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The Impact of Chronic Conditions Among Older Adults on Family and Whānau in Aotearoa New Zealand: A Cross-Sectional Nationwide Study Using Linked Microdata

Te Pāpānga o Ngā Mate Tauroa o Te Hunga Mātāpuputu ki ngā Whānau kei Aotearoa: He Rangahau Mokowā-Wā e Whakamahi Raraunga Whāiti ana kua Honoa

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Abstract

As populations age, the prevalence of chronic health conditions and comorbidities rises. While the impact of chronic conditions (CCs) on individuals and health and social systems is well-documented, the effects that older adults with CCs could impose on their families remain underinvestigated. In this paper, we focus on several key family outcomes (income, social benefits, residential mobility, overseas travelling and hospitalisations) in the IDI-derived cohort of over one million family units, and how they are affected by the family composition and characteristics. We identified considerable differences in family outcomes likely affected by the presence of older family members with CCs.

Keywords: chronic conditions, older people, family outcomes, individual-level microdata

Whakarāpopotonga

I ngā taupori e kaumātua haere ana e piki ana hoki te nui o ngā mate tauroa me ngā mate ngātahi. Ahakoa kua pai kē te mau kōrero mō te pāpānga o ngā mate tauroa ki ngā tāngata takitahi me ngā pūnaha pāpori, kāore anō kia āta tūhuratia ngā pānga pea o te hunga mātāpuputu whai mate tauroa ki ō rātou whānau. I tēnei pepa e arotahi ana mātou ki ētahi putanga matua ā-whānau (te moniwhiwhi, ngā painga pāpori, te nekeneke ā-wharenoho, te haere ki tāwāhi me ngā whakaurunga hōhipera) i te pūtoi he mea take i te IDI o te neke atu i te kotahi miriona whānau, me te pānga o te hanganga me ngā āhuatanga o te whānau anō ki a rātou. He mea tautuhi ētahi rerekētanga hira i ngā putanga whānau tērā pea kua pāngia e ngā tāngata mātāpuputu whai mate tauroa

Ngā kupu matua: mate tauroa, hunga mātāpuputu, putanga whānau, raraunga whāiti ā-tangata takitahi

Disclaimer

Access to the data used in this study was provided by Stats NZ under conditions designed to give effect to the security and confidentiality provisions of the Data and Statistics Act 2022. The results presented in this study are the work of the authors, not Stats NZ or individual data suppliers. These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI), which is carefully managed by Stats NZ. For more information about the IDI, please visit https://www.stats.govt.nz/integrated-data/.

Primary research data cannot be shared due to their confidentiality and ethical restrictions. Data are available for approved researchers as a part of New Zealand's Integrated Data Infrastructure.

Chronic health diseases can be considered long-lasting conditions that have ongoing effects (Denton & Spencer, 2010). As a result of population ageing, the prevalence of *chronic health conditions* (CCs) is increasing among older adults in industrialised countries throughout the world, and they have become a priority for action in the health sector (Anderson & Horvath, 2004; Nihtila et al., 2008). Older adults are often living with more than one CC, and this increasing level of multi-morbidity is a significant burden on individuals, their families, and the health and social systems that are endeavouring to support them (Sheridan et al., 2011; Tu & Cohen, 2009; Zwar et al., 2006). Although definitions of CCs can vary, it is estimated that approximately one in three adults lives with more than one CC (Hajat & Stein, 2018). In the USA, more than 60 per cent of adults aged 65 and older have been diagnosed with two or more CCs (Guy et al., 2017).

Major CCs, which include chronic obstructive pulmonary disease (COPD), heart failure, dementia and diabetes, have a well-documented negative impact both on the individual diagnosed and the health system as a whole (Abegunde et al., 2006; Zwar et al., 2006). A number of studies have highlighted the impact of CCs on both the quality of life and the mental health of those diagnosed with one or more of these conditions (Megari, 2013; Verhaak et al., 2005). Studies have also examined the psychological and quality of life impact that CCs have on other family members aside from the individual diagnosed (Golics et al., 2013; Holmes & Deb, 2003). Much work has also been undertaken to examine the significant impact and burden on caregivers (Schulz & Beach, 1999), as well as carer stress in those supporting family members with a diagnosis of dementia (Brodaty & Donkin, 2009; Etters et al., 2008).

There has been little large-scale research, however, using quantifiable outcome measures examining the impact of CCs on the wider household. The increasing reliance on informal carers who live with older adults with CCs makes further understanding of this area particularly significant (Longacre et al., 2016). In addition, it is also important for us to fully understand the impact of CCs on all household family members, including those that may not be considered carers, because the CC of the person they are living with may still impact them in some way. Therefore, although the increasing longevity of worldwide populations is a cause for celebration, the increasing prevalence and rise in multiple CCs is a cause of

increasing concern for health planners, and more needs to be understood about the impact over the life course on both the individual and other family members (McPhail, 2016).

Given the association between high health burden and lower socio-economic status (Menec et al., 2010), a detailed understanding at a national level of how CCs impact all household family members from a financial, educational, health and career perspective could add real value for health and social services planners. Only with this important layer of additional information can financially limited health and social care systems direct funds and resources to those areas where benefits are most likely to be realised.

A further important perspective in this field is an acknowledgement and greater understanding of the ethnic disparities that exist worldwide, both in terms of health outcomes and socio-economic status (Cutler et al., 2008; Eapen et al., 2015). In Aotearoa New Zealand (AoNZ), where this study was undertaken, both Indigenous Māori and Pacific Peoples have poorer health outcomes and higher levels of deprivation than the European New Zealand population (Abey-Nesbit et al., 2021). Given this and the fact that different ethnicities living in one country may have different living arrangements (Jamieson et al., 2018), a clear picture of the impact of CCs on other household family members can provide us with additional data that can inform interventions that help to address and reduce health inequity.

As part of a wider life course project (National Science Challenges, 2023), this large population-wide study aims to quantify the impact that an older person with CCs has on the family members they are living with.

Methods

Study design

This study is an analysis of cross-sectional data of people living with their family members in AoNZ sourced using the Stats NZ Integrated Data Infrastructure (IDI), a national database of de-identified linked individual-level microdata set up for research purposes (Stats NZ, 2025). Data sets in the IDI come from multiple government agencies, services and surveys that record when people in AoNZ interact with them. The IDI includes data from AoNZ censuses as well as on health, education, benefits and social services,

justice, income and work, housing, population and communities. Individuals' data across different sectors are linked using probabilistic matching via the spine. Secured access to the IDI is granted only to approved researchers working on approved projects that benefit AoNZ.

Study population

A cohort of all individuals who were living in the families was derived from the IDI based on the 2013 Census. The families in the study were defined as groups of individuals living together in a family in a household on census day (5 March 2013) using mutual *family* (family nucleus) or *extended family* (group of related people who usually reside together) identifiers. Families were included if they contained at least two individuals who were on the spine and present on census day (and thus were linkable to health data), and at least one individual was over 15 years of age. Family identifiers do not allow for detail on the length and status of family relationships. Those individuals usually living in a family setting where all other family members were not present on census day and thus were not linkable to families, were excluded from the analysis.

Sociodemographic characteristics

Sociodemographic information, particularly age, sex (male, female) and level 1 ethnicity (Asian, European and Other, Māori, MELAA (Middle Eastern, Latin American & African), and Pacific Peoples), were identified from the census data and the personal details table (summary IDI table drawing on cross-agency data) (Teng et al., 2024). People with two or more ethnicities contributed to all the groups to which they identified (total response approach). Family ethnicity was then estimated based on the ethnicities of individuals in the family unit (total response), meaning that the family can be categorised in multiple ethnic groups rather than using one particular ethnicity based on the prioritisation. Older adults were defined as people of 55 years and older to account for the known earlier onset of ageing among Māori and Pacific Peoples. Family size and counts of family members by sex and age (older adults (55+), youth (< 18)) were aggregated based on the family unit identifiers.

The area-level socio-economic deprivation index in 2018 (NZDep18) (Atkinson et al., 2019) was assigned in deciles to each individual and family

unit using their most recent residential address available before 30 June 2018. Additionally, urbanicity of the family based on the Urban-Rural Indicator 2018 categories (major urban area, large urban area, medium urban area, small urban area, rural settlement, rural other) (Stats NZ, 2018) was linked to the individuals and families based on the same residential address.

Health conditions

National health data sets were searched to identify nine CCs, from 5 March 2008 up to 6 March 2018 (the date of the 2018 Census). Data sets consisted of public and private hospital discharges (NMDS), speciality mental health service contacts (PRIMHD), disability needs assessment and service coordination information (SOCRATES), needs assessment for older people (interRAI), pharmaceutical dispensing, laboratory claims, the cancer registry, outpatient visits (NNPAC), Accident Compensation Corporation data set (ACC) and the chronic conditions table (IDI summary table) (Teng et al., 2024).

Nine health conditions were chosen due to their inclusion in the New Zealand Ministry of Health classification of chronic conditions: diabetes, cancer, chronic obstructive pulmonary disease (COPD), coronary heart disease (including acute myocardial infarction; CHD), gout, stroke and traumatic brain injury (TBI), with the addition of dementia (Walesby et al., 2020) and mental health/behavioural conditions (MH) (Bowden et al., 2020; Richmond-Rakerd et al., 2021; Teng et al., 2024). Mental health conditions were created as a wider group consisting of attention deficit hyperactivity disorder, anxiety, autism spectrum disorder, bipolar disorder, conduct disorder, depression, eating disorders, emotional problems, personality disorders, psychotic disorders and sleep disorders (but not drug or alcohol disorders, or self-harm) (Teng et al., 2024). The data used for the analysis did not contain specifics on the diseases, such as the type of cancer or the severity of a stroke. We also noted when the health condition was recorded and calculated the proportion of time spent with the health condition between 2013 and 2018 for each individual.

Binary indicators (condition present or absent) were derived for each CC and the presence/absence of any condition. The detailed methodology of deriving health conditions for individuals is explained in Underwood et al.

(2024). The presence of a CC in the family (older adult, other members) and the number of family members with a CC(s) were aggregated based on the family unit identifiers.

Family outcomes

Our research focused on multiple plausible family outcomes with data available in the IDI: the number of changes of residential addresses, total family income, benefits received (total benefits and total months on benefits), hospitalisations and overseas travels. All outcomes were measured in the period between 2013 and 2018, except total family income, which is based on 2013 Census data. Furthermore, as we investigated the impact of the older family members on the family outcomes, we removed the contribution of any and all of the older person(s) to the family outcomes if the older family member(s) is present in the family unit. However, we also utilised analysis with the contribution of the older person kept as a sensitivity analysis. Address changes were extracted for each individual living in the family unit (including and excluding older family members) from the IDI address notification table. Residential address changes are represented by a median number of address changes per family unit. Total family income (ordinal categories) was extracted from the 2013 Census based on the family identifier. Received benefits are the total sum of monthly benefits and the total sum of months receiving benefits by all individuals (including and excluding older family members) living in the family unit extracted from the IDI tax records (2013–2018), with source defined as benefit payments from the Ministry of Social Development (MSD) or Accident Compensation Corporation (ACC) payments. Hospitalisations were the sum of days spent in the hospital by family members (including and excluding older family members) extracted from the public and private discharge events in the IDI. Time spent overseas is the sum of days spent overseas by all family members (including and excluding older family members) extracted from the IDI overseas spell data set.

Data management

Geographic data (NZDep 2018 and urbanicity) were linked using the meshblock code of the last available residential address. Population, demographic and health condition data sets were combined using IDI unique identifiers. These identifiers are assigned by StatsNZ to individuals using

deterministic linkage within agency data sets (e.g., using the National Health Index number (NHI) to link the various health data sets) and by the probabilistic linkage between distinct agency data sets (e.g., links between health and the spine, and between census and the spine) (Stats NZ, 2013). Data held in the IDI, including linking, is managed by Stats NZ. Confidentiality rules required suppression of small numbers (< 6) and random rounding of all counts to the base of 3, as well as confidentialising summary statistics. Therefore, some total counts may not perfectly add up. Analysis results were released by Stats NZ after the screening.

Analysis

Descriptive tables were produced to examine overall individual and family composition patterns by sex, ethnicity and health condition. We used (zero-inflated) negative binomial models to analyse the impact that the presence of an older person(s) with(out) a CC has on all outcomes of the family (dependent variable), except family income, which is recorded as ordered categories and ordered logistic regression was used for analysing it. The independent variables were: the count of older adults with any CC(s); the count of other family members with any CC; family size; counts of males, youth and older person(s) in the family; and family ethnicity. We further controlled for socio-economic deprivation and urbanicity of the family's residence. We report the incidence rate ratios for outcomes including the contribution of the older person (IRR_{iop}) and excluding the older person's contribution (IRR_{eop}). For income, we report adjusted odds ratios (aOR).

All the analyses were carried out in the IDI Data lab, using SAS Enterprise Guide Version 8.3 (data extraction) (SAS Help Center, 2025) and R project 4.1 (R Core Team, 2025). Missing data are presented in tables where numbers are large enough to do this.

Ethics

Ethics approval was given by the University of Auckland Health Research Ethics Committee (AH21563).

Results

Within the IDI 2013 Census data, we identified 3,096,837 individuals, of which 51.3 per cent were female, linked with 1,080,279 family units. Of those, 503,841 individuals identified as Māori and 210,246 as Pacific Peoples. Table 1 provides a breakdown of the population by level 1 ethnicity, age band, and presence or absence of any chronic condition. Supplementary Table 1 provides an additional breakdown by gender, including the count and percentage.[1]

We analysed the family units by the number of individuals in the family unit, by ethnicity, and by the number of CCs recorded for all family members, and showed results when the families with an older adult(s) with CCs were included in the count (Table 2) and excluded from the count (Supplementary Table 2). When breaking down the family units by size and ethnicities present in each family unit, the number of families differs, as multi-ethnic families count independently as one unit for each ethnicity present.

Table 1: Number of individuals by ethnicity, age band and status of chronic condition

	European and Other	Māori	Pacific Peoples	Asian	MELAA	Total
No CC	**1,075,245 (54.4%) a)**	**315,630 (62.6%)**	**135,792 (64.6%)**	**264,192 (71.6%)**	**25,218 (67.4%)**	**1,816,077 (58.6%)**
<18	352,311 (17.8%) b)	178,491 (35.4%)	67,386 (32.1%)	89,625 (24.3%)	10,068 (26.9%)	697,881 (22.5%)
18–54	535,149 (27.1%)	122,820 (24.4%)	62,343 (29.7%)	154,140 (41.8%)	14,100 (37.7%)	888,552 (28.7%)
55+	187,785 (9.5%)	14,319 (2.8%)	6,063 (2.9%)	20,427 (5.5%)	1,050 (2.8%)	229,644 (7.4%)
With CC	**901,185 (45.6%)**	**188,211 (37.4%)**	**74,454 (35.4%)**	**104,700 (28.4%)**	**12,210 (32.6%)**	**1,280,760 (41.4%)**
<18	132,906 (6.7%)	57,198 (11.4%)	18,513 (8.8%)	15,990 (4.3%)	2,526 (6.7%)	227,133 (7.3%)
18–54	404,850 (20.5%)	97,089 (19.3%)	40,260 (19.1%)	59,589 (16.2%)	7,566 (20.2%)	609,354 (19.7%)
55+	363,429 (18.4%)	33,924 (6.7%)	15,681 (7.5%)	29,121 (7.9%)	2,118 (5.7%)	444,273 (14.3%)
Total	**1,976,430 (100.0%)**	**503,841 (100.0%)**	**210,246 (100.0%)**	**368,892 (100.0%)**	**37,428 (100.0%)**	**3,096,837 (100.0%)**

Notes: 1. a) Percentage of population in the group; b) Percentage of population in the subgroup.
2. MELAA = Middle East Latin America Africa; CC = chronic condition.

Table 2: Family units (including older people with CC) by size, number of family members with a chronic condition, and ethnicity

Number of family members with CC	Number of family members						Total (%)
	2	3	4	5	6	7+	
European and Other	**488,652** [a] **(55.1%)** [b]	**178,164 (20.1%)**	**150,606 (17.0%)**	**52,617 (5.9%)**	**12,870 (1.5%)**	**4,428 (0.5%)**	**887,337** [c] **(65.8%)** [d]
0	114,990 [e] (23.5%)	43,008 (24.1%)	34,458 (22.9%)	10,383 (19.7%)	2,133 (16.6%)	570 (12.9%)	205,542 (23.2%)
1	204,201 (41.8%)	67,002 (37.6%)	52,572 (34.9%)	16,863 (32.0%)	3,597 (27.9%)	1,101 (24.9%)	345,336 (38.9%)
2	169,461 (34.7%)	50,010 (28.1%)	40,686 (27.0%)	14,103 (26.8%)	3,447 (26.8%)	1,128 (25.5%)	278,835 (31.4%)
3		18,144 (10.2%)	18,327 (12.2%)	7,665 (14.6%)	2,169 (16.9%)	834 (18.8%)	47,139 (5.3%)
4+			4,563 (3.0%)	3,603 (6.8%)	1,524 (11.8%)	795 (18.0%)	10,485 (1.2%)
Māori	**92,808 (45.0%)**	**50,925 (24.7%)**	**36,672 (17.8%)**	**16,563 (8.0%)**	**6,075 (2.9%)**	**3,270 (1.6%)**	**206,313 (15.3%)**
0	25,533 (27.5%)	12,897 (25.3%)	8,283 (22.6%)	3,276 (19.8%)	1,017 (16.7%)	426 (13.0%)	51,432 (24.9%)
1	40,584 (43.7%)	19,638 (38.6%)	13,140 (35.8%)	5,493 (33.2%)	1,797 (29.6%)	837 (25.6%)	81,489 (39.5%)
2	26,691 (28.8%)	13,827 (27.2%)	9,810 (26.8%)	4,431 (26.8%)	1,632 (26.9%)	849 (26.0%)	57,240 (27.7%)
3		4,563 (9.0%)	4,395 (12.0%)	2,325 (14.0%)	1,020 (16.8%)	606 (18.5%)	12,909 (6.3%)
4+			1,044 (2.8%)	1,038 (6.3%)	609 (10.0%)	552 (16.9%)	3,243 (1.6%)

(Table 2 continues over the page…)

Pacific Peoples	**33,972 (36.6%)**	**22,773 (24.5%)**	**17,358 (18.7%)**	**9,927 (10.7%)**	**5,049 (5.4%)**	**3,759 (4.0%)**	**92,838 (6.9%)**
0	10,665 (31.4%)	6,033 (26.5%)	4,062 (23.4%)	1,899 (19.1%)	834 (16.5%)	453 (12.1%)	23,946 (25.8%)
1	14,757 (43.4%)	8,763 (38.5%)	6,300 (36.3%)	3,348 (33.7%)	494 (29.6%)	990 (26.3%)	35,652 (38.4%)
2	8,550 (25.2%)	6,138 (27.0%)	4,653 (26.8%)	2,682 (27.0%)	1,437 (28.5%)	1,032 (27.5%)	24,492 (26.4%)
3		1,839 (8.1%)	1,896 (10.9%)	1,434 (14.4%)	828 (16.4%)	705 (18.8%)	6,702 (7.2%)
4+			447 (2.6%)	564 (5.7%)	456 (9.0%)	579 (15.4%)	2,046 (2.2%)
Asian	**62,301 (41.5%)**	**40,953 (25.9%)**	**31,662 (20.8%)**	**8,421 (8.0%)**	**1,845 (2.5%)**	**642 (1.3%)**	**145,824 (10.8%)**
0	27,207 (43.7%)	16,164 (39.5%)	11,004 (34.8%)	2,442 (29.0%)	450 (24.4%)	114 (17.8%)	57,381 (39.3%)
1	23,202 (37.2%)	15,390 (37.6%)	11,688 (36.9%)	2,979 (35.4%)	606 (32.8%)	186 (29.0%)	54,051 (37.1%)
2	11,892 (19.1%)	7,602 (18.6%)	6,567 (20.7%)	1,986 (23.6%)	471 (25.5%)	168 (26.2%)	28,686 (19.7%)
3		1,797 (4.4%)	2,010 (6.3%)	762 (9.0%)	204 (11.1%)	105 (16.4%)	4,878 (3.3%)
4+			393 (1.2%)	252 (3.0%)	114 (6.2%)	69 (10.7%)	828 (0.6%)
MELAA	**6,885 (41.5%)**	**4,305 (25.9%)**	**3,456 (20.8%)**	**1,320 (8.0%)**	**411 (2.5%)**	**219 (1.3%)**	**16,596 (1.2%)**
0	2,868 (41.7%)	1,362 (31.6%)	969 (28.0%)	342 (25.9%)	87 (21.2%)	33 (15.1%)	5,661 (34.1%)
1	2,700 (39.2%)	1,617 (37.6%)	1,242 (35.9%)	417 (31.6%)	129 (31.4%)	54 (24.7%)	6,159 (37.1%)
2	1,317 (19.1%)	1,020 (23.7%)	846 (24.5%)	336 (25.5%)	111 (27.0%)	48 (21.9%)	3,678 (22.2%)
3		306 (7.1%)	330 (9.5%)	156 (11.8%)	45 (10.9%)	51 (23.3%)	888 (5.4%)
4+			69 (2.0%)	69 (5.2%)	39 (9.5%)	33 (15.1%)	210 (1.3%)
Total [f]	**684,618 (50.8%)**	**297,120 (22.0%)**	**239,754 (17.8%)**	**88,848 (6.6%)**	**26,250 (1.9%)**	**12,318 (0.9%)**	**1,348,908** [g] **(100.0%)**

Notes: 1. a) Number of family units, b) percentage of families of that size over all families of that ethnicity (by row), c) totals by row, d) percentage by ethnic group, e) breakdown by number of chronic conditions and ethnicity (number and percentage), f) total of all ethnic groups by column (percentage by row of total), g) the total number of families is higher than the actual family count as multi-ethnic families contribute a count for each ethnicity present in that family unit.
2. MELAA = Middle East Latin America Africa; CC = chronic condition.

The analysis focuses on six family outcomes. Their overall and ethnicity-specific descriptive statistics are shown in Table 3, which contains summaries including and excluding the contribution of older family members. New Zealand families changed their home address 2.43 times on average (when including the contribution of older family members) in 2013–2018. This number is higher, however, for Māori (3.04 times) and Pacific families (2.74 times), while European families moved slightly less (2.38 times).

Typically, families received $15,603 in benefits, and the support lasted for 12.24 months on average; however, Māori ($32,086 over 25.27 months) and Pacific ($30,397, 24.99 months) families received more support over the longer periods than did European ($13,744, 10.33 months) and Asian ($11,983, 11.10 months) families. The contribution of older people is roughly $3000 for all ethnicities.

While the most common family annual income was $70k–$100k for each ethnicity, there was a considerable difference in proportions of families that did not state their income, had no income, or has a negative income (loss). This was particularly high for Pacific families (20.1 per cent), while only 7.9 per cent in the case of European families. Asian (315 days), MELAA (312 days), and Pacific (209 days) families spend considerably more time overseas than European (155 days) and Māori (115 days) families when older family members are included. This pattern also holds for overseas travels without older people's contribution.

Family members were hospitalised for 13.5 days on average; however, the contribution of older family members is substantial, as it drops to 5.9 days on average when excluding older family members. Asian and MELAA are the least hospitalised, while other ethnicities are comparable overall. However, one can still notice longer hospital stays for other than older family members in Pacific (9.7 days) and Māori (8.6 days) families when compared with European (5.6 days) and Asian (5.1 days) families.

Table 3: Overall and ethnicity-specific descriptive statistics of family outcomes (2013–2018) when including and excluding the contribution of an older person (OP)

Ethnicity (*n*)	Address changes mean (sd)		Benefits (total) mean (sd)		Months on benefits mean (sd)	
	Including OP	Excluding OP	Including OP	Excluding OP	Including OP	Excluding OP
Overall (*n=1,080,279*)	2.43 (1.72)	2.07 (1.99)	15,603.14 (37,360.22)	13,206.09 (33,801.1)	12.24 (27.88)	10.35 (25.15)
European and Other (*n=887,361*)	2.38 (1.70)	1.99 (1.98)	13,744.62 (35,778.38)	11,767.03 (32,388.12)	10.33 (25.25)	8.97 (23.26)
Māori (*n=206,406*)	3.04 (2.17)	2.93 (2.37)	32,086.40 (48,487.4)	29,263.96 (45,920.34)	25.27 (36.81)	23.10 (35.00)
Pacific Peoples (*n=92,880*)	2.74 (1.95)	2.70 (2.08)	30,397.16 (45,717.59)	27,092.35 (42,858.01)	24.99 (36.35)	22.08 (33.65)
Asian (*n=145,881*)	2.39 (1.54)	2.21 (1.67)	11,983.00 (31,419.73)	8,312.83 (25,805.76)	11.10 (27.94)	7.20 (20.85)
MELAA (*n=16,668*)	2.71 (1.76)	2.65 (1.87)	22,695.11 (43,321.2)	19,625.10 (39,529.27)	20.13 (38.24)	17.21 (34.16)

(Table 3 continues over the page…)

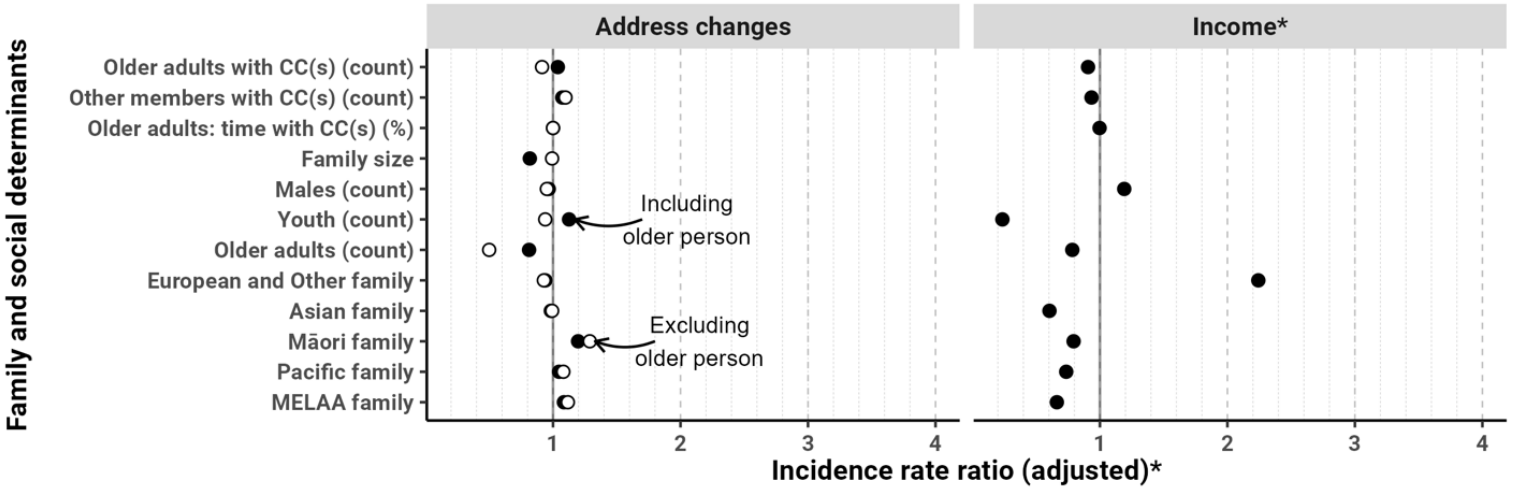
Ethnicity (*n*)	**Days hospitalised** mean (sd)		**Days overseas** mean (sd)		**Income** [1, 2] NS, ZI, Loss [3] (%)
	Including OP	Excluding OP	Including OP	Excluding OP	
Overall (*n=1,080,279*)	13.50 (47.28)	5.89 (18.30)	176.09 (315.46)	134.87 (296.27)	19.30% 9.49%
European and Other (*n=887,361*)	14.08 (50.16)	5.63 (17.68)	154.81 (283.51)	114.23 (263.88)	20.21% 7.88%
Māori (*n* = 206,406)	12.74 (34.56)	8.58 (23.86)	114.53 (278.49)	101.68 (271.9)	17.11% 14.10%
Pacific Peoples (*n=92,880*)	13.68 (33.71)	9.69 (25.09)	209.25 (416.87)	185.36 (405.73)	15.65% 20.10%
Asian (*n=145,881*)	8.07 (25.03)	5.05 (14.41)	314.65 (396.54)	258.46 (376.17)	17.70% 11.80%
MELAA (*n=16,668*)	9.29 (23.38)	7.12 (17.96)	312.43 (480.67)	283.43 (471.22)	18.75% 12.60%

Notes: 1 Total family income from the 2013 Census.
2 Mode for all ethnicities was $70–100k.
3 NS = not stated, ZI = zero income, and Loss = negative income.

To answer our research question about the impact of older adults' CC(s) on other members of their family and whānau, we used regression modelling to calculate the estimates for all variables of concern related to all family outcomes with and without the contribution of older adults in the family unit. We further controlled for deprivation and urbanicity of the place of residence (the last place of residence in the study period) of the family unit. The results are visually shown in Figure 1 and numerically in the Supplementary Table 3.

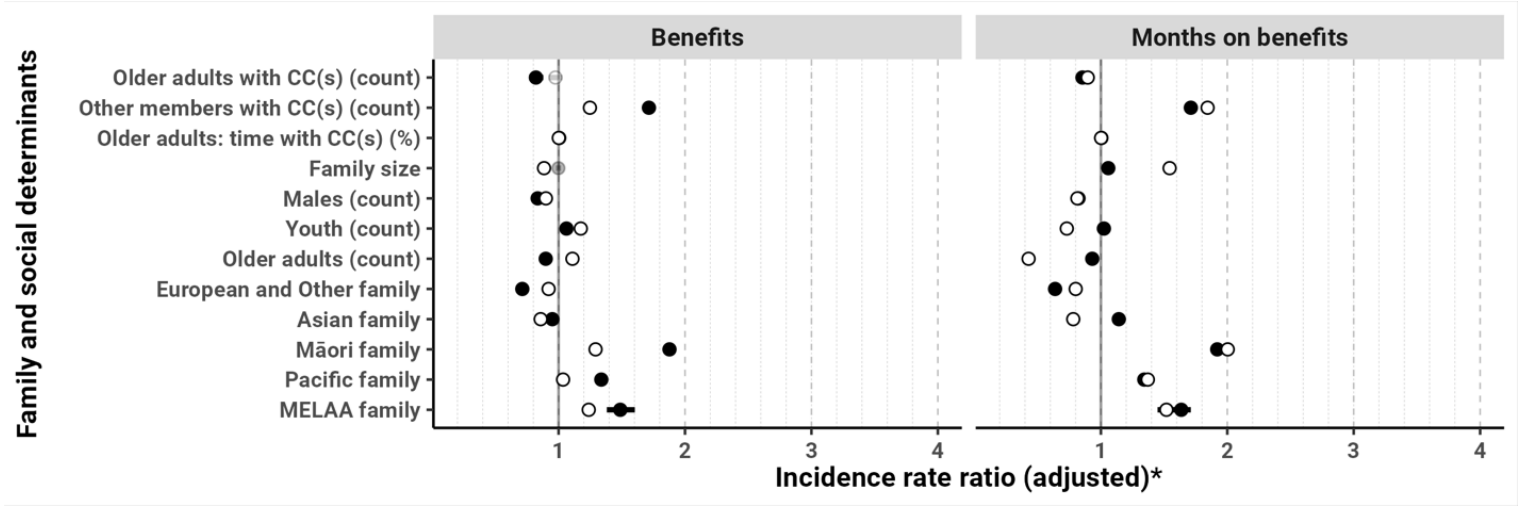
Figure 1: Family and social determinants of family outcomes, including (filled circles) and excluding (empty circles) contribution of older person(s), related to chronic conditions of older adults in the family unit, with and without older person's contribution

a)



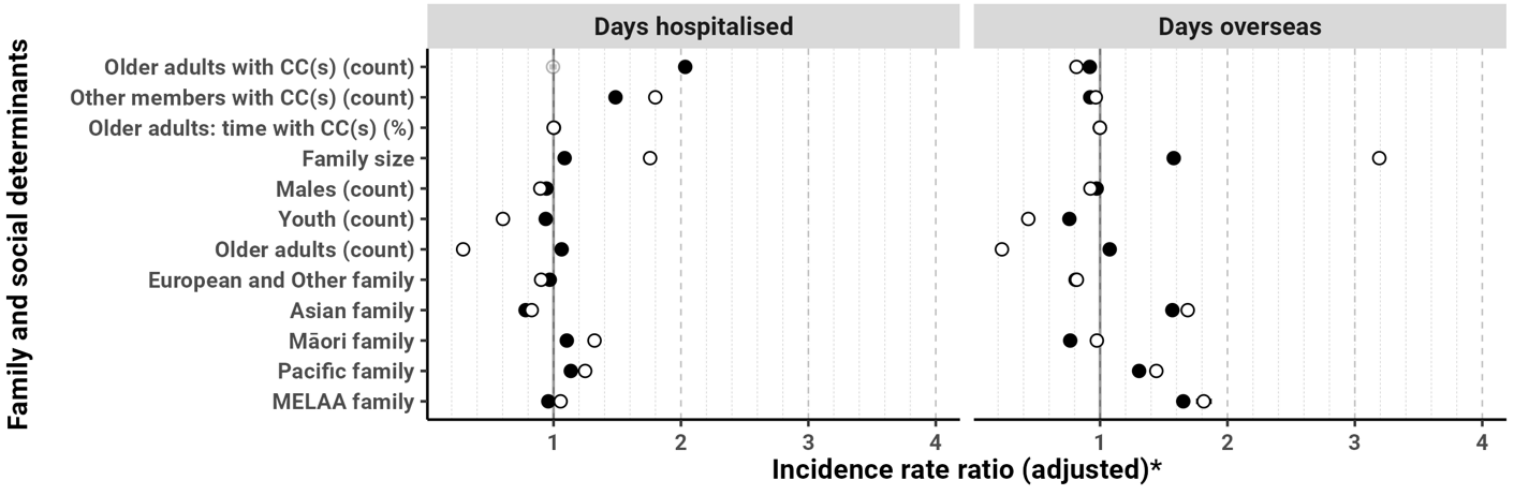
(Figure 1 continues over the page…)

b)



(Figure 1 continues over the page…)

c)



Notes:
1. * = Ordinal logistic regression and adjusted odds ratio for income.
2. Transparent lines and points show variables with p-value ≥ 0.05.
3. Models adjusted for deprivation and urban-rural classification.

Address Changes

After accounting for all other factors in the model, families are 50 per cent less likely (IRR_{eop} = 0.499 [0.497, 0.502]) to move if there was an extra older adult in the family or 19 per cent less likely to move (IRR_{iop} = 0.812 [0.810, 0.815]) if the median address change includes an older person.

Likewise, the likelihood of moving is a further 7.5 per cent lower (IRReop = 0.925 [0.907, 0.944]) for every older adult with a CC present (outcome excluding older person). On the other hand, every other family member with a CC being present in the family unit presents an 8 per cent (IRRiop = 1.076 [1.074, 1.077]) or 10 per cent (IRReop = 1.102 [1.100, 1.103]) increase in the likelihood of moving. Furthermore, European and Asian families tend to change their residential address less often than families with Māori, Pacific and MELAA members. Results show mostly consistent direction of effects, although sometimes of various strengths, whether we account for the contribution of older person(s) or not.

Benefits

The total amount in benefits received was 10 per cent less (17 per cent less with the contribution of the older person) [IRR_{eop} = 0.899 [0.894,0.905] / IRR_{iop} = 0.834 [0.821, 0.848]] for every male family member, but increases by 18 per cent (IRR = 1.175 [1.169, 1.182]) for every youth. The presence of an additional older person in the family shows inconsistent results based on the inclusion of an older person in the outcomes, however, if the older person suffers a CC, the total benefits amount was 3 per cent less (IRR_{eop} = 0.975 [0.923, 1.030]), and 18 per cent less when the contribution of the older person is included (IRR_{iop} = 0.820 [0.766, 0.879]). Māori, Pacific and MELAA families tend to receive a higher total sum of benefits than European and Asian families. Similar patterns are observable at total time in months that family members spent receiving benefits, except having an older person in the family shows 7 per cent shorter total time of receiving benefits when the older person's outcome is included (IRR_{iop} = 0.932

[0.920, 0.943]), and 57 per cent shorter (IRR_{eop} = 0.428 [0.422, 0.434]) when excluded.

Family Income

Families with an additional older person with a CC had lower family income (aOR = 0.907 [0.883, 0.931]), as did the families with an additional youth (aOR = 0.235 [0.233, 0.237]), and an older person (aOR = 0.784 [0.777, 0.790]). The strongest positive association with family income is seen for family size (aOR = 4.019 [3.984, 4.055]), followed by European and Other ethnicity (aOR = 2.242 [2.213, 2.72]), and number of males in the family (aOR = 1.191 [1.183, 1.198]).

Hospitalisation

The presence of every older adult in the family unit shows shorter lengths of hospitalisation of a family member by 71 per cent (IRR_{eop} = 0.290 [0.288, 0.293]) if the contribution in days in the hospital of the older person is excluded from the family outcome. However, the effect is marginally in the opposite direction (IRR_{iop} = 1.063 [1.057, 1.070]) if the outcome includes older person(s). We see a similar pattern with higher magnitude in the case of the older person with a CC that does not show a significant effect on the outcome if the older person is excluded (IRR_{eop} = 0.996 [0.996, 1.026]), while hospitalisation length is 103 per cent higher when the older person is included (IRR_{iop} = 2.034 [1.994, 2.074]). Another strong predictor for time spent in the hospital is the number of other family members with an existing CC(s) (IRR_{iop} = 1.486 [1.481, 1.491] and IRR_{eop} = 1.799 [1.792, 1.806]). We also see longer hospitalisations in Māori and Pacific families. The direction of effects stays consistent (with different scales of impact) with older family member(s) included in the family outcome or not.

Overseas travel

The presence of older adults shows negative association (−77 per cent) with the number of days spent overseas for the family (IRR_{eop} = 0.230; 95% CI 0.228–0.232) if the older family members are not included in

the outcome. However, the direction of this association is opposite (+8 per cent) if they are included (IRR_{iop} = 1.076 [1.067, 1.084]). Nevertheless, families with the older adult with CC spent less time overseas regardless of the inclusion of older adults' outcomes (IRR_{iop} = 0.919 [0.896, 0.943] and IRR_{eop} = 0.815 [0.789, 0.841]). Other important factors positively associated with longer overseas trips were family size (IRR_{iop} = 1.578 [1.576, 1.590] and IRR_{eop} = 3.192 [3.163, 3.220]), and Asian, MELAA and Pacific families. Families with more youth family members travelled overseas for shorter times.

Discussion

We set out to quantify the impact chronic conditions of older adults have on the family and whānau they are living with. Our study uses probability-linked population data held by Stats NZ in the IDI. We identified six plausible outcome measures representing five dimensions of impact on family wellbeing: health (length of hospitalisation), economic (income), social welfare (benefits – total amount and length of support), leisure (overseas travelling), and wider family circumstances (change of residential address), for which data were available in the IDI. We computed incident rate ratios and adjusted odds ratios for the outcomes with and without including the contribution of older persons. We also included the effects of family composition and sociodemographic and socio-economic characteristics on the outcomes.

The two model parameters most informative about our research question are the presence of an older adult with a CC and the length of time those individuals have been living with a CC. For all our outcome variables, the length of time appears not to make any difference for the family, regardless of including the older person in the model. Intuitively, one would suggest that the longer a person endures a CC, the greater the impact on self and others would be; however, our results do not support such a suggestion. A study evaluating the quality of life and duration of the illness found associations only for some specific conditions (stroke, depression and anxiety) over longer durations of the illness, providing some support for an expected impact

(Busija et al., 2017). The same study also noted that most of the participants had received their diagnoses more than five years ago. In addition, individual chronic conditions and their respective development stages require various levels of care that may create subsequent levels of impact/burden on the family's quality of life (Shah et al., 2021). We believe that by broadly grouping diagnoses together and calculating the proportion of time with the diagnosis in the 5-year interval between 2013 and 2018, any detectable effect may have been lost.

We can detect changes in incident rates associated with the number of adults with a CC in the family and compare the results with and without older family members being included. The largest effect, observed for the outcome variable 'days hospitalised', representing total length of hospitalisations for the family members in 2013–2018, and showing the difference in the result without older adults included, suggests that it is the older person with a CC who is admitted to the hospital. This suggestion is congruent with findings on hospital admissions for older patients with multiple CCs (Hernandez et al., 2009; Longman et al., 2012). Furthermore, mostly carers-oriented research evidence shows the impact of chronic conditions in the family on other family members' physical and mental health, including emotional and sleep deterioration. The stress and fatigue from managing the needs of older adults with chronic illnesses can lead to declines in their carer's psychological resilience and physical functioning (Jika et al., 2021), potentially leading to their burnout or hospitalisation (Golics et al., 2013; Shah et al., 2021, 2025; Shah, Salek, et al., 2024; Smith et al., 2020), with spouses/partners being most impacted, followed by parents and adult children (Oliva et al., 2025; Shah, Salek, et al., 2024). In addition, the older person's hospitalisations have also been linked to direct and indirect financial burden due to forced changes of jobs, reduction of work hours, and further career choices to look after a family member with CC and to manage hospital visits (Shah et al., 2021; Su et al., 1997; Suthoff et al., 2019).

The results related to benefits (total benefits received and time on benefits) are rather surprising. In both instances, the results show

a negative association for every person with a CC in the household. However, that reduction is greater with the effect of the older person included, indicating that benefits are provided to other family members. We hypothesise that policies related to benefit schemes may be responsible for this observation. This finding is also most likely related to the fact that a proportion of older people with CC won't be employed/working either due to age (retirement) or their health conditions and are, therefore, not eligible for accident compensation and work-related benefits. We further show a lower family income in families with older people with CC. Financial burden is among the most researched topics when it comes to the impacts of people with CCs on caregivers and families. Our findings are in line with international research showing finances being the area critically impacted by the presence of CCs in the family (Golics et al., 2013; Ribi et al., 2024; Shah et al., 2021, 2025) where burden can be objective (covering illness-related direct medical and non-medical costs) or subjective (perceived difficulties and reaction to them) (Ribi et al., 2024).

We also observe a shorter time spent overseas by all family members for every older household member with a CC. This is more prominent when considering travel of family members below 55 years of age only. This finding, combined with the fact that two-person households are predominant, may point towards the travel patterns of older adults where financial and time constraints are of lesser impact than for families at an earlier phase in life. This is not surprising as literature shows that holidays and leisure activities in general are often impacted by chronic disease due to health conditions, caring responsibilities or further financial burden (Golics et al., 2013; Jafari et al., 2018; Shah et al., 2021; Suthoff et al., 2019).

Our analysis also suggests that families with older persons included in the household tend to be less transient and are more likely to remain in their location/dwelling. This is even more so when the older person has a chronic condition. While our research cannot point to the exact reasons for this observation, we suspect that factors such as home ownership and long-term integration of older family members in their communities may influence older people's willingness or ability to move. Family size shows a strong positive association with family

income and days spent overseas. This is because we assessed the total of those measures received by the family, not using a median or average across the family. This will, by default, lead to a positive association between family size and these outcome measures.

Several effects can be seen for ethnicity. First, there is a substantive difference in family income and benefits received, whereby Europeans and Others are the most advantaged groups, and Māori and Pacific Peoples, the most disadvantaged. On the other hand, we also see a higher incident rate for days overseas for Pacific, Asian and MELAA families. We suggest that this reflects that those individuals and families travel to their countries of origin and accrue more days overseas that way.

This research is a novel contribution to the evidence and attempts to quantify the overall impact of older persons with chronic condition(s) on their family members who are not the patient and at the same time are not necessarily a caregiver either. As the majority of related research has focused on single or disease-specific perspectives, the improvement of disease management (Ribi et al., 2024; Schwind et al., 2025), or caregivers in general, it has tended to overlook the broader family and social contexts, and thus it fails to address the diverse needs of (and impact on) all family members involved (Schwind et al., 2025) and their daily lives (Ribi et al., 2024). In addition, the extant research has often neglected linked factors like gender, socio-economic status, and access to the formal health, care and welfare systems (Ribi et al., 2024; Schwind et al., 2025).

Beyond financial and health (both mental and physical) strain, the presence of the older person in the family, and potentially caregiving, disrupts daily routines, social lives and family relationships, including holidays and leisure activities (Golics et al., 2013). Cultural expectations (Shah et al., 2021), gender roles (Shah et al., 2021; Shah, Salek, et al., 2024), and access to formal care systems (Schwind et al., 2025) further shape the caregiving experience, yet these factors are often overlooked in research and policy. While some family-focused care interventions show promise, their overall impact on family outcomes remains inconclusive (Smith et al., 2020). Findings from research like ours, together with the implementation of tools such

as FROM-16 (Shah, Finlay, et al., 2024; Shah, Salek, et al., 2024) and the COPE (Roud et al., 2006) would offer valuable ways to assess caregiver needs and family quality of life, highlighting the importance of integrating family perspectives into healthcare planning and support systems.

While thorough and complex, it is also important to present the limitations and some of the underlying assumptions of our research. First, we used a cross-sectional design of the study and therefore causality cannot be inferred. Secondly, the family unit in our research is defined as a rather static unit based on the 2013 Census. Due to this, we do not assume changes in the family units during the study period. Thirdly, we used the 2013 Census household income because it reflects the family's perspective of their income, even though it may not be as objective as actual tax records (as we used for benefits). Furthermore, we defined family deprivation based on NZDep2018, as we were considering only the last residential address available in the study period (2013–2018), and we also did not account for the residential (and deprivation) changes of the area. While NZDep2013 could be slightly more associated with 2013 Census household income, it is not likely that using NZDep2018 instead of NZDep2013 would have a significant impact on effect directions, sizes, patterns or interpretation of other variables due to deprivation not being used as a central explanatory variable, and the results showing that effects of NZDep2018 exhibit expected gradients/behaviour for every outcome.

Lastly, we used the concept of total response ethnicity that allows for overlapping ethnicity categories, meaning that anyone can identify as more than one ethnic group. We extended this approach to families, thus up to five ethnic groups can be assigned to any family. We believe that this approach reflects well the complexity of ethnic groups in Aotearoa New Zealand and is well suited for health-related research. Moreover, the total response is, together with the single/combination categorisation method, endorsed by Stats NZ (Stats NZ, 2020), unlike prioritised ethnicity (Boven et al., 2020) which is still commonly used in research and policy. While the total response ethnicity can inflate total counts in summaries that are split by ethnicity (such as in Table 2), Boven et al. (2020) showed that the total

response and prioritised ethnicity provide comparable estimates/rates, and the total response did not lead to undercounting of individual ethnic groups.

Conclusion

This study used the largest and most comprehensive collection of integrated data available in New Zealand. Outcome variables were limited to those that have face validity, given the age range of those with a chronic condition being investigated. The results show an effect on other family members for address changes, overseas travel, hospitalisation (if older adults' contribution is included), benefits received and family income. Pacific Peoples, Asian and MELAA ethnicity travel more, while Māori and Pacific Peoples show a higher number of days hospitalised. Socio-economics favours families of European and Other ethnicity.

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Appendix: Supplementary Material

The supplementary material consists of three tables that provide additional details and complement the tables in the main body of the manuscript. Supplementary Table 1 shows a further breakdown of the population by ethnicity, health condition, age group and sex. Supplementary Table 2 describes the population grouped in families by size, and number of family members who are not older persons with a chronic condition(s) in the family, stratified by ethnicity. Supplementary Table 3 provides coefficients and summaries of models' parameters for family and social determinants of family outcomes related to chronic conditions of older adults with chronic conditions in the family unit.

Supplementary Table 1: Population breakdown by ethnicity, health condition, age group and sex

	European, Other	**Māori**	**Pacific Peoples**	**Asian**	**MELAA**	**Total [a)]**
No CC	**1,075,245 (59.2%)**	**315,630 (17.4%)**	**135,792 (7.5%)**	**264,192 (14.5%)**	**25,218 (1.4%)**	**1,816,077 (100.0%)**
< 18	352,311 (50.5%)	178,491 (25.6%)	67,386 (9.7%)	89,625 (12.8%)	10,068 (1.4%)	697,881 (100.0%)
Female [d)]	180,789 (51.3%)	92,115 (51.6%)	35,604 (52.8%)	44,868 (50.1%)	5,085 (50.5%)	358,461 (51.4%)
Male [d)]	171,522 (48.7%)	86,376 (48.4%)	31,782 (47.2%)	44,757 (49.9%)	4,983 (49.5%)	339,420 (48.6%)
18–54	535,149 (60.2%)	122,820 (13.8%)	62,343 (7.0%)	154,140 (17.3%)	14,100 (1.6%)	888,552 (100.0%)
Female	270,384 (50.5%)	69,975 (57.0%)	36,243 (58.1%)	85,923 (55.7%)	7,290 (51.7%)	469,815 (52.9%)
Male	264,765 (49.5%)	52,845 (43.0%)	26,100 (41.9%)	68,217 (44.3%)	6,810 (48.3%)	418,737 (47.1%)
55+	187,785 (81.8%)	14,319 (6.2%)	6,063 (2.6%)	20,427 (8.9%)	1,050 (0.5%)	229,644 (100.0%)

With CC	**901,185 (70.4%)**	**188,211 (14.7%)**	**74,454 (5.8%)**	**104,700 (8.2%)**	**12,210 (1.0%)**	**1,280,760 (100.0%)**
< 18	132,906 (58.5%)	57,198 (25.2%)	18,513 (8.2%)	15,990 (7.0%)	2,526 (1.1%)	227,133 (100.0%)
Female	56,574 (42.6%)	23,349 (40.8%)	6,771 (36.6%)	6,504 (40.7%)	1,026 (40.6%)	94,224 (41.5%)
Male	76,332 (57.4%)	33,849 (59.2%)	11,742 (63.4%)	9,486 (59.3%)	1,500 (59.4%)	132,909 (58.5%)
18–54	404,850 (66.4%)	97,089 (15.9%)	40,260 (6.6%)	59,589 (9.8%)	7,566 (1.2%)	609,354 (100.0%)
Female	232,791 (57.5%)	54,852 (56.5%)	18,840 (46.8%)	32,724 (54.9%)	4,284 (56.6%)	343,491 (56.4%)
Male	172,059 (42.5%)	42,237 (43.5%)	21,420 (53.2%)	26,865 (45.1%)	3,282 (43.4%)	265,863 (43.6%)
55+	363,429 (81.8%)	33,924 (7.6%)	15,681 (3.5%)	29,121 (6.6%)	2,118 (0.5%)	444,273 (100.0%)
Female	165,000 (45.4%)	16,512 (48.7%)	7,395 (47.2%)	13,407 (46.0%)	936 (44.2%)	203,250 (45.7%)
Male	198,429 (54.6%)	17,412 (51.3%)	8,286 (52.8%)	15,714 (54.0%)	1,182 (55.8%)	241,023 (54.3%)
Total [b)]	**1,976,430 (63.8%)**	**503,841 (16.3%)**	**210,246 (6.8%)**	**368,892 (11.9%)**	**37,428 (1.2%)**	**3,096,837[c)] (100.0%)**
Female	95,448 (50.8%)	8,076 (56.4%)	3,486 (57.5%)	10,893 (53.3%)	471 (44.9%)	118,374 (51.5%)
Male	92,337 (49.2%)	6,243 (43.6%)	2,577 (42.5%)	9,534 (46.7%)	579 (55.1%)	111,270 (48.5%)

Notes: 1 a) totals and % by row, b) total of all age groups by column, c) grand total, d) breakdown by sex (number and %) shown in italic totals to age group.
2 MELAA = Middle East Latin America Africa; CC = chronic condition.

Supplementary Table 2: Family units (excluding older persons with CCs) by size, number of family members who are not older persons with a chronic condition(s) in the family, stratified by ethnicity

Number of family members with CC	Number of family members						Total (row)
	2	3	4	5	6	7+	
European and Other	**255,420** [a] **(41.7%)** [b] **233,232** [c]	**147,384 (24.1%) 30,780**	**142,131 (23.2%) 8,475**	**50,886 (8.3%) 1,731**	**12,465 (2.0%) 405**	**4,281 (0.7%) 147**	**612,567 (61.8%) 274,770**
0	114,990 (45.0%) [d] 0	43,008 (29.2%) 0	34,458 (24.2%) 0	10,383 (20.4%) 0	2,133 (17.1%) 0	570 (13.3%) 0	205,542 (33.6%) 0
1	99,462 (38.9%) 104,739	58,098 (39.4%) 8,904	50,613 (35.6%) 1,959	16,521 (32.5%) 342	3,528 (28.3%) 69	1,068 (24.9%) 33	229,290 (37.4%) 116,046
2	40,968 (16.0%) 128,493	35,907 (24.4%) 14,103	37,464 (26.4%) 3,222	13,515 (26.6%) 588	3,336 (26.8%) 111	1,098 (25.6%) 30	132,288 (21.6%) 146,547
3		10,371 (7.0%) 7,773	15,927 (11.2%) 2,400	7,218 (14.2%) 447	2,055 (16.5%) 114	0,810 (18.9%) 24	36,381 (5.9%) 10,758
4+			3,669 (2.6%) 894	3,249 (6.4%) 354	1,413 (11.3%) 111	735 (17.2%) 60	9,066 (1.5%) 1,419

(Supplementary Table 2 continues on the next page…)

Māori	**64,995 (38.6%) 27,813**	**44,019 (26.1%) 6,906**	**34,596 (20.5%) 2,076**	**15,948 (9.5%) 615**	**5,856 (3.5%) 219**	**3,174 (1.9%) 96**	**168,588 (17.0%) 37,725**
0	25,533 (39.3%) Δ 0	12,897 (29.3%) Δ 0	8,283 (23.9%) Δ 0	3,276 (20.5%) Δ 0	1,017 (17.4%) Δ 0	426 (13.4%) Δ 0	51,432 (30.5%) Δ 0
1	28,191 (43.4%) 12,393	17,661 (40.1%) 1,977	12,663 (36.6%) 477	5,379 (33.7%) 114	1,761 (30.1%) 36	822 (25.9%) 15	66,477 (39.4%) 15,012
2	11,271 (17.3%) 15,420	10,629 (24.1%) 3,198	9,045 (26.1%) 765	4,218 (26.4%) 213	1,572 (26.8%) 60	828 (26.1%) 21	37,563 (22.3%) 19,677
3		2,832 (6.4%) 1,731	3,768 (10.9%) 627	2,154 (13.5%) 171	939 (16.0%) 81	588 (18.5%) 18	10,281 (6.1%) 2,628
4+			837 (2.4%) 207	921 (5.8%) 117	567 (9.7%) 42	510 (16.1%) 42	2,835 (1.7%) 408

(Supplementary Table 2 continues on the next page…)

Pacific Peoples	**24,771 (32.4%) 9,201**	**18,753 (24.5%) 4,020**	**15,528 (20.3%) 1,830**	**9,168 (12.0%) 759**	**4,701 (6.1%) 348**	**3,558 (4.7%) 201**	**76,479 (7.7%) 16,359**
0	10,665 (43.1%) Δ 0	6,033 (32.2%) Δ 0	4,062 (26.2%) Δ 0	1,899 (20.7%) Δ 0	834 (17.7%) Δ 0	453 (12.7%) Δ 0	23,946 (31.3%) Δ 0
1	10,536 (42.5%) 4,221	7,605 (40.6%) 1,158	5,880 (37.9%) 420	3,207 (35.0%) 141	1,425 (30.3%) 69	957 (26.9%) 33	29,610 (38.7%) 6,042
2	3,570 (14.4%) 4,980	4,173 (22.3%) 1,965	3,897 (25.1%) 756	2,394 (26.1%) 288	1,329 (28.3%) 108	981 (27.6%) 51	16,344 (21.4%) 8,148
3		942 (5.0%) 897	1,377 (8.9%) 519	1,215 (13.3%) 219	720 (15.3%) 108	654 (18.4%) 51	4,908 (6.4%) 1,794
4+			312 (2.0%) 135	453 (4.9%) 111	393 (8.4%) 63	513 (14.4%) 66	1,671 (2.2%) 375

(Supplementary Table 2 continues on the next page…)

Asian	**44,589 (32.4%) 17,712**	**34,707 (24.5%) 6,246**	**29,241 (20.3%) 2,421**	**7,845 (12.0%) 576**	**1,731 (6.1%) 114**	**612 (4.7%) 30**	**118,725 (7.7%) 27,099**
0	27,207 (61.0%) Δ 0	16,164 (46.6%) Δ 0	11,004 (37.6%) Δ 0	2,442 (31.1%) Δ 0	450 (26.0%) Δ 0	114 (18.6%) Δ 0	57,381 (48.3%) Δ 0
1	13,962 (31.3%) 9,240	12,813 (36.9%) 2,577	10,833 (37.0%) 855	2,814 (35.9%) 165	579 (33.4%) 27	177 (28.9%) 9	41,178 (34.7%) 12,873
2	3,420 (7.7%) 8,472	4,878 (14.1%) 2,724	5,595 (19.1%) 972	1,761 (22.4%) 225	432 (25.0%) 39	59 (26.0%) 9	16,245 (13.7%) 12,441
3		852 (2.5%) 945	1,548 (5.3%) 462	639 (8.1%) 123	174 (10.1%) 30	99 (16.2%) 6	3,312 (2.8%) 1,566
4+			261 (0.9%) 132	189 (2.4%) 63	96 (5.5%) 18	63 (10.3%) 6	609 (0.5%) 219

(Supplementary Table 2 continues on the next page…)

MELAA	**5,634** **(39.2%)** **1,251**	**3,735** **(26.0%)** **570**	**3,186** **(22.2%)** **270**	**1,212** **(8.4%)** **108**	**399** **(2.8%)** **12**	**210** **(1.5%)** **9**	**14,376** **(1.5%)** **2,220**
0	2,868 (50.9%) Δ 0	1,362 (36.5%) Δ 0	969 (30.4%) Δ 0	342 (28.2%) Δ 0	87 (21.8%) Δ 0	33 (15.7%) Δ 0	5,661 (39.4%) Δ 0
1	2,085 (37.0%) 615	1,446 (38.7%) 171	1,176 (36.9%) 66	402 (33.2%) 15	129 (32.3%) Δ 0	54 (25.7%) Δ 0	5,292 (36.8%) 867
2	681 (12.1%) 636	738 (19.8%) 282	732 (23.0%) 114	297 (24.5%) 39	105 (26.3%) 6	48 (22.9%) Δ 0	2,601 (18.1%) 1,077
3		189 (5.1%) 117	255 (8.0%) 75	117 (9.7%) 39	45 (11.3%) Δ 0	42 (20.0%) 9	648 (4.5%) 240
4+			54 (1.7%) 15	54 (4.5%) 15	33 (8.3%) 6	33 (15.7%) Δ 0	174 (1.2%) 36
Total (column)	**395,409** **(39.9%)** **289,209**	**248,598** **(25.1%)** **48,522**	**224,682** **(22.7%)** **15,072**	**85,059** **(8.6%)** **3,789**	**25,152** **(2.5%)** **1,098**	**11,835** **(1.2%)** **483**	**990,735** **(100.0%)** **358,173**

Notes: 1 a) Number of families, b) percentage of families of that size over all families of that ethnicity (by row), c) a number of families with older persons with a CC, d) percentage of families of a specific size and ethnicity with that number of CCs (column)..

2 MELAA = Middle East Latin America Africa; CC = chronic condition.

Supplementary Table 3: Model parameters for family and social determinants of family outcomes related to chronic conditions of older adults with chronic conditions in the family unit

Variable	Address changes		Benefits		Days hospitalised	
	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value
Older adults with CC(s) (count)	1.038 (1.027; 1.049) < 0.001	0.914 (0.897; 0.931) < 0.001	0.820 (0.766; 0.879) < 0.001	0.975 (0.923; 1.030) 0.360	2.034 (1.994; 2.074) < 0.001	0.996 (0.967; 1.026) 0.793
Other members with CC(s) (count)	1.073 (1.071; 1.074) < 0.001	1.098 (1.096; 1.100) < 0.001	1.714 (1.694; 1.735) < 0.001	1.248 (1.242; 1.253) < 0.001	1.486 (1.481; 1.491) < 0.001	1.799 (1.792; 1.806) < 0.001
Older adults: time with CC(s) (%)	1.000 (1.000; 1.000) < 0.001	1.000 (0.999; 1.000) 0.001	1.005 (1.004; 1.006) < 0.001	1.002 (1.001; 1.002) < 0.001	1.003 (1.003; 1.003) < 0.001	1.001 (1.001; 1.001) < 0.001
Family size	0.818 (0.816; 0.820) < 0.001	0.993 (0.989; 0.996) < 0.001	0.999 (0.979; 1.019) 0.902	0.885 (0.879; 0.891) < 0.001	1.087 (1.081; 1.093) < 0.001	1.758 (1.746; 1.769) < 0.001
Males (count)	0.967 (0.964; 0.969) < 0.001	0.952 (0.949; 0.954) < 0.001	0.834 (0.821; 0.848) < 0.001	0.899 (0.894; 0.905) < 0.001	0.945 (0.941; 0.949) < 0.001	0.896 (0.891; 0.901) < 0.001

(Supplementary Table 3 continues on the next page…)

Variable	Address changes		Benefits		Days hospitalised	
	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value
Youth (count)	1.126 (1.123; 1.128) < 0.001	0.939 (0.936; 0.941) < 0.001	1.062 (1.044; 1.081) < 0.001	1.175 (1.169; 1.182) < 0.001	0.939 (0.934; 0.943) < 0.001	0.603 (0.599; 0.606) < 0.001
Older adults (count)	0.812 (0.810; 0.815) < 0.001	0.499 (0.497; 0.502) < 0.001	0.898 (0.880; 0.917) < 0.001	1.110 (1.093; 1.127) < 0.001	1.063 (1.057; 1.070) < 0.001	0.290 (0.288; 0.293) < 0.001
European and Other family	0.940 (0.936; 0.944) < 0.001	0.928 (0.923; 0.933) < 0.001	0.713 (0.690; 0.736) <0 .001	0.921 (0.910; 0.931) < 0.001	0.970 (0.961; 0.979) < 0.001	0.903 (0.893; 0.912) < 0.001
Asian family	0.983 (0.978; 0.988) < 0.001	0.993 (0.987; 0.998) 0.011	0.950 (0.918; 0.984) 0.004	0.858 (0.846; 0.870) < 0.001	0.781 (0.773; 0.789) < 0.001	0.828 (0.819; 0.838) < 0.001
Māori family	1.197 (1.193; 1.201) < 0.001	1.288 (1.283; 1.293) < 0.001	1.877 (1.831; 1.924) < 0.001	1.292 (1.281; 1.304) < 0.001	1.104 (1.096; 1.112) < 0.001	1.321 (1.310; 1.333) < 0.001
Pacific Peoples family	1.047 (1.042; 1.052) < 0.001	1.081 (1.075; 1.087) < 0.001	1.338 (1.291; 1.387) < 0.001	1.035 (1.023; 1.048) < 0.001	1.136 (1.124; 1.147) < 0.001	1.248 (1.233; 1.263) < 0.001
MELAA family	1.086 (1.075; 1.096) < 0.001	1.116 (1.104; 1.129) < 0.001	1.488 (1.381; 1.603) < 0.001	1.238 (1.203; 1.275) < 0.001	0.959 (0.938; 0.980) < 0.001	1.055 (1.029; 1.082) < 0.001

Variable	Address changes		Benefits		Days hospitalised	
	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value
Deprivation: D1	Reference group		Reference group		Reference group	
Deprivation: D2	1.012 (1.006; 1.018) < 0.001	1.022 (1.015; 1.029) < 0.001	1.243 (1.194; 1.293) < 0.001	1.091 (1.067; 1.117) < 0.001	1.050 (1.038; 1.062) < 0.001	1.029 (1.014; 1.043) < 0.001
Deprivation: D3	1.050 (1.044; 1.056) < 0.001	1.057 (1.049; 1.064) < 0.001	1.480 (1.423; 1.539) < 0.001	1.185 (1.160; 1.212) < 0.001	1.113 (1.101; 1.126) < 0.001	1.066 (1.051; 1.081) < 0.001
Deprivation: D4	1.093 (1.087; 1.100) < 0.001	1.103 (1.095; 1.111) < 0.001	1.734 (1.667; 1.804) < 0.001	1.251 (1.225; 1.278) < 0.001	1.176 (1.163; 1.190) < 0.001	1.064 (1.050; 1.079) < 0.001
Deprivation: D5	1.119 (1.113; 1.125) < 0.001	1.132 (1.124; 1.140) < 0.001	1.938 (1.863; 2.016) < 0.001	1.325 (1.297; 1.353) < 0.001	1.225 (1.211; 1.239) < 0.001	1.121 (1.106; 1.137) < 0.001
Deprivation: D6	1.139 (1.133; 1.146) < 0.001	1.158 (1.150; 1.166) < 0.001	2.277 (2.188; 2.369) < 0.001	1.431 (1.402; 1.462) < 0.001	1.287 (1.273; 1.302) < 0.001	1.168 (1.152; 1.185) < 0.001
Deprivation: D7	1.140 (1.133; 1.146) < 0.001	1.172 (1.164; 1.181) < 0.001	2.650 (2.545; 2.759) < 0.001	1.550 (1.519; 1.583) < 0.001	1.316 (1.301; 1.331) < 0.001	1.182 (1.165; 1.199) < 0.001

Variable	Address changes		Benefits		Days hospitalised	
	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value	Including older person IRR (95% CI) *p*-value	Excluding older person IRR (95% CI) *p*-value
Deprivation: D8	1.147 (1.140; 1.153) < 0.001	1.190 (1.182; 1.199) < 0.001	3.090 (2.965; 3.220) < 0.001	1.703 (1.668; 1.738) < 0.001	1.332 (1.316; 1.348) < 0.001	1.306 (1.287; 1.325) < 0.001
Deprivation: D9	1.145 (1.138; 1.151) < 0.001	1.208 (1.199; 1.217) < 0.001	3.798 (3.639; 3.963) < 0.001	1.928 (1.888; 1.968) < 0.001	1.375 (1.358; 1.392) < 0.001	1.403 (1.382; 1.424) < 0.001
Deprivation: D10	1.091 (1.084; 1.098) < 0.001	1.173 (1.164; 1.182) < 0.001	4.710 (4.499; 4.930) < 0.001	2.208 (2.162; 2.254) < 0.001	1.439 (1.420; 1.458) < 0.001	1.534 (1.510; 1.558) < 0.001

	Address changes		Benefits		Days hospitalised	
Major urban area	Reference group		Reference group		Reference group	
Large urban area	1.004 (1.000; 1.008) 0.030	1.007 (1.002; 1.012) 0.004	1.139 (1.108; 1.171) < 0.001	1.041 (1.029; 1.053) < 0.001	0.974 (0.966; 0.982) < 0.001	0.975 (0.965; 0.984) < 0.001
Medium urban area	1.019 (1.014; 1.024) < 0.001	0.999 (0.993; 1.005) 0.672	1.080 (1.044; 1.118) < 0.001	1.011 (0.996; 1.026) 0.155	1.018 (1.008; 1.028) < 0.001	0.922 (0.911; 0.933) < 0.001
Small urban area	1.036 (1.032; 1.041) < 0.001	1.020 (1.015; 1.026) < 0.001	1.109 (1.073; 1.146) < 0.001	1.037 (1.023; 1.051) < 0.001	1.007 (0.998; 1.017) 0.143	0.958 (0.947; 0.969) < 0.001
Rural settlement	1.049 (1.041; 1.057) < 0.001	1.019 (1.009; 1.029) < 0.001	1.149 (1.088; 1.213) < 0.001	1.032 (1.007; 1.056) 0.010	0.957 (0.942; 0.972) < 0.001	0.923 (0.905; 0.941) < 0.001
Rural other	1.033 (1.029; 1.037) < 0.001	1.019 (1.014; 1.023) < 0.001	1.106 (1.075; 1.137) < 0.001	0.983 (0.970; 0.996) 0.008	0.935 (0.928; 0.943) < 0.001	0.966 (0.956; 0.975) < 0.001

(Supplementary Table 3 continues on the next page…)

Characteristic	Address changes		Benefits		Days hospitalised	
	Including older person	Excluding older person	Including older person	Excluding older person	Including older person	Excluding older person
theta	53.705	7.035	0.044	0.687	0.561	0.436
SE theta	1.395	0.040	0.000	0.002	0.001	0.001
nobs	1080135	1080135	1080135	1080135	1080135	1080135
NAs	144	144	144	144	144	144
deviance	915347	1097273	779857	—	1237531	1036690
null deviance	1060919	1653126	812538	—	1564778	1504404
logLik	−1894602	−1810882	−5664218	−4777172	−3560608	−2527357
AIC	3789260	3621819	11328492	9554402	7121273	5054770
BIC	3789593	3622152	11328825	9554747	7121606	5055103
Pseudo-R^2	0.137	0.336	0.040	0.124	0.209	0.311
Cox-Snell R^2	0.126	0.402	0.030	—	0.261	0.351
Nagelkerke R^2	0.202	0.513	0.056	—	0.342	0.468

(Supplementary Table 3 continues on the next page…)

Variable	Days overseas		Income	Months on benefits	
	Including older person	Excluding older person	Including older person	Including older person	Excluding older person
	IRR (95% CI) *p*-value	IRR (95% CI) *p*-value	0R 9(5% CI) *p*-value	IRR 95% CI) *p*-value	IRR 95% CI) *p*-value
Older adults with CC(s) (count)	0.919 (0.896; 0.943) < 0.001	0.815 (0.789; 0.841) < 0.001	0.907 (0.883; 0.931) < 0.001	0.854 (0.819; 0.891) < 0.001	0.896 (0.857; 0.937) < 0.001
Other members with CC(s) (count)	0.923 (0.919; 0.927) < 0.001	0.966 (0.961; 0.971) < 0.001	0.934 (0.930; 0.938) < 0.001	1.712 (1.699; 1.724) < 0.001	1.844 (1.830; 1.859) < 0.001
Older adults: time with CC(s) (%)	0.998 (0.998; 0.999) < 0.001	0.999 (0.998; 0.999) < 0.001	0.997 (0.997; 0.998) < 0.001	1.004 (1.004; 1.005) < 0.001	1.002 (1.001; 1.002) < 0.001
Family size	1.578 (1.567; 1.590) < 0.001	3.192 (3.163; 3.220) < 0.001	4.019 (3.984; 4.055) < 0.001	1.059 (1.046; 1.071) < 0.001	1.544 (1.526; 1.561) < 0.001
Males (count)	0.974 (0.968; 0.979) < 0.001	0.925 (0.918; 0.931) < 0.001	1.191 (1.183; 1.198) < 0.001	0.823 (0.815; 0.831) < 0.001	0.814 (0.807; 0.822) < 0.001
Youth (count)	0.759 (0.754; 0.764) < 0.001	0.437 (0.433; 0.440) < 0.001	0.235 (0.233; 0.237) < 0.001	1.024 (1.013; 1.035) < 0.001	0.730 (0.723; 0.738) < 0.001

(Supplementary Table 3 continues on the next page…)

Variable	Days overseas		Income	Months on benefits	
	Including older person	Excluding older person	Including older person	Including older person	Excluding older person
	IRR (95% CI) *p*-value	IRR (95% CI) *p*-value	0R 9(5% CI) *p*-value	IRR 95% CI) *p*-value	IRR 95% CI) *p*-value
Older adults (count)	1.076 (1.067; 1.084) < 0.001	0.230 (0.228; 0.232) < 0.001	0.784 (0.777; 0.790) < 0.001	0.932 (0.920; 0.943) < 0.001	0.428 (0.422; 0.434) < 0.001
European and Other family	0.808 (0.798; 0.818) < 0.001	0.818 (0.806; 0.830) < 0.001	2.242 (2.213; 2.272) < 0.001	0.638 (0.626; 0.651) < 0.001	0.801 (0.786; 0.816) < 0.001
Asian family	1.568 (1.547; 1.588) < 0.001	1.688 (1.661; 1.715) < 0.001	0.604 (0.596; 0.613) < 0.001	1.142 (1.118; 1.166) < 0.001	0.781 (0.765; 0.798) < 0.001
Māori family	0.766 (0.759; 0.773) < 0.001	0.975 (0.964; 0.986) < 0.001	0.794 (0.786; 0.801) < 0.001	1.920 (1.892; 1.950) < 0.001	2.003 (1.972; 2.035) < 0.001
Pacific Peoples family	1.306 (1.289; 1.324) < 0.001	1.442 (1.419; 1.466) < 0.001	0.736 (0.725; 0.746) < 0.001	1.343 (1.314; 1.373) < 0.001	1.371 (1.342; 1.402) < 0.001
MELAA family	1.653 (1.608; 1.699) < 0.001	1.814 (1.754; 1.876) < 0.001	0.662 (0.643; 0.682) < 0.001	1.636 (1.564; 1.712) < 0.001	1.519 (1.449; 1.592) < 0.001

(Supplementary Table 3 continues on the next page…)

Variable	Days overseas		Income	Months on benefits	
	Including older person	Excluding older person	Including older person	Including older person	Excluding older person
	IRR (95% CI) *p*-value	IRR (95% CI) *p*-value	0R 9(5% CI) *p*-value	IRR 95% CI) *p*-value	IRR 95% CI) *p*-value
Deprivation: D1	Reference group		Reference group		Reference group
Deprivation: D2	0.917 (0.904; 0.931) < 0.001	0.953 (0.936; 0.970) < 0.001	0.715 (0.704; 0.726) < 0.001	1.345 (1.312; 1.378) < 0.001	1.341 (1.307; 1.375) < 0.001
Deprivation: D3	0.865 (0.853; 0.878) < 0.001	0.914 (0.898; 0.931) < 0.001	0.560 (0.552; 0.569) < 0.001	1.652 (1.612; 1.692) < 0.001	1.623 (1.582; 1.665) < 0.001
Deprivation: D4	0.796 (0.785; 0.808) < 0.001	0.851 (0.836; 0.866) < 0.001	0.458 (0.451; 0.465) < 0.001	2.005 (1.957; 2.054) < 0.001	1.963 (1.914; 2.014) < 0.001
Deprivation: D5	0.741 (0.730; 0.752) < 0.001	0.804 (0.790; 0.819) < 0.001	0.383 (0.377; 0.389) < 0.001	2.337 (2.281; 2.394) < 0.001	2.264 (2.208; 2.323) < 0.001
Deprivation: D6	0.677 (0.667; 0.687) < 0.001	0.739 (0.726; 0.753) < 0.001	0.327 (0.322; 0.332) < 0.001	2.790 (2.723; 2.858) < 0.001	2.734 (2.665; 2.805) < 0.001

(Supplementary Table 3 continues on the next page…)

Variable	Days overseas		Income	Months on benefits	
	Including older person	Excluding older person	Including older person	Including older person	Excluding older person
	IRR (95% CI) *p*-value	IRR (95% CI) *p*-value	0R 9(5% CI) *p*-value	IRR 95% CI) *p*-value	IRR 95% CI) *p*-value
Deprivation: D7	0.610 (0.601; 0.619) < 0.001	0.679 (0.667; 0.692) < 0.001	0.282 (0.278; 0.286) < 0.001	3.320 (3.239; 3.403) < 0.001	3.214 (3.132; 3.298) < 0.001
Deprivation: D8	0.565 (0.557; 0.574) < 0.001	0.640 (0.628; 0.652) < 0.001	0.246 (0.242; 0.250) < 0.001	3.897 (3.800; 3.997) < 0.001	3.821 (3.721; 3.923) < 0.001
Deprivation: D9	0.525 (0.517; 0.534) < 0.001	0.617 (0.605; 0.629) < 0.001	0.206 (0.202; 0.209) < 0.001	4.826 (4.702; 4.954) < 0.001	4.801 (4.673; 4.934) < 0.001
Deprivation: D10	0.505 (0.496; 0.513) < 0.001	0.621 (0.608; 0.634) < 0.001	0.159 (0.156; 0.162) < 0.001	5.938 (5.774; 6.106) < 0.001	5.966 (5.796; 6.141) < 0.001

(Supplementary Table 3 continues on the next page…)

Variable	Days overseas		Income	Months on benefits	
	Including older person	Excluding older person	Including older person	Including older person	Excluding older person
	IRR (95% CI) *p*-value	IRR (95% CI) *p*-value	0R 9(5% CI) *p*-value	IRR 95% CI) *p*-value	IRR 95% CI) *p*-value
Major urban area	Reference group		Reference group		Reference group
Large urban area	0.787 (0.779; 0.795) < 0.001	0.737 (0.727; 0.746) < 0.001	0.744 (0.736; 0.752) < 0.001	1.127 (1.108; 1.147) < 0.001	1.136 (1.116; 1.156) < 0.001
Medium urban area	0.719 (0.710; 0.728) < 0.001	0.647 (0.637; 0.657) < 0.001	0.659 (0.650; 0.667) < 0.001	1.053 (1.032; 1.075) < 0.001	1.038 (1.016; 1.061) 0.001
Small urban area	0.738 (0.729; 0.748) < 0.001	0.660 (0.651; 0.670) < 0.001	0.651 (0.643; 0.660) < 0.001	1.080 (1.059; 1.102) < 0.001	1.059 (1.038; 1.082) < 0.001
Rural settlement	0.795 (0.779; 0.812) < 0.001	0.740 (0.722; 0.759) < 0.001	0.623 (0.611; 0.636) < 0.001	1.118 (1.081; 1.155) < 0.001	1.053 (1.017; 1.090) 0.003
Rural other	0.771 (0.763; 0.779) < 0.001	0.754 (0.745; 0.764) < 0.001	0.780 (0.772; 0.789) < 0.001	0.980 (0.963; 0.996) 0.017	0.915 (0.899; 0.931) < 0.001

(Supplementary Table 3 continues on the next page…)

Variable	Days overseas		Income	Months on benefits	
	Including older person	Excluding older person	Including older person	Including older person	Excluding older person
theta	0.315	0.212	—	0.120	0.112
SE theta	0.000	0.000	—	0.000	0.002
nobs	1080135	1080135	987933	1080135	1080135
NAs	144	144	92343	144	144
deviance	1296373	1126990	3908078	796143	—
null deviance	1389336	1442448	—	896567	—
logLik	−5995193	−4861680	−1954039	−2466539	−2189602
AIC	11990442	9723416	3908150	4933134	4379263
BIC	11990775	9723749	3908575	4933467	4379608
Pseudo-R^2	0.067	0.219	0.083	0.112	0.070
Cox-Snell R^2	0.082	0.253	0.301	0.089	—
Nagelkerke R^2	0.114	0.344	0.305	0.157	—