
Article:
Darlington-Pollock, F, Norman, P orcid.org/0000-0002-6211-1625, Lee, AC et al. (3 more authors) (2016) To move or not to move? Exploring the relationship between residential mobility, risk of cardiovascular disease and ethnicity in New Zealand. Social Science & Medicine, 165. pp. 128-140. ISSN 0277-9536

https://doi.org/10.1016/j.socscimed.2016.07.041

To move or not to move? Exploring the relationship between residential mobility, risk of cardiovascular disease and ethnicity in New Zealand

Abstract

Residential mobility can have negative impacts on health, with some studies finding that residential mobility can contribute to widening health gradients in the population. However, ethnically differentiated experiences of residential mobility and the relationship with health are neglected in the literature. To examine the relationship between residential mobility, risk of cardiovascular disease (CVD) and ethnicity, we constructed a cohort of 2,077,470 participants aged 30+ resident in New Zealand using encrypted National Health Index (eNHI) numbers linked to individual level routinely recorded data. Using binary logistic regression, we model the risk of CVD for the population stratified by ethnic group according to mover status, baseline deprivation and transitions between deprivation statuses. We show that the relationship between residential mobility and CVD varies between ethnic groups and is strongly influenced by the inter-relationship between residential mobility and deprivation mobility. Whilst residential mobility is an important determinant of CVD, much of the variation between ethnic groups is explained by contrasting deprivation experiences. To reduce inequalities in CVD within New Zealand, policies must focus on residentially mobile Māori, Pacific and South Asian populations who already have a heightened risk of CVD living in more deprived areas.

Key words

New Zealand; CVD; Ethnicity; Inequalities; Mobility; Migration; Deprivation; Record Linkage

Introduction

Cardiovascular disease (CVD) and associated morbidities are among the leading causes of global deaths (World Health Organisation, 2014). In New Zealand (NZ) there are marked variations between ethnic groups in the prevalence of CVD (Blakely et al., 2004; Riddell et al., 2007; Jatrana and Blakely, 2008; Kerr et al., 2008; Grey et al., 2010; Mehta et al., 2011; Perumal et al., 2012; Ker et al., 2015; Mehta et al., 2014; Exeter et al., 2015; Wells et al., 2015). Between 1980 and 1999, while all ethnic groups experienced reductions in CVD mortality, Māori and Pacific populations saw markedly smaller

reductions than non-Māori non-Pacific (nMnP) groups (Blakely et al., 2005). By 2007, these disparities had not disappeared: Māori males and females almost invariably had the highest age-specific prevalence of CVD across all age groups, as well as the highest age-standardised prevalence of CVD (7.41 compared to NZ's total population at 4.77, and 5.68 for the Pacific group) (Cheuk Chan et al., 2008). Stark differences in risk of CVD and CVD mortality between ethnic groups are not restricted to NZ. For example, rates of ischaemic heart disease amongst South Asian males are 30 to 40% higher than rates amongst the UK's general population (Department of Health, 2001). In the US in 2013, Black groups had 30% higher mortality from CVD than Whites, increasing to 113% higher CVD mortality than Asians and Pacific Islanders (Singh et al., 2015).

Exploring why ethnic inequalities in CVD exist is therefore of international importance. The existence of these inequalities across different contexts and across different ethnic groups suggests that these disparities are not solely explained by 'ethnicity'. Rather, these differences may (in part) be explained by similarities in the experiences of minority groups across different contexts and the social gradient to risk of CVD.

The impact of both traditional and environmental risk factors for CVD is modified by socioeconomic status (Albert et al., 2006). Thus, lower socioeconomic status and general disadvantage are associated with higher levels of CVD (Kanjilal et al., 2006; Clark et al., 2009) or increased exposure to CVD risk factors, such as smoking or low levels of physical activity (Gupta et al., 2012). A review of CVD mortality in the US and 11 western European countries found that risk increased with decreasing occupational class and lower levels of educational attainment, as well as factors such as smoking uptake and alcohol consumption (Mackenbach et al., 2000).

Given the social gradient of CVD occurrences, it is important to consider the contrasting socioeconomic circumstances which invariably characterise the experience of marginalised minority ethnic groups (MEGs) in different contexts, particularly when assessing ethnic inequalities in CVD. Where broader structural inequalities exist, these may exaggerate the already disadvantaged experience of marginalised MEGs and exacerbate health differences. For example, it has been suggested that in NZ, widening

inequalities in employment, housing, education and income during the 1980s and 1990s between Māori and Pacific groups compared to non-Māori non-Pacific groups may have had significant health implications (Blakely et al., 2005). This may explain the smaller reductions in CVD mortality for Māori and Pacific populations than observed for the non-Māori non-Pacific population. However, results of a previous study in Auckland, NZ suggest that there is an additional mechanism potentially driving inequalities in CVD: residential mobility.

XXXX found residential mobility to be an important determinant of CVD in Auckland, NZ. Residential mobility has important implications for health (Morris et al., 2016), and has been examined in NZ in the context of child health outcomes (Jelleyman and Spencer, 2008), but also more generally in Australia (Larson et al., 2004) and the UK (Boyle et al., 2005; Norman et al., 2005; 2011). However, the relationship between residential mobility and CVD is under-explored. In particular, no previous work has specifically investigated whether this relationship varies by ethnic group. Residential mobility is an inherently selective event: a wealth of research demonstrates this, highlighting that movers are often distinct from stayers in their age, sex, stage in the lifecourse, tenure, educational attainment, social class, income and health (e.g. Bentham, 1988; Findlay, 1988; Simpson and Finney, 2009). As the socioeconomic circumstances of different ethnic groups in any socio-political context varies, with substantial evidence that people from ethnic minorities also have significantly worse health experiences than people from non-ethnic minority groups, the patterning to residential mobility may vary between ethnic groups. More importantly, the nature of residential mobility experienced by different ethnic groups may also vary and therefore differently influence risk of CVD. For example, if certain groups are more likely to move frequently over shorter distances, or perhaps move frequently within similarly deprived neighbourhoods, the influence of these moves on CVD risk may vary compared with groups who move infrequently or experience upwards deprivation mobility, moving from more to less deprived areas. Results of XXXX research support this, revealing that those moving from less to more deprived areas having a higher risk of CVD hospitalisation than those moving in the opposite direction. The concept of health-selective migration can help us begin to disentangle possible variations in the patterning to residential mobility for different ethnic groups.

Theories of health-selective migration hypothesise that health gradients are widened as differently healthy groups of people are sorted into different area types (e.g. Boyle, 2004; Norman et al., 2011; Exeter et al., 2011). Those in good health or with favourable health-related individual characteristics are more likely to experience upward mobility, moving to less deprived areas. Conversely, those in poor health or with unfavourable health-related individual characteristics are more likely to experience downward mobility or remain in more deprived areas. These scenarios exacerbate existing health gradients as those in poor health continue to suffer the deleterious consequences of their relative disadvantage, while those living in more advantaged circumstances continue to reap the health benefits of their elevated situation. In a recent review of the literature on health and mobility, Morris et al. (2016) distinguish between population level aggregate studies, those which are typically used in the context of discussions of health-selective migration and changing health gradients (e.g. Boyle and Norman, 2009), and individual level studies wherein the relationship between health and mobility is more often viewed negatively (e.g. Jelleyman and Spencer, 2008).

Thus, in this study we might hypothesise that through health-selective migration, risk of CVD is lower for movers as compared to stayers as those at risk of CVD are less likely to move. However, we might also assume that risk of CVD is higher for an individual who has moved due to the stress associated with a move, perhaps exacerbated or attenuated by the nature of the move itself. Moreover, are they moving to a more or less deprived area? Given the results of the previous study (XXXX), we can hypothesise that movers across NZ will also have a higher risk of CVD than stayers, as found in Auckland. However, what is of interest is why this occurs, and whether the relationship varies between ethnic groups. This focuses attention on the complex relationship between mobility and health, and the context within which different ethnic groups live out their day-to-day lives.

The persistent (albeit narrowing) inequalities in areas such as housing and education experienced by MEGs in NZ (see Blakely et al., 2005) are echoed in the overwhelming concentration of minority groups in the most deprived areas of the country (see Table 2). The marginalisation of these groups both spatially but also more broadly (see work on the relationship between poor health outcomes and racial discrimination in NZ such as Harris et al., 2006; Harris et al., 2012; Harris et al., 2015) suggests that

MEGs in NZ might be more likely to experience increased rates of residential mobility. The neglected concept of 'malign migration' holds that marginalised, socially disadvantaged groups are more likely to experience residential mobility, and this is more common in inner city (often deprived) areas: this is detrimental to health (Warfa et al., 2006). It therefore seems likely that different ethnic groups in NZ will have different experiences of residential mobility, perhaps through processes of 'malign migration' but also more broadly in terms of socioeconomic inequalities and the selective nature of migration. We can assume that this will differently influence the relationship between CVD and residential mobility for different ethnic groups. One aspect of the relationship between residential mobility and health which gets less specific coverage in the literature is immobility. Notwithstanding a few notable exceptions (e.g. Boyle et al., 2004; Exeter et al., 2011; Brown et al., 2012), much of the extant literature in this area focuses on the selection of mobile groups into different socioeconomic circumstances. However, reasons for immobility may be as important in the selection process as reasons for mobility. This will also be addressed.

This paper uses a unique, unrivalled longitudinal dataset to investigate an under-explored determinant of CVD, that of residential mobility, and evaluate whether the salience of residential mobility (and immobility) as a determinant of CVD varies between ethnic groups. Extending the research for the Auckland Region by XXXX, a cohort of participants are derived from national routine health databases in NZ. We address the following research questions:

1. Do movers in NZ have a higher risk of CVD than stayers?
2. Is risk of CVD for movers attenuated by baseline deprivation at the start of the study period?
3. Do the patterns observed for movers and stayers in NZ overall vary for specific ethnic groups?
4. How does the nature of a move influence risk of CVD for different ethnic groups in NZ? and;
5. Does risk of CVD for ethnic groups who do not move (stayers) vary by deprivation?

Data and methods

A cohort of participants was identified using the unique health identifier which is assigned to the majority of all NZ residents. Using these identifiers, patient records are anonymously and securely

linked between four national routine health databases: enrolment with a Primary Health Organisation (PHO), hospital discharges, mortality records and pharmaceutical dispensing claims from community pharmacies. As data held by the Ministry of Health on discharges from private hospitals are incomplete, these are excluded from the cohort (Ministry of Health, 2014).

Building on XXXX study, we use the same population eligibility criteria, but increase the coverage to the entire adult population of NZ rather than focusing on Auckland residents. Thus, participants are eligible for inclusion if enrolled in any PHO within NZ during at least one of the 34 calendar quarters of the study period from 1 January 2006 to 30 June 2014; aged 30 years or over at the start of the study period; had complete demographic information; and had no prior history of CVD (defined below) before 1 January 2006. Figure 1 summarises the eligibility criteria for this study.

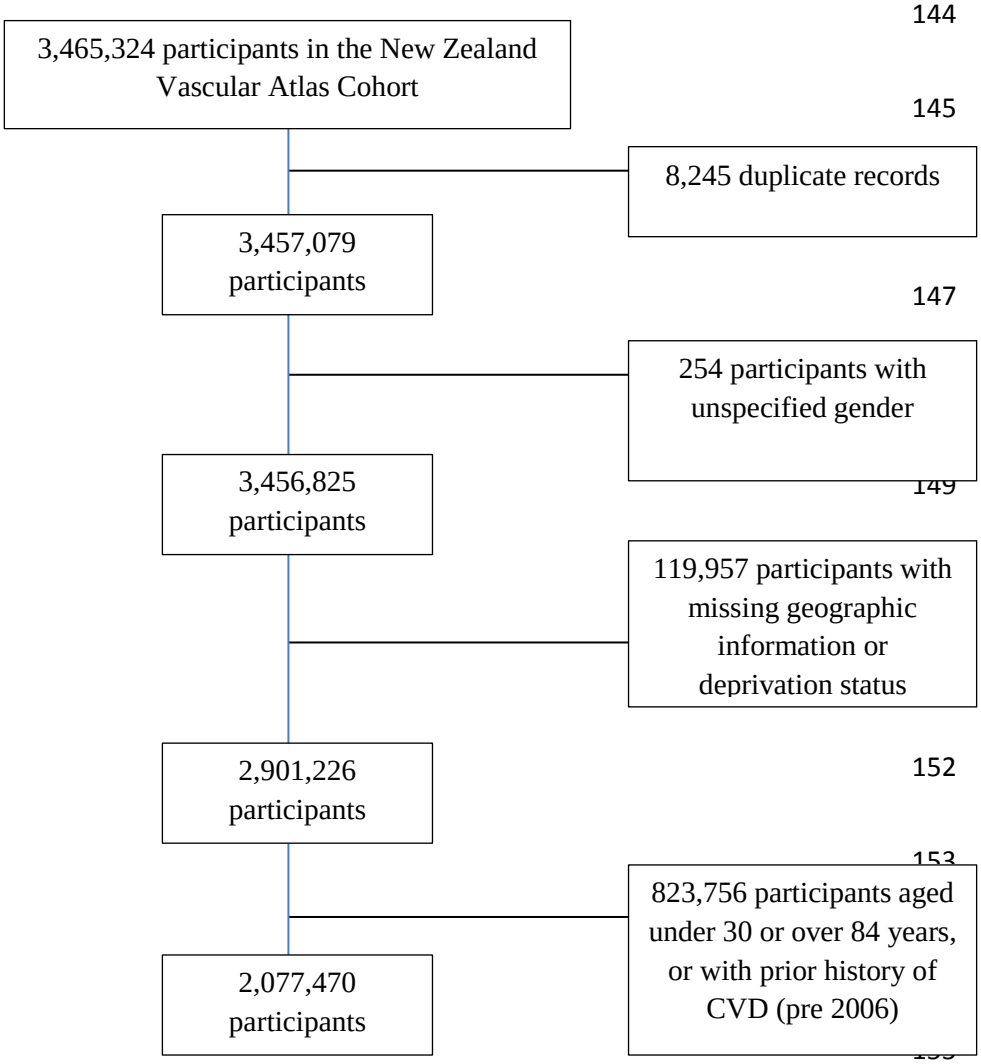


Figure 1 Population eligibility flow chart

Variables

Variables identifying each participant's age, sex, ethnicity and area of residence are the key independent demographic variables for this analysis. Consistent with previous work, age was categorised into six groups (30-44; 45-54; 55-64; 65-74; 75-85) with the 55-64 age band used as the reference group (XXXX; Grey et al., 2014; Warin et al., 2016). The age group was restricted due to the low risk of CVD for those aged below 30 years, and the incomplete data, increased risk of having a history of CVD and the statistical problem of small numbers for those aged over 85.

Using the national ethnicity coding protocols for NZ, we prioritised ethnicity to identify five ethnic groups: Māori, Pacific, Indian (Indian groups are distinguishable from Other South Asian groups in

NZ's ethnicity coding system), Other Asian, and NZ and Other European combined (NZEO). Consistent with the PREDICT study (Wells et al., 2015), we distinguish between Indian and Other Asian groups given the higher risk of CVD amongst Indian participants relative to Other Asian participants (Ministry of Health, 2012). We use Census Meshblocks (MBs) to identify a participant's area of residence in each calendar quarter, and to derive information on residential mobility and area deprivation.

MBs consist of (on average) approximately 100 persons and are the most detailed geographic unit of analysis available for census data in NZ. Using the NZ Index of Deprivation (NZDep2006), we assigned a deprivation score to each participant based on their MB for each calendar quarter. This is a measure of area level socioeconomic deprivation based on nine variables from the 2006 Census (Salmond et al., 2007). Scores are ranked into quintiles where quintile 1 (Q1) comprises the least deprived 20% of areas across NZ and quintile 5 (Q5) the most deprived 20%.

By assigning each participant to a MB and NZDep2006 score at each calendar quarter, we identified participants who moved during the study period as well as their deprivation trajectory according to moves between or within deprivation quintiles. We focus on overall deprivation trajectory; for participants who moved, we investigate the change between first and last recorded MB and NZDep2006 score. We use the same measure of deprivation for all time points (from 2006 to 2014), as NZDep2013 was not published when we obtained our dataset. However, we do recognise that areas can change their level of deprivation over time (Norman, 2010), and that changing and persistent area deprivation can have a concomitant influence on health (Boyle et al., 2004; Norman et al., 2010; Exeter et al., 2011). The implications of using fixed deprivation levels to analyse changes in health has been considered elsewhere and found not to affect interpretations (Bajekal et al., 2013). In the main this is because the relative position of areas with regard to their level of deprivation has great consistency over time (Norman and Darlington-Pollock, 2016).

Any participant with a previous hospitalisation or procedure related to acute coronary syndrome, ischaemic and haemorrhagic stroke, peripheral arterial disease or for congestive failure was defined as having a CVD event, either for exclusion purposes or for identification during the study period. Table

192 1 summarises the variables included in the analysis, distinguishing between movers and stayers for the
193 NZ cohort of participants.

194 Analysis

195 We used binary logistic regression to model risk of CVD for different ethnic groups in NZ. All results
196 are expressed as odds ratios (ORs) and accompanied by 95% confidence intervals (CIs). We constructed
197 five models adjusting for: 1) mover status; 2) mover status and baseline deprivation; 3) deprivation
198 mobility status; 4) detailed deprivation transitions; and 5) deprivation circumstances for stayers.
199 Deprivation mobility status identifies the overall nature of the deprivation mobility experienced by each
200 participant- moving to more deprivation; churning within comparable deprivation; or moving to less
201 deprivation. The detailed deprivation transitions expand on this, in particular identifying moves into,
202 out of or within the least (Q1) and most (Q5) deprived areas, as well as those who move within Q2 to
203 Q4. Given the anticipated role of deprivation in contributing to risk of CVD, the results begin with a
204 discussion of the ethnic profile of the deprivation quintiles (according to baseline deprivation). In the
205 first instance, all models were run using the total sample population, adjusting for age, sex and ethnicity.
206 Then, the five models were stratified by ethnic group, adjusting for age and sex (models 1e to 5e). For
207 the models adjusting for stable deprivation, movers are the reference group. For all other models, we
208 use stayers as the reference group in the relevant variables. We take females and NZEO as the reference
209 group for gender and ethnicity. As mentioned above, we take those aged 55-64 as the reference group
210 in line with wider literature investigating CVD (e.g. Warin et al., 2016). The models were stratified by
211 ethnic group as we hypothesised that the relationships between residential mobility and risk of CVD
212 may vary by ethnic group. Ethnic-specific models illuminate how the relationship between residential
213 mobility and risk of CVD may interact differently with different ethnic groups: this is not captured in
214 models only adjusting for ethnicity. Results for the ethnic-specific models are presented as modelled
215 probabilities. Modelled probabilities are more comparable than ORs which only summarise the constant
216 effect of the predictor variable (e.g. becoming less deprived) on risk of CVD. Modelled probabilities
217 quantify the likelihood of CVD for the predictor variable (e.g. becoming less deprived), holding all
218 other variables constant. All analyses were conducted in IBM SPSS Statistics 23.

219 Table 1. Demographics of movers and stayers aged 30-85 years in New Zealand

Total	Stayers (n =950,151 45.7%)	Movers (n = 1,127,319 54.3%)	Total (n = 2,077,470)
CVD event			
Yes	75,263 (7.9%)	78,867 (7.0%)	154,130 (7.4%)
No	874,888 (92.1%)	1,048,452 (93.0%)	1,923,340 (92.6%)
Gender			
Male	460,004 (48.4%)	532,608 (47.2%)	992,612 (47.8%)
Female	490,147 (51.6%)	594,711 (52.8%)	1,084,858 (52.2%)
Age			
30-44	333,784 (35.1%)	581,225 (51.6%)	915,009 (44.0%)
45-54	242,051 (25.5%)	251,287 (22.3%)	493,338 (23.7%)
55-64	191,279 (20.1%)	159,863 (14.2%)	351,142 (16.9%)
65-74	119,198 (12.5%)	83,915 (7.4%)	203,113 (9.8%)
75-85	63,839 (6.7%)	51,029 (4.5%)	114,868 (5.5%)
Ethnic			
Māori	65,741 (6.9%)	111,876 (9.9%)	177,617 (8.5%)
Pacific	49,620 (5.2%)	61,641 (5.5%)	111,261 (5.4%)
Indian	22,716 (2.4%)	32,000 (2.6%)	54,716 (6.5%)
Other Asian	61,759 (6.5%)	67,166 (6.0%)	128,961 (6.2%)
NZEO	750,279 (79.0%)	854,636 (75.8%)	1,604,915 (77.3%)
Baseline deprivation			
Q1 – least deprived	235,253 (24.8%)	243,123 (21.6%)	478,376 (23.0%)
Q2	206,990 (21.8%)	235,474 (20.9%)	442,464 (21.3%)
Q3	186,050 (19.6%)	222,702 (19.8%)	408,752 (19.7%)
Q4	169,273 (17.8%)	220,189 (19.5%)	389,462 (18.7%)
Q5 – most deprived	152,585 (16.1%)	205,831 (18.3%)	358,416 (17.3%)
Of movers:			
Deprivation change			

To less deprived area		374,467 (33.2%)
Moved within same level		421,114 (37.4%)
To more deprived area		331,738 (29.4%)
Deprivation transitions		
Within Q1		111,072 (9.9%)
Into Q1		133,457 (11.8%)
Out of Q1		118,654 (10.5%)
Within Q2-Q4		460,532 (40.9%)
Out of Q5		114,158 (10.1%)
Into Q5		97,773 (8.7%)
Within Q5		91,673 (8.1%)
Of stayers:		
Stable Q1 – least	235,253 (24.8%)	
deprived	206,990 (21.8%)	
Stable Q2	186,050 (19.6%)	
Stable Q3	169,273 (17.8%)	
Stable Q4	152,585 (16.1%)	
Stable Q5 – most		
deprived		

Results

i) Ethnic profile of deprivation quintiles in NZ

Table 2 summarises the distribution of each ethnic group across the baseline deprivation quintiles. Māori and Pacific peoples, and to a lesser extent Indians, are disproportionately represented in the more deprived quintiles (Q4 and Q5). For Māori and Pacific, this accounts for the majority of the population. NZEO peoples are skewed towards the less deprived quintiles (Q1-Q3) whilst Other Asian peoples are fairly evenly distributed between Q1 and Q4. Given the unequivocal relationship between poor health

and increasing deprivation (e.g. Boyle et al., 2005), the distribution of NZ's population across the deprivation quintiles will be pertinent to experiences of specific health outcomes, including CVD.

Table 2. Population by ethnic group and baseline deprivation quintile

	Q1 Least deprived	**Q2**	**Q3**	**Q4**	**Q5 Most deprived**
Māori	12,535 (7.1%)	18,181 (10.2%)	26,096 (14.7%)	41,383 (23.3%)	79,422 (44.7%)
Pacific	4,992 (4.5%)	7,889 (7.1%)	12,150 (10.9%)	23,077 (20.7%)	63,153 (56.8%)
Indian	7,341 (13.4%)	9,330 (17.1%)	10,850 (19.8%)	14,777 (27.0%)	12,418 (22.7%)
Other Asian	28,917 (22.4%)	29,455 (22.8%)	26,286 (20.4%)	25,199 (19.5%)	19,104 (14.8%)
NZEO	424,591(26.5%)	377,609 (23.5%)	333,370 (20.8%)	285,026 (17.8%)	184,319 (11.5%)
Total	478,376 (23.0%)	442,464 (21.3%)	408,752 (19.7%)	389,462 (18.7%)	358,416 (17.3%)

ii) The influence of mobility on CVD in a national health database cohort

We summarise the results of each model first for all persons, and then by ethnic group. Table 3 presents ORs and CIs for the five all-person models. Statistically significant ORs are starred. Males consistently have significantly higher odds of CVD than females. Adjusting for different residential mobility or deprivation mobility variables has only a marginal impact on the size of the ORs for males. A clear age-gradient in CVD risk is apparent across all models, whereby participants aged 30-44 and 45-54 years have significantly lower odds of CVD than participants aged 55-64. This reverses in the older age groups: those aged 65-74 and 75-85 years have a significantly higher risk of CVD than the reference group. As with the ORs for gender, adjusting for different residential mobility or deprivation mobility variables has only a marginal impact on the ORs for each age group. This does not affect the statistical significance of the variables, or the interpretation of the ORs.

243 Table 3. Binary logistic regression modelling CVD events in NZ adult population

Model description	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 3 Odds Ratio (95% CI)	Model 4 Odds Ratio (95% CI)	Model 5 Odds Ratio (95% CI)
Adjusts for gender, age ethnicity plus:	Mover status	Mover status, baseline deprivation	Deprivation mobility status	Detailed deprivation transitions	Deprivation quintile for stayers
Gender					
Female	**REF**	**REF**	**REF**	**REF**	**REF**
Male	1.66* (1.64 – 1.68)	1.66*(1.64 – 1.68)	1.66*(1.64 – 1.68)	1.66*(1.64 – 1.68)	1.66*(1.64 – 1.68)
Age group					
30-44	0.12* (0.12-0.12)	0.12*(0.12-0.12)	0.12* (0.12-0.12)	0.12* (0.12-0.12)	0.12*(0.12-0.12)
45-54	0.42* (0.42 -0.43)	0.42* (0.42 -0.43)	0.42* (0.42 -0.43)	0.42* (0.42 -0.43)	0.43*(0.42 -0.43)
55-64	**REF**	**REF**	**REF**	**REF**	**REF**
65-74	2.41*(2.37 – 2.44)	2.38* (2.34 – 2.42)	2.40* (2.37 – 2.44)	2.39* (2.35 – 2.43)	2.39* (2.36 – 2.43)
75-85	5.54*(5.45 – 5.63)	5.43* (5.34 – 5.52)	5. 54* (5.44 – 5.63)	5.48* (5.39 – 5.57)	5.48* (5.39 – 5.58)
Ethnicity					
NZEO	**REF**	**REF**	**REF**	**REF**	**REF**
Māori	2.25* (2.21 – 2.30)	1.97* (1.93– 2.01)	2.26* (2.21 – 2.30)	2.05* (2.01 – 2.09)	2.15* (2.10 – 2.19)
Pacific	1.63* (1.59 – 1.67)	1.38* (1.35 – 1.42)	1.64* (1.60 – 1.68)	1.47* (1.43 – 1.51)	1.53* (1.49 – 1.57)
Indian	1.21*(1.17 - 1.26)	1.14* (1.10 - 1.19)	1.21* (1.17 - 1.26)	1.17* (1.12 - 1.22)	1.19* (1.15 - 1.24)
Other Asian	0.56*(0.54 - 0.58)	0.55* (0.54 - 0.57)	0.56* (0.54 - 0.58)	0.56* (0.54 – 0.57)	0.56* (0.54 - 0.58)
Mover status					
Stayer	**REF**	**REF**			
Mover	1.26* (1.25 – 1.28)	1.26* (1.24 – 1.27)			
Baseline deprivation (NZDep2006)					
Q1(least deprived)		**REF**			
Q2		1.14* (1.12 – 1.16)			
Q3		1.26* (1.24 – 1.29)			
Q4		1.39* (1.37 – 1.42)			
Q5		1.58* (1.55 – 1.61)			
Deprivation mobility status					
Stayer			**REF**		
Moves up			1.29* (1.27 – 1.31)		
Moves w/in			1.23* (1.21 – 1.25)		
Moves down			1.28* (1.26 – 1.30)		
Deprivation transitions (detailed moves between quintiles)					
Stayer				**REF**	

Within Q1	0.88* (0.85 – 0.91)	
Into Q1	1.08* (1.05 – 1.11)	
Out of Q1	1.06* (1.03 – 1.08)	
Within Q2-4	1.26* (1.24 – 1.28)	
Out of Q5	1.55* (1.51 – 1.58)	
Into Q5	1.52* (1.48 – 1.56)	
Within Q5	1.71* (1.66 – 1.76)	
Stable deprivation		
Mover		REF
Stable Q1		0.65* (0.64 – 0.67)
Stable Q2		0.73* (0.72 – 0.75)
Stable Q3		0.81* (0.79 – 0.82)
Stable Q4		0.89* (0.87 – 0.90)
Stable Q5		0.94* (0.92 – 0.96)

Note: statistically significant ORs are starred: $p < 0.001$.

Adjusting for residential or deprivation mobility has a more discernible impact on the ORs for certain ethnic groups. Across all five models, the highest odds of CVD are consistently observed for Māori groups, ranging from an OR of 2.26 (95% CI 2.21-2.30) in model 3 to 1.97 (1.93-2.01) in model 2. The odds of Māori having CVD, however, are attenuated by baseline deprivation, evident in the reduction of the odds of CVD for Māori in model 2 compared to the other models. Models 1, 3, 4 and 5 all suggest that the odds of Māori being hospitalised for CVD is more than twice that of NZEO. However, when adjusting for baseline deprivation the odds are significantly lower (1.97). The importance of baseline deprivation in explaining odds of CVD is not limited to Māori, as the odds of CVD also notably declines for Pacific and Indian participants in model 2. Baseline deprivation appears to exert a stronger influence on odds of CVD for each ethnic group than mover status alone. Indeed the ORs for each deprivation quintile are all significantly different from each other, increasing in size with increasing deprivation with Q2 at 1.14 (1.12-1.16) and Q5 climbing to 1.57 (1.54-1.59). Odds of CVD for Māori and Pacific groups are more notably attenuated when adjusting for deprivation than the other ethnic groups. It is possible this is largely driven by the likelihood of Māori, Pacific, and to a lesser extent, Indian groups, living in more deprived areas as CVD is socially graded.

Results of models 4 and 5 further demonstrate the importance of deprivation in explaining risk of CVD for different ethnic groups. ORs are attenuated when adjusting for detailed deprivation transitions (model 4) and stable deprivation for stayers (model 5). Although the reduction in the ORs for each ethnic group is smaller in models 4 and 5 than observed in model 2, it is still notable. Despite the apparent importance of deprivation, it is important to note that even after adjusting for deprivation and deprivation transition, the odds of CVD for Māori and Pacific groups are still notably high. Variables not adjusted for in these models, such as social class, tenure, education and employment may explain some of the variation observed here. The importance of these variables in relation to risk factors for CVD has been determined in the wider literature (e.g. Albert et al., 2006).

After Māori, Pacific people have the highest odds of CVD, followed by Indians. These three ethnic groups consistently have significantly higher odds of CVD than NZEO, whether adjusting for residential or deprivation mobility. Conversely, Other Asian peoples have significantly lower odds of

CVD relative to NZEO in all five models. While the ORs for Māori, Pacific and Indian peoples are attenuated when adjusting for residential or deprivation mobility, this is not true for Other Asians. The odds of Other Asians being hospitalised for CVD are consistently about 45% less likely than for NZEO participants.

In models 1 and 2, movers have significantly higher odds of CVD than stayers (1.26 (1.24-1.27) when adjusting for baseline deprivation). There is no change in the size of the ORs or the size of the confidence interval between these two models. The influence of residential mobility on the odds of being hospitalised for CVD can also be seen in model 3: after adjusting for deprivation mobility status, the odds of CVD are significantly higher for movers regardless of their deprivation mobility status. Further, the odds of CVD for these differently mobile groups are not significantly different from each other. However, as demonstrated in model 4, the odds of CVD are influenced by detailed deprivation transition: variations begin to emerge when looking at residential mobility in the context of transitions into and out of the extremes of the deprivation spectrum.

Movers who churn within the least deprived quintile (Q1) are the only mobile group to have significantly lower odds of CVD than stayers (0.88 (0.85-0.91)). Model 4 shows that the odds of CVD generally increases successively with each transition down the deprivation spectrum. Of those moving within the same deprivation quintile (i.e. churning), the highest odds of CVD are for those churning within the most deprived quintile (Q5) (1.71 (1.66-1.76)), followed by those who move out of or into Q5. There is no significant difference in the odds of CVD among those moving into Q5 (1.52 (1.48-1.56)) or out of Q5 (1.55 (1.51-1.58)), or between those moving into (1.08 (1.05-1.11)) or out of (1.06 (1.03-1.08)) Q1.

Model 5 further demonstrates that movers are, generally, at significantly higher risk of CVD than stayers. Odds of CVD for stayers (in model 5) are consistently significantly lower than for the reference group of movers. Here, we see a clear deprivation gradient with the odds of CVD increasing significantly for stayers with increasing levels of area deprivation. However, despite these significant

increases stayers in Q5, the most deprived area, are still significantly less likely than movers to have CVD.

The results of the all-person models suggest: a) there is an important relationship between residential mobility and CVD but that the overall direction of the move is less important than the move itself, and b) CVD is socially graded. This is apparent in the clear deprivation gradient in odds of CVD by baseline deprivation, stable deprivation (for stayers), and when accounting for specific moves into and out of the most and least deprived areas. Importantly, we also see clear and consistent disparities in the odds of CVD by ethnic group, each somewhat attenuated by residential mobility and deprivation (change). The following set of results explore the social gradient to CVD and the influence of residential mobility and deprivation (change) in more detail for each ethnic group.

iii) Ethnic-specific influences of mobility on CVD

For models 1e to 5e (subset by ethnic group), modelled probabilities of CVD are calculated for each ethnic group by origin deprivation, deprivation mobility status, detailed deprivation transitions, and stable deprivation for stayers. These are compared to the modelled probabilities of CVD for the total population. All probabilities are derived from models adjusting for age and sex in addition to the relevant residential mobility or deprivation-related variables. Probabilities derived from the all-persons models discussed above also adjust for ethnicity. Error bars are presented on each graph to represent the 95% confidence intervals.

Figure 2 presents the modelled probability of CVD by mover status stratified by ethnicity from models 1e. For all ethnic groups, the probability of CVD is significantly higher for movers than for stayers. Compared to the total population, Māori and Pacific movers and stayers, and Indian movers have significantly higher probabilities of CVD. Probability of CVD for Other Asian stayers is significantly lower than the probability of CVD for all other groups (3.31% compared to 17.47% for Māori movers).

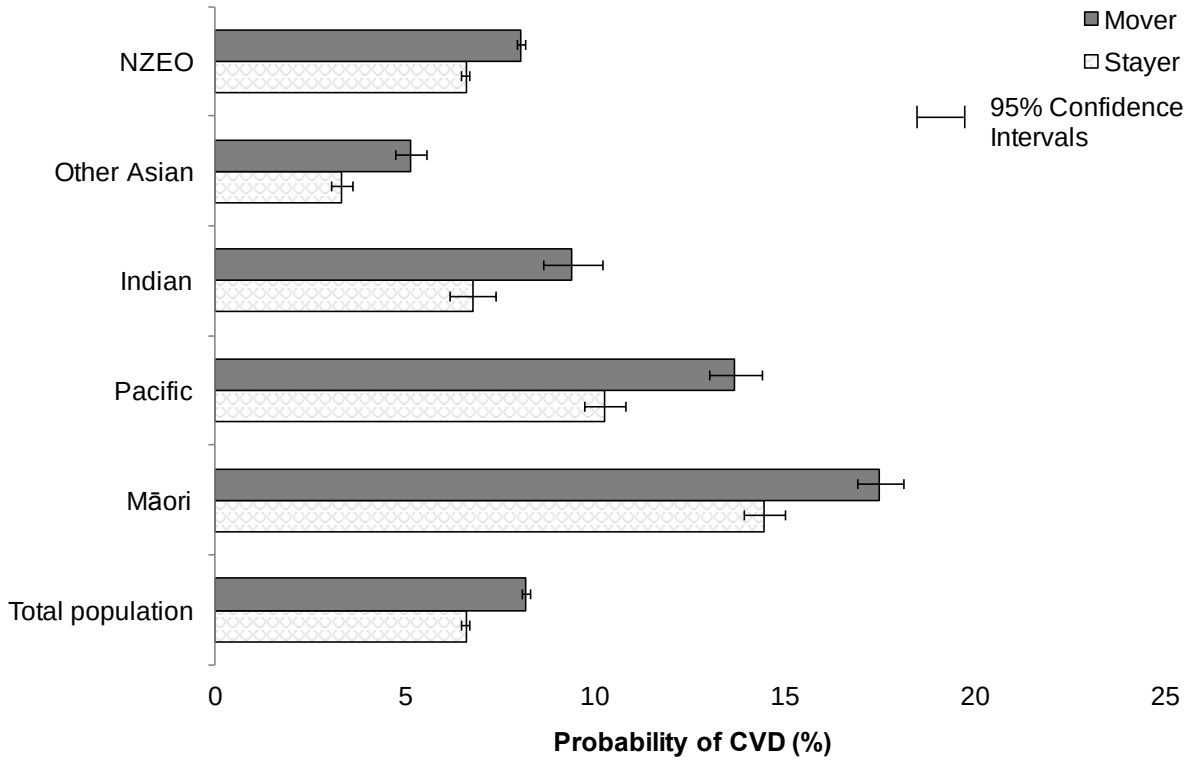


Figure 2 Probability of CVD (%) by mover status, stratified by ethnic group (adjusting for age, gender, [and ethnicity])

Figure 3 summarises results from models 2e: the probability of having CVD by baseline deprivation stratified by ethnic group. Whilst a deprivation gradient is apparent for all ethnic groups, the steepness of this gradient varies. It is steepest for Māori and Pacific groups who have a disproportionate share of their population in the more deprived quintiles (see Table 2). Further, although increasing deprivation is generally associated with increasing probabilities of CVD for all groups, Māori groups in Q1-Q5 (9.76% - 16.38%), Pacific groups in Q1-Q5 (7.91% - 10.81%) and Indian groups in Q1 (6.24%) have a higher probability of CVD than observed for corresponding quintiles of the NZEO population. Differences are significant for Māori. The distribution of probability of CVD by deprivation is flatter around Q2-Q4 for Other Asian, Indian and Pacific groups than for the total population, or for Māori and NZEO groups.

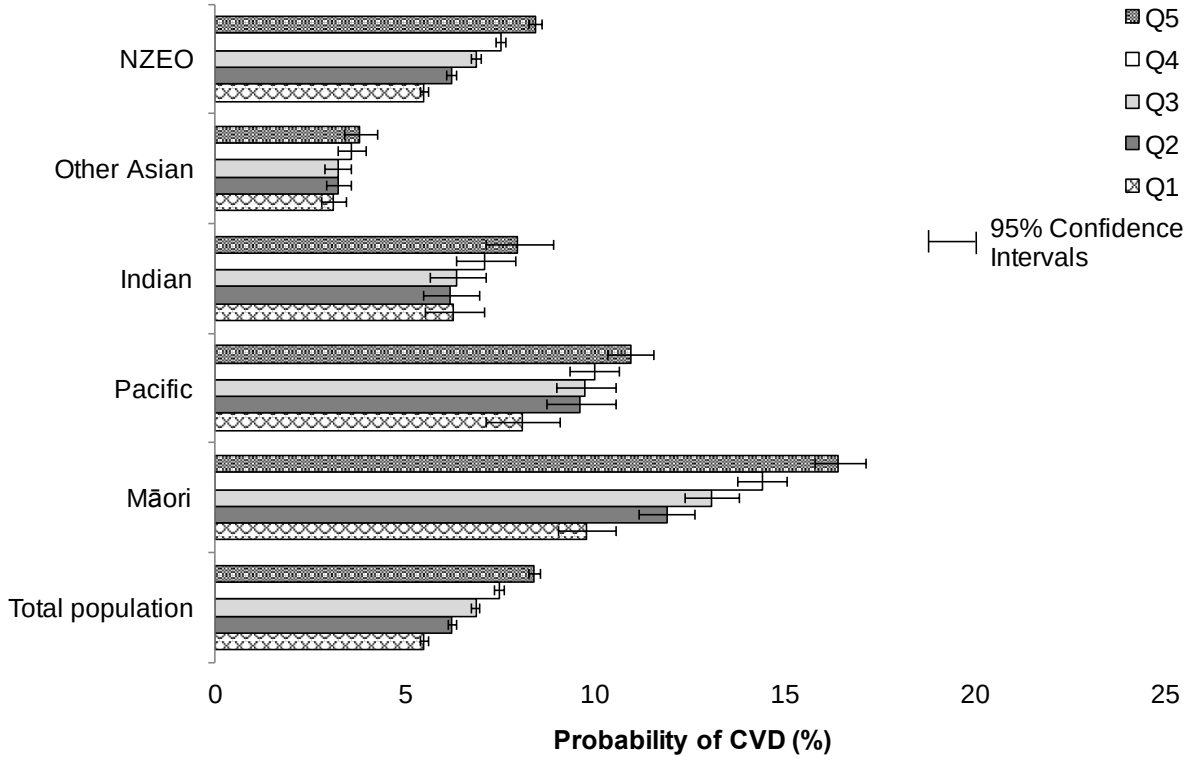


Figure 3 Probability of a patient having CVD (%) by baseline deprivation, stratified by ethnic group (adjusting for mover status, age, gender, [and ethnicity])

The patterning to probability of CVD varies somewhat between ethnic groups according to their deprivation mobility status (figure 4). For Māori and Pacific groups (18.42% and 14.01% respectively), the highest probability of CVD is for movers who churn within the same deprivation quintile. Differences are significant for Māori. Conversely, for all other ethnic groups movers churning within the same deprivation quintile tend to have lower probabilities of CVD than those who either become more or less deprived, significantly lower for NZEO.

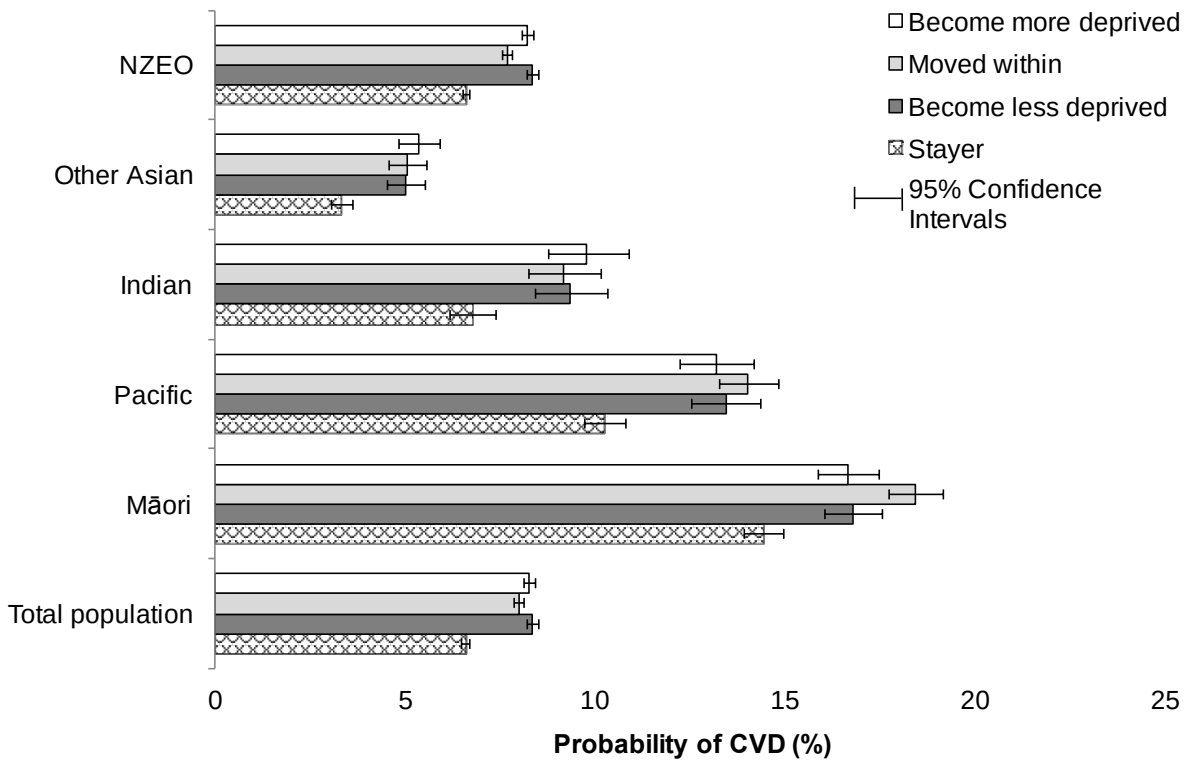


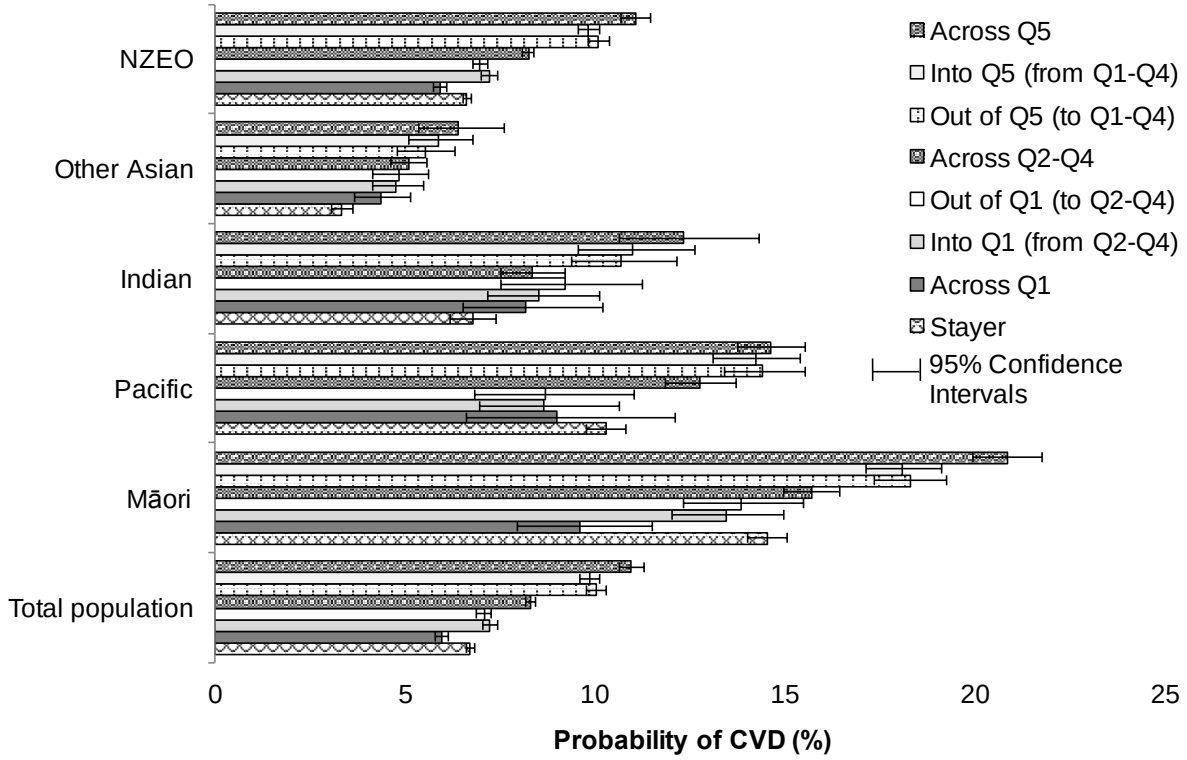
Figure 4 Probability of CVD (%) by deprivation mobility status, stratified by ethnic group (adjusting for age gender, [ethnicity])

This likely reflects the high concentrations of Māori (68.0%) and Pacific (67.5%) populations residing in Q4 and Q5 at baseline: the majority of their moves will therefore be within very deprived areas. Differences in the probability of CVD between those whose areas become more or less deprived are small for all ethnic groups (less than 0.5% for all groups).

To further explore how the nature of a move influences probability of CVD between ethnic groups, we also adjusted for detailed deprivation transitions (models 4e). Māori groups consistently have the highest probability of CVD when compared to all other ethnic groups in comparable circumstances. There is a significant marked gap between those churning within Q5 (the most deprived quintile) and all other movers within NZEO, Indian and Māori groups (figure 5). Conversely, differences between Other Asian and Pacific groups are much smaller (although still significant for Pacific groups). Indian and Other Asian stayers had the lowest probability of CVD compared to mobile Indian or Other Asian peoples. Māori stayers have a higher probability of CVD (14.50%) than Māori movers moving across (significant difference for this group), into or out of the least deprived quintile (9.56%, 13.41% and

360 13.81%, respectively). However, this is unsurprising given that 68.7% of Māori stayers remain in Q4
361 and Q5. Pacific and NZEO stayers also have a higher probability of CVD than those moving across,
362 into or out of Q1, but differences are small (but significant for NZEO). It is important to note that as
363 only 4.5% of Pacific reside in Q1 (at baseline) compared to 26.5% of NZEO, the reasons for these
364 similar probabilities will vary.

365



366

367 Figure 5 Probability of CVD (%) by detailed deprivation transition, stratified by ethnic group (adjusting
368 for age, gender, [ethnicity])

369 Figure 6 illustrates the results of models 5e as probabilities of CVD by experience of deprivation for
370 stayers compared to movers, stratified by ethnic group. The similarities in the patterning of health for
371 stayers by deprivation quintile and for movers by baseline deprivation quintile are striking. The steepest
372 gradient is observed for Māori stayers (differences between quintiles are generally significant).
373 Probability of CVD for Māori stayers who remain in Q5 (16.31%) is more than 1.5 times that of Māori
374 stayers who remain in Q1 (9.17%). However, probability of CVD for stayers in Q5 is not significantly
375 different from movers. Conversely, the gradient for Pacific, Indian and Other Asian stayers is less

marked with probability of CVD only about 1.2 times greater for stayers in Q5 than for stayers in Q1. Movers for these groups consistently have a significantly higher probability of CVD than stayers, irrespective of deprivation. The lowest probabilities of CVD for stayers are consistently found for those remaining in the least deprived areas for all ethnic groups.

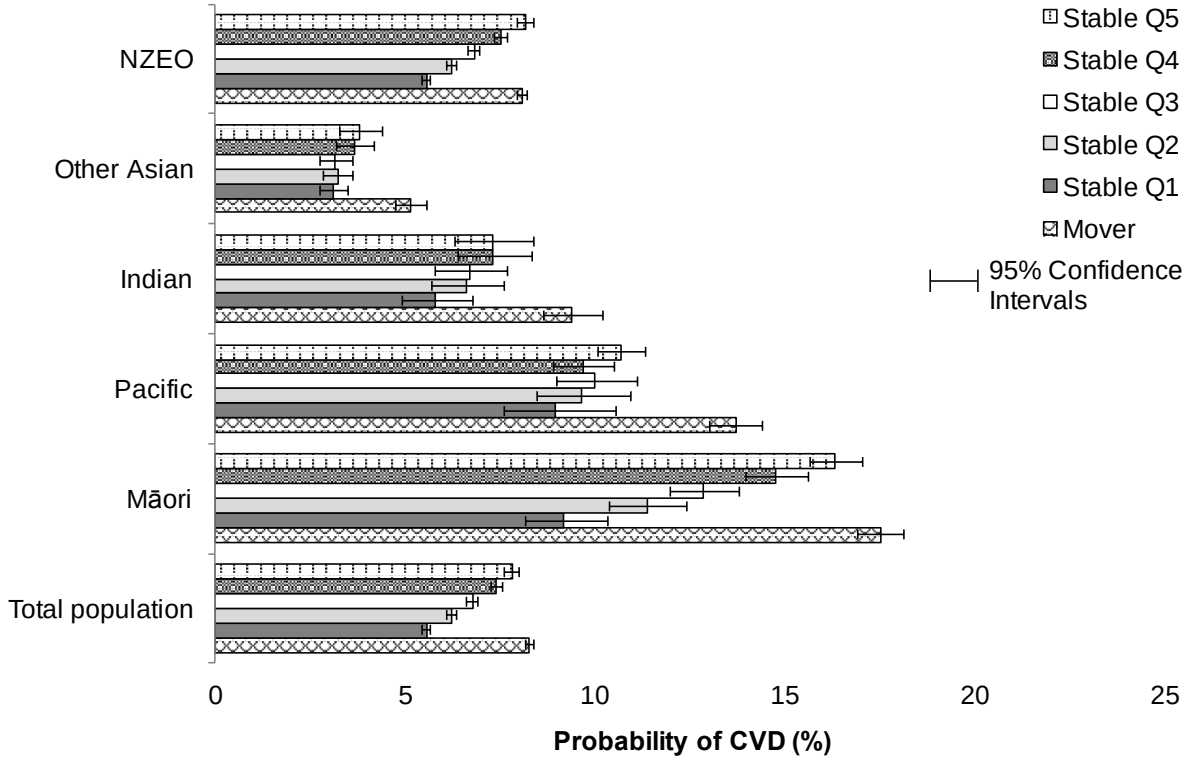


Figure 6 Probability of CVD (%) by stable deprivation for stayers compared to movers, stratified by ethnic group (adjusting for age, gender, [ethnicity])

Discussion

This paper aimed to investigate the relationship between residential mobility and risk of CVD for different ethnic groups, building on previous results of a study of Auckland's adults. We expanded the research, exploring whether the relationship between residential mobility and CVD varies between ethnic groups across the whole of NZ. Further, we addressed the role of immobility in explaining differences in health between ethnic groups, an idea that has not been extensively explored in comparable literature.

390 The key findings of this paper are a) movers have a higher risk of CVD than stayers across the adult
391 population of NZ (similar to the results of XXXX for Auckland's adults); the influence of residential
392 mobility on risk of CVD gains in importance through its relationship with deprivation mobility; and c)
393 the relationship between residential mobility and risk of CVD varies notably between ethnic groups.
394 Interpretation of the all-person models (see Table 3) suggested that the salience of residential mobility
395 varied for each ethnic group through the complex relationship with deprivation, whether at baseline or
396 through changing deprivation trajectories. Adjusting for baseline deprivation, deprivation mobility
397 status or detailed deprivation transitions attenuated the odds of CVD for all ethnic groups, apart from
398 Other Asians. The importance of deprivation was also apparent in the clear gradient to odds of CVD
399 for stayers by deprivation quintile (model 5).

400 To explore the attenuation of the odds of CVD by ethnic group observed in models 1-5, we calculated
401 modelled probabilities of CVD, sub-setting each of the models by ethnic group. We refer to the results
402 of these models as 1e to 5e. Calculating modelled probabilities allows comparisons within and between
403 ethnic groups and reveal a more nuanced picture of the relationships between residential mobility,
404 deprivation and CVD for different ethnic groups in NZ. As with the all-person models, we found that
405 movers consistently have a significantly higher probability of CVD than stayers for all ethnic groups.
406 This is consistent with wider literatures investigating the relationship between residential mobility and
407 health (albeit not ethnically differentiated): at the individual level, Morris et al. (2016) note that
408 residential mobility is often associated with poorer health outcomes for movers compared to stayers
409 (see Jelleyman and Spencer, 2008; Scanlon and Devine, 2001; Piro et al., 2007). However, the nature
410 of the residential mobility event will vary markedly between ethnic groups: disadvantaged groups will
411 have very different motivations and opportunities for residential mobility to those of advantaged groups.
412 This, in turn, will influence the relationship with CVD.

413 To effectively disentangle these relationships, we should look to the detailed health, social and physical
414 histories of individuals. Morris et al. (2016: 2) advocate such an analytical framework, also drawing on
415 individual experiences and personal biographies. Within the scope of this study, we use baseline
416 deprivation and deprivation change (measured as deprivation mobility status and detailed deprivation

417 transitions) to try and unpack the relationship between residential mobility and CVD for different ethnic
418 groups.

419 In the Auckland study, the odds of CVD were lower for those moving up the deprivation spectrum (to
420 lower deprivation) compared to those moving down (to more deprivation). XXX question whether
421 health status is more associated with an individual's current residence, or where they have been.
422 However, it is more complex than that. We must also examine whether the extent of the influence of
423 current or previous residence varies by, for example, deprivation, and consider the relationship with
424 literatures on selective sorting (see Norman et al., 2005). In terms of the results in Auckland, we might
425 assume that movers take some of the health advantage of more prosperous areas with them when
426 moving from less to more deprived areas, while those moving out of more deprived areas may inherit
427 the health status of the less deprived areas they move to, particularly if those groups of movers have
428 been sorted into less deprived areas by virtue of their better health.

429 Our results reveal a more nuanced picture for different ethnic groups across NZ, and one with marginal
430 differences when looking at the population as a whole. Maori, Pacific and NZEO movers who move to
431 less deprived areas have a (marginally) higher risk of CVD than their peers moving to move deprived
432 areas, perhaps suggesting they inherit the health status of the areas they move to or are sorted into these
433 less deprived areas due to their good health. However, differences between the mobile groups are too
434 small to be significant. Conversely, Indian and Other Asian movers who become more deprived have a
435 higher probability of CVD than their peers who become less deprived. Are these down the deprivation
436 spectrum precipitated by poor health? This downward deprivation mobility is the most detrimental to
437 Indian and Other Asian groups as this is associated with the highest probability of CVD. Yet for Maori
438 and Pacific movers, the highest probability of CVD is associated with churning within the same
439 deprivation quintile. Indeed for Maori, churning with the same level deprivation results in significantly
440 higher probabilities of CVD than for any other deprivation mobility status. In contrast, churning within
441 the same level of deprivation for NZEO movers results in a significantly lower probability of CVD.
442 This likely reflects the markedly higher concentration of Maori and Pacific groups in the most deprived
443 quintiles (see Table 2; Salmond and Crampton, 2012): the health of those churning within these

444 deprived areas will likely be poorer than those who have spent time in less deprived areas and then
445 moved down.

446 These results highlight the importance of looking, insofar as possible, to the wider experiences of
447 differently mobile groups in order to understand the relationship with risk of CVD. Results of models
448 4e further illustrate this: Maori and Pacific movers who move within, into or out of the least deprived
449 quintile (Q1) all have a lower probability of CVD than their stable counterparts, significantly lower for
450 those moving within Q1. Similarly, NZEO movers churning with Q1 also have a significantly lower
451 probability of CVD than their stable counterparts. This strengthens the conclusions drawn above: the
452 health advantage of those groups in Q1 likely reflects their relatively social advantage, here defined by
453 residency in the least deprived quintiles. Maori and Pacific groups residing in the least deprived
454 quintiles will be particularly advantaged compared to their stable peers given the overwhelming
455 concentration of these ethnic groups in the most advantaged areas.

456 It seems likely that deprivation histories interact with the opportunities for residential mobility and the
457 nature of the move itself (in terms of changing deprivation). We must therefore ask, are there different
458 causal pathways operating which might be explaining these results and the marked (often significant)
459 variations within and between ethnic groups?

460 Firstly, those MEGS which concentrate in more deprived areas may have a heightened risk of CVD,
461 irrespective of any residential mobility or the nature of the move, as CVD is socially graded. Those
462 living in socially deprived areas may also be individually deprived, perhaps with lower levels of
463 educational attainment and working in lower occupational classes. Each are associated with a higher
464 risk of CVD mortality (Mackenbach et al., 2000): lower educational attainment may mean individuals
465 are less able to participate in health promotion activities or are less aware of appropriate life-style
466 choices and health-enabling behaviours (Glymour et al., 2014). However, those living in more deprived
467 areas may also have access to fewer facilities or services which promote health-enabling behaviours,
468 thus contributing to an increased risk of CVD. These compositional and contextual factors may
469 collectively contribute to ethnic and social disparities in CVD.

Secondly, residential mobility is associated with poorer health outcomes as already noted, and this is consistent across ethnic groups. However, the relationship varies, evidenced by the ratio of the probabilities of CVD for movers compared to stayers in models 1e: probability of CVD is 1.5 times as likely for NZEO movers compared to stayers, this increases to 1.8 times as likely for Other Asians 2.6 times as likely for Indians, and more than 3 times as likely for Maori and Pacific movers. This may be explained by their contrasting deprivation experiences and the extent to which this determines the nature of the move itself. To understand this, we must revisit the concept of 'malign migration' and the notion that marginalised, socially excluded groups in inner city, deprived areas "experience higher than average levels of residential mobility which is detrimental to health" (Warfa et al., 2006: 504). 26% of the Maori population who moved during the study period moved more than 4 times within the most deprived areas. This increases to 37% of Pacific movers, yet only accounts for 4% of NZEO movers. The interaction between deprivation and higher than average levels of residential mobility may be particularly pertinent to our understanding of the causal pathways driving the varying relationships between residential mobility and CVD for ethnic groups through uptake of health-related behaviours and the relationship with access to healthcare.

Increased residential mobility is associated with increased participation in risk behaviours, including smoking, alcohol consumption even drug use (see Morris et al., 2016 for a review of relevant literatures): these risk factors, particularly smoking, may influence risk of CVD. Participation in these health-related behaviours is socially graded and varies between ethnic groups: while relative deprivation is the most important predictor of smoking uptake in NZ, increased inequality between Maori and non-Maori groups leads to higher smoking rates amongst Maori (Barnett et al., 2005).

Residential mobility, particularly amongst those concentrated in more deprived areas, may disrupt access to preventative healthcare services (see Warfa et al., 2006; Jelleyman and Spencer, 2008). However, it is likely that there are additional salient interactions. Healthcare provision has famously been found to follow an inverse care law (Hart, 1971) whereby services are inversely distributed according to need. In NZ, recent research concluded that despite improvements in cardiac interventions, the inverse care law in the context of ischaemic heart disease persist for the Maori population (Sandiford

et al., 2015: 974). Ethnic differences in access or utilisation of healthcare may be variously explained by cultural, linguistic or religious factors influencing perceptions of healthcare services (e.g. willingness or perceived ability to access services) and participation in in health promotion activities (Zanchetta and Poureslami, 2006). However, these barriers extend past patient-level characteristics, including factors such as the attitudes of healthcare providers or structural barriers in the organisation of the healthcare system (see Scheppers et al., 2006).

We might therefore assume that the higher risk of CVD for MEGs churning with more deprived areas can, in part, be explained by the interaction between deprivation, residential mobility (or perhaps 'malign migration'), ethnicity and access to preventative healthcare. Each are associated with a heightened risk of CVD, and collectively reflect a significant policy concern. To extent Jelleyman and Spencer's (2008) arguments in the context of child health outcomes, CVD preventative healthcare services should be reoriented to effectively engage residentially mobile Maori, Pacific and Indian populations living in more deprived areas already vulnerable to CVD.

Notwithstanding the likely important of the interactions outlined above, the reported results may be confounded by cultural factors differently influencing the patterning of residential mobility between ethnic groups, or by ethnically differentiated experiences of tenure and housing conditions across NZ. Firstly, despite broad similarities important differences in the age profile of movers across ethnic groups have been observed in the UK (Finney and Simpson, 2008; Simpson and Finney, 2009). Although younger adults are consistently the most mobile, South Asian groups are less likely to move than other ethnic groups. Finney and Simpson (2008) attribute this to differences in household formation as South Asian young adults are more likely to remain the family home until marriage contrasting with non-South Asian young adults who are more likely to live alone before marriage. It is reasonable to assume that patterns of residential mobility may be similarly influenced by different cultural traditions in the NZ population which may be pertinent.

Secondly, recent research has shown that falls in owner-occupied housing have been greater in Maori (20%) and Pacific (35%) groups than for the total population (15%) between the 1986 and 2013 NZ

censuses. This may be explained by increasing housing costs prices, the younger age structure for Māori and Pacific people and lower rates of employment and income levels among these ethnic groups (Statistics New Zealand 2016). Other important factors include ethnic differences in intergenerational attitudes to home ownership Statistics New Zealand 2016) and institutionalised racism (Houkamau and Sibley, 2015). Data from the 2002/3 New Zealand Health Survey found that the odds of Māori experiencing racism in the context of housing was 13 times higher than NZ Europeans (Harris et al. 2006). Decreasing owner-occupation pushes groups into rental accommodation, insecure by nature and therefore related to residential mobility. A recent survey found that Maori (58%) and Pacific (71%) peoples were more likely to be renters than Asian (41%) or NZ Europeans (27%). To address the issues raised here, future research should assess the impact of transitions within and between tenures on ethnic differences in CVD as well as exploring whether and why propensity to migrate varies between ethnic groups.

In addition to these confounding factors, it is worth drawing out a final key point of interest from these data. Despite the relative disadvantage of Māori populations who generally have some of the highest probabilities of CVD, the patterning of health for Maori is closely aligned to the experiences of the NZEO. This contrasts with the similarities in the patterning to probabilities of CVD for Pacific, Indian and Other Asian groups. We may speculate that the similarities in the distribution of risk of CVD between these two sets of ethnic groups are related to wider migration and settlement patterns in NZ. Pacific, Indian and Other Asian populations are more likely to comprise recent migrants whose health may follow from their place of origin or are not yet similarly susceptible to the determinants influencing Māori and NZEO health. The similarities between Māori and NZEO groups on the one hand, and Pacific, Indian and Other Asian on the other, may therefore be attributed to longevity in NZ and the resulting gradual convergence between cultural and socio-political heritages. As we were unable to exclude (recent) international migrants from the cohort, a common practice in research into selective migration and health (e.g. Norman et al., 2005), this cannot be further tested. However, future work should explore how the influence of residential mobility and deprivation mobility on health may not only vary between ethnic groups in terms of the magnitude of the influence, but also may vary according

550 to length of residence in a country. Such work would build on literatures exploring the 'healthy migrant
551 effect' and wider international migration (e.g. Silventoinen et al., 2008; Norredam et al., 2013; Blair
552 and Schneeberg, 2014), rather than internal migration or residential mobility.

553 We have shown that the relationship between residential mobility and risk of CVD varies notably
554 between ethnic groups. However, much of this variation is attributable to the contrasting deprivation
555 experiences of different ethnic groups in NZ, evident in the attenuating influence of baseline deprivation
556 circumstances on the odds of CVD by ethnic group, the consistent deprivation gradient in probability
557 of CVD for stayers, and the varying probabilities of CVD for different ethnic groups according to the
558 nature of the move. It is apparent that while residential mobility is an important determinant of CVD in
559 NZ, as was found in the Auckland study, the extent of the influence will vary by ethnic group according
560 to their deprivation experiences. Further differences may also arise if ethnic groups are differentiated
561 by sex as gendered differences in risk of CVD have been determined in the literature (Mieres 2005,
562 Maas and Appelman 2010, Mosca et al., 2011; Brunner, 2016). There may also be gendered differences
563 in migration propensities between ethnic groups. Future work should investigate whether gendered
564 differences in risk of CVD interact with possible gendered differences in propensity to migrate by ethnic
565 group.

566 Despite the strengths of this study, particularly in the value of the dataset used, there are a number of
567 limitations. Firstly, we are not able to fully disentangle the complexities of the relationship between
568 residential mobility and health in the absence of richer socioeconomic data on the participants included.
569 However, deprivation acts as a good proxy for individual-level socioeconomic data and reveals much
570 as to the socially graded risk of CVD and how this varies between ethnic groups. Secondly, we are not
571 able to account for certain factors such as access to healthcare or cultural differences influencing
572 residential mobility patterns. In the case of the latter, it is important to recognise that we are not
573 necessarily comparing like-for-like when looking at different ethnic groups. Relatedly, we must ask
574 whether comparisons between movers and stayers are not necessarily comparing like-for-like: are
575 differences in health outcomes the result of mover or stayer status, or merely an 'artefact of differences
576 in their demographic composition' (Green et al., 2015: 30). While the distinct characteristics of mobile

groups compared to immobile groups are the basis of theories of health-selective migration, the inherent bias in the data is problematic (note the different composition of movers compared to stayers in Table 1).

Green et al. (2015) note that this inherent bias is rarely adequately accounted for in migratory research. To overcome this bias, they advocate the use of 'matching', comparing the change in status of one group (e.g. the migration event) with the manually changed status of an alternative control group. Using this pseudo-experimental design, the authors of the study find that migration, regardless of the nature of the move, increased the likelihood that an individual reported poor health. Thus, while the process of matching might help reduce selection bias in the data given the contrasting demographic characteristics of movers compared to stayers, the results of their study are similar to those reported here. Namely, probability of CVD is greater for movers compared to stayers, regardless of the nature of the move. Although this reflects a limitation of the study, our interpretation of the results are still significant.

We must look to discussions of health-selective migration to expand on these results. How confident can we be that there is a causal relationship between residential mobility and risk of CVD? The findings presented in this paper contrast with some of the wider literature on migration and health which finds that migrants, or at least younger migrants, are in better health than their stable counterparts (Bentham, 1988; Larson et al., 2004). On the one hand, this may reflect the neglect of 'malign migration' in the literature, something that has also been explored in terms of the 'drift' hypothesis in research exploring mental health and selective migration (see Curtis et al., 2006; De Verteuil et al., 2007). The heightened risk of CVD for marginalised minority groups in more deprived areas may be attributed to higher rates of residential mobility. Future research should examine the frequency of moves and the deprivation trajectory of these moves over time to address this issue. On the other hand, the health outcome may be important in assessing the influence of health-selective migration or residential mobility on health inequalities in a population, as is the nature of the move itself in terms of changing deprivation. It is possible that movers may have a heightened susceptibility to certain morbidities such as CVD as a consequence of the move itself. Apart from not having experienced a CVD event by the start of the study period, the sequencing of the CVD and migration events are not accounted for here. Thus, for

604 different ethnic groups in NZ, are CVD events the reason for the move (for informal care, for example),
605 are CVD events associated with the move (relating to the stress of moving), or are certain characteristics
606 of movers associated with a higher risk of CVD (see forthcoming research)?

607 Notwithstanding these limitations, this study clearly identifies a number of fruitful avenues for future
608 research. Further, ethnic inequalities in CVD are a major policy concern in NZ, and of international
609 relevance given the existence of these inequalities in countries across the world. The policy
610 implications of this study are clear. Residentially mobile Māori, Pacific and South Asian populations
611 who already have a heightened risk of CVD living in more deprived areas must be the focus of policies
612 aiming to reduce inequalities in CVD within NZ. Moreover, healthcare providers must effectively
613 engage with those mobile vulnerable groups if health inequalities are to reduce.

614

615 **Bibliography**

616 Albert, M.A., Glynn, R.J., Buring, J. and Ridker, P.M. (2006) Impact of traditional and novel risk factors
617 on the relationship between socioeconomic status and incident cardiovascular events, Circulation, 114:
618 2619-2626.

619 Bajekal, M., Sholes, S., Love, H., Hawkins, N., O'Flaherty, M., Raine, R. and Capewell, S. (2012)
620 Analysing recent socioeconomic trends in coronary heart disease mortality in England, 2000-2007: A
621 population modelling study, PLoS Medicine, 9 (6): e1001237.

622 Barnett, R., Pearce, J. and Moon, G. (2005) Does social inequality matter? Changing ethnic socio-
623 economic disparities and Maori smoking in New Zealand, 1981-1996, Social Science & Medicine, 60:
624 1515-1526.

625 Bentham, G. (1988) Migration and morbidity: Implications for geographical studies of disease, Social
626 Science & Medicine, 26 (1): 49-54.

627 Blair, A.H. and Schneeberg, A. (2014) Changes in the 'Healthy Migrant Effect' in Canada: Are recent
628 immigrants healthier than they were a decade ago? Journal of Immigrant and Minority Health 16 (1):
629 136-142.

630 Blakely, T., Ajwani, S., Robson, B., Tobias, M. and Bonne, M. (2004) Decades of disparity: widening
631 ethnic mortality gaps from 1980 to 1999, New Zealand Medical Journal, 117 (1199): U995.

632 Blakely, T., Tobias, M., Robson, B., Ajwani, S., Bonne, M. and Woodward, A. (2005) Widening ethnic
633 mortality disparities in New Zealand, 1981-99, Social Science & Medicine, 61: 2233-2251.

634 Boyle, P. (2004) Population geography: migration and inequalities in mortality and morbidity, Progress
635 in Human Geography, 28 (6): 767-776.

636 Boyle, P. and Norman, P. (2009) Migration and Health in Brown, T., McLafferty, S. and Moon, G.
637 (eds) A Companion to Health and Medical Geography. Oxford: Wiley Blackwell, 346-374.

638 Boyle, P., Norman, P. and Rees, P. (2004) Changing places: do changes in the relative deprivation of
639 areas influence limiting long-term illness and mortality among non-migrant people living in non-
640 deprived households? Social Science & Medicine, 58:2459-2471.

641 Brown, D., O'Reilly, D., Gayle, V., Macintyre, S., Benzeval, M. and Leyland, A.H. (2012) Socio-
642 demographic and health characteristics of individuals left behind in deprived and declining areas in
643 Scotland, Health & Place, 18: 440-444.

644 Cheuk Chan, W., Wright, C., Riddell, T., Wells, S., Kerr, A.J., Gala, G. and Jackson, R. (2008) Ethnic
645 and socioeconomic disparities in the prevalence of cardiovascular disease in New Zealand, The New
646 Zealand Medical Journal, 121 (1285): 11-19.

647 Clark, A.M., DesMeules, M., Luo, W., Duncan, A.S. and Wielgosz, A. (2009) Socioeconomic status
648 and cardiovascular disease: risks and implications for care, Nature Reviews Cardiology, 6: 712-722.

649 Curtis, S., Copeland, A., Fagg, J., Congdon, P., Almog, M. Fitzpatrick, J. (2006) The ecological
650 relationship between deprivation, social isolation and rates of hospital admission for acute psychiatric
651 care: a comparison of London and New York City, Health & Place, 12: 19-37.

652 Exeter, D. J., Moss, L., Zhao, J., Kyle, C., Riddell, T., Jackson, R. and Wells, S. (2015) The distribution
653 and frequency of blood lipid testing by sociodemographic status among adults in Auckland, New
654 Zealand, Journal of Primary Health Care, 7 (3): 182-191.

655 Exeter, D.J., Boyle, P. and Norman, P. (2011) Deprivation (im)mobility and cause-specific premature
656 mortality in Scotland, Social Science & Medicine, 72: 389-397.

657 Findley, S. (1988) The Directionality and Age Selectivity of the Health-Migration Relation: Evidence
658 from Sequences of Disability and Mobility in the United States, International Migration Review, 22
659 (3): 4-29.

660 Glymour, M.M., Clark, C.R. and Patton, K.K. (2014) Socioeconomic determinants of cardiovascular
661 disease: recent findings and future directions, Current Epidemiology Reports, 1 (2): 89-97.

662 Green, M.A., Subramanian, S.V., Vickers, D. and Dorling, D. (2015) Internal migration, area effects
663 and health: Does where you move to impact upon your health? Social Science & Medicine, 136-137:
664 27-34.

665 Grey, C., Jackson, R., Wells, S., Marshall, R., Riddell, T. and Kerr, A.J. (2014) Twenty-eight day and
666 one-year case fatality after hospitalisation with an acute coronary syndrome: a nationwide data linkage
667 study, Australian and New Zealand Journal of Public Health, 38 (3): 216-220.

668 Grey, C., Wells, S., Riddell, T., Pylypchuk, R., Marshall, R., Drury, P., Elley, R., Ameratunga, S.,
669 Gentles, D., Erick-Peletiy, S., Bell, F., Kerr, A. and Jackson, R. (2010) A comparative analysis of
670 cardiovascular disease risk profiles of five Pacific ethnic groups assessed in New Zealand primary care
671 practice: PREDICT CVD-13, NZ Medical Journal, 123 (1325): 41-52.

672 Gupta, R., Deedwania, P.C., Sharma, K., Gupta, A., Guptha, S., Achari, V., Asirvatham, A.J., Bhansali,
673 A., Gupta, B., Gupta, S., Jali, M.V., Mahanta, T.G., Maheshwari, A., Saboo, B., Singh, J. and Gupta,
674 R. (2012) Association of educational, occupational and socioeconomic status with cardiovascular risk
675 factors in Asian Indians: A cross-sectional study, PLOS One, 7 (8): 1-10 (e44098).

676 Harris, R., Tobias, M., Jeffreys, J., Waldegrave, K., Karlsen, S. and NAzroo, J. (2006) Effects of self-
677 reported racial discrimination and deprivation on Maori health and inequalities in New Zealand: cross-
678 sectional study, The Lancet, 367 (9527): 2005-2009.

679 Houkamau, C.A. and Sibley, C.G. (2015) Looking Māori predicts decreased rates of home
680 ownership: Institutional racism in housing based on perceived appearance. PLoS One, 10 (3):
681 e0118540.

682 Jatrana, S. and Blakely, T. (2008) Ethnic inequalities in mortality among the elderly in New Zealand,
683 Australia and NZ Journal of Public Health, 32 (5): 437-443.

684 Jelleyman, T. and Spencer, N. (2008) Residential mobility in childhood and health outcomes: a
685 systematic review, Journal of Epidemiology and Community Health, 62: 584-592.

686 Kanjilal, S., Gregg, E.W., Cheng, Y.J., Zhang, P., Nelson, D.E., Mensah, G. and Beckles, G.L.A. (2006)
687 Socioeconomic status and trends in disparities in 4major risk factors for cardiovascular disease among
688 US adults, 1971-2002, Archives of International Medicine, 166: 2348-2355.

689 Kerr, A., Exeter, D., Hanham, G., Grey, C., Zhao, J., Riddell, T., Lee, M., Jackson, R. and Wells, S.
690 (2014) Effect of age, gender, ethnicity, socioeconomic status and region on dispensing of CVD
691 secondary prevention medication in New Zealand: the Atlas of Health Care Variation CVD cohort
692 (VIEW-1), NZ Medical Journal, 127 (1400): 39-69.

693 Kerr, A., J., McLachlan, A., Furness, S., Broad, J., Riddell, T., Jackson, R. and Wells, S. (2008) The
694 burden of modifiable cardiovascular risk factors in the coronary care unit by age, ethnicity, and
695 socioeconomic status--PREDICT CVD-9, NZ Medical Journal, 121 (1285): 20-33.

696 Larson, A., Bell, M. and Young, A.F. (2004) Clarifying the relationships between health and residential
697 mobility, Social Science & Medicine, 59: 2149-2160.

698 Maas, A. and Appelman, Y.E.A. (201) Gender differences in coronary heart disease, Netherlands Heart
699 Journal, 18 (12): 598-602.

700 Mackenbach, J.P., Cavelaars, A.E., Kunst, A.E. and Groenhof, F. (2000) Socioeconomic inequalities in
701 cardiovascular disease mortality; an international study, European Heart Journal, 21 (14): 1141-1151.

702 Mehta, S., Wells, S., Grey, C., Riddell, T., Kerr, A., Marshall, R., Ameratunga, S., Harrison, J., Kenealy,
703 T., Bramley, C., Chan, W.C., Thornley, S., Sundborn, G. and Jackson, R. (2014) Initiation and
704 maintenance of cardiovascular medications following cardiovascular risk assessment in a large primary
705 care cohort: PREDICT CVD-16, European Journal of Preventive Cardiology, 21 (2): 192-202.

706 Mehta, S., Wells, S., Riddell, T., Kerr, A., Pylypchuk, R., Marshall, R., Ameratunga, S., Chan, W.C.,
707 Thornley, S., Crengle, S., Harrison, J., Drury, P., Elley, C.R., Bell, F. and Jackson, R. (2011) Under-
708 utilisation of preventive medication in patients with cardiovascular diseases is greatest in younger age
709 groups (PREDICT-CVD 15), Journal of Primary Health Care, 3 (2): 93-101.

710 Mieres, J.H. (2005) Gender- and race-based differences in CVD, Journal of Family Practice,
711 Supplement 3.

712 Morris, T., Manley, D. and Sabel, C.E. (2016) Residential mobility: Towards progress in mobility health
713 research, Progress in Human Geography, 1-22.

714 Mosca, L., Barrett-Connor, E., Wenger, N.K. (2011) Sex/gender differences in cardiovascular disease
715 prevention: what a difference a decade makes, Circulation, 124 (19): 2145-2154.

716 Norman, P. (2010) Identifying change over time in small area socio-economic deprivation, Applied
717 Spatial Analysis and Policy 3(2-3) 107-138

718 Norman, P. & Darlington-Pollock, F. (2016) The Changing Geography of Deprivation in Great Britain:
719 Exploiting Small Area Census Data, 1971 to 2011. Chapter 30 in Stillwell, J & Duke-Williams O.
720 Unlocking the UK 2011 Census: Handbook of Census Resources, Methods and Applications.

721 Norman, P., Boyle, P. and Rees, P. (2005) Selective migration, health and deprivation: a longitudinal
722 analysis, Social Science & Medicine, 60 (12): 2755-2771.

723 Norman, P., Boyle, P., Exeter, D., Feng, Z. and Popham, F. (2011) Rising premature mortality in the
724 UK's persistently deprived areas: Only a Scottish phenomenon? Social Science & Medicine, 73: 1575-
725 1584.

726 Norredam, M., Hoejbjerg Hansen, O., Holm Pedersen, J., Byberg, S., Krasnik, A., Agyemang, C.,
727 Kunst, A.E. (2013) Exploring disease trajectories according to migrant status – does the 'healthy
728 migrant effect' last? The European Journal of Public Health 23 (1): 234.

729 Perumal, L., Wells, S., Ameratunga, S., Pylypchuk, R.D., Elley, C.R., Riddell, T., Kerr, A., Crengle,
730 S., Gentles, D. and Jackson, R. (2012) Markedly different clustering of CVD risk factors in New
731 Zealand Indian and European people but similar risk scores (PREDICT-14), Australia NZ Journal of
732 Public Health, 36 (2): 141-144.

733 Piro, F.N., Naess, O. and Claussen, B. (2007) Area deprivation and its association with health in a cross-
734 sectional study: are the results biased by recent migration? International Journal of Equity and Health
735 6 (10).

736 Riddell, T., Jackson, R. T., Wells, S., Broad, J. and Bannink, L. (2007) Assessing Māori/non-Māori
737 differences in cardiovascular disease risk and risk management in routine primary care practice using
738 web-based clinical decision support: (PREDICT CVD-2), NZ Medical Journal, 120 (1250): U2445.

739 Salmond C, Crampton P and Atkinson J (2007). NZDep2006 Index of Deprivation. Department of
740 Public Health, University of Otago, Wellington: Wellington.

741 Salmond, C.E. and Crampton, P. (2012) Development of New Zealand's deprivation index (NZDep)
742 and its uptake as a national policy tool, Canadian Journal of Public Health, 103 (8 Suppl 2): S7-11.

743 Sandiford, P., Bramley, D.M., El-Jack, S.S., Scott, A.G. (2015) Ethnic differences in coronary artery
744 revascularisation in New Zealand: does the inverse care law still apply? Heart, Lung and Circulation,
745 24: 969-974.

746 Scheppers, E., van Dongen, E., Dekker, J., Geertzen, J. and Dekker, J. (2008) Potential barriers to the
747 use of health services among ethnic minorities: a review. Family Practice—an international journal,
748 325-248.

749 Silventoinen, K., Hammar, N., Hedlund, E., Koskenvuo, M., Rönnemaa, T. and Kaprio, J. (2008).
750 Selective international migration by social position, health behaviour and personality, European
751 Journal of Public Health 18 (2): 150-155.

752 Singh, G.K., Siahpush, M.S., Azuine, R.E. and Williams, S.D. (2015) Widening socioeconomic and
753 racial disparities in cardiovascular disease mortality in the United States, 1969-2013, International
754 Journal of MCH and AIDs, 3 (2).

755 Statistics New Zealand (2015) Perceptions of housing quality in 2014/15, www.stats.govt.nz [last
756 accessed June 2016].

757 Statistics New Zealand (2016) Changes in home-ownership patterns 1986-2013: Focus on Māori and
758 Pacific people. Available at www.stats.govt.nz [last accessed June 2016].

759 Warfa, N., Bhui, K., Craig, T., Curtis, S., Mohamud, S., Stansfeld, S., McCrone, P. and
760 Thornicroft, G. (2006) Post-migration geographical mobility, mental health and health service
761 utilisation among Somali refugees in the UK: A qualitative study, Health & Place, 12: 503-
762 515.

763 Warin, B., Exeter, D.J., Zhao, J., Kenealy, T. and Wells, S. (2016) Geography matters: the prevalence
764 of diabetes in the Auckland Region by age, gender and ethnicity, New Zealand Medical Journal, 129
765 (1436).

766 Wells, S., Riddell, T., Kerr, A., Pylypchuk, R., Chelimo, C., Marshall, R., Exeter, D.J., Mehta, S.,
767 Harrison, J., Kyle, C., Grey, C., Metcalf, P., Warren, J., Kenealy, T., Drury, P.L., Harwood, M.,
768 Bramley, D., Gala, G. and Jackson, R. (2015) Cohort Profile: The PREDICT Cardiovascular Disease
769 Cohort in New Zealand Primary Care (PREDICT-CVD 19), International Journal of Epidemiology,
770 dyv312.

771 Zanchetta, M.S. and Poureslami, I.M. (####) Health literacy within the reality of immigrants culture
772 and language, Canadian Journal of Public Health, 97 (s2): S26-S30.

773