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**Title:** Changing the balance of social care for older people: Simulating scenarios under demographic ageing in New Zealand

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## **Abstract**

The demographic ageing of New Zealand society, as elsewhere in the developed world, has dramatically increased the proportion of older people (aged 65 years and over) in the population. This has major policy implications for the future organisation of social care. Our objective was to test the effects on social care use, firstly, of putative changes in the overall disability profile of older people, and, secondly, of alterations to the balance of their care, that is, whether it was community-based or residential. In order to undertake these experiments, we developed a microsimulation model of the later life course using individual-level data from two official national survey series on health and disability respectively to generate a synthetic version which replicated original data and parameter settings. A base-line projection under current settings from 2001 to 2021 showed moderate increases in disability and associated social care use. Artificially decreasing disability levels, below the base-line projection, only moderately reduced the use of community care (both informal and formal). Scenarios implemented by rebalancing towards informal care use moderately reduced formal care use. However, only moderate compensatory increases in community-based care were required to markedly decrease the transition to residential care. The disability impact of demographic ageing may not have a major negative effect on system resources in developed countries like New Zealand. As well as healthy ageing, changing the balance of social care may alleviate the impact of increasing demand due to an expanding population of older people.

**Keywords:** ageing, old age and social care, older people, policy analysis, social care, social policy

### **What is known about the topic**

- There is debate about the future impact of increased life expectancy - related to the expansion or compression of morbidity - on social care resources in developed countries.
- The 'balance of care' approach has been applied in many policy settings but not to the range of social care for older people.

### **What this paper adds**

- Demographic ageing in developed countries may not have a major negative impact on care resources particularly with healthier populations over time.
- Changing the balance of social care - supporting ageing in place, and preventing or delaying the need for residential care - may make better use of finite system resources.

## Introduction

As in other developed countries, the demographic composition of New Zealand is changing as birth rates decline and life expectancy steadily increases (Christensen *et al.* 2009). The result is to greatly increase the proportion of older people in the population, the sub-group most likely to experience disability – as functional loss - and to require social care (Rodrigues *et al.* 2012). This shift in age structure - and the rise of chronic diseases - contribute to the so-called ‘disability transition’ marked by changes in patterns of functional status (Myers *et al.* 2002), with major implications for the provision of social services and other supports for older people (Picard *et al.* 2012). Yet the extent of the future social care needs of older people remains unclear. For some older people, this extended period of life will be spent largely free of serious disability (i.e. compression of disability), while for others it is more likely to be a time of significant disability and dependency (i.e. expansion of disability) (Fries 1980, Crimmins *et al.* 2011).

There is pressure on available resources to keep pace with the sheer increase over time in the volume of social care (here defined as assistance in the activities of daily living) required for larger numbers of older people. Even as dependence on informal care increases, demographic and social changes are diminishing the supply of available carers (Stuifbergen *et al.* 2008). The major current policy initiative is the promotion of healthier ageing to reduce or at least delay the need for social care (Oxley 2009). Another more recent initiative put forward is to change the balance of care (Tucker *et al.* 2013), e.g. towards supported care at home rather than institutionalisation (Wanless *et al.* 2006). Policy questions posed by demographic ageing apply no less to New Zealand - with the proportion of people aged 65 years and over projected to increase by nearly two-fifths (over the period examined in this paper) from 12.1% in 2001 to 16.8% in 2021 (Statistics New Zealand 2015). With similar policy issues

(and a long-standing tax-funded universal public health system as perhaps a point of difference), New Zealand may offer lessons to other developed countries (Cumming *et al.* 2014).

The technical approach we adopt here is microsimulation which has been previously used to assess the impact of demographic ageing on population health and aged care (Gupta & Harding 2007). Microsimulation relies on data from the real world to create an artificial version upon which investigations can be conducted (Spielauer 2011). It operates at the level of individual units (here older people), each with a set of attributes as a starting point - e.g. age and disability state - to which quantitative rules (e.g. statistical equations) are applied to simulate changes in state or behaviour. This model essentially combines information and generates a set of representative synthetic life histories. The model can then be used to test hypothetical scenarios by modifying key influential factors and then assessing impact on outcomes of policy interest. Microsimulation is a technique well suited to modelling the dynamics of a complex system such as the configuration of social care.

In this paper, we apply a microsimulation model to social care use among older people (aged 65 years and over) in New Zealand. The model is used both for projections - that is, the impact of demographic ageing (under current 2001 settings) to 2021 - and for policy scenario testing, for example, 'what if' questions regarding the balance of care. Our model provides a virtual laboratory that can be used for assessment of the likely effect of policy options under conditions of demographic ageing. We report on the construction of and results from the model.

***INSERT BOX 1 ABOUT HERE***

The model comprised disability (based on support levels), and associated social care (informal, formal or residential components) (see Figure 1). The model was: (1) hierarchically structured - disability level, adjusted for socio-demographic factors, drives social care use (Luppa *et al.* 2010, Vlachantoni *et al.* 2013); informal care use affects formal care use (both defined as being types of community care); and residential care is linked to community care – and (2) dynamic - incorporating change over time.

***INSERT FIGURE 1 ABOUT HERE***

## **Methods**

We constructed a discrete-time dynamic microsimulation model of disability and concomitant social care use over time based on empirical data from a New Zealand sample of older people. Neither ethical approval nor individual informed consent were required as the study used official data sources. A detailed report of our methods has been published online (Lay-Yee *et al.* 2015), and is summarised in this section.

### *Study design*

To build a realistic and representative model, we used data from national repeated cross-sectional surveys. We derived quantitative rules (e.g. statistical equations) from these data to drive the simulation, thus ageing the starting sample and creating a virtual cohort composed of synthetic but representative life histories. Different policy-relevant scenarios could then be posed by altering features of the model. Data manipulation and analysis were carried out using SAS, and simulation was implemented in R.

### *Data sources*

We combined confidentialised individual-level data on older people aged 65 years and over from two series of the five-yearly New Zealand disability survey (NZDS) and health survey (NZHS) respectively (Statistics NZ 2002, Ministry of Health NZ 2004). As well as the person's demographic characteristics (from NZHS), there was information on whether they had a disability (from NZDS), and on their use of social care (from NZDS); NZDS was the only available national data source with these features. These survey data had the advantage of being nationally representative and relatively recent with adequate sample sizes. NZDS comprised two separate sub-surveys (community and institution based respectively) that together covered the population of older people. However, given different questions in each sub-survey, it was difficult to include respondents from both in the same analysis, e.g. we could not investigate the direct effect of informal care on residential care.

We employed these data sources in the following ways. Firstly, to form a *starting sample* at the base year (2001) that provided initial conditions representative of older people living in the community ('householders') or in an institutional residence ('residents'). The NZHS (2002) contributed data on 2,206 householders; disability level was imputed to these individuals using NZDS (2001) data from a multinomial regression model with socio-demographic covariates: age, gender, ethnicity, deprivation level, and partnership status; there is evidence that particularly age and gender are the primary predictors of a range of chronic conditions and their associated disability (Jagger *et al.* 2006). The NZDS (2001) also contributed data on 601 residents. A description of characteristics of the starting sample can be found in Table 1. Of householders, 9.3% were aged 85 years and over while 8.5 % were experiencing severe disability. In contrast, 47.9% of residents were aged 85 years and over while 81.6% experienced severe disability.



Secondly, to derive *statistical equations* from *cross-sectional data* to inform dependencies and outcomes within any particular year, e.g. which variables does formal care depend upon and what is the resulting probability an individual will receive formal care. The NZDS (2001) was used to model social care use.

Thirdly, to derive *transition probabilities* from *repeated-cross-sectional data* to inform dynamic changes from year to year, e.g. what is the probability of an individual who was moderately disabled in 2001 changing their state to become severely disabled in 2006. The NZDS data (1996 and 2001) were used to estimate transition probabilities for disability level, and residential care status. The NZHS data (2002 and 2006) were used to estimate transition probabilities for partnership status. The survey years compared were dictated by availability and compatibility of variables.

And fourthly, to provide 2006 empirical benchmarks against which to compare the simulated results of running the model from the base 2001.

***INSERT TABLE 1 ABOUT HERE***

***INSERT BOX 2 ABOUT HERE***

### *Analysis*

We analysed data from the NZDS and NZHS series to derive parameters – using regression equations and transition probabilities - for time-variant outcomes of interest to inform the simulation process.

Firstly, we used the NZDS cross-sectional data (2001) to predict community-based care use from disability in a series of related logistic regression models. Earlier states could exert an influence over later ones (Figure 1). For example, the level of disability could affect the level of informal care use which could in turn affect the use of formal care. Socio-demographic control variables were age, gender, ethnicity, deprivation level, and partnership status. Residential care status at baseline was assigned deterministically according to the original NZDS (2001) data source.

Secondly, we assumed that the level of disability, reflecting need, was the prime driver of social care use, and so transition probabilities were first estimated from matrices using repeated cross-sectional data (from NZDS). We matched individuals on age and gender (using other characteristics was prohibited by small numbers) as the main determinants of disability (Jagger *et al.* 2006). The matrix of probabilities was based on known disability levels in 1995 and 2001, and assumed that an individual could remain in the same state or progress to the next state but not revert to a former state; thus certain cells in the matrix could be assigned probability values of '0' or '1', and the remaining cells could be imputed. Transition probabilities were also estimated for partnership status (from NZHS), and for those moving into residential care facilities (from NZDS).

Then thirdly, the transition probabilities for disability flowed through to impart dynamic change to cross-sectional models of various social care modalities.

In summary, estimated transition probabilities for disability were fed into logistic regression models for informal care and formal care use respectively. Informal care was in turn included

as a predictor of formal care. Thus, informal care is a function of disability, while formal care is a function of both disability and informal care.

### *Simulation*

The starting sample for simulation comprised original data on older people in the base year 2001. The simulation process in each subsequent update followed a sequence of steps from demographic characteristics, through disability status, to final social care use. Older people living in the community and in residential care facilities were considered separately because of the data structure.

We created a virtual cohort from a representative starting sample of 2,807 older people for the period 2001 to 2021. We then applied equations (derived from statistical analysis of the national survey data) to update each individual's time-variant attributes (e.g. receiving informal care or not) at five-year intervals (e.g. 2006). A Monte Carlo process was used whereby a random number generated from a standard uniform distribution (between 0 and 1) was compared to the probability of, say, receiving informal care (derived from statistical analysis) – thus if the random number was equal to or less than the probability value then the individual was deemed to have been receiving informal care (in 2006).

To maintain population-level representativeness over time, we made demographic adjustments as follows. Firstly, risks of *mortality* were derived from life tables, adjusted by disability, and applied to gender-age groups.

Secondly, the sample was *rejuvenated* with new entrants at each five-yearly iteration. This was necessary as 65-69 year-olds would have aged five years (to the 70-74 year age group).

New entrants were randomly drawn from 65-69 year-olds in the national survey data according to their proportion in the population in the iteration year.

And thirdly, the sample was calibrated to account for *migration* and for *future demographic trends* (i.e. future changes in population composition) by re-weighting to official projections based on medium fertility, mortality, and migration.

To reduce the effect of random error, a simulated estimate was taken as the average result of 20 runs (sufficient to generate a stable estimate). Thus a sample of typical though varied individual life histories was created.

### *Validation*

Validation of simulated results was carried out by comparison to the actual NZDS data (latest available from 2006). The test was whether the simulation model was able to approximate benchmark averages and a similar distribution of outcomes. Where necessary and possible, simulated quantities were calibrated to benchmarks so that findings could be generalised to the New Zealand population.

### *Scenario testing*

We asked a range of ‘what if’ questions related to disability, and the use and balance of care. For example, what if there was a policy intervention that could shift the balance of care - what would be its impact?

We used the simulated results for the virtual cohort – with no changes made - as the base case. Scenario testing was carried out by varying relevant factors of interest in the starting sample, while holding other initial factors constant, and observing impact on the potential outcome (compared to the base case). Note that the settings for the disability and care scenarios were heuristic. We started with small changes in disability or care levels and gradually increased or decreased them to assess impact on downstream outcomes.

Key influential factors on social care use may be considered as levers through which policy interventions can improve outcomes. We simulated the following three situations which address our three corresponding research questions.

First is our *base projection* of the status quo to 2021. We simulated from the starting sample in 2001 forward to 2021 with no changes to inputs or parameters. We considered 20 years as a useful period without pushing data and model limitations.

Second is our *disability scenario (2021)*. We artificially reduced both the prevalence of and transition probabilities to ‘moderate or severe disability’ - by varying degrees (5%, 10%, and 20%) - to assess the impact on social care use (informal care, formal care, and residential care).

And third is our *care scenario (2021)*. We undertook two sets of scenarios addressing our question on the balance of care: (i) We artificially increased the level of informal care use, by varying degrees (5%, 10%, and 20%), to assess the impact on the level of formal care use; and (ii) we artificially reduced the transition probability to residential care, by varying

degrees (5%, 10%, and 20%), to ascertain the amount of increase in community care (informal or formal) that might be required to achieve such an outcome.

The outcomes of the two policy-related scenarios ('disability' and 'care') were the proportions of social care users (in the sample of older people) as they changed in response to alterations in model settings.

## **Results**

### *Validation*

In order to check the validity of our work we compared simulated levels of disability and social care use, by age group, with corresponding benchmark values from the real cohort in 2006 (Table 2). An unusual drop in disability rates – with a flow-on effect to rates of social care – was obtained from the 2006 NZDS which may have been due to an artefact of the survey design, and so must be interpreted with caution (Statistics NZ 2007). A subsequent survey, in 2013, found an increase in disability rates that fitted better to the secular trend from 1996 to 2001 (to 2013) (Statistics NZ 2014). We were able to run a simulation to 2011 which showed 58.7% (95% CI: 56.9-60.3) of older people (65+) had some level of disability, compared to 59.0% reported in the 2013 survey. Otherwise, the virtual cohort followed the general pattern for the real cohort with simulated measures tending to be larger, though the size of the difference was not uniform across all measures of disability and social care use. Note that, in the interpretation of simulated results, greater importance should be placed on direction and magnitude rather than specific point estimates. Our comparison between the base simulation (with no changes) and a scenario (with a factor change) were relative to one another within the virtual world. The two simulated results - conditioned on the same input

data and parameters - are directly comparable, and give a good assessment of impact of the changed factor of interest.

***INSERT TABLE 2 ABOUT HERE***

*Scenario testing: 1. Base projection (2001-2021)*

The projected simulation from 2001 to 2021, with no change in inputs or parameter settings, showed a moderate increase in disability (13.3%) - as measured by the level of 'moderate or severe disability' - for people aged 65 years and over living in the community (Table 3). Over this period, for those people with some level of disability, there was a moderate projected increase in the use of informal care (up 15.7%), and formal care (up 2.6%) (Table 3).

***INSERT TABLE 3 ABOUT HERE***

*Scenario testing: 2. Disability scenario (2021)*

Scenarios implemented by progressively decreasing disability levels - for people aged 65 years and over living in the community with some level of disability - had the effect of moderately reducing the use of social care – informal or formal - compared to the base projection to 2021 (Table 3). For example, with disability level (the proportion that was moderate or severe) reduced by 20%, there were reductions of 6.2% in informal care use, and 3.6% in formal care use.

*Scenario testing: 3. Care scenario (2021)*

We posed two types of care scenario investigating the balance of care. Firstly, scenarios implemented by progressively rebalancing towards the use of informal care - for people aged

65 years and over living in the community with some level of disability - had the effect of moderately decreasing formal care use, compared to the base projection to 2021 (Table 4). This is illustrated by the scenario where the level of informal care use was raised by 20% (for people aged 65 and over); the proportion using formal care was reduced by only 1.1%.

***INSERT TABLE 4 ABOUT HERE***

Secondly, scenarios implemented by setting reduced levels of residential care - for people aged 65 years and over with some level of disability - show that such reductions can be achieved by moderate increases in informal and formal care - compared to the base projection to 2021 (Table 5). For example, reducing the level of residential care use by a fifth could be offset by increasing the level of informal care use by 2.2%, and of formal care use also by 2.2%.

***INSERT TABLE 5 ABOUT HERE***

## **Discussion**

The New Zealand social care system, in resource terms, is driven by a complex mix of demand and supply elements, one of which is demographic ageing (Ministry of Social Development NZ 2014). We developed and tested a model of older age with a set of key drivers and selected social care use outcomes (sensitive to changes in those drivers) that may be useful for policy decision-making. The microsimulation approach employed is advantageous as it can integrate, and enable manipulation of, the effects of variables across multiple equations - representing a system of inter-dependent processes - where each equation is given its context and influence among other equations.



### *Principal findings and implications*

We were able to construct a microsimulation model of disability level, and a range of social care resources used by older people (65+) by combining information from two nationally representative data sources. The principal findings and their implications will be discussed in the context of each of the research questions posed earlier in the paper. Based on the findings, we show what would happen if there were policy interventions that could increase or decrease current settings in disability or care levels. Discussion of actual policy initiatives, their feasibility or effectiveness is beyond the scope of this paper.

### *Research question 1 (Base projection)*

“What will be future levels of social care use for older people under the status quo?”

There is debate as to the whether New Zealand’s future will be one characterised by the expansion or compression of disability (Graham *et al.* 2004). The base projection under current settings from 2001 to 2021 showed a moderate increase in both disability and in the associated use of social care for older people living in the community. This projection assumed that, while older people were living longer, they were experiencing the same historical pattern of disability. The projected increase, over a 20-year period, in the proportion of older people with moderate or severe disability, points to a moderate future expansion of disability. In addition, the base projection, given the prevailing pattern of care-giving, led to only a moderate rise in future levels of social care use. This finding indicates that pure demographic ageing in itself – i.e. the impact of a greater proportion of older people with disability - may not have a major negative effect on aged care resources (Spijker & MacInnes 2013), and is consistent with evidence showing, for example, proximity to death rather than age being more influential in this regard (Murphy & Martikainen 2013). In effect,

improvement in life expectancy postpones the time when social care - especially residentially based care - leading up to death is needed and utilised.

The projected increase in the future level of utilisation by older people was greater for informal care than for formal care. This has implications for the future supply of informal carers in the face of recent social and demographic trends that are exerting a strain particularly on partners and adult children (Choi *et al.* 2015). These trends tend to diminish the numbers of carers available just as the baby-boomer generation is ageing leading to a gap between demand and supply, with growing unmet need (Picard *et al.* 2012). Policy intervention may be needed to provide support to family members or friends who are already caring or wanting to care for older people at home.

#### *Research question 2 (Disability scenario)*

“What is the impact of reducing disability levels on use of social care for older people?”

The receipt of social care by older people is primarily determined by functional ability (Laditka 1998). Scenarios in which disability was artificially decreased – a proxy for healthy ageing - had the effect of reducing the use of both informal and formal care for older people living in the community. This mimics the potential compression of disability in the event of a dynamic change (Graham *et al.* 2004). Thus the impact of demographic ageing on social care use would be attenuated, though to a moderate extent here, by any future reduction in disability (Stearns *et al.* 2007). Our findings indicate the limited effect of policy interventions on levels of social care use that are based solely on promoting healthier ageing (though there are other benefits for older people and society as a whole).

### *Research question 3 (Care scenario)*

“What is the impact of changing the balance among providers on levels of social care use for older people?”

The balance of care approach refers to the mix of services for that group of older people ‘at the margins of care’ whose needs could be met in alternative ways (Challis & Hughes 2002).

For older people living in the community: (i) scenarios in which social care use was rebalanced towards informal care had the effect of moderately decreasing formal care, while (ii) decreasing the transition to residential care was attainable by moderate increases in informal and formal care. Thus changing the balance of social care - shifting to alternatives (where feasible) such as informal care rather than formal care or to community-based care from residential care – may make better use of limited system resources (as well as potentially improving patient outcomes).

Policy debate regarding the supply of social care is increasingly couched in terms of the balance between different sources of support, and between public and private resources (Pavolini & Ranci 2008, Swartz 2013). It is unclear the extent to which support from one source may be substituted or offset by that from another. Informal care may be a substitute for formal care, particularly when the disability level of an older person is of low intensity (Bonsang 2009, Pickard 2012). In turn formal care may complement informal care (Geerlings *et al.* 2005, Sole-Auro & Crimmins 2014). Furthermore, supported care at home (informal and/or formal) may prevent or delay the need for institutionalisation (rather than having an immediate direct effect) (Gaugler *et al.* 2000).

Changing the balance from formal to informal care places pressure on the supply of available carers, among family members or friends, which may already be insufficient and dwindling.

Public policy has a role to play in supporting informal carers perhaps with the re-direction of resources. Such change of emphasis could be achieved where social services were deemed to be amenable to rebalancing (along with carer supply implications).

The potential for re-balancing also applies in the case of institutional care. Leaving aside their degree of disability (Laditka & Laditka 2001), and despite social risk factors for institutionalisation (Noël-Miller *et al.* 2010), there is evidence that older people tend to prefer to be cared for in their own homes (Tucker *et al.* 2008). There is a proportionately high residential population in New Zealand compared to other OECD countries (Broad *et al.* 2013), with, arguably, leeway for reduction without detriment to the well-being of older people. The balance of care approach is useful for addressing resource issues. For example, drawing on our findings, a potential policy intervention might be higher criteria for entry – such as a threshold of need - to residential care (Williams *et al.* 2009), along with supported care in the community, which would cement the benefits of ageing in place, and which could generate cost savings (Kuluski *et al.* 2012). Although investing in home-based care in the community can reduce the risk of institutionalisation (Muramatsu *et al.* 2007), there is a limit to its advantages as the level of disability - and hence need - of the older person increases (Hebert *et al.* 2001).

### *Strengths and limitations*

The microsimulation approach has many combined advantages: it has an empirical basis; multiple processes are modelled together and contextualised within a system; and pathways are modelled that may be amenable to policy influence (Spielauer 2011). However, it relies heavily on the availability, quality, and compatibility of data, especially sufficient scope and detail of extant variables to model the core processes and key outcomes of substantive

interest. In our case, official data sources were particularly advantageous as results from modelling could be generalised to New Zealand's future population. Data limitations in our case were: a small starting sample; self-reported information on use of care (not need nor supply); narrow range of explanatory variables; no longitudinal data to derive transition probabilities (matching only by age and gender biases against finer-grained sub-groups, and assuming state progression leads to over-estimation); and no costing information.

The base year of the sample was from 2001 national survey data which - at the time the model was first developed - were the most recent that contained the requisite information. These national surveys were carried out only about every five years. We held back more recent data (from 2006) for benchmarking simulation results. Thus our findings are squarely based on the data at hand. The model was able to approximate benchmark data and parameter settings, suggesting that simulated results may give a useful indication of future trends.

The data and model also did not reflect policy developments in New Zealand since 2001 (Cumming *et al.* 2014). Nor are there considerations of changes in social expectations or obligations regarding the provision of social care over that period (Haberkern & Szydklik 2010).

In this paper, we have not considered health care as part of a better integrated system of care – i.e. care co-ordinated across a range of services - for older people (Leichsenring 2004). For example, a consequence of improving life expectancy may shift the balance from acute to long-term care services (Murphy & Martikainen 2013), while informal care may complement doctor and hospital visits (Bolin *et al.* 2008).

In testing a scenario by manipulating a factor of interest, we assumed that other initial conditions and relationships between factors remained the same. Results from scenario testing have been plausible and interpretable. Scenario testing generally showed modest impact on outcomes with a degree of stability in the model perhaps due to the manner of its construction. However, this may also be a reflection of social reality as being complex and difficult to change. Our model is a simplification – based on assumptions, and testing broad-brush scenarios - but can be considered indicative and placed beside other policy evidence.

There are of course differences but also similarities in the social care systems of developed countries. For example, the United Kingdom and Australia would be the most similar countries to New Zealand. We do not claim that our results are generalizable in total to all countries but think that there are lessons to be learnt where there are system similarities.

### *Conclusions*

By bringing together data from various official sources, we were able to construct a microsimulation model of older age and apply that model to a substantive policy area. The model serves as a starting point with the potential to be improved and extended. Findings suggest that the system is robust to change. Adding to the international debate on the impact of demographic ageing, our model indicates that it may not have a major negative impact on system resources. Furthermore, the sheer volume of social care required with larger numbers of older people may not only be alleviated by healthier ageing but also by adopting a balance of care approach to make better use of constrained resources.

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**Box 1.***Research questions*

1. What will be future levels of social care use for older people under the status quo? This is our 'base projection'.
2. What is the impact of reducing disability levels – proxy for healthier ageing - on use of social care for older people? This is our 'disability scenario'.
3. What is the impact of changing the balance among providers on levels of social care use for older people? This is our 'care scenario'.

## Box 2.

### *Definition of variables*

The variables employed in the model can be categorised into three types:

#### *1. Socio-demographic*

- Age: 65+ years.
- Gender: male, female.
- Ethnicity (prioritised sequence): Māori (the indigenous people), Pacific, Other, European. Using prioritisation, a single ethnicity variable was constructed to account for individuals who reported multiple ethnic affiliations; the total number of responses equalled the total sample (Lang 2002).
- Socio-economic deprivation: 'NZDep' (decile) – a census-based small-area measure derived from a combination of variables, i.e. respective proportions of people in an area with various socio-economic disadvantages (Salmond & Crampton 2012).
- Partnership: married, or partnered and not legally married (yes/no)

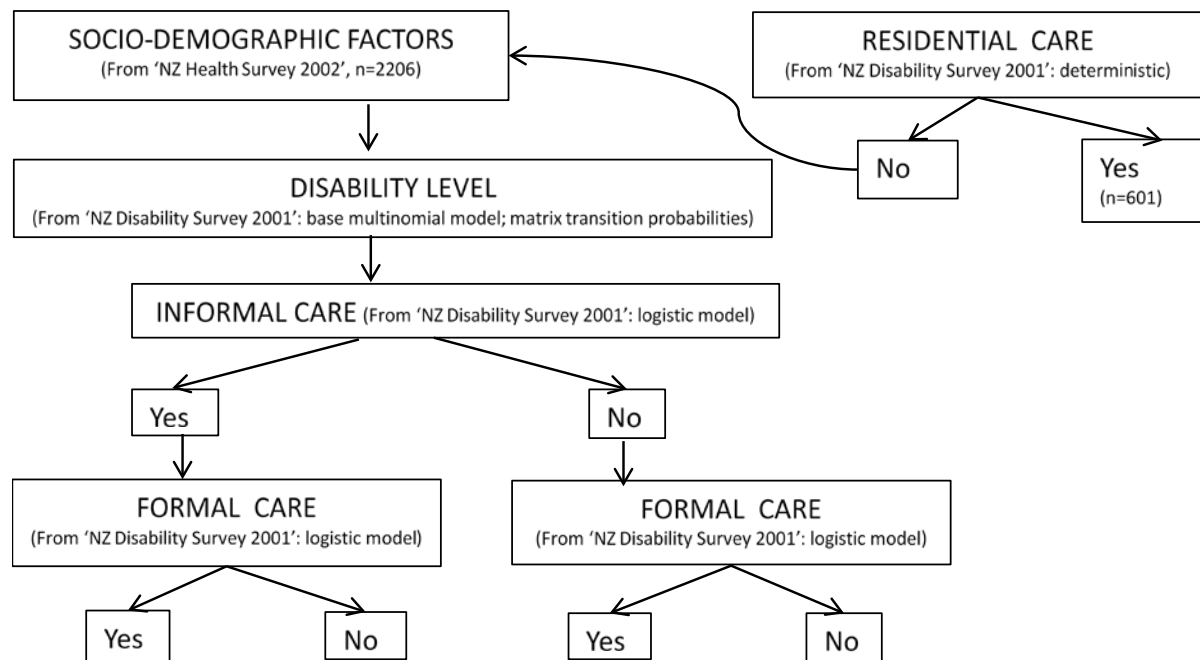
#### *2. Disability*

- Disability level - corresponding to required levels of assistance in activities of daily living: 'none' and 'mild' disability requiring no assistance; 'moderate' disability requiring some assistance, and 'severe' disability requiring assistance every day (yes/no) (Statistics NZ 2002). The moderate and severe categories are combined in the reporting of simulated results for ease of tracking changes.

#### *3. Social care use (outcomes)*

- Social care use – use of assistance in activities of daily living, provided under three modalities: 'informal' – provided at home by family or friends, and unpaid (yes/no), 'formal' – provided at home by government or other service agencies, and paid (yes/no), 'residential' – long-stay rest home (yes/no) (Statistics NZ 2002).

**Figure 1. Conceptual model of late-life ageing and social care trajectory.**



**Table 1. Description of starting sample. Characteristics of older people aged 65+ years living in various settings, 2001.**

|                                      | Percentage of weighted sample <sup>a</sup> |                           |  |
|--------------------------------------|--|---------------------------|--|
|                                      | Householders only<br>(n=2206)              | Residents only<br>(n=601) | Householders and residents<br>(n=2807) |
| <b>Age group</b>                     |  |                           |  |
| 65-74                                | 54.2                                       | 16.9                      | 51.9                                   |
| 75-84                                | 36.5                                       | 35.2                      | 36.4                                   |
| 85+                                  | 9.3  | 47.9                      | 11.7                                   |
| <b>Gender</b>                        |  |                           |  |
| Female                               | 55.3                                       | 70.6                      | 56.3                                   |
| <b>Ethnicity</b>                     |  |                           |  |
| European                             | 91.8                                       | 86.6                      | 91.5                                   |
| Maori                                | 4.0  | 1.5                       | 3.8                                    |
| Pacific                              | 1.7  | 1.8                       | 1.7                                    |
| Asian                                | 2.2  | 0.7                       | 2.1                                    |
| Other                                | 0.3  | 9.5                       | 0.9                                    |
| <b>Marital status</b>                |  |                           |  |
| Partnered                            | 56.5                                       | 19.6                      | 54.2                                   |
| <b>Deprivation decile</b>            |  |                           |  |
| 1 (low deprivation)                  | 6.5  | -                         | -                                      |
| 2                                    | 7.6  | -                         | -                                      |
| 3                                    | 9.3  | -                         | -                                      |
| 4                                    | 10.4                                       | -                         | -                                      |
| 5                                    | 10.1                                       | -                         | -                                      |
| 6                                    | 13.5                                       | -                         | -                                      |
| 7                                    | 10.6                                       | -                         | -                                      |
| 8                                    | 13.8                                       | -                         | -                                      |
| 9                                    | 11.1                                       | -                         | -                                      |
| 10 (high deprivation)                | 7.3  | -                         | -                                      |
| <b>Disability level <sup>b</sup></b> |  |                           |  |
| None                                 | 49.1                                       | 0                         | 46.0                                   |
| Mild                                 | 14.7                                       | 0                         | 13.8                                   |
| Moderate                             | 27.7                                       | 18.4                      | 27.1                                   |
| Severe                               | 8.5  | 81.6                      | 13.1                                   |

a. The starting sample was taken from the New Zealand (NZ) Health Survey 2002/3 (Ministry of Health 2004), and the NZ Disability Survey 2001 (Statistics NZ 2002), with weighting calibrated to the NZ Census 2001.

b. Imputed from NZ Disability Survey 2001.

**Table 2. Disability level and social care for older people aged 65+ years living in various settings. Comparing simulated to real data, 2006.**

| Age group        | Disability<br>(for all householders) |                   | Social care modalities                     |                   |                        |                   |                                |                   |
|------------------|--------------------------------------|-------------------|--|-------------------|------------------------|-------------------|--------------------------------|-------------------|
|                  |                                      |                   | Householders with some level of disability |                   |                        |                   | All householders and residents |                   |
|                  | Moderate or severe (%)               |                   | Any informal (%)                           |                   | Any formal (%)         |                   | Residential (%)                |                   |
|                  | Simulated <sup>a</sup>               | Real <sup>a</sup> | Simulated <sup>a</sup>                     | Real <sup>a</sup> | Simulated <sup>a</sup> | Real <sup>a</sup> | Simulated <sup>a</sup>         | Real <sup>a</sup> |
| <b>65-69</b>     | 23.4                                 | 16.7              | 30.5                                       | 26.6              | 22.5                   | 17.3              | 1.3                            | 0                 |
| <b>70-74</b>     | 35.4                                 | 23.6              | 36.3                                       | 25.4              | 30.4                   | 23.4              | 2.8                            | 4.9               |
| <b>75-79</b>     | 38.1                                 | 29.5              | 35.6                                       | 31.0              | 35.7                   | 30.3              | 4.7                            | 8.5               |
| <b>80-84</b>     | 55.3                                 | 47.3              | 44.9                                       | 37.2              | 48.9                   | 39.7              | 8.6                            | 17.5              |
| <b>85+</b>       | 79.3                                 | 62.8              | 58.6                                       | 51.3              | 55.5                   | 47.0              | 27.7                           | 35.0              |
| <b>All (65+)</b> | 38.9                                 | 29.2              | 39.3                                       | 32.7              | 36.3                   | 30.0              | 6.4                            | 5.9               |
| <b>(95% CI)</b>  | ( 37.7-39.7)                         |                   | ( 37.7-41.1)                               |                   | (34.2-38.2 )           |                   | ( 6.1-6.8)                     |                   |

a. Starting sample (n=2,807)

b. Taken from NZ Disability Survey 2006 (n=4,035)

**Table 3. Base projection and disability scenarios. Disability and social care for older people aged 65+ years living in the community, 2001-2021.**

| Simulations <sup>a</sup>                     | Disability                       | Social care modalities                           |             |
|--|----------------------------------|--|-------------|
|  | (for all householders)           | (for householders with some level of disability) |             |
|  | Moderate or severe               | Any informal                                     | Any formal  |
| <b>Q1. Base projection <sup>b</sup></b>      | (%)                              | (%)  | (%)         |
| <b>2001</b>                                  | 36.0                             | 35.1   | 35.0        |
| <b>2006</b>                                  | 38.8                             | 39.3   | 36.3        |
| <b>2011</b>                                  | 40.3                             | 40.3   | 36.8        |
| <b>2016</b>                                  | 38.1                             | 38.1   | 33.7        |
| <b>2021</b>                                  | 40.8                             | 40.6   | 35.9        |
| <b>Q2. Disability scenarios <sup>c</sup></b> |                                  |  |             |
|  | Make 5% reduction in disability  | (% ) [% change] <sup>d</sup>                     |             |
| <b>2006</b>                                  | -                                | 39.3   | 36.1        |
| <b>2011</b>                                  | -                                | 39.6   | 36.3        |
| <b>2016</b>                                  | -                                | 37.5   | 33.0        |
| <b>2021</b>                                  | -                                | 40.0 [-1.5]                                      | 35.5 [-1.1] |
|  | Make 10% reduction in disability |  |             |
| <b>2006</b>                                  | -                                | 38.9   | 36.0        |
| <b>2011</b>                                  | -                                | 39.2   | 36.2        |
| <b>2016</b>                                  | -                                | 36.9   | 32.8        |
| <b>2021</b>                                  | -                                | 39.2 [-3.4]                                      | 35.0 [-2.5] |
|  | Make 20% reduction in disability |  |             |
| <b>2006</b>                                  | -                                | 37.6   | 35.7        |
| <b>2011</b>                                  | -                                | 38.0   | 35.2        |
| <b>2016</b>                                  | -                                | 35.5   | 32.1        |
| <b>2021</b>                                  | -                                | 38.1 [-6.2]                                      | 34.5 [-3.6] |

a. Simulations are calibrated to NZ Disability Survey 2006 data.

b. Base projection to 2021 is on current settings.

c. Scenarios represent the impact of reducing base prevalence of and transition probabilities for disability by nominated percentage of base projected level.

d. Proportional change in outcome (due to the scenario settings) compared to the base projection for that year.



**Table 4. Care scenario no. 1. Balance towards more informal care for older people aged 65+ years living in the community, 2006-2021.**

| Simulations <sup>a</sup>                | Social care modalities<br>(for householders with some level of disability) |                             |
|---|--|-----------------------------|
|   | Any informal   | Any formal                  |
| <b>Q1. Base projection <sup>b</sup></b> | (%)  | (%)                         |
| <b>2001</b>                             | 35.1   | 35.0                        |
| <b>2006</b>                             | 39.3   | 36.3                        |
| <b>2011</b>                             | 40.3   | 36.8                        |
| <b>2016</b>                             | 38.1   | 33.7                        |
| <b>2021</b>                             | 40.6   | 35.9                        |
| <b>Q3. Care scenario <sup>c</sup></b>   |  |                             |
|   | Make 5% increase in any informal care                                      | (%) [% change] <sup>d</sup> |
| <b>2006</b>                             | -  | 36.2                        |
| <b>2011</b>                             | -  | 36.2                        |
| <b>2016</b>                             | -  | 34.0                        |
| <b>2021</b>                             | -  | 35.5 [-1.1]                 |
|   | Make 10% increase in any informal care                                     |                             |
| <b>2006</b>                             | -  | 36.0                        |
| <b>2011</b>                             | -  | 36.3                        |
| <b>2016</b>                             | -  | 33.5                        |
| <b>2021</b>                             | -  | 35.4 [-1.1]                 |
|   | Make 20% increase in any informal care                                     |                             |
| <b>2006</b>                             | -  | 35.9                        |
| <b>2011</b>                             | -  | 36.2                        |
| <b>2016</b>                             | -  | 33.1                        |
| <b>2021</b>                             | -  | 35.4 [-1.1]                 |

a. Simulations are calibrated to NZ Disability Survey 2006 data.

b. Base projection to 2021 is on current settings.

c. Scenarios represent the impact of increasing the level of ‘any informal care’ use by nominated percentage of base projected level.

d. Proportional change in outcome (due to the scenario settings) compared to the base projection for that year.

**Table 5. Care scenario no. 2. Balance towards less residential care for older people aged 65+ years, 2006-2021.**

| Simulations <sup>a</sup>                | Social care modalities<br>(for householders with some level of disability and residents) |             |  |
|---|--|-------------|--|
|   | Any informal   | Any formal  | Residential                              |
| <b>Q1. Base projection <sup>b</sup></b> | (%)  | (%)         | (%)                                      |
| <b>2001</b>                             | 31.3   | 31.3        | 10.7                                     |
| <b>2006</b>                             | 34.9   | 32.1        | 11.4                                     |
| <b>2011</b>                             | 35.5   | 32.5        | 11.7                                     |
| <b>2016</b>                             | 34.6   | 30.7        | 9.0                                      |
| <b>2021</b>                             | 36.1   | 31.9        | 11.0                                     |
| <b>Q3. Care scenario <sup>c</sup></b>   |  |             |  |
|   | (%) [% change] <sup>d</sup>  |             | Target 5% reduction in residential care  |
| <b>2006</b>                             | 35.2   | 32.3        | -  |
| <b>2011</b>                             | 35.7   | 32.5        | -  |
| <b>2016</b>                             | 34.9   | 30.8        | -  |
| <b>2021</b>                             | 36.1 [0]   | 31.9 [0]    | -  |
|   |  |             | Target 10% reduction in residential care |
| <b>2006</b>                             | 35.1   | 32.5        | -  |
| <b>2011</b>                             | 36.1   | 32.8        | -  |
| <b>2016</b>                             | 35.0   | 30.8        | -  |
| <b>2021</b>                             | 36.7 [+1.7]  | 32.4 [+1.6] | -  |
|   |  |             | Target 20% reduction in residential care |
| <b>2006</b>                             | 35.6   | 33.1        | -  |
| <b>2011</b>                             | 36.8   | 33.1        | -  |
| <b>2016</b>                             | 35.4   | 31.3        | -  |
| <b>2021</b>                             | 36.9 [+2.2]  | 32.6 [+2.2] | -  |

a. Simulations are calibrated to NZ Disability Survey 2006 data.

b. Base projection to 2021 is on current settings.

c. Scenarios represent the impact of reducing the transition probabilities for residential care use by nominated percentage of base projected level.

d. Proportional change in outcome (due to the scenario settings) compared to the base projection for that year.