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Title: Using micro-simulation to create a synthesised data set and test policy options: the case of health service effects under demographic aging

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Keywords: Health policy; Demographic aging; Computer simulation.

Corresponding Author: Mr Roy Lay-Yee,
Corresponding Author’s Institution: University of Auckland

First Author: Peter B Davis

Order of Authors: Peter B Davis; Roy Lay-Yee; Janet E Pearson

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To assess micro-simulation for testing policy options under demographic ageing.

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Individual-level data were drawn from the New Zealand Health Survey (1996/7 and 2002/3), a national survey of ambulatory care in New Zealand (2001/2), and the Australian National Health Survey (1995). Health service effects assessed were: visits to the family doctor, and rates of prescribing and referral. We created a representative set of synthetic health histories by imputation and tested the health service effects of different policy scenarios. These were created by varying ageing and morbidity trajectories, degree of social support available, and intensity of practitioner behaviour.

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Conclusions:
There is potential for micro-simulation to assist in the synthesis of data and to help quantify scenario options for policy development.
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Authors: Peter Davis a, Roy Lay-Yee a, Janet Pearson a

a Centre of Methods and Policy Application in the Social Sciences (COMPASS), University of Auckland,

Private Bag 92019,
Auckland 1142,
New Zealand.

Email addresses:

Peter Davis, pb.davis@auckland.ac.nz
Roy Lay-Yee, r.layyee@auckland.ac.nz
Janet Pearson, je.pearson@auckland.ac.nz

Corresponding author:

Roy Lay-Yee
Centre of Methods and Policy Application in the Social Sciences (COMPASS), University of Auckland,
Private Bag 92019,
Auckland 1142,
New Zealand.

Email: r.layyee@auckland.ac.nz.
Telephone: +64 9 3737599, extension 85160.
Fax: +64 9 3737986.
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INTRODUCTION

With the growing complexity and potential intractability of policy issues facing governments, there is a pressing need to draw together and synthesise information from a number of sources in order to inform policy decisions [1]. A range of techniques have been developed. Thus, for the narrowest of technical decisions where quantitative data are available – for example, health technology assessment [2] – there is a well-developed, and widely accepted, technique of meta-analysis which combines data from a number of sources [3]. In many cases, however, the area of interest is not narrowly or technically defined, and the sources of data may be generated under a range of methodologies. In these instances there is a growing consensus around techniques of systematic review where data outcomes, methodology, and issue domains are combined in a parsimonious manner [4]. Finally, there are many instances where non-quantitative data sources are important, either on their own or in combination with numerical information [5]. These do not lend themselves to easy synthesis and summary and are still addressed by way of a range of largely implicit, tacit and judgement-based methods.

Simulation techniques have been applied in the health area to test hypothetical scenarios in instances where the requisite data are not directly available but can be plausibly estimated or synthesised [6] and/or where the experimental conditions for testing scenarios in real-world settings are either not feasible or not justified [7]. The area of application of these techniques that has not been well developed is in the combination of data from multiple sources in a relatively pragmatic manner to test scientific, policy and operational scenarios for decision support [8]. This form of
application brings the field of simulation into a closer relationship to the requirements
of data synthesis for decision support. This is the approach we take in this paper,
using micro-simulation as a vehicle for both combining data and testing scenarios, and
we illustrate this application in the area of demographic ageing.

Demographic ageing is a feature of the developed countries. It is exemplified by a
shift in the age structure of these societies towards a growing numerical predominance
of older cohorts [9]. This structural shift is likely to have major implications for future
policies in health, social care, and retirement provision [10]. By its nature the policy
debate in this area is future oriented, albeit well grounded in trends that are currently
well documented. Although these issues have been well canvassed, including with the
use of simulation methods [11, 12], approaches have been based on demographic or
macro-economic extrapolations, with limited contributions from behavioural
components [13]. Micro-simulation allows us to model these behavioural elements.

**Rationale**

Micro-simulation is based on the modelling of individual behaviour and allows for a
more disaggregated approach to scenario building. This is useful in the health area
where it is often necessary to mimic the heterogeneity of the population and the
complexity of relationships [8, 14]. Micro-simulation operates at the level of
individual units; in our case this is a representative, real-world sample of the host
population. Each person has a unique identifier and a set of associated attributes
which, as a starting point, are fixed; for example, age, gender, location, and ethnicity.
A set of rules is then applied to these persons to simulate changes in state and
behaviour. In our case, in the first instance behavioural rules are applied in order to
generate a set of synthetic health histories for our sample, with the empirical content
of those rules being also derived from real-world data. Once the synthetic data set has
been created in this way, then carefully managed changes in other attributes – such as
age distribution, morbidity experience, social capital, and doctor behaviour – are
carried out to test “what if” scenarios for key outcomes of policy interest (such as
rates of visits, referral, and prescribing).

The overall aim of this paper is to describe the construction of such a micro-
simulation model designed to do two things. Firstly it must represent in an empirically
realistic way the policy linkages of the three major components of demographic
ageing; that is, (a) the pattern of morbidity and disability associated with the extension
of the life span, (b) the informal sector of community and family support, and (c) the
formal sector of care (represented by the family doctor or general practitioner (GP)).
Secondly, it must permit the testing of policy scenarios around this model

Constructing a synthetic data set

In order to represent this policy model in an empirical and realistic manner, a diversity
of data sources is required because a single data set with complete coverage of all
system components is not available. This is outlined in Table 1. Thus, the National
Health Survey (NZHS) provides a representative sample of the non-institutional
population of New Zealand, together with details on household composition, an
important feature of the informal sector. The Australian Health Survey (ANHS) gives
details on the morbidity experience and health care utilisation patterns of a population
survey with many attributes similar to those in New Zealand. Finally, the National
Primary Medical Care Survey (NPMCS) gives information on the patient visits to the GP, as well as patterns of practitioner behaviour.

How are these data integrated into the logic of micro-simulation? In Figure 1 an outline is provided of the logic of first synthesising a data set from these sources and then proceeding to test scenarios. At the top of the diagram is the representative sample with fixed attributes (drawn from the New Zealand Health Surveys). This is then enhanced through imputation techniques in four steps - using matching (step 1. to allocate a doctor from the New Zealand Primary Medical Care Survey) and random assignment (steps 2. and 3. from the Australian Health Survey and step 4. the New Zealand Primary Medical Care Survey). This produces a representative set of synthetic health histories around the original sample data in the central box labelled “Synthetic data set”. This is now a synthesised data set that can then be interrogated to determine the likely health service effects of creating different “what if” policy scenarios with the carefully managed manipulation of key parameters (step 5.), such as the age distribution and areas of policy interest ((a) illness experience, (c) community support, (c) doctor behaviour).

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1 Via a Monte Carlo process, random numbers were used throughout the simulation to convert probabilities into characteristics for an individual, whether from tables (Australian data), or from statistical models (New Zealand data). A random number from a uniform distribution between 0 and 1 was first assigned. If that random number was less than or equal to the probability, then the characteristic was deemed to be present, thus ensuring that the data set reproduced in aggregate the probabilities derived from the tables and statistical models.
Testing policy scenarios

The quality of these “what if” scenarios is dictated by the integrity of the policy model. The three behavioural components of the model dictate a certain logic: (a) people undergo health experiences (morbidity and disability, ANHS data), (b) which they experience in their community context (informal sector, ANHS and NZNHS data) and (c) which they then may take to their GP, who will respond in various ways (formal sector, NPMCS data). These components can in turn be related to different possible policy-relevant scenarios:

(a) profile of morbidity and disability associated with demographic ageing, as reflected in contrasting predictions of expansion and compression [15];
(b) “healthy ageing”, as reflected in the potential of family and community capacity to assist in coping (autonomy, dependency, intermediate) [16];
(c) the impact of changes in health service delivery, such as, technology and changes in practitioner repertoires [17, 18].

All of these can be represented by careful manipulation of key parameters in the micro-simulation model in the form of “what if” settings in the synthesised data.

These scenarios can be cast as a series of binary alternatives and represented in tabular form, as in Figure 2. Thus, the first cell can be taken as an “optimistic” scenario, optimistic in the sense that it heralds a future of low demand on formal health services with a coincidence of compressed or low morbidity and disability, autonomous or “healthy” ageing, and a higher threshold of practitioner intervention.
By contrast, the diagonally opposite cell encapsulates a “pessimistic” policy outcome of high future demand on health services, with a combination of expanded or high morbidity and disability, service-dependent ageing, and intensified medical practice.

FIGURE TWO ABOUT HERE

This “map” or tabulation of the logical range of policy scenarios can be populated with data on key health service outcomes – such as average number of visits to the GP, or rate of referral – by careful manipulation of the settings of the micro-simulation model to canvass realistic and contrasting, if speculative, scenarios.

MATERIALS AND METHODS

This section provides methodological details of:

- creation of the data system,
- verification and validation of the integrity of the data system,
- and testing of policy scenarios.

Details of model construction and testing are described more fully elsewhere [19]. Data manipulation and model implementation were programmed using SAS [20].

Creating the synthesised data set

Data sources

The model used data from multiple sources: New Zealand Health Survey (NZHS, 1996/7 and 2002/3) [21, 22], National Primary Medical Care Survey (NPMCS,
2001/2) [23], and Australian National Health Survey (ANHS, 1995) [24, 25] (see Table 1).

Individual-level data from the NZHSs, weighted to be representative of the population, and NPMCS, representative of GP users, were statistically matched to create a representative base-file of 13,548 individuals each with an assigned GP. The ANHS was used to provide information on population levels of recent health conditions (i.e. conditions occurring in the last 2 weeks that were never seen by a GP as well as those that were), and GP use. NPMCS was used as the source of GP and practice information that was statistically matched with the base file, and as the data for predictive logistic regression models that derived probabilities of GP actions.

Definition of variables in the synthesised data file

From NZHS:

**Age group:** 0-24, 25-44, 45-64, and 65+.

**Gender:** male, female.

**Ethnicity:** Maori, Pacific, Asian, Other, European.

**Household type:**

1 = do not live with adult (person aged 15 or over), 2 = live with adult partner (husband/wife or de facto, boyfriend or girlfriend), 3 = live with adult but not partnered.

From ANHS:

**Recent illness** is defined as a condition occurring in the last 2 weeks including both short-term and/or flare-ups of long-term ones. Conditions were classified according to 17 standard categories.
Most important condition and whether seen by a doctor: the condition category, chosen from the conditions present in a fortnight (that were allocated as likely to be seen by a GP) for a person, deemed to be the most important in predicting how many GP visits - if any - that person will have for the fortnight.

From NPMCS:

Practitioner: age, gender, ethnicity

Practice: Type, location, size

Primary diagnosis: the condition category deemed to be the main reason, out of all the conditions a person has in a fortnight (that were allocated as likely to be seen by a GP), for any given visit.

GP clinical activity: outcome related to a visit (yes/no): investigation, prescription, non-drug treatment, follow up, and referral.

Verification and validation

Verification involved internal checking of the SAS code throughout the simulation program to ensure that variable creation and key components and steps were working properly, and results were being produced as expected. Validation of the simulation output was done via comparison to external real-world benchmarks (in this case, data from the NPMCS 2001/2 survey of GPs and their patients) (see Table 2). Comparison was made at an aggregate level, and, where appropriate and possible, also by age group, gender, ethnicity and household type.

Scenario testing
This was carried out by simulating a potential outcome by manipulating a variable of interest, while holding other variables constant, and observing change to the outcome. The focus was, respectively: impact of demographic ageing by forward projection; different morbidity and disability trajectories; availability of family and community support; and, intensity of practitioner behaviour. These analyses will be used to canvass policy options by generating the values of health service effects for different scenarios under demographic ageing, according to the annual number of GP visits, and rates of prescribing and referral.

**RESULTS**

**Validation**

In order to externally validate the simulation model’s ability to produce output close to what would happen in the real world, results for the synthetic data set were compared to benchmark data from the NPMCS 2001/2 by specific sub-groupings [19]. Aggregate comparisons are outlined in Table 2. As can be seen, the average error over all comparisons was small, although there were some notable individual discrepancies (for example, musculoskeletal and connective tissue).

**Scenario testing**

**Impact of demographic ageing by forward projection**
We re-weighted the 2002 population via an official projection (Statistics New Zealand) to 2021 - by age, gender and ethnicity - that assumed medium birth, mortality and migration rates. The simulation program was run again using the re-weighted data. The results for two sets of outcomes – the distribution of the top ten presenting conditions, and rates of clinical activity - are presented in Table 3. As can be seen, changes over these sets of comparisons were on average less than half a percentage point. There were only slight changes, mostly in the expected directions, in all three outcomes: the number of visits (from 6.7 to 6.9 for GP users), the distribution of condition categories, and GP activity levels.²

The projection to 2021 represents a form of counterfactual analysis – what if the current age distribution for 2002 looked like that expected in 2021? This is a “pure” demographic effect (i.e. a change in age distribution, but no corresponding change in the associated profile of age-specific morbidity or service characteristics). To assess the full effect of the policy model, however, we need to incorporate the major components as outlined in Figure 2 – namely, morbidity experience, social support, and practitioner behaviour. These have been articulated as follows:

² Although our results showed little relative change proportionally, the contribution by the 65 years and over age-group increased as expected (from 20% in 2002 to 24% in 2021). This translates into a not inconsiderable change in the absolute numbers of visits (an extra six million visits for the New Zealand population) and thus consequent GP activities [26].
1. **Morbidity and disability trajectories:** what if the years 65 and over were characterised by the “worst case” scenario of morbidity experience for this group (as derived from the ANHS)? This is our proxy for the “expansion” hypothesis of future age-related morbidity and disability.

2. **Availability of family and community support:** what if the home circumstances of all those 65 and over were such that far more were on their own without household support (as derived from the NZHS)? This is our proxy for a scenario of reduced social support and informal care, representing a reversion of the “healthy ageing” hypothesis.

3. **Intensity of practitioner behaviour:** what if the activity levels of family doctors came to be characterised by those of the most interventionist of practitioners (as derived from the NPMCS)? This is our proxy for a medicalised and intensive response by health providers to an ageing practice population.

The results of these three exercises for number of visits and for the associated rates of prescribing and referral can be used to populate the range of scenarios from Figure 2 to canvass the likely outcomes. These are outlined in Tables 4-6

**TABLES 4 -6 ABOUT HERE**

Table 4 represents a baseline counterfactual scenario – how many visits per year would members of a population 65 and older make under hypothetical extremes of social support and morbidity experience? Social support has no effect, but average GP
visits double for the higher morbidity scenario.\(^3\) Table 5 addresses prescribing rates. The rates of prescribing for more interventionist GPs are nearly double those of their least interventionist colleagues. However, there is virtually no difference in prescribing rate according to high- and low-user patients (our proxy for morbidity experience). On the other hand, if we factor in the likely number of visits and express prescribing rates on this basis, individuals in the first column would be predicted to have an average of four visits per year in which they would receive a prescription, while the comparable figure for individuals in the fourth column would be over 13, a threefold difference. Finally, referral rates for the most interventionist GPs are about six times those of the most conservative (30 per cent versus 5 per cent) (Table 6). If, in the same manner, we take into account the number of visits per year that distinguish high- and low-user patients, this gives a tenfold difference in the number of visits per annum on which a referral is made (0.5 versus 5).

**Discussion**

The contribution that micro-simulation models can make to addressing ‘what if?’ scenarios and realistic extrapolation into the future is well known [8]. However, a feature of such models that has not been sufficiently emphasised is their potential for drawing together data from different sources and combining them into scenarios. There is increasing interest in synthesising information from different sources for

\(^3\) This result is not surprising, given that we have used visits to the GP as an indirect measure of morbidity experience. Clearly the measures are confounded, and this is due to our lack of an independent measure of level of morbidity. However, it can be justified on grounds that our model is interested in expressed morbidity, and visits are a reasonable proxy for this.
complex policy issues [1], and the micro-simulation approach provides a model-based framework for performing this function in the case of more complex and data-rich policy questions than those addressed by meta-analyses and the more traditional systematic reviews. We have attempted to demonstrate this by building a model that can be used to test a range of scenarios in a three-component representation of the impact of demographic aging. Necessarily, the construction of such a model relies heavily on its foundation in empirical data and hence makes reasonably strong assumptions about the plausibility of results arising from their combination.

The major strength of this model lies in its use of existing micro-level data from various relevant sources. However, the need to harmonise data sources as to, for example, their intrinsic classification categories and time scales, meant that there was potential information loss to the model. Furthermore, as longitudinal data were not available to derive proper transition probabilities, the model is a static one so that any extrapolation into the future is hedged with assumptions. As much as possible, data sources were selected that related to New Zealand and a specific time period, circa 2002. The obvious exception on both counts was our use of the Australian National Health Survey 1995 to obtain recent illness information which was otherwise not available. The rationale, borne out by evidence, was that the two countries shared much social similarity and, particularly pertinent here, also comparable demographic structure and primary health care system.

In testing various scenarios by manipulating specific factors of interest, the model must assume that everything else remains the same - including inherent structural relationships. This is a limit on the realism that can be achieved. Nevertheless, our
substantive findings from the projections and from the scenario assessment exercises are plausible. Thus, our finding (Table 3) that the forward projection of a simple or “pure” demographic ageing model makes little difference to visit rates or to aggregate levels of clinical activity is consistent with results from a growing number of studies on the subject (for example, [27, 28], with greater emphasis being placed on time to death rather than the impact on health costs of ageing as such [29, 30]). Similarly with the results of our scenario analysis – Tables 4-6 - suggesting that practitioner behaviour could be the more important determinant of future costs (see [28]).

Conclusions

A novel micro-simulation approach was successfully applied both to create a synthesised data set from a number of sources and to present quantifiable scenarios. Model projections suggest limited change in system demand on a “pure” demographic model, although substantially more on scenario analysis of projections of morbidity burden and practitioner behaviour. There is potential to improve and extend the model. This will enhance its usefulness as a scenario-testing tool for policy purposes.
1 Acknowledgements

2 The project was funded by the Health Research Council of New Zealand.
References


Figure 1. The model: data synthesis, simulation and scenario testing

1. Match with doctor
2. Impute recent illness experience
3. Impute most important condition & whether seen by doctor
4. Impute primary diagnosis & doctor behaviour
5. Modify parameters:
   - Age
   - Illness experience
   - Community support
   - Doctor behaviour

Verification & validation

NZ General Practice Survey (NPMCS)
NZ National Health Surveys (NZHS): Individual attributes
AU. National Health Survey (ANHS)

Synthetic data set

‘What if?’ scenario testing
Figure 2. Scenario map

<table>
<thead>
<tr>
<th>Autonomous ageing</th>
<th>Higher Threshold</th>
<th>Intensification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compress</td>
<td>Expand</td>
</tr>
<tr>
<td>Best</td>
<td>Optimistic scenarios</td>
<td>Intermediate scenarios</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service-dependent ageing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Social support</td>
<td></td>
</tr>
</tbody>
</table>

1. Morbidity experience

3. Practitioner repertoire

Demographic ageing
Table 1. New Zealand and Australian data sources and model contributions

<table>
<thead>
<tr>
<th>Study</th>
<th>National Health Surveys (NZHS)</th>
<th>National Health Survey (ANHS)</th>
<th>General Practice Survey (NPMCS)</th>
<th>General Practice Survey (NPMCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>New Zealand</td>
<td>Australia</td>
<td>New Zealand</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Year</td>
<td>1996/7 (children)</td>
<td>1995</td>
<td>2001/2</td>
<td>2001/2</td>
</tr>
<tr>
<td></td>
<td>2002/3 (adults)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td>Children &amp; adults</td>
<td>Children &amp; adults</td>
<td>Patient visits</td>
<td>Doctors (GP)</td>
</tr>
<tr>
<td>N</td>
<td>13,548</td>
<td>53,828</td>
<td>9,272</td>
<td>244</td>
</tr>
<tr>
<td>Model Component</td>
<td>Community</td>
<td>Morbidity; Community</td>
<td>Morbidity; Practitioner</td>
<td>Practitioner</td>
</tr>
</tbody>
</table>


Table 2. Validation: visit rates and morbidity experience of GP users, and GP activity per year for 2002 (synthesised data) compared with NPMCS data

<table>
<thead>
<tr>
<th></th>
<th>Synthesised data 2002</th>
<th>NPMCS 2001/2</th>
<th>Absolute error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean number of visits per year</td>
<td>6.7</td>
<td>6.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Morbidity: Top 10 condition categories</td>
<td>Percent of all conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory system diseases</td>
<td>16.0</td>
<td>14.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Cardiovascular/circulatory diseases</td>
<td>9.7</td>
<td>9.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Musculoskeletal and connective tissue diseases</td>
<td>9.4</td>
<td>5.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Digestive system diseases</td>
<td>6.8</td>
<td>4.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Nervous system/sense organ diseases</td>
<td>6.1</td>
<td>8.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Skin and subcutaneous tissue diseases</td>
<td>5.8</td>
<td>6.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Endocrine/nutritional/metabolic/immunity disorders</td>
<td>5.4</td>
<td>4.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Injury and poisoning</td>
<td>5.0</td>
<td>7.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Genitourinary system diseases</td>
<td>3.3</td>
<td>4.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Mental disorders</td>
<td>3.0</td>
<td>5.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Average error</td>
<td></td>
<td></td>
<td>1.4</td>
</tr>
<tr>
<td>GP activity</td>
<td>Percent of visits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigation</td>
<td>27.8</td>
<td>24.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Prescription</td>
<td>64.5</td>
<td>66.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Non-drug treatment</td>
<td>62.6</td>
<td>62.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Follow-up</td>
<td>60.3</td>
<td>57.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Referral</td>
<td>18.3</td>
<td>15.9</td>
<td>2.4</td>
</tr>
<tr>
<td>Average error</td>
<td></td>
<td></td>
<td>2.1</td>
</tr>
</tbody>
</table>

The simulations for the synthesised data for 2002 are the average results of 100 runs with a different random seed specified for each run.
Table 3. Age projection: Visit rates and morbidity experience of GP users, and GP activity per year as for 2002 (synthesised data) and as projected to 2021

<table>
<thead>
<tr>
<th></th>
<th>Synthesised data 2002</th>
<th>Projection 2021</th>
<th>Absolute change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean number of visits per year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.7</td>
<td>6.9</td>
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<td><strong>Morbidity: Top 10 condition categories</strong></td>
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<td>Skin and subcutaneous tissue diseases</td>
<td>5.8</td>
<td>5.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Endocrine/nutritional/metabolic/immunity disorders</td>
<td>5.4</td>
<td>5.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Injury and poisoning</td>
<td>5.0</td>
<td>4.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Genitourinary system diseases</td>
<td>3.3</td>
<td>3.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Mental disorders</td>
<td>3.0</td>
<td>2.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>GP activity</strong></td>
<td>Percent of visits</td>
<td></td>
<td>Average change</td>
</tr>
<tr>
<td>Investigation</td>
<td>27.8</td>
<td>28.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Prescription</td>
<td>64.5</td>
<td>64.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Non-drug treatment</td>
<td>62.6</td>
<td>62.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Follow-up</td>
<td>60.3</td>
<td>61.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Referral</td>
<td>18.3</td>
<td>18.2</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Average change</strong></td>
<td></td>
<td></td>
<td>0.4</td>
</tr>
</tbody>
</table>

The simulations for the synthesised data for 2002 and the projection to 2021 are the average results of 100 runs with a different random seed specified for each run.
Table 4. Mean number of visits per year for GP users aged 65+ in 2021

<table>
<thead>
<tr>
<th>Social support</th>
<th>Morbidity experience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compress (+)</td>
</tr>
<tr>
<td>Autonomous aging (+)</td>
<td>8.8</td>
</tr>
<tr>
<td>Service-dependent aging (-)</td>
<td>8.7</td>
</tr>
</tbody>
</table>

1. ‘Compress (+)’ signifies that all GP users have below the median number of visits; ‘Expand (-)’ signifies that all GP users have above the median number of visits.
2. ‘Autonomous aging (+)’ signifies that no GP users are living alone; ‘Service-dependent aging (-)’ signifies that all GP users are living alone.
Table 5. Percentage of visits (average number of visits p.a.) prescribed for GP users aged 65+ in 2021

<table>
<thead>
<tr>
<th>Social support ²</th>
<th>Practitioner repertoire ³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher threshold (+)</td>
</tr>
<tr>
<td>Morbidity experience ¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compress (+)</td>
</tr>
<tr>
<td>Autonomous aging (+)</td>
<td>46.2%</td>
</tr>
<tr>
<td></td>
<td>(= 4.1 visits p.a.)</td>
</tr>
<tr>
<td>Service-dependent aging (-)</td>
<td>46.9</td>
</tr>
<tr>
<td></td>
<td>(4.1)</td>
</tr>
</tbody>
</table>

1. ‘Compress (+)’ signifies that all GP users have below the median number of visits; ‘Expand (-)’ signifies that all GP users have above the median number of visits.
2. ‘Autonomous aging (+)’ signifies that no GP users are living alone; ‘Service-dependent aging (-)’ signifies that all GP users are living alone.
3. ‘Higher threshold (+)’ signifies probability of practitioner activity set at level below the median rate; ‘Intensification (-)’ signifies probability of practitioner activity set at level above the median rate.
### Table 6. Percentage of visits (average number of visits p.a.) referred for GP users aged 65+ in 2021

<table>
<thead>
<tr>
<th>Social support</th>
<th>Practitioner repertoire</th>
<th>Morbidity experience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher threshold (+)</td>
<td>Intensification (-)</td>
</tr>
<tr>
<td></td>
<td>Compress (+)</td>
<td>Expand (-)</td>
</tr>
<tr>
<td><strong>Autonomous aging (+)</strong></td>
<td>5.5% (0.5 visits p.a.)</td>
<td>4.9% (0.7 visits p.a.)</td>
</tr>
<tr>
<td><strong>Service-dependent aging (-)</strong></td>
<td>5.1 (0.4)</td>
<td>4.6 (0.7)</td>
</tr>
</tbody>
</table>

1. ‘Compress (+)’ signifies that all GP users have below the median number of visits; ‘Expand (-)’ signifies that all GP users have above the median number of visits.

2. ‘Autonomous aging (+)’ signifies that no GP users are living alone; ‘Service-dependent aging (-)’ signifies that all GP users are living alone.

3. ‘Higher threshold (+)’ signifies probability of practitioner activity set at level below the median rate; ‘Intensification (-)’ signifies probability of practitioner activity set at level above the median rate.