the NHS plans to provide. It is expressed with respect to health to ensure that future needs are reflected in planned service levels. Increasing service levels for a particular health group will, ceteris paribus, increase worker requirements.
- (iii) $\left(\frac{L}{Q}\right)^*$ is the target number of workers per unit of service provision. It represents the reciprocal of labour productivity.

Data

Demography

Population estimates and population projections produced by the ONS by single year of age, gender and year of observation provide the demographic component of (B) P_t for the subsequent analysis. Population projections forecast characteristics and sizes of populations in the future based on assumptions regarding mortality, fertility and migration. Estimating mortality, fertility and particularly migration can be problematic.

Epidemiology

Data on limiting longstanding conditions is taken from the General Household Survey (1979-2008). The GHS is an annual, nationally representative survey of over 20,000 individuals living in private households in Great Britain. Respondents are interviewed in their own homes and provide information on demographic and socio-economic characteristics (including income), health status, health care utilisation and lifestyles.

There are no GHS data for 1997 and 1999. For the analyses in this paper, we use data on the following GHS variables: gender; age in survey-year; year-of-birth; presence of a limiting longstanding illness; and whether the respondent reports attendance in the last 3 months at a casualty or outpatient department at a hospital.

Respondents to the GHS are asked: “Do you have any longstanding illness, disability or infirmity? By longstanding I mean anything that has troubled you over a period of time or that is likely to affect you over a period of time.” If so, they were further asked whether it ‘limited their activities in any way?’ Combined responses to these questions are used to generate a binary measure of health status - limiting longstanding illness (LLSI).

We use limiting longstanding illness as a simple indicator of higher health care needs H_j . This measure has been widely used for this purpose and in preliminary analyses we confirmed that, in each year of the GHS, persons aged 75 years and over reporting a limiting longstanding illness had over twice the level of health care utilisation of those of the same age not reporting a limiting longstanding illness.

Service Levels

For the purpose of this example, we also make use of a simple service utilisation variable. Respondents to the GHS are asked whether they attended a casualty or outpatient department at a hospital in the preceding 3 months. The utilisation variable is an imperfect indicator of health care utilisation as it is a measure of the incidence of use as opposed to the quantity, type or quality of service used. For example, it fails to distinguish between individuals who have used a resource once in a certain time period and individuals with multiple visits.

We do not incorporate productivity in our analysis: we estimate service requirements as opposed to provider requirements. We provide an overview of the implications of omitting productivity in the discussion section.

Methods

The GHS is a time series of cross sections. We use these data to follow cohorts of individuals over time in which cohorts are defined by the year of birth. For example, we can observe the proportion of individuals reporting a limiting longstanding illness aged 60 in the 1986 survey, aged 61 years in the 1987 sample, aged 62 years in the 1988 survey, and so on. These cell means, because they relate to the same group of individuals, retain many of the properties of panel data - as there are many cohorts observed at any one time, cohort data are richer and more varied than aggregate data (Deaton 1997). Measures of health status decrease as age increases but the health profiles of consecutive cohorts may differ from previous cohorts. Changes in socio-economic conditions, working conditions, environmental conditions and

cultural attitudes to health, diet and fitness may have important roles to play in determining health. It would seem likely that these conditions and attitudes vary across cohorts.

Cohort data and genuine panel data can be considered time series of observations in which the unit of analysis is the birth cohort and the individual respectively. We can observe distributions within cohorts at a single point in time but we are not able to observe the joint distributions of a variable over multiple periods. Thus, there is some loss of information in cohort data as compared to panel data as we cannot observe dynamics within cohorts. However, cohort methods offer another way of controlling for unobservable fixed effects when panel data are unavailable which can be an important advantage (Deaton 1997).

Cohort methods have some advantages over alternatives. As cell means are analysed, measurement error in the variables of interest may be reduced as averaging enhances the signal-to-noise ratio (Deaton 1997). Thus, cohort methods can be considered as an instrumental variables approach in which the instruments are grouping variables whose application averages away measurement error (Deaton 1997). Furthermore, as the unit of analysis is simply the birth cohort, richer analysis is possible by combining datasets.

Estimating average health status

There are various specifications that can be proposed when assessing the separate effects of age, year of birth and year of observation on health status and service use. We have decided to use dummy variables for each single year of age, single year of birth and single year of observation:

$$\left(\frac{H}{P}\right)_j^t = \alpha + \sum_{k=2}^K \beta_k a_k + \sum_{t=3}^T \sigma_t \delta_t^* + \sum_{v=2}^V \lambda_v \pi_v + \varepsilon_{jt} \quad (1)$$

where $\left(\frac{H}{P}\right)_j^t$ is the average level of limiting longstanding illness in cell age j in year t ; α is a constant across all groups and periods; $\sum_{k=2}^K \beta_k a_k$ is a set of $(K - 1)$ age dummies (one reference category is dropped); $\sum_{t=3}^T \sigma_t \delta_t^*$ are year effects; $\sum_{v=2}^V \lambda_v \pi_v$ are cohort dummies and ε_{jt} is an idiosyncratic error term.

Using a large set of dummy variables in this way allows the data to choose any pattern rather than imposing a certain functional form on the data by, for example, using a polynomial function to model age effects. The year effects are set up so as to capture cyclical fluctuations that average to zero in the long run (Deaton 1997). Thus, our model attributes changes to

health status and service use to age and cohort effects. This normalisation is achieved by making the year effects orthogonal to a time trend:

$$\delta_t^* = \delta_t - [(t-1)\delta_2 - (t-2)\delta_1] \quad t = 3, \dots, T \quad (2)$$

where δ_t takes on the value 1 in a particular year and 0 otherwise. The above procedure enforces the restriction that the year effects are orthogonal to a time trend in addition to the restriction that the year effect sum to zero (Deaton 1997). This methodology requires sufficient years and observations to allow a decomposition of the trend and transitory shocks.

We assume that the final predicted cohort effect from (1), $\hat{\lambda}_V$, is appropriate for new (not yet born) cohorts. Consequently, predicted health needs of future generations are given by:

$$\left(\frac{H}{P}\right)_j^t = \hat{\alpha} + \sum_{k=2}^K \hat{\beta}_k a_k + \hat{\lambda}_V \quad (3)$$

We also analyse mortality rates as a function of age, year and cohort:

$$m_j^t = \alpha + \sum_{k=2}^K \beta_k a_k + \sum_{t=3}^T \sigma_t \delta_t^* + \sum_{v=2}^V \lambda_v \pi_v + \varepsilon_{jt} \quad (4)$$

where m_j^t is the mortality rate for cell aged j at time t .

Changes to mortality rates over time may have impacted on the proportion of the living population reporting limiting longstanding illnesses. We test for the effects of the cumulative survival rate on the prevalence of limiting conditions:

$$\left(\frac{H}{P}\right)_j^t = \alpha + \theta s_j^t + \sum_{k=2}^K \beta_k a_k + \sum_{t=3}^T \sigma_t \delta_t^* + \sum_{v=2}^V \lambda_v \pi_v + \varepsilon_{jt} \quad (5)$$

where s_j^t is the proportion of individuals that were born that are still alive at time t . The results of this analysis may provide a partial explanation regarding potential changes of the observed changes in illness between cohorts.

There are competing hypotheses regarding the effects of decreases in mortality rates on the health needs of the population. The competing hypotheses regarding how mortality changes impact on health needs have different expectations of the sign on the parameter θ . If the distribution of population health has shifted to high levels of health, this would imply that we will have lower mortality and lower population health needs (Figure 5). We would expect the parameter θ to be negative if this were the case. If we are simply decreasing the minimum

level of health at which individuals can remain alive (Figure 6) then we would expect the parameter θ to be positive as decreasing mortality is increasing the population health burden. Figures 5 and 6 geometrically depict the result:

$$[f^1(H_{ill}) - f^1(H_{min})] < [f(H_{ill}) - f(H_{min}^1)] \quad (6)$$

A combination of these effects would make the sign unpredictable.

Estimating planned level of services by health status group

Variation across age only occurs due to age projections: $\hat{\lambda}_v$ and $\hat{\alpha}$ are constant to all. By using age effects from a regression of (1), we adjust for any bias on our age estimates brought about by failing to model cohort effects. This approach not only strips out any correlated cohort effects but also captures more accurate age effects than regressions on age alone would.

To convert projected levels of morbidity into levels of planned service requirements we need a set of quantity weights. We estimate the probability of reporting an outpatient visit in the prior two weeks for individual i , age j at time t :

$$Q_{ijt} = \kappa_{jt} + \psi_{jt}H_{ijt} + e_{ijt} \quad (7)$$

we estimate equation (6) for three three-year periods: 1979-1981, 1992-1994 and 2004-2006. As H_{ijt} is a binary indicator for needs (limiting longstanding illness), $\hat{\kappa}_{jt^*}$ will be planned total service use for respondents without limiting longstanding illness in cell age j in year t if they had service use patterns as at time t^* , and conversely $\hat{\kappa}_{jt} + \hat{\psi}_{jt}$ will be predicted service use for respondents with limiting longstanding illness in cell age j in year t .

Thus, our model will predict the required volume of services for three different scenarios that reflect patterns of service use per unit of need at different points in time as follows:

$$L_{t+x}^r = P_{t+x} \left(\frac{H_{t+x}}{P_{t+x}} \right) \left(\frac{Q}{H} \right)^* \quad (C)$$

Thus we can estimate the required volume of services over time based on the parameter estimates of our models of service use and health needs, population estimates and population projections. The expression $2\hat{\kappa}_{jt} + \hat{\psi}_{jt}$ (the sum of the planned volume of services for the two health status subgroups) will be estimated three times for different subsamples as

previously stated and thus we will have three different projections of required service volumes over time.

For comparative purposes, we also estimate the following model of service use which attributes changes in average service levels to age, cohort effects and idiosyncratic year effects with zero expectation:

$$\left(\frac{Q}{P}\right)_j^t = \alpha + \sum_{k=2}^K \beta_k a_k + \sum_{t=3}^T \sigma_t \delta_t^* + \sum_{v=2}^V \lambda_v \pi_v + \varepsilon_{jt} \quad (8)$$

We use robust standard errors in all regression analyses to adjust for the effects of heteroskedasticity. The reference category for the age dummies is aged 45 and the reference category for the cohort dummies is the birth cohort born in 1930.

Results

Health Needs

Figure 1 presents the results for limiting longstanding illness. The top left panel shows lowest estimates of how the illness proportion changes with age for birth cohorts born five years apart. The remaining three panels show how the health variable is decomposed into an age effect, a birth cohort effect and year effects using equation (1).

The probability of reporting a limiting longstanding illness is an increasing function of age. The rate at which the probability of reporting a limiting longstanding illness increases with age is high during infancy (aged 4 and under) and decreases thereafter until older ages (55 and older). The variation in the rates at which the probability of reporting a limiting longstanding illness increases with age suggests that the relationship is non-linear. The age effects are all strongly statistically and large in magnitude, with parameter estimates greater than 0.35 compared to the reference category (age=45) at older ages.

The year effects are modelled as random fluctuations and thus have a mean and expectation of zero. The strongest year effect is 0.03 in 1996 which is still small (relative to the age effects). Around one third of the year dummies are statistically insignificant. The main purpose of including year dummies was to capture certain macroeconomic events that may have been correlated with being a given age in a given year.

The cohort effects show that the eldest cohorts in our sample had higher levels of limiting longstanding illness than their more recent counterparts even when adjusting for the effects of

ageing. This result suggests that needs by age are not constant over time. More recent cohorts (at the same age) are in better health. The earliest observed birth year is 1889, and the parameter estimates for the dummy variables from 1889 until around 1930 steadily decrease at which point they remain largely flat until the end of our sample. In terms of magnitude, the changes in health in this earlier subsample are approximately equivalent to the effects of five years of ageing. The effects are large (relative to the year effects) prior to 1950 and modest thereafter. An F-test for the joint significance on the parameters $\hat{\lambda}_v$ ($v = 1, \dots, V-1$) yielded a statistic of 2.21 and a p-value less than 0.001 indicating a rejection of the null hypothesis that the parameters are all equal to zero.

We compare our projections of numbers of individuals with limiting longstanding illness with the projected increase in the numbers of individuals aged 65 and over (Table 1). This is one current method applied by workforce planners to forecast needs and it results in an expected growth in needs of almost double as compared to our projections.

Impact of changes in mortality upon population health needs

Figure 2 presents the same analysis for mortality rates. These results are similar to the decomposition of LLSI: mortality rates decreased amongst the earliest observed cohorts in our sample but there is little difference between cohorts born post-1930 after controlling for age and year effects.

We estimated equation (5) to see how the cumulative survival rate of cohorts impacted on the prevalence of LLSI in the cohort after controlling for age, year and cohort effects. We obtained an estimate of -.09 on the parameter θ in (5), with an associated p-value of 0.06 which is marginally insignificant at 5%.

This result suggests that the increase in survival rates across cohorts does not account for the rise in LLSI.

Service use within need groups

Figures 3 and 4 present a decomposition of service use by cohort, year and age effects for GP and outpatient services. Primary care services are an increasing function of age across all ages whereas outpatient service use varies little between ages less than 50. For both GP and outpatient services, more recent cohorts utilise service more compared to their former counterparts.

In estimating service use by health needs (7), we obtained interesting results regarding how age-specific service utilisation rates by needs have changed over time. Table 2 shows that service levels by needs in 1980 did not vary substantially by age. For the subsample reporting a limiting longstanding illness, service use is high at younger ages and declines slightly by age for the remainder of the population. Those without limiting conditions had service use that varies even less by age in 1980. The age gradient in service use by needs was greater in 1993 and increased again by 2005. Clearly, patterns of utilisation by health needs have changed over time.

Using the predicted values yielded by equations (1) and (7) and population projections from the ONS, we predicted (C) from 2009 to 2033. Table 1 shows projected total incidence of outpatient visits under three alternative scenarios: utilisation to need ratios are assumed to be as at levels in 1980, 1993 and 2005. The projected increase in the required volume of services is highest at utilisation-needs ratios in 2005. Under this scenario and comparing to levels in 2008, the required volume of services will increase by 5% by 2014, by 2019 the required volume will increase by 10% and by 2030 service levels will have increased by 20% of their 2008 level. Holding service levels per unit need constant in scenario modelling means that the effects of changes in needs for services can be estimated without concealing some of the effects of these changes through unplanned changes to service levels (Birch et al. 2007).

We also estimated equation (8) which models service use as a function of age, cohort and year effects. Service use is higher amongst more recent cohorts and is an increasing function of age. We then used the parameters from (8) and combined them with population projections to project total service requirements until 2033. It was assumed that future generations will have the same age-specific service use as the most recently observed cohort. Service requirements predicted based on past utilisation are estimated to be 7.5 percent higher in 2033 than for even the predictions yielded for service by need at 2005 levels.

The increase in the requirement for services is driven by the impact of population growth and population ageing on the need for services. The population is projected to grow at an approximately constant rate of 0.66% in the next twenty years and the increasing headcount of the population will increase the required volume of services.

In addition to increases in the total population, the age structure of the population is projected to change. By 2034, 23 percent of the population is anticipated to be aged 65 and over compared to 16 percent in 2008. As a consequence of increases in the quantity of older

people, the median age of the population is increasing. The median age anticipated to continue to increase over the next 25 years - rising to 42 by 2034. As older people tend to have higher health needs, the expected volume of services will be higher than if the population was growing but not ageing. This effect will be ameliorated by cohort effects that predict lower needs in the future than (for example) the mean cohort of our sample, but the age effects dominate, especially because negative cohort effects stop after birth year 1950.

The planned ratio of utilisation to needs has an important impact on the predicted required amount of services. Service requirements in 2025 are 23% higher under the ratio of utilisation to needs as at 2005 than the ratio as at 1980. Service requirements in 2033 are 5% higher under 2005 levels than at 1993 levels. In the absence of explicit policies and management of service levels by need, workforce requirements can easily become self-perpetuating. Reducing per capita needs can be met with increasing services per unit need in order to maintain provider workloads.

Discussion

The results above serve as an illustration of how the needs-based analytical framework explicitly models important determinants of service requirements. However, an important determinant of provider requirements, productivity, was omitted.

Productivity

As shown in the results, different scenarios in the utilisation by needs ratio have a strong impact on requirements and the same applies to the production component of (B). The contribution of productivity to the requirement for providers is likely to be very important in the coming years as the funding prospects for the NHS change in light of the global economic crisis. A recent comparison on likely funding compared to the funding recommended in the Wanless review (Wanless 2004) to make improvements in health services estimated a £21 billion fiscal shortfall in the NHS if productivity does not change over the next parliament or there are no real changes to NHS funding (Appleby et al. 2010). The coalition government have made a commitment to increase NHS funding in real terms year on year and thus over the course of the present parliament this may reduce the expected funding gap by £3 billion. However, to meet a shortfall of £21 billion, the NHS as a whole would need to see year on year productivity gains of 6 percent for six years.

There has been some disagreement as regards how NHS productivity has changed in recent years, with the University of York and the Office of National Statistics producing divergent estimates of productivity change. The mismatch between estimates may be unsurprising; output in health services is known to be very poorly measured with little yet by way of international consistency (Castelli et al. 2007).

Birch et al. (2007) modelled three alternative scenarios for the productivity component of the framework: (i) existing levels of productivity are assumed constant over time; (ii) productivity increases by 0.5 percent per annum; (iii) productivity increases by 0.2 percent per annum. The authors state that these scenarios are conservative estimates of changes to productivity as compared to the economy overall (Birch et al. 2007: 11-12).

Incorporation of alternate scenarios in changes to productivity will be an important improvement for future applications of this framework.

Endogeneity of Service Use

Another limitation of this study concerns the potential endogeneity of service use and health needs. It is possible that service levels have a causal effect on health needs. For example, increased provision of a vaccine may reduce the population health need over time. If service use is not exogenous, then equation (3) may yield biased estimates.

Conclusion

The needs based framework allows decision-makers to explicitly plan workforce numbers. Current use of basic models such as (A) assumes that provider requirements are exclusively determined by the age structure of the population. Whilst age is a strong predictor of health needs, needs by age have changed over time and there are other important determinants of provider requirements.

We have outlined an alternative model and illustrated how the needs based framework can be used to project service requirements under more realistic assumptions than those embodied in widely used planning models such as (A) by predicting service requirements until 2033. It is clear from our forecasting that the predicted volume of services is highly sensitive to changes in scenarios regarding service level per unit need and providers per unit of service. Incorporation of the latter (productivity) should be an important feature of future studies despite the acknowledged difficulties in the measurement of productivity.

As Birch et al. (2007: 14) have stated, “By identifying the separate determinants of provider requirements, the analytical framework helps to avoid human health resource planning falling for the ‘illusions of necessity’ of self-perpetuating increases in provider requirements”. It also enables policymakers to analyse whether changes in the sizes of provider stocks or changes to training and education need to occur and the scale of such changes. This needs based framework makes better use of available information instead of basing the planning for the NHS on just two pieces of information: population projections by age and past provider to population ratios

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Appendix

Table 1: Historical and Predicted Population, Morbidity and Annual Service Volumes (millions)

Year	Population	Numbers with LLSI	Number of over-65s	Annual Outpatient Attendances				Annual GP Attendances			
1980	46.8	9.1	7.1	23.4				163.9			
1985	47.1	9.0	7.2	24.7				167.0			
1990	47.7	9.1	7.5	26.2				199.5			
1993	48.1	9.1	7.6	27.2				207.1			
1995	48.4	9.2	7.7	27.9				196.3			
2000	49.2	9.4	7.8	29.1				174.2			
2005	50.5	9.7	8.1	28.3				178.6			
<i>% Growth</i>	<i>7.86</i>	<i>6.88</i>	<i>13.92</i>	<i>20.75</i>				<i>8.94</i>			
Year	(Projected)	(Projected)	(Projected)	1980	1993	2005	(7)	1980	1993	2005	(7)
2011	52.6	10.2	8.8	25.9	29.9	31.1	32.6	179.2	212.4	190.2	235.7
2016	54.5	10.8	9.9	26.9	31.2	32.5	34.3	186.8	221.2	198.5	254.1
2021	56.4	11.4	10.8	27.8	32.5	33.9	36.1	194.3	229.9	207.0	278.2
2026	58.3	12.0	11.9	28.9	33.8	35.4	37.9	201.8	238.2	215.4	304.2
2031	60.1	12.6	13.2	29.8	35.0	36.7	39.5	208.8	246.0	223.3	325.0
2033	60.7	12.8	13.7	30.1	35.4	37.2	40.0	211.5	248.8	226.4	335.4
<i>% Growth</i>	<i>15.48</i>	<i>25.34</i>	<i>56.46</i>	<i>16.28</i>	<i>18.43</i>	<i>19.65</i>	<i>22.81</i>	<i>18.03</i>	<i>17.13</i>	<i>19.08</i>	<i>42.30</i>

Table 2: Age profiles of service use over time by health status (proportions)

Age	Outpatient Use if LLSI=0			Outpatient Use if LLSI=1			GP Consultations if LLSI=0			GP Consultations if LLSI=1		
	1980	1993	2005	1980	1993	2005	1980	1993	2005	1980	1993	2005
0-5	0.102	0.102	0.110	0.403	0.369	0.458	0.167	0.202	0.132	0.345	0.394	0.302
5-10	0.086	0.083	0.075	0.280	0.283	0.257	0.088	0.092	0.062	0.226	0.241	0.186
10-15	0.082	0.096	0.088	0.242	0.286	0.277	0.068	0.094	0.053	0.187	0.185	0.143
15-20	0.109	0.095	0.088	0.269	0.236	0.243	0.100	0.120	0.087	0.206	0.240	0.213
20-25	0.107	0.104	0.102	0.286	0.314	0.238	0.122	0.133	0.115	0.217	0.299	0.284
25-30	0.093	0.100	0.094	0.221	0.268	0.254	0.121	0.132	0.109	0.221	0.293	0.280
30-35	0.089	0.093	0.097	0.252	0.275	0.293	0.106	0.119	0.120	0.220	0.306	0.246
35-40	0.094	0.098	0.098	0.250	0.279	0.267	0.099	0.115	0.112	0.215	0.266	0.262
40-45	0.100	0.108	0.096	0.271	0.272	0.281	0.089	0.103	0.098	0.240	0.244	0.277
45-50	0.088	0.098	0.107	0.262	0.285	0.324	0.087	0.113	0.100	0.232	0.285	0.283
50-55	0.088	0.115	0.109	0.244	0.308	0.320	0.094	0.121	0.104	0.218	0.284	0.278
55-60	0.086	0.113	0.129	0.241	0.294	0.301	0.099	0.118	0.114	0.238	0.292	0.258
60-65	0.088	0.124	0.151	0.243	0.320	0.325	0.087	0.125	0.128	0.230	0.275	0.266
65-70	0.105	0.131	0.150	0.245	0.312	0.325	0.095	0.136	0.144	0.241	0.293	0.252
70-75	0.098	0.143	0.167	0.236	0.316	0.336	0.124	0.140	0.146	0.229	0.274	0.283
75-80	0.091	0.167	0.185	0.230	0.308	0.353	0.117	0.153	0.168	0.244	0.270	0.261
80-85	0.092	0.153	0.188	0.190	0.276	0.337	0.159	0.155	0.183	0.248	0.260	0.286
85+	0.094	0.135	0.202	0.174	0.252	0.288	0.143	0.148	0.171	0.268	0.243	0.273

Figure 1: Decomposition of LLSI by age, year and cohort

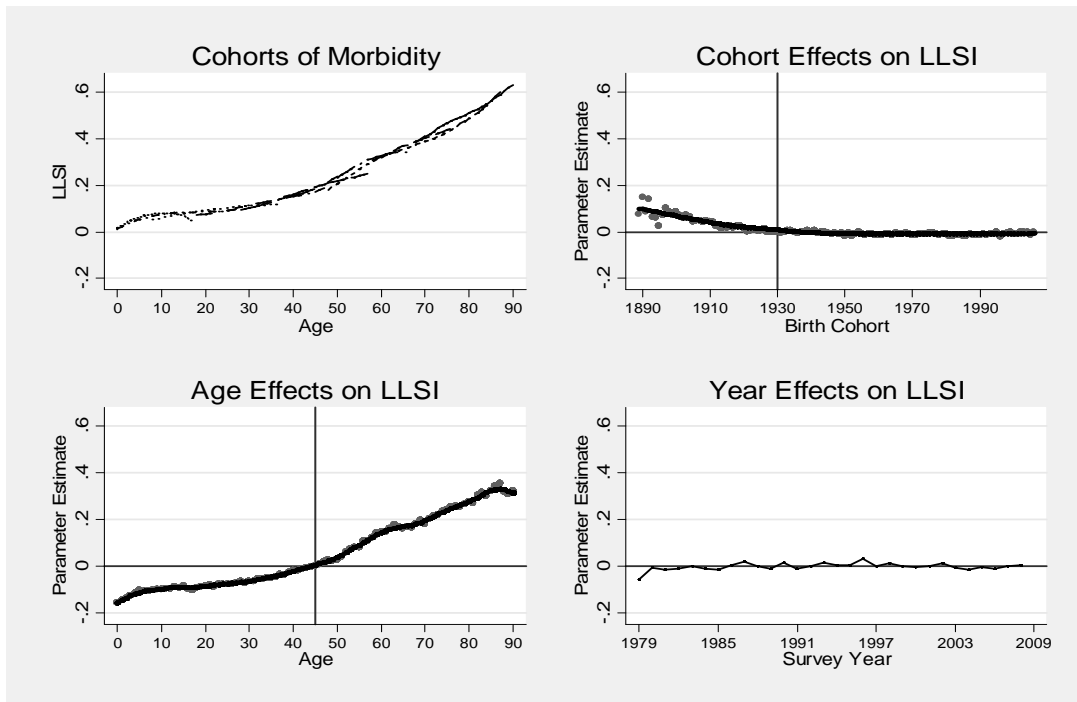


Figure 2: Decomposition of Mortality Rates by age, year and cohort

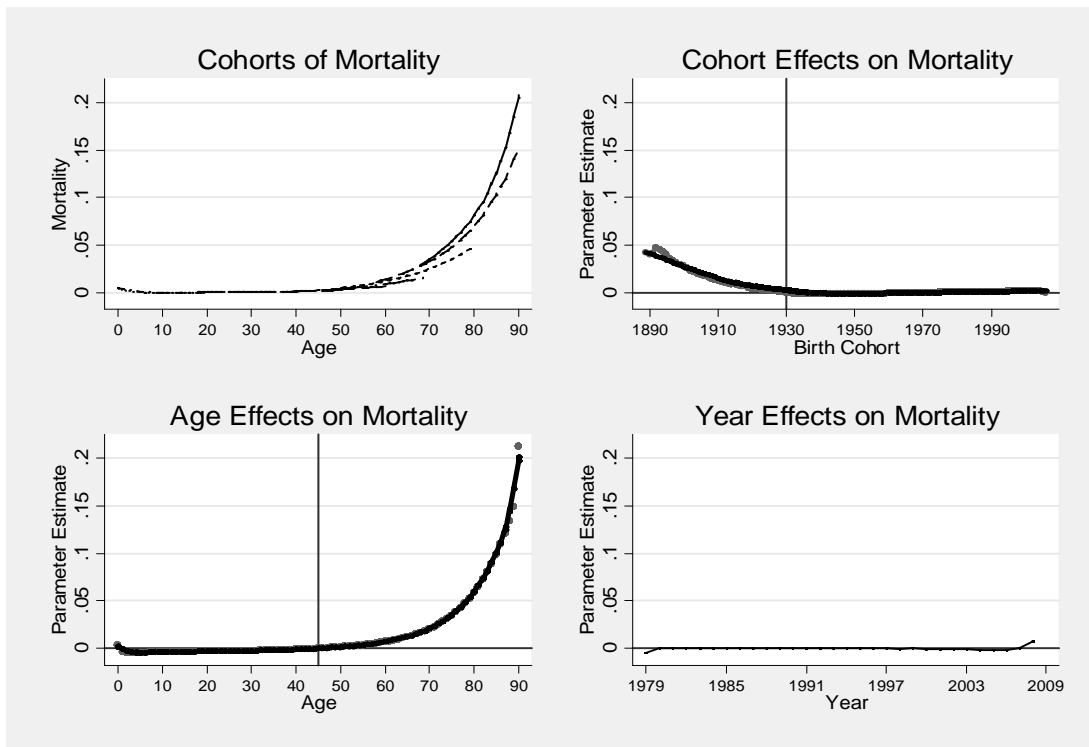


Figure 3: Decomposition of GP Service Use by age, year and cohort

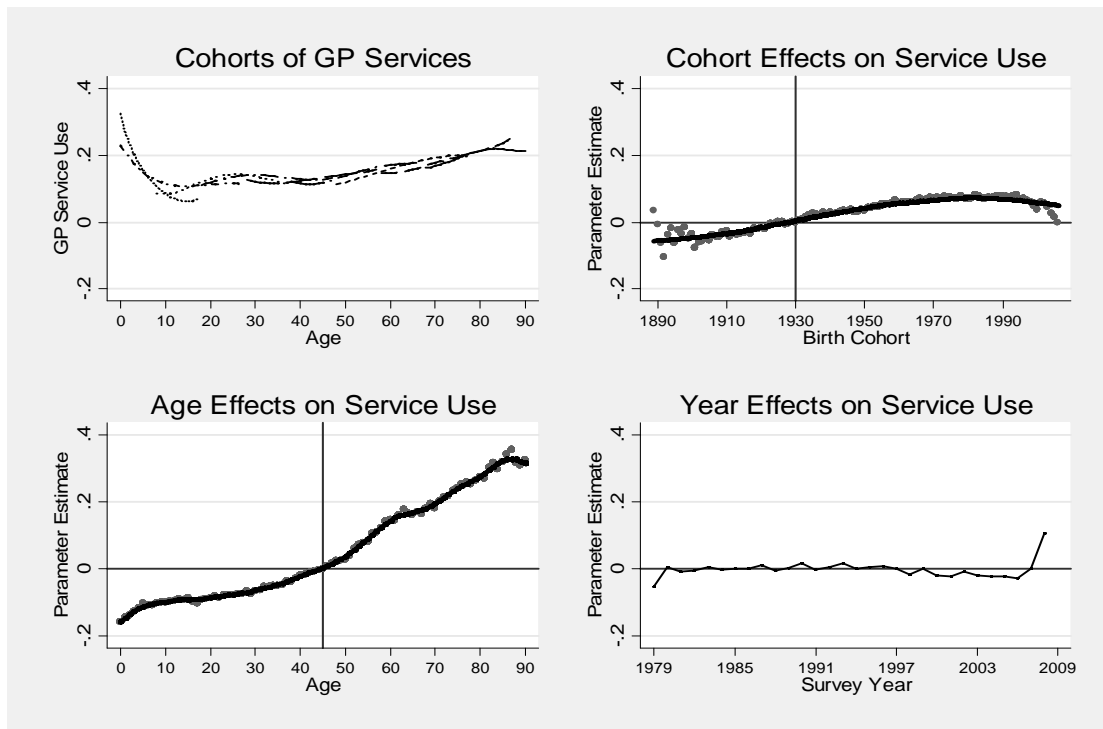


Figure 4: Decomposition of Outpatient Services by age, year and cohort

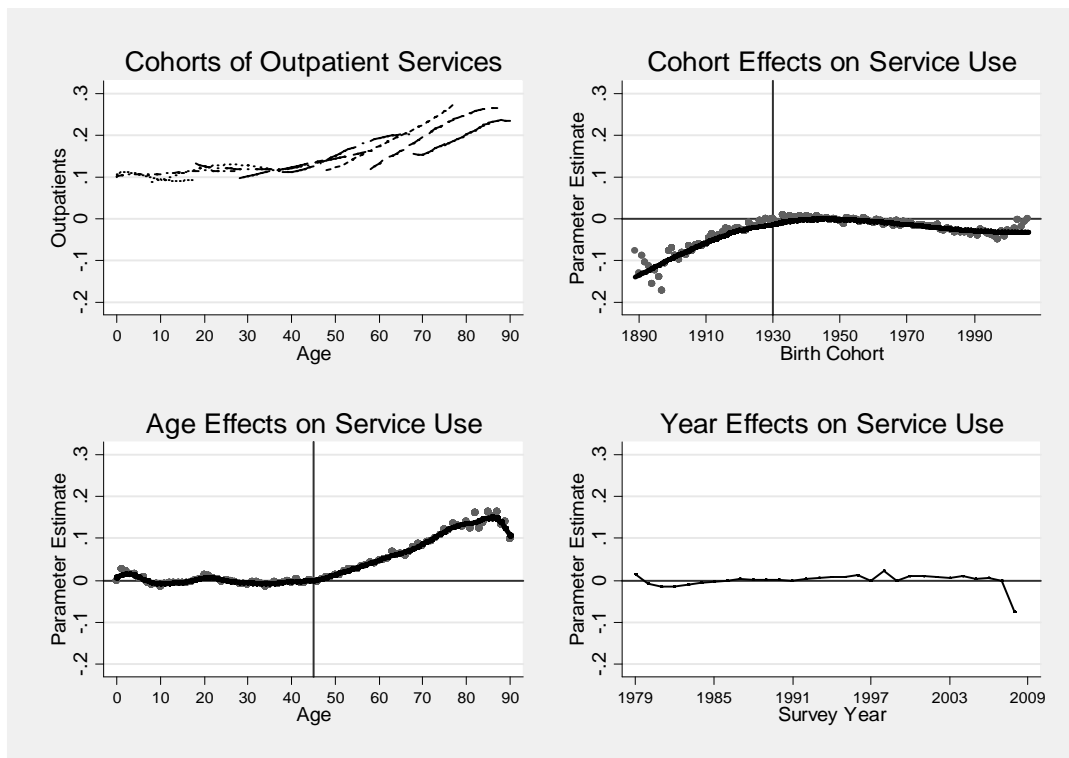


Figure 5: The potential effects of decreasing mortality on population health needs

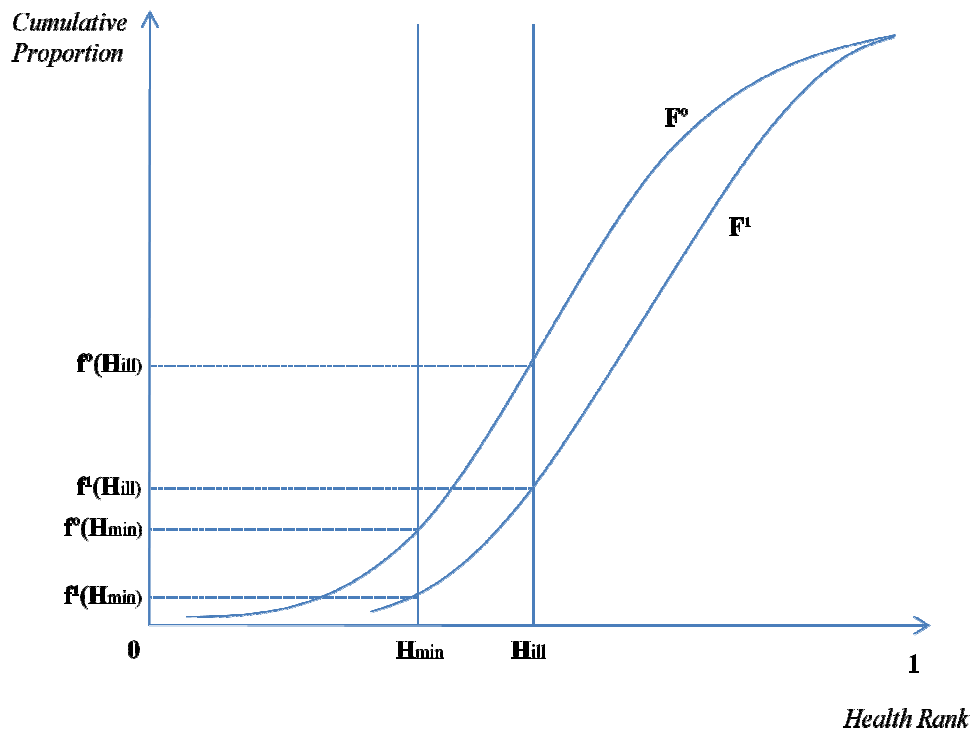


Figure 6: The potential effects of decreasing mortality on population health needs

