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Differences in the potential for dementia prevention between major ethnic groups within one country: A cross sectional analysis of population attributable fraction of potentially modifiable risk factors in New Zealand

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ABSTRACT

Background: Twelve potentially modifiable risk factors (less education, hypertension, obesity, alcohol, traumatic brain injury (TBI), hearing loss, smoking, depression, physical inactivity, social isolation, diabetes, air pollution) account for an estimated 40% of worldwide dementia cases. We aimed to calculate population attributable fractions (PAFs) for dementia for the four largest New Zealand ethnic groups (European, Māori, Asian, and Pacific peoples) to identify whether optimal dementia prevention targets differed by ethnicity.

Methods: We calculated risk factor prevalence for 10 risk factors using the New Zealand Health Survey 2018/19 and published reports for hearing loss and TBI prevalences. We calculated the PAF for each risk factor using calculated prevalence and relative risk estimates from previous meta-analyses. To account for risk factor overlap, we calculated communality of risk factors and a weighted PAF.

Findings: The weighted PAF for dementia was 47•7% overall in New Zealand, 47•6% for Europeans, 51•4% for Māori, 50•8% for Pacific peoples, and 40•8% for Asians. Highest PAFs for Europeans were hearing loss (8%) and social isolation (5•7%), and for Asians hearing loss (7•3%) and physical inactivity (5•5%). For Māori and Pacific peoples, highest PAFs were for obesity (7•3% and 8•9% respectively) and hearing loss (6•5% and 6•6%).

Interpretation: New Zealand has higher dementia prevention potential than worldwide estimates with high prevalences of untreated hearing loss and obesity. The relative contribution of individual risk factors PAFs varies by ethnic group. Public health strategies for dementia prevention need to be tailored to these differences.

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Introduction

Dementia, a syndrome defined as acquired decline from previously attained cognition which impairs daily functioning[1] affects not only the individual, but also their family who in general are the main carers, and is associated with significant health and social care costs.[2] As the New Zealand population ages, as in the rest of the world, the prevalence of dementia is projected to triple. In

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New Zealand, numbers are expected to increase from 70,000 in 2020 to 170,000 by the year 2050, with the total economic costs from direct health system costs and indirect economic costs (including carer support and informal care) projected to increase from $1•9 billion to $4•5 billion in that time, putting increased strain on health care resources.[3] In New Zealand, the non-European populations (Māori, Pacific peoples, and Asian) are all projected to comprise an increasing proportion of the 65+ population in the coming decades,[4] with a concomitant increase in the prevalence of dementia in these ethnic groups.

The 2017 Lancet Commission on dementia prevention, intervention, and care[5] specified nine potentially modifiable risk factors for dementia: smoking, depression, physical inactivity, social isolation, diabetes, obesity, hypertension, hearing loss and less education, with each factor carrying a relative risk (RR) of 1•4-1•9 in those who had it compared to those who did not. The authors estimated the worldwide population attributable fraction (PAF), defined as potential reduction in dementia prevalence if a particular risk factor was eliminated, using summary global estimates for risk factor prevalences.[6] They calculated these for each of the nine risk factors and, adjusting for the fact that individuals could have multiple risk factors, estimated 35% of dementia cases were potentially preventable. The 2020 Lancet Commission report found more and convincing evidence for and included three additional risk factors for dementia: traumatic brain injury (TBI), air pollution, and excess alcohol consumption and estimated 40% of dementias were potentially preventable worldwide if all 12 risk factors were completely eliminated.[7]

Many risk factors cluster around socio-economic deprivation which may occur particularly in minority ethnic groups and in vulnerable populations.[7] New Zealand is a bicultural country with a majority population of European descent (70•2%) and indigenous Māori population (16•5%) that also includes other sizeable minority populations, including Pacific peoples (8•1%) and Asian (15•1%), summing to >100% as individuals can identify with more than one ethnic group. Non-European populations in New Zealand have substantial socioeconomic deprivation compared to Europeans, to the extent that the country has been conceptualised as having low and middle income populations within a high income country.[8] While there is no data on the prevalence of dementia across different ethnicities in New Zealand, there is clear evidence that Māori and Pacific populations have poorer health outcomes than European, reflected in a shorter life expectancy and a disproportionate burden of illness. [9] There is also evidence of increased burden of dementia in non-European populations in some other countries. [10, 11] Socioeconomic deprivation is often cited as a contributory reason for these poorer health outcomes [12] but there is also compelling evidence of an association between experiences of racism and negative health outcomes. [13]

The figures used to estimate population attributable fractions in the Lancet commissions used worldwide data, and so most of the research was conducted in high income countries, and within them in mainly white populations.[5] In contrast, analysis of cross-sectional prevalence data for the original nine risk factors[5] from representative populations in China, India, and six Latin American countries, resulted in higher PAF calculations of 40%, 41% and 56% respectively, indicating a higher proportion of potentially preventable dementia if those risk factors were completely eliminated.[14] The study also demonstrated the influence of differences in risk factor prevalence on individual risk factor PAF calculations and their relative contribution to the total PAF when compared with worldwide estimates. This highlights the need for population specific PAF calculations to inform interventions with the greatest potential for risk reduction.

While it is thought that risks for dementia in differing ethnic groups in a single country population will vary,[5, 7] this has not been quantified, to our knowledge. The aim of this study is to calculate the total PAF for the 12 risk factors identified in the 2020 Lancet Commission report[7] using New Zealand-specific prevalence data for the total New Zealand population and for the four largest ethnic groups in New Zealand – Māori, Pacific peoples, Asian (includes South and East Asian peoples, the majority of whom are Chinese and Indian) and European. The findings regarding potential within-country differences in population dementia risk could inform tailored dementia risk reduction policies for different ethnic groups and the necessity for these considerations in other countries.

Methods

Ethics Approval

This study received ethics approval from the Auckland Health Research Ethics Committee (Ref:AH2974).

Patient population and data sources

We used data from the New Zealand Health Survey 2018/19 (NZHS 2018/19).[15] The survey includes data on 10 of the 12 risk factors identified in the Lancet Commission 2020 report but not for hearing loss or TBI.[7] It is a Ministry of Health (MoH) data collection tool used to monitor population health and inform health policy by collecting information including population health, health risk and protective factors, and health service usage. The target population of the NZHS is the New Zealand "usually resident population" of all ages, with approximately 99% of the population eligible to participate. It has a multi-stage, stratified, probability-proportional-to-size (PPS) sampling design, with a sample size of 13,572 people aged 15 years and older. For this study, we included all 7,745 NZHS 2018/19 participants aged 45 years and older. The survey selects participants from both an area-based sample and list-based electoral roll sample, designed to increase the sample sizes for Māori, Pacific peoples, and Asian ethnic groups.[15] Interviewers collect information on sociodemographics, long-term conditions, health status and development, health behaviours, health service utilisation and patient experience. Height, weight, waist circumference and blood pressure are directly measured. The NZHS has been carried out annually since 2011 and, due to its methodological rigour, is considered an accurate reflection and representation of the major ethnic subgroups in the New Zealand population. Prior to 2011, separate surveys were carried out for different health issues (for example smoking, alcohol, and nutrition)[16] but these have since been incorporated into the single survey. The NZHS is used by the Ministry of Health as the source of prevalence estimates for many health conditions.

Risk factor prevalence

We present definitions of each risk factor in Table 1. Each factor has consistent, biologically plausible, dose-related, longitudinal evidence from multiple studies as a risk factor for dementia.[5, 7] The justification for inclusion in the analyses and the calculation of their relative risks for dementia is described in more detail in the Lancet reports. [5, 7]

Education and Smoking

The two main sources of prevalence estimates for education and smoking are the NZHS and Census 2018 [17] with the NZHS 2018/19 estimates for both risk factors mirroring those of the census. We chose to use the NZHS 2018/19 as it allowed comparison by prioritised ethnicity to ensure the complete independence of groups.

Table 1
Definitions of risk factors for dementia

Risk factor	Definition
Less education	Self-reported highest education attained is less than upper secondary (Age < 15 years)
Hypertension	Systolic blood pressure ≥140mmHg
Obesity	Body Mass Index (BMI) ≥30Kg/m^2
Hearing loss	Difficulty hearing at a threshold of 20dB or greater
Smoking	Identifies as a current smoker
Depression	Self reports ever being diagnosed with depression by a doctor
Physical inactivity	Did not meet WHO physical activity guidelines for exercise of > 30 minutes a day for at least 5 days a week
Social isolation	Lives alone
Diabetes	Self reports ever being diagnosed with diabetes by a doctor
Alcohol	Consumes > 17 units of alcohol a week (1 unit = 10g pure alcohol)
Air Pollution	Urban residence (living in an area with >10,000 population)
Traumatic Brain Injury (TBI)	WHO definition of TBI[29]

Obesity and Hypertension

The NZHS 2018/19 prevalence estimates of obesity and hypertension are considered the best estimate as these are based on objective anthropometric measurements.

Diabetes

The NZHS estimates of diabetes prevalence based on are similar to that of the national virtual diabetes register, the currently considered gold standard of diabetes prevalence based on laboratory findings of an elevated HbA1c or prescription of diabetes medication.[15] As with education and smoking, due to the similar prevalence estimates we chose to use the NZHS estimates as it allowed comparison by prioritised ethnicity.

Air pollution

While New Zealand has low levels of air pollution compared with other OECD countries, [18] there is evidence of an association between air pollution and adverse health outcomes in the country. [19] There are no studies comparing air pollution in urban and rural settings in New Zealand. However, a 2019 report by the National Institute of Water and Atmospheric Research (NIWA) [20] modelled $PM_{2.5}$ levels throughout the country and demonstrated an association between annual mean $PM_{2.5}$ concentrations and population. Towns with a population of <10,000 had an annual mean $PM_{2.5}$ concentration of 6.2μg/m^3 compared with 8.25μg/m^3 for populations ≥10,000. Ministry for the Environment data also shows an association between annual mean PM_{10} concentrations and population size, with towns and cities having a higher mean concentration compared to more rural areas. [21] We therefore defined urbanicity as living in a town with a population ≥10,000 and used this as a proxy for air pollution.

Alcohol

The NZHS is considered the best prevalence estimates for alcohol consumption and is the source used by Te Hiringa Hauora, the national health promotion agency. [22] The NZHS provides information on alcohol use frequency and the range of number of units consumed at a time, allowing the calculation of the range of standard units consumed by an individual in a typical week. We used the mid-point of the range of values an individual reported to calculate number of units consumed per week. A standard unit of alcohol in New Zealand contains more alcohol than a UK standard unit (10 grams vs 8 grams), so a cut-off of 17 units per week was used to approximate to the 21 unit/week recommendation in the UK.

Social isolation

In line with the 2017 Lancet Commission report,[5, 23] and additional systematic review evidence,[23] cohabitation was used as a proxy for social isolation, with the assumption that those who live alone have less social contact than those who live with others.

Hearing loss

There are three sources of recent prevalence data for hearing loss in New Zealand. A report on the social and economic costs of hearing loss in New Zealand[24] used data from a meta-analysis of international audiometry studies to estimate the NZ prevalence of mild (20-34dB), moderate (35-64dB), and severe hearing loss (>65dB).[25]. We used this prevalence estimate in our calculations as it was the only study to use objective audiometric findings and many of the studies included in the meta-analysis were from high income countries, similar to New Zealand. The other studies used self-reported hearing loss.[26, 27] However, self-reported hearing loss is often inaccurate with false positive and negative findings described in the literature.[28]

TBI

Prevalence data on TBI in New Zealand used estimates from the Brain Injury Outcomes New Zealand in the Community (BIONIC) study group based on a large New Zealand prospective population based register, and is the best estimate of TBI prevalence available for New Zealand.[29] The prevalence data for both hearing loss and TBI were presented by 5 year age bands but did not disaggregate data by ethnicity. For these two risk factors, prevalence was estimated using each ethnicity's population age distribution.

Exercise

As with many of the other risk factors, the NZHS estimate of physical activity is considered an accurate representation of the population. Sport NZ, the government agency to promote and improve physical activity through sport and recreation, also carries out the Active NZ survey, [30] last done in 2019, to measure participation in sport and physical activity. The findings of the survey for levels of activity mirror those of the NZHS so we chose to use the NZHS as it allowed comparisons by prioritised ethnicity.

Depression

New Zealand's only national mental health survey, Te Rau Hinengaro: The New Zealand Mental Health Survey[31] was carried out in 2003/04 and employed similar multistage area probability sampling of the New Zealand population to the NZHS to estimate

Table 2
Population attributable fraction (PAF) calculations for the whole New Zealand population

	Relative Risk	Prevalence (%)	Communality	PAF (%)	Adjusted PAF (%)
Early Life (<45 years)					
Less education	1•6	31•0	0•49	15•7	4•6
Midlife (age 45-65 years)					
Hypertension	1•6	33•5	0•61	16•7	4•9
Obesity	1•6	38•4	0•70	18•7	5•5
Alcohol	1•2	9•8	0•74	1•9	0•6
TBI	1•8	18•2	0•63	12•7	3•7
Hearing loss	1•9	39•9	0•63	26•4	7•8
Later life (age >65 years)					
Smoking	1•6	13•5	0•65	7•5	2•2
Depression	1•9	19•1	0•65	14•7	4•3
Physical inactivity	1•4	53•6	0•44	17•6	5•2
Social isolation	1•6	37•3	0•67	18•3	5•4
Diabetes	1•5	11•6	0•59	5•5	1•6
Air pollution	1•1	71•7	0•81	6•7	1•9
Total adjusted PAF					47•7

12 month and lifetime prevalence of mental disorders (including depression) using the World Mental Health (WMH) Survey Initiative version of the Composite International Diagnostic Interview (WMH-CIDI). Lifetime prevalence of major depressive disorder was estimated in the total New Zealand, Maori, and Pacific populations but did not disaggregate by any other ethnicities and published data or allow not disaggregated by both age and ethnicity. Questions exploring depression have since been incorporated in to the NZHS and we chose to use NZHS 2018/19 due to it being more recent and allowing comparison across the four ethnic groups.

Ethnicity

New Zealand is a multicultural country and individuals can identify with multiple ethnic groups so to ensure fully independent groups, prioritised ethnicity as defined by the Ministry of Health was used for the 10 NZHS 2018/19 risk factors. This means each person is allocated to one ethnic group based on the groups they identify with, in the prioritised order of Māori, Pacific peoples, Asian, European/Other. [32]

Statistical Analysis

The risk factors for dementia are associated with their presence from mid-life onwards (except childhood education which does not change in adulthood) so we calculated prevalence of each risk factor for those aged 45 years and older for the 10 risk factors available in the NZHS 2018/19 NZ population and by prioritised ethnicity for Māori, Pacific peoples, Asian, and European ethnicities.

We used the same relative risks (RR) as those reported in the Lancet Commission 2020 report to allow comparison of findings.[7] We calculated an unadjusted PAF for the total New Zealand population using the formula

$$PAF = \frac{Pe(RRe - 1)}{1 + Pe(RRe - 1)}$$

where Pe is the prevalence of the exposure and RRe the relative risk of disease because of that exposure•

We then calculated it for each of the main ethnic groups – European, Māori, Pacific peoples, and Asian. To account for an individual having multiple risk factors that often overlap and cluster, we calculated communality of risk factors, as described in the Lancet Reports and then weighted PAF.[5, 7] Communality calculates the extent of the shared variance between risk factors and allows for the calculation of an adjusted PAF, weighted by each factors' unique risk contribution. We followed the standard method for the calculation of PAF and communality (appendix 1) for the 10 risk factors available in one database, the NZHS 2018/19, for the total NZ population aged >45 years. When calculating communality, we dealt with incomplete data by case-wise deletion as the number of missing data points was low for all risk factors (<1%) except hypertension and obesity which had 7•4% and 7•5% data points missing respectively. We used the mean of the 10 communality calculations as the estimated communality for hearing loss and TBI, in line with previous analyses as there is no dataset containing all 12 risk factors.[7] These calculations were used as the communality for all subgroup analyses by ethnic groups.

We carried out two sensitivity analyses. The first used alternate prevalence estimates for hearing loss from the self-reported prevalence papers to assess the effect of the wide range of prevalences reported. [24, 26, 27] As people in population surveys tend to underreport alcohol use by 40-50%,[33] our second sensitivity analysis repeated PAF calculations using prevalence based on the upper estimate in each category for alcohol consumption frequency and volume .

Role of the funding source

The funders had no role in study design, data collection, data analysis, interpretation, or writing of the report

Results

There were participant data for 7,745 individuals aged 45 years and older in the NZHS 2018/19. For calculations using prioritised ethnicity, there were 5,449 NZ European (70•4%), 1,286 Māori (16•6%), 266 Pacific peoples (3•4%), and 466 individuals of Asian ethnicity (6•0%). The group comprising the 278 (3.4%) of Middle Eatern/Latin American/African (MELAA) or other ethnicity were not further analysed. The median age for the total sample was 63 years (range 45-90 years; Inter-quartile range; IQR 53-72 years), with Māori (59 years), Pacific peoples (59 years) and Asian (56 years) being younger compared to European (65 years). There was a female preponderance for the total sample (58%) as well as for European (57•4%), Asian (57•5%), Pacific peoples (58•7%) and Māori (63•5%) participants.

Risk factor prevalence, communality and weighted PAFs for the total NZ population are presented in Table 2. After case-wise deletion of 909 individuals missing at least one risk factor, communality was calculated using data for 6,836 individuals. We found five principal components explained 63•5% of the variance, suggesting significant overlap. Communality of risk factors ranged from 44% for physical inactivity to 81% for air pollution.

The proportion of dementia cases in the New Zealand population that were theoretically preventable if all 12 dementia risk

Table 3
Population attributable fraction (PAF) calculations for Māori, Pacific, Asian and European ethnic groups living in New Zealand

	Māori		Pacific		Asian		European	
	Prevalence	Adjusted PAF(%)	Prevalence	Adjusted PAF(%)	Prevalence	Adjusted PAF(%)	Prevalence	Adjusted PAF(%)
Early Life (<45 years)								
Less education	40•6	5•6	43•4	6•0	22•5	3•8	30•2	4•5
Midlife (age 45-65 years)								
Hypertension	35•7	5•0	38•9	5•5	30•3	4•9	33•5	4•9
Obesity	57•6	7•3	74•0	8•9	16•6	2•9	36•3	5•3
Alcohol	12•6	0•7	5•3	0•3	4•5	0•3	10•3	0•6
TBI	17•8	3•5	17•8	3•6	17•8	3•9	18•3	3•7
Hearing loss	33•2	6•5	32•9	6•6	33•7	7•3	41•7	8•0
Later life (age >65 years)								
Smoking	29•6	4•3	17•7	2•8	5•8	1•1	11•7	1•9
Depression	19•0	4•2	8•4	2•0	9•9	2•6	21•0	4•7
Physical inactivity	53•6	5•0	59•9	5•6	52•8	5•5	53•5	5•2
Social isolation	36•6	5•1	19•6	3•0	18•2	3•1	40•4	5•7
Diabetes	18•2	2•4	32•3	4•1	19•6	2•8	8•6	1•2
Air pollution	67•7	1•8	91•0	2•4	92•7	2•6	69•9	1•9
Total adjusted PAF		51•4		50•8		40•8		47•6

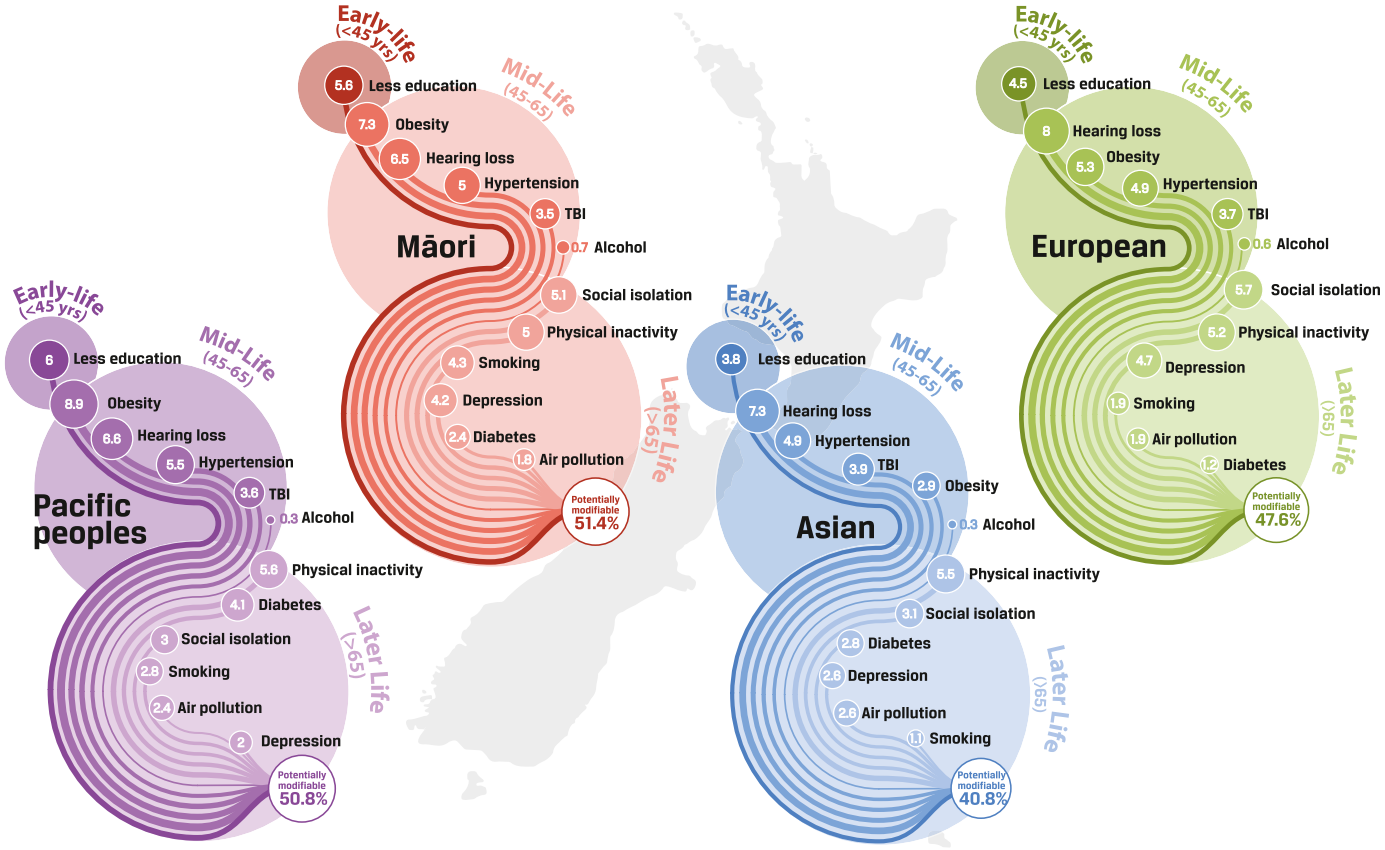

Figure 1. Relative PAF contributions of each risk factor across four ethnic groups in New Zealand

factors were eliminated was 47•7%. PAF calculations by prioritised ethnicity for each of the ethnic groups are presented in Table 3 and were 40•8% for Asian, 47•6% for Europeans, 50•8% for Pacific peoples, and 51•4% for Māori (Table 3).

In the overall New Zealand population, hearing loss (7•8%), obesity (5•5%) and social isolation (5•4%) were the risk factors with the highest PAF. For Māori and Pacific peoples, obesity (7•3% and 8•9% respectively), hearing loss (6•5% and 6•6%) and education (5•6% and 6•0%) were the largest contributors to PAF. The top three risk factors for Europeans were hearing loss (8•0%), social isolation (5•7%) and obesity (5•3%), while for Asians the factors with the highest PAF were hearing loss (7•3%), physical inactivity (5•5%) and hypertension (4•9%). These relative contributions to dementia risk are shown for each ethnic group in Figure 1.

Sensitivity analyses

Using the lower subjective estimates of hearing loss prevalence (13•6-15•5% across all four ethnic groups vs 32•9-41•7%)[26] resulted in a lower weighted PAF for hearing loss for the New Zealand population and all ethnic groups (3•2-3•7% vs 6•5-8%) and a lower range of total PAF calculations (37•8-49•0% vs 40•8-51•4%). Using the higher prevalence estimates for alcohol (7•1-31•1% vs 5•3-12•6%) resulted in a small increase in the PAF for alcohol (0•5-1•7%

vs 0•3-0•7%) and total PAF (40•8-51•9% vs 40•8-51•4%) across the different ethnic groups.

Discussion

To our knowledge, this is the first study to investigate the population attributable fraction of 12 known risk factors for dementia between different ethnic groups in New Zealand. The overall PAF of 47•7% for the New Zealand population is higher than the global estimate of 40%[7] incorporating the same risk factors. The estimated PAF for Māori (51•4%) and Pacific peoples (50•8%) were higher than for the NZ population, while those of Asian ethnicity (40•8%), who are mainly of Chinese (35%) and Indian (33•8%) origin, were lower than for the total New Zealand population. This is in line with US population estimates of lower dementia incidence in East Asian populations in US.[34] There are no comparable data for South Asians as a minority population although the estimate in India using nine risk factors was similar at 41%.[14]

Compared to global figures, New Zealand has a higher prevalence of all but three risk factors: education, smoking, and air pollution. Some risk factor prevalence estimates for the New Zealand population were multiple times higher than global figures such as obesity (11 times higher), hypertension (3•8 times) and physical inactivity (3 times). The relative contributions of each risk factor differed by ethnicity. For the total New Zealand population and for New Zealand Europeans, the three risk factors with the highest PAF were hearing loss, social isolation and obesity. For Māori and Pacific peoples obesity was the largest factor, followed by hearing loss and education, while the factors with the highest PAF for those of Asian ethnicity were hearing loss, physical inactivity and hypertension. New Zealand ranks third among OECD countries for obesity, contributed to by an increasingly obesogenic environment resulting in changes in dietary and physical activity patterns over the years. [35] The higher prevalence of obesity in Māori and Pacific peoples is unlikely to be due to genetic variations [36] but rather reflect their overrepresentation in socioeconomically disadvantaged areas more susceptible to obesogenic influences. [35, 37] Obesity and the obesogenic environment also contribute to the higher prevalence of risk factors such as hypertension and diabetes.[35, 36]

The estimation of PAF relies on accurate prevalence data. The NZHS 2018/19 is a methodologically rigorous tool designed to accurately survey a representative sample of the population. Furthermore, it allowed prevalence estimates by prioritised ethnicity, allowing for PAF calculations across independent groups. The anthropometric measurements used for hypertension and obesity were objectively measured and the prevalence estimates for many risk factors match other population based surveys, indicating validity. While all datasets are limited by missing data the NZHS 2018/19 has a low proportion of missing data (<1%) for eight of the 10 risk factors in the dataset. Missing data for hypertension (7.4%) and obesity (7.5%) may affect the prevalence estimates for these two risk factors and this limitation is acknowledged."

The NZHS 2018/19 likely underestimates the prevalence of depression in Asian and Pacific peoples as the question asked in the survey was specifically about being diagnosed with depression by a doctor and there is evidence of ethnic disparities in self-reported diagnosis of depression by a doctor relative to their scores on screening measures for depression.[38] This may have resulted in an underestimation of the true prevalence of depression in these groups and therefore a lower estimated PAF for dementia. Using the mid-range estimate for alcohol consumption may have resulted in a conservative estimate of the PAF for alcohol as research has shown individuals can underreport alcohol consumption by up to 50%.[33] However, calculations using the upper estimate of consumption only resulted in a small increase in the PAF for alcohol and overall PAF.

Interactions between concurrent risk factors in individuals can also influence dementia prevalence. Adjusting PAF calculations to account for the shared variance between risk factors may have resulted in a lower PAF estimation for those factors with a tendency to cluster in individuals, such those associated with cardiovascular risk. The estimates of relative risk used to calculate PAF are based on worldwide studies associated with each specific risk factor. There may be no ethnic difference in risk factor association with dementia per se but the literature to date does not include the influence of ethnicity on relative risk for dementia.

TBI and hearing loss were not asked as part of the NZHS, so their communality with other risk factors could not be measured directly and alternate sources of prevalence estimates were required. The BIONIC data on TBI is from a large prospective cohort study of TBI incidence in New Zealand and is robust but not disaggregated by ethnicity.[29] The prevalence estimates on hearing loss in New Zealand vary depending on how hearing was assessed and what cut-offs were used. The two surveys asking a single question to assess for the presence of subjective hearing loss reported a prevalence for the total New Zealand population of 15•2% and 17% respectively. [26, 27] Using international audiometry data, and a cut-off of 20dB, the National Foundation for the Deaf report on the Social and economic costs of hearing loss in New Zealand reported a higher prevalence estimate of 46•8% for hearing loss.[24] The sensitivity analysis shows that there would have been differences in PAF using the former studies but subjective hearing loss consistently underreports hearing loss and includes false positives and we therefore judge that these figures are less accurate [28]. Neither of these studies of hearing loss were disaggregated by ethnicity but there is evidence that younger Māori have greater rates of hearing loss so the prevalence estimates for Māori may be higher than we have used in our calculations.[39]

No direct measures were available for exposure to air pollution or social isolation so proxy measures were used for both risk factors. The correlation between urban living and air pollution, as well as the association between increased dementia incidence and living in close proximity to heavy traffic routes suggests urbanicity is a reasonable proxy for exposure to air pollution. [40] However, the limitations of urbanicity as a proxy for air pollution is acknowledged as some may live in low pollution areas. In addition, there is a likely correlation of urban living and population size with other factors associated with dementia such as access to health care. The use of cohabitation as a proxy for social isolation is acknowledged as a limitation as it assumes that those who live alone have less social contact, although the increased risk of dementia in lifelong singles compared to married people suggests this is reasonable.[23] There is no consensus on what defines social contact and there is evidence that living alone confers an increased dementia risk.[41]

While complete elimination of risk factors will not happen, any reduction in risk factors should delay, or even prevent, dementia onset, thereby reducing overall prevalence and this probably accounts for reductions in population prevalence estimates over the last two decades.[42] It is possible that risk factor reduction may lead to increased longevity which, in turn, may increase the number of people living with dementia due to the association between increasing age and dementia. This impact of longevity on numbers of people with dementia prevalence is not accounted for by the PAF calculations, so it is possible the reduction in dementia prevalence due to complete risk factor elimination is overestimated or possibly even reversed. It is also possible that those who live longer due to tackling the risk factors are less likely to develop dementia so the age related prevalence is decreased. The reduction in overall dementia incidence in many countries over the past few decades has occurred despite the increased risk associated with the concurrent ageing of the population during this time.[43]

In line with the theory of risks causing dementia, the reported reduction in the incidence and prevalence of dementia in many high income countries is attributed to the reducing prevalence of risk factors associated with dementia such as low education, smoking, lack of exercise and hypertension. [42, 44] Conversely, low and middle income countries (LMICs), such as those in Latin America, carry a heavier risk factor burden[14] and this is associated with a higher dementia prevalence. Although New Zealand is considered a high income country, our study suggests the prevalence of many of the risk factors, particularly in Māori and Pacific peoples, are similar to, or even exceed, those of some LMICs. There has never been a national dementia prevalence study in New Zealand and current estimates are extrapolated from other countries' data.[3, 45] Our findings raise the question of whether the 2015 World Alzheimer report prevalence estimate of 6•9% for dementia in those aged >60 years in Australasia,[46] upon which the current New Zealand prevalence estimates are based,[3] is an underestimate. The prevalence of dementia in people aged >60 years in New Zealand may in fact be closer to the 8•3% estimate for Latin America which also has a higher prevalence of many risk factors when compared to global estimates.[46]

In line with findings from the Lancet Commission reports,[5, 7] hearing loss contributed a significant PAF for dementia in New Zealand, and was important across all ethnicities. The cost of hearing aids is high in New Zealand and many cannot afford them.[24] This might be a relatively simple but cost-effective intervention for New Zealand that may result in the more equitable reduction of dementia risk across all major ethnic groups living in New Zealand. Indeed, a recent cost modelling study in the UK[47] demonstrated not only a reduction in dementia prevalence and quality adjusted life year gains for the individual associated with the provision of hearing aids but also a net cost saving to the care system.

The relatively small contribution of diabetes (1•6%) and smoking (2•2%) to total PAF in the overall New Zealand population, when compared with other risk factors, suggests they would not be the targets of choice if dementia prevention was the primary aim. However, smoking has a higher PAF in Māori (4•3%), and diabetes a higher PAF in Pacific peoples (4•1%), suggesting these risk factors may be more important for dementia prevention if targeted to these ethnic groups. These findings are important because Europeans account for 78•8% of the New Zealand population aged >45 years,[4] so PAF calculations for the whole population will inevitably reflect their risk profile. If packages of risk reduction are to be effective as well as acceptable they need to be tailored to each ethnic group and delivered in a culturally appropriate way.[48]

This study identifies the high risk factor burden associated with dementia prevalence in New Zealand and across the four largest ethnic groups. It suggests almost half of dementia cases in New Zealand are potentially preventable if the 12 identified risk factors are completely eliminated. While the risk factors with the highest associated PAF were similar between Māori and Pacific peoples, they were not the same as those for Europeans and Asians, indicating the need for targeted dementia prevention interventions.

Our calculations highlight the risk factors to target within each ethnic group to achieve the greatest reduction in dementia prevalence. The relative contribution of individual risk factors to dementia varies by ethnic group in New Zealand so any public health strategies need to be tailored to ethnic groups to maximise the benefit from interventions.

Research in context

Evidence before this study

The 2020 Lancet Commission on dementia prevention, intervention and care considered 12 potentially modifiable risk factors for dementia, (less education, hypertension, obesity, alcohol, traumatic brain injury (TBI), hearing loss, smoking, depression, physical inactivity, social isolation, diabetes, and air pollution). The population attributable fraction (PAF) is the potential reduction in dementia prevalence if a particular risk factor was eliminated. The commission found, using global figures of prevalence estimates and relative risk from meta-analyses that the total weighted PAF for these factors, taking into account that people frequently have overlapping risks, was 40% of dementia cases worldwide. PAF estimates vary between countries as prevalence of risk factors differ; for example, they have been found to be higher in India, China and Latin America than worldwide. We searched PubMed from inception to 4 January 2021 for studies investigating dementia prevention in New Zealand using the search terms "dementia", "prevention" and "New Zealand" with no limits on language or date of publication. We found no papers on overall dementia risk but there were papers investigating individual risk factors for dementia.

Added value of this study

To the best of our knowledge this is the first study to investigate the individual and overall population attributable fraction of potentially preventable risk factors for dementia in people from different ethnic groups living within one country. This paper reports the weighted PAF for the four main ethnic groups in New Zealand: Māori, and those of European, Asian or Pacific ethnicity. The prevalence of many risk factors for dementia varies between ethnic groups in New Zealand with estimated weighted PAF for the whole New Zealand population (47•7%), European (47•6%), Māori (51•4%), Pacific peoples (50•8%), and Asian (40•8%) all higher than the worldwide estimates. The relative contribution of individual risk factors also differs among different ethnicities. Hearing loss is the risk factor with the highest PAF for European and Asian ethnicities, and obesity the highest PAF for Māori and Pacific peoples. Risk factors with large contributions to risk are social isolation for Europeans, hearing loss and lower education levels for Māori and Pacific peoples, and physical inactivity for Asians.

Implications of all the available evidence

The PAF percentage of these 12 potentially modifiable risk factors for dementia in New Zealand, and in each of the four main ethnic groups, is higher than the worldwide estimates, indicating high prevention potential. It also demonstrates that within the one country, overall risk for dementia and the relative contribution of individual risk factors may vary greatly among ethnic groups. This suggests that interventions to prevent dementia should be tailored according to the most relevant risks within each ethnic group.

Contributors

EM, GC and SC conceptualised and all authors designed the study. EM conducted the literature search, the calculations and wrote the first draft of the manuscript. All authors commented on and edited the manuscript.

Declaration of interests

We declare no competing interests.

Declaration of Competing Interest

The authors declare no conflict of interest.

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Data sharing

The New Zealand Health Survey (NZHS) is overseen by the Ministry of Health with the questionnaires/content guide and methodology reports available at https://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/surveys/new-zealand-health-survey. Access to the New Zealand Health Survey 2018/19 microdata used in this paper can be requested from Statistics New Zealand at https://www.stats.govt.nz/integrated-data/apply-to-use-microdata-for-research/confidentialised-unit-record-files-curfs/. The data is made available as confidentialised unit record files (CURFs). CURFs have had all identifying information about individuals removed, and have been modified to protect individual information. The CURFs are accompanied by a data dictionary.

Appendix 1: Standard method for the calculation of population attributable fractions and communality 14

Formula for individual population attributable fraction

Population attributable fraction (PAF)=Pe(RRe − 1) / (1 + Pe[RRe − 1]), in which Pe is the prevalence of the exposure and RRe the relative risk of disease because of that exposure•

Calculation of communality

We input data for all risk factors into our model and calculated the tetrachoric correlation to generate correlation coefficients and a correlation matrix. This calculation establishes the correlation between unobserved and latent variables and observed dichotomous variables.

We conducted a principal component analysis on the correlation matrix to generate eigenvectors, which are directions mapped onto the datapoints from which variance to the data is measured. These eigenvectors represent unobserved factors underlying all the variables that explain the variance observed.

We retained components with eigenvalues of at least 1 in the model, as is standard practice, so that only eigenvectors that hold the most information about the data distribution are retained.

We calculated communality as the sum of the square of all factor loadings (i.e., how much each unobserved component explained each measured variable).

Calculation of overall PAF

We then calculated overall PAF:

PAF=1 − [(1 − PAF1)(1 − PAF2)(1 − PAF3)...]

Each individual risk factor's PAF was weighted according to its communality using the formula:

Weight (w)=1 − communality

Weighting was included in the calculation of the adjusted total PAF using the formula:

Total PAF(adjusted) =1 − [(1 − w*PAF1)(1 − w*PAF2)(1 − w*PAF3)...]

Individual adjusted PAF was then calculated using the formula:

$$\text{Individual adjusted PAF} = \frac{(\text{Individual PAF})}{\sum(\text{Individual PAF})} \text{ X } (\text{TotalPAF(adjusted)})$$

References

[1] World Health Organisation ICD-10: international statistical classification of diseases and related health problems: tenth revision. World Health Organization; 2004. 2nd ed.
[2] Paterson C. World Alzheimer Report 2018. The state of the art of dementia research: New frontiers, London: Alzheimer's Disease International; 2018. 2018.
[3] Deloitte Access EconomicsDementia Economic Impact Report 2016. Wellington: Alzheimers New Zealand 2017.
[4] Statistics New Zealand. National ethnic projections, by age and sex, 2013(base)-2038.[Available from: http://nzdotstat.stats.govt.nz/wbos/index.aspx?_ga=2.167222078.1858078526.1608157184-728299346.1606357223&_gac=1.22450889.1606687761.Cj0KCQiAqo3-BRDoARIsAE5vnaL7FJn_Jq9u72ZOMDO8kaY5pZQypuLyqOrWuq6_b3JPzegg5ir2inAaAmFDEALw_wcB.
[5] Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. Lancet 2017;390(10113):2673–734.
[6] Barnes DE, Yaffe K. The projected effect of risk factor reduction on Alzheimer's disease prevalence. Lancet Neurol 2011;10(9):819–28.
[7] Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet. 2020;396(10248):413–46.
[8] Milne RJ, Lennon DR, Stewart JM, Vander Hoorn S, Scuffham PA. Incidence of acute rheumatic fever in New Zealand children and youth. J Paediatr Child Health 2012;48(8):685–91.
[9] Ministry of Health Health and Independence Report: The Director-General of Health's Annual Report on the State of Public Health, Wellington: Ministry of Health; 2017. 2018.
[10] Adelman S, Blanchard M, Rait G, Leavey G, Livingston G. Prevalence of dementia in African-Caribbean compared with UK-born White older people: two-stage cross-sectional study. Br J Psychiatry 2011;199(2):119–25.
[11] Lee HB, Richardson AK, Black BS, Shore AD, Kasper JD, Rabins PV. Race and cognitive decline among community-dwelling elders with mild cognitive impairment: findings from the Memory and Medical Care Study. Aging Ment Health 2012;16(3):372–7.
[12] Yaffe K, Falvey C, Harris TB, Newman A, Satterfield S, Koster A, et al. Effect of socioeconomic disparities on incidence of dementia among biracial older adults: prospective study. BMJ 2013;347:f7051.
[13] Harris RB, Stanley J, Cormack DM. Racism and health in New Zealand: Prevalence over time and associations between recent experience of racism and health and wellbeing measures using national survey data. PLoS One 2018;13(5):e0196476.
[14] Mukadam N, Sommerlad A, Huntley J, Livingston G. Population attributable fractions for risk factors for dementia in low-income and middle-income countries: an analysis using cross-sectional survey data. Lancet Glob Health 2019;7(5):e596–603.
[15] Ministry of Health Methodology Report 2018/19: New Zealand Heath Survey. Wellington: Ministry of Health; 2019.
[16] Ministry of Health. Surveys [Available from: https://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/surveys. 2021.
[17] Statistics New Zealand 2018 Census. Statistics New Zealand; 2018. [Available from:https://www.stats.govt.nz/2018-census/.
[18] OECD. Exposure to PM2.5 in countries and regions [Available from: https://stats.oecd.org/viewhtml.aspx?datasetcode=EXP_PM2_5&lang=en#.
[19] Richardson EA, Pearce J, Kingham S. Is particulate air pollution associated with health and health inequalities in New Zealand? Health Place 2011;17(5):1137–43.
[20] NIWA PM2.5 in New Zealand. Modelling the current (2018) levels of fine particulate air pollution. Wellington: NIWA; 2019.
[21] Ministry for the Environment. National PM10 concentrations 2006-13 [Available from: https://data.mfe.govt.nz/search/?q=pm10.
[22] Te Hiringa Hauora. Where to find alcohol statistics [Available from: https://www.alcohol.org.nz/resources-research/facts-and-statistics/where-to-find-other-alcohol-statistics.
[23] Sommerlad A, Ruegger J, Singh-Manoux A, Lewis G, Livingston G. Marriage and risk of dementia: systematic review and meta-analysis of observational studies. J Neurol Neurosurg Psychiatry 2018;89(3):231–8.
[24] Deloitte Access Economics. Social and economic costs of hearing loss in New Zealand. Wellington: The National Foundation for the Deaf; 2016.
[25] Stevens G, Flaxman S, Brunskill E, Mascarenhas M, Mathers CD, Finucane M, et al. Global and regional hearing impairment prevalence: an analysis of 42 studies in 29 countries. Eur J Public Health 2013;23(1):146–52.
[26] Exeter DJ, Wu B, Lee AC, Searchfield GD. The projected burden of hearing loss in New Zealand (2011-2061) and the implications for the hearing health workforce. N Z Med J 1419;128:12–21 2015.
[27] Statistics New Zealand The 2013 New Zealand Disability Survey, Wellington: Statistics New Zealand; 2013. https://www.stats.govt.nz/information-releases/disability-survey-2013.
[28] Wilson DH, Walsh PG, Sanchez L, Davis AC, Taylor AW, Tucker G, et al. The epidemiology of hearing impairment in an Australian adult population. Int J Epidemiol 1999;28(2):247–52.
[29] Te Ao B, Tobias M, Ameratunga S, McPherson K, Theadom A, Dowell A, et al. Burden of Traumatic Brain Injury in New Zealand: Incidence, Prevalence and Disability-Adjusted Life Years. Neuroepidemiology 2015;44(4):255–61.
[30] Sport NZ Active NZ 2019 participation report, Wellington: Sport NZ; 2020. [Available from:https://sportnz.org.nz/resources/active-nz-survey-2019/.

[31] Oakley Browne MA, Wells JE, Scott KM, McGee MA. New Zealand Mental Health Survey Research T. Lifetime prevalence and projected lifetime risk of DSM-IV disorders in Te Rau Hinengaro: the New Zealand Mental Health Survey. Aust N Z J Psychiatry 2006;40(10):865–74.
[32] Ministry of Health HISO 10001:2017 Ethnicity Data Protocols.. Wellington: Ministry of Health; 2017.
[33] Livingston M, Callinan S. Underreporting in alcohol surveys: whose drinking is underestimated? J Stud Alcohol Drugs 2015;76(1):158–64.
[34] Mayeda ER, Glymour MM, Quesenberry CP, Whitmer RA. Inequalities in dementia incidence between six racial and ethnic groups over 14 years. Alzheimers Dement 2016;12(3):216–24.
[35] Ministry of Health Tracking the obesity epidemic: New Zealand 1977-2003. Wellington: Ministry of Health; 2004.
[36] Gosling AL, Buckley HR, Matisoo-Smith E, Merriman TR. Pacific Populations, Metabolic Disease and 'Just-So Stories': A Critique of the 'Thrifty Genotype' Hypothesis in Oceania. Ann Hum Genet 2015;79(6):470–80.
[37] Ministry of Health Annual Update of Key Results 2019/20: New Zealand Health Survey 2020. New Zealand Health Survey; 2020. [Available from: https://www.health.govt.nz/publication/annual-update-key-results-2019-20-new-zealand-health-survey.
[38] Lee CH, Duck IM, Sibley CG. Ethnic inequality in diagnosis with depression and anxiety disorders. N Z Med J 2017;130(1454):10–20.
[39] Digby JE PS, Kelly AS. Deafness Notification Report. Hearing loss (not remediable by grommets) in New Zealanders under the age of 19, New Zealand: Enable New Zealand Auckland; 2018. 2019.
[40] Chen H, Kwong JC, Copes R, Hystad P, van Donkelaar A, Tu K, et al. Exposure to ambient air pollution and the incidence of dementia: A population-based cohort study. Environ Int 2017;108:271–7.
[41] Desai R, John A, Stott J, Charlesworth G. Living alone and risk of dementia: A systematic review and meta-analysis. Ageing Res Rev 2020;62:101122.
[42] Prince M, Ali G-C, Guerchet M, Prina AM, Albanese E, Wu Y-T. Recent global trends in the prevalence and incidence of dementia, and survival with dementia. Alzheimer's Research & Therapy 2016;8(1):23.
[43] Matthews FE, Stephan BC, Robinson L, Jagger C, Barnes LE, Arthur A, et al. A two decade dementia incidence comparison from the Cognitive Function and Ageing Studies I and II. Nat Commun 2016;7:11398.
[44] Ahmadi-Abhari S, Guzman-Castillo M, Bandosz P, Shipley MJ, Muniz-Terrera G, Singh-Manoux A, et al. Temporal trend in dementia incidence since 2002 and projections for prevalence in England and Wales to 2040: modelling study. BMJ 2017;358:j2856.
[45] Cullum S, Dudley M, Kerse N. The case for a bicultural dementia prevalence study in Aotearoa New Zealand. N Z Med J 2020;133(1524):119–25.
[46] Prince M, Wimo A, Guerchet M, Ali G, Wu Y, Prina M. The Global Impact of Dementia: An analysis of prevalence, incidence, cost and trends.. London: Alzheimer's Disease International 2015 2015.
[47] Mukadam NA, R, Knapp M, Wittenberg R, Karagiannidou M, Costafreda SG, Tutton M, Alessi C, Livingston G. Effective interventions for potentially modifiable risk factors for late-onset dementia: a costs and cost-effectiveness modelling study. The Lancet Healthy Longevity 2020;1(1):e13–20.
[48] Dudley M, Menzies O, Elder H, Nathan L, Garrett N, Wilson D. Mate wareware: Understanding 'dementia' from a Maori perspective. N Z Med J 2019;132(1503):66–74.