Potentially preventable dementia in a First Nations population in the Torres Strait and Northern Peninsula Area of North Queensland, Australia: A cross sectional analysis using population attributable fractions

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Summary

Background Dementia is highly prevalent among Australia's First Nations peoples, including Torres Strait Islander and Aboriginal peoples in Far North Queensland (FNQ). It is likely that historically recent exposure to modifiable risk factors underlies these rates, and a large proportion of dementia may be potentially preventable.

Methods Data from two adult community health checks (2015-2018) were analyzed to determine the prevalence of 11 modifiable dementia risk factors among the First Nations residents of the Torres Strait and Northern Peninsula Area of FNQ. Population attributable fractions (PAF%) for dementia were calculated using age-standardized prevalence estimates derived from these health checks and relative risks obtained from previous meta-analyses in other populations. PAF% estimates were weighted for communality to account for overlap of risk factors.

Findings Half (52·1%) of the dementia burden in this population may be attributed to 11 potentially modifiable risk factors. Hypertension (9·4%), diabetes mellitus (9·0%), obesity (8·0%), and smoking (5·3%) were the highest contributing risk factors. The contribution of depression (2·0%) and alcohol (0·3%) was lower than other global and national estimates. While the adjusted PAF% for social isolation was low based on the adult community health check data (1·6%), it was higher (4·2%) when official census data were analyzed.

Interpretation These results suggest that a substantial proportion of dementia in FNQ First Nations peoples could potentially be prevented. Government investment in preventative health now is essential to reduce the future burden of dementia.

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Keywords: Dementia; Prevention; First Nations; Indigenous; Population attributable fractions; Australia

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Research in context

Evidence before this study

The Lancet Commission on Dementia Prevention, Intervention, and Care (*The Lancet Commission*) used population attributable fractions (PAF%) to estimate that 40% of dementias worldwide were due to 12 potentially modifiable risks. These risks were obesity, physical inactivity, smoking, low education, diabetes mellitus, hypertension, depression, hearing impairment, alcohol consumption, social isolation, traumatic brain injury and air pollution. One of Australia's First Nations peoples, Torres Strait Islanders, experience high rates of dementia. It is likely that historically recent exposure to modifiable risk factors underlies these rates, and a large proportion of dementia may be potentially preventable. Studies from New Zealand and Canada have used PAF% to show the contribution of modifiable risks is higher among their First Nations residents compared to other populations. We aimed to use PAF% analyses to estimate the current proportion of dementia due to 11 potentially modifiable risks among First Nations peoples living in the Torres Strait region of Australia. We first searched PubMed until 18 February 2022 using the search terms *'(dementia) AND ("attributable fraction") AND (Indigenous OR Aboriginal OR "First Nations")'*. We found there were no studies investigating the contribution of modifiable risks on dementia in a First Nations population in Australia.

Added value of this study

To the best of our knowledge, this is the only study to investigate the PAF% of potentially modifiable risk factors for dementia at a smaller 'sub-population' regional level. This is also the first study to quantify the dementia PAF% in a First Nations peoples in Australia. This study reports that half of the burden of dementia in this population may be attributed to 11 potentially modifiable risk factors, which is higher compared to worldwide estimates and many other countries. In this study, the highest contributors were vascular risk factors, while other risks were lower compared to other populations.

Implications of all the available evidence

These results suggest that a substantial proportion of dementia in the First Nations peoples living in the Torres Strait region of Australia is preventable. While this study has identified important modifiable risk factors that are likely contributing to dementia in this population, these findings are theoretical and do not provide conclusive evidence that reducing risks will result in decline in dementia. Increased government investment in preventative health now would be essential to address the future burden of dementia in this population. This study produced results specific to a smaller population, providing critical regional information about dementia risks for planning future health services and interventions. The information can also guide clinicians as they address key dementia risks at the 'sub-population' level, especially the potentially reversible risks.

Introduction

Dementia describes a collection of conditions characterized by the progressive impairment of brain function to the extent of significantly reducing independence in activities of daily living. In 2019, more than 55 million people were estimated to have dementia worldwide, with a global societal cost of US$ 1.3 trillion.[1] In Australia, over 484,000 residents were estimated to have dementia in 2022.[2] As the Australian population grows and ages, this number is projected to exceed one million by 2056.[2] Given the magnitude of this projected growth, even a 5% reduction in the annual incidence of this condition is estimated to result in billions of dollars in savings during this time.[2]

The Lancet Commission on Dementia Prevention, Intervention, and Care (*The Lancet Commission*) estimates that 40% of dementias worldwide are due to 12 potentially modifiable risks; obesity, physical inactivity, smoking, low education, diabetes mellitus, hypertension, depression, hearing impairment, alcohol consumption, social isolation, traumatic brain injury (TBI), and air pollution.[3] Similar work has been conducted to estimate the proportion of potentially preventable dementia in Australia,[4] New Zealand,[5] Canada,[6] India, China, and several Latin American countries.[7] These estimates are based on population attributable fractions (PAF%), which quantify how much a set of risk factors contributes to the burden of dementia in a population. PAF% calculations utilize the strength of each risk factor, its prevalence in a population, and how much the risks overlap within individuals; that is, how common multiple risks are in the same person.[8] Although there is considerable design heterogeneity between studies that estimate dementia PAF%, this approach has signaled how much dementia in various populations is potentially preventable and the major contributing factors in specific populations.

In Australia, approximately 3% of the population identifies as Aboriginal and/or Torres Strait Islander, the First Nations peoples of the continent.[9] This diverse population has strong connections to family, community, and culture, with rich kinship systems that govern social interaction, law, education, and resource management.[10] A fifth (21%) of Australia's First Nations people were aged 45 years and over in 2016, structurally younger than the non-Indigenous population (40·4%).[11] However, the projected speed of aging will be comparable for the two populations over the next 30 years. Both populations are projected to have an approximate five percent increase in the proportion of people aged 45 years during this time.[11] This projected change suggests that aging, and its associated impacts, will become increasingly important for First Nations Australians.

First Nations Australians already experience higher rates of age-related diseases than their non-Indigenous counterparts.[9] This inequity arises from the enduring result of European colonization, which corroded

traditional lifestyles[12] and introduced many adverse social determinants of disease. These determinants include intergenerational trauma, racial discrimination, cultural disconnection, land dispossession, and reduced access to health services and education. Improvement in these determinants has been slow. High rates of cardiovascular and metabolic disorders persist[13] along with a high prevalence of smoking and ear disease.[9,13] The prevalence of dementia is three to five times higher among Australia's Aboriginal peoples compared to national estimates for all Australians.[14-16] Given that this increased rate is likely related to greater lifetime exposure to potentially modifiable dementia risk factors, the issue of dementia in this population needs to be examined separately from non-Indigenous Australians.

Recent work has also revealed an elevated prevalence of dementia in the culturally, historically, and linguistically diverse First Nations people in the Torres Strait and Northern Peninsula Area (NPA) communities at the tip of Far North Queensland (FNQ), Australia. In this population of approximately 9,000 people, the rate of dementia in those aged 45 years and over was almost three times higher than overall Australian estimates for the same age group.[17] Stroke and chronic kidney disease were associated with an individual's risk of having dementia,[18] while rates of other vascular diseases, such as diabetes, are also historically high in this population.[19-24] There are currently no published estimates of how much these diseases and their associated risk factors contribute to the burden of dementia for this population or how they will shape the future burden.

This study aimed to use PAF% analyses to estimate the proportion of dementia due to 11 of the potentially modifiable risks identified by *The Lancet Commission* report among First Nations peoples living in the Torres Strait and NPA regions of Australia. This study also aimed to explore the dementia PAF% of chronic kidney disease, given this condition was associated with dementia risk in the Torres Strait and NPA[18] and is a risk for dementia in other populations.[25] Information on dementia prevention is critical for FNQ health organizations to advocate and plan for the burgeoning demand dementia will have on services. Appropriate interventions and health promotion must be guided by a sound understanding of the potentially-reversible contributing risk factors in this high-risk population.

Methods

PAF% analyses require three components, 1) the prevalence of risk factors, 2) the magnitude of these risks (relative risk, RR), and 3) the shared variance between risks or 'communality'. In this study, the steps to obtain these three components were 1) create a dataset that contains health information for residents in the Torres Strait, 2) derive dementia risk factors from this dataset, 3) calculate the crude and age standardized prevalence of these

risks, 4) calculate the communality of these risks, 5) obtain RR estimates from existing published studies and, 6) calculate the PAF% for dementia in the Torres Strait and NPA. The methods to calculate dementia PAF% have been extensively documented elsewhere[3,4,7,26,27] and further information is provided in Supplementary Box 1.

Create a dataset of health information

Two independent community health checks/research projects were conducted in the Torres Strait and NPA between 2015 and 2018. These checks were the Dementia Prevalence Survey (DPS, 2015-2018) and the Zenadth-Kes Health Partnership (ZKHP, 2016). The methods and ethics approvals for these studies have been published elsewhere,[17,22] and are summarised below. Approval to combine the data from the two projects was provided by the Far North Queensland Human Research Ethics Committee (HREC/18/QCH/92-1262).

The DPS was a cross-sectional survey that aimed to determine the prevalence of dementia across the wider Torres Strait region.[17] The study was conducted across all 18 island and 5 main-land communities in the Torres Strait and NPA. Participants were recruited through local health centers, snowballing, and community presentations by the research team. Recruitment was limited to people aged 40 years and over. There were no other inclusion or exclusion criteria, as the aim was to assess as many residents as possible and provide a representative sample of the geographic region. Data were collected for 322 residents, of whom 88% were First Nations, although published analyses were limited to a subset of these residents.[17] The research team administered the Kimberley Indigenous Cognitive Assessment tool (KICA) to participants to collect self-reported clinical information (social, medical, smoking/alcohol history, and depression/anxiety), functional status, and a brief cognitive screen for dementia. Geriatricians in the research team also conducted a medical examination of disease status, physical health, and cognitive functioning and reviewed medical records. For the current study, the presence or absence of dementia risk factors was determined using the results of the KICA and the geriatrician assessments.

The ZKHP was a community-based health-screening program for residents aged 15–78 years residing on one inner island and one outer island of the Torres Strait, which occurred over three a week period in 2016.[22] The ZKHP aimed to provide a health service for the community and explore the association between metabolic syndrome and other chronic health conditions. There were no exclusion criteria as the health check aimed to review as many residents as possible. A total of 228 participants, of whom 92% were First Nations, completed a survey of demographic information, health behaviors, health status, depressive symptoms, and underwent a

brief health assessment. Body mass index (BMI) was measured using height and weight at the survey time, and hypertension, assessed via a single blood pressure measure, was defined as systolic ≥140 or diastolic ≥90 mmHg. Glycosylated hemoglobin (HbA1c%) was collected via a blood sample. Participants were defined as having diabetes if they self-reported being treated for diabetes or had an HbA1c ≥6.5%. A urine sample was used to assess albumin creatinine ratio (urinary ACR). The presence or absence of dementia risk factors was determined for the current study from all available information collected during the ZKHP.

The DPS and the ZKHP datasets were combined through appending, which combines rows of observations one after the other. Probabilistic data linkage using individual identifiers (names, date of birth, and sex) and the Stata command 'dtalink' was used to identify individuals who participated in both studies.[28] Non-Indigenous participants (n=57) and participants aged less than 40 years (n=109) were subsequently removed. The remaining study dataset comprised 371 First Nations participants aged 40 years and over, of whom 270 participated in the DPS only, 88 in the ZKHP only, and 13 in both studies. While these 13 individuals had information from both studies, the data linkage process ensured they were not duplicated (i.e., they were represented on one row in the final dataset). The combined study dataset of 371 people was used to determine the prevalence of dementia risk factors and to calculate dementia PAF% estimates for this study.

Derive risk factors
There was sufficient information provided by the DPS and ZKHP to derive 11 of the 12 dichotomous risk factors identified by The Lancet Commission. Air pollution, the 12th risk, was excluded as the study population resides in a remote region, where atmospheric pollution is an unlikely risk.[5] For the 13 people who participated in both the DPS and the ZKHP, the recency and completeness of their data from both surveys were reviewed to determine if they had a dementia risk factor. Table 1 summarises the definitions of dementia risk factors in the two surveys, and the harmonization of these risks is described below. The risks were obesity, physical inactivity, smoking, education, diabetes, hypertension, depression, hearing impairment, excessive alcohol consumption, social isolation, and TBI.

Obesity status was sourced from participants' medical history in the DPS and BMI in the ZKHP (Table 1). For the 13 linked participants, obesity information was taken from the ZKHP as this source was more accurate. Physical activity was only collected in the ZKHP, and inactivity was defined as not meeting Australia's 2014 Physical Activity and Sedentary Behaviour Guidelines. Smoking information was collected via self-report from both studies, and daily smoking was defined as smoking one or more cigarettes per day. Low education was

collected via self-report in both the DPS and ZKHP. For the 13 linked participants, the education level at the most recent survey was used to determine low education. Diabetes and hypertension were identified in the DPS during the medical examination, review of medical records, or through self-report. In the ZKHP, diabetes was from an HbA1c result of ≥6.5% or self-report, and hypertension was from a single blood pressure reading or self-report. For the 13 linked participants, an indication of diabetes or hypertension from any available data sources was used to flag the presence of these diseases. Depression was defined as scoring ≥10 on the Patient Health Questionnaire 9-item (PHQ-9) in both studies, and the latest available PHQ-9 information was used for the 13 linked participants.

Hearing impairment in the DPS was identified during a medical examination or a review of medical records and defined as a person having hearing aids, hearing loss/reduction/impairment, or deafness (Table 1). In the ZKHP, hearing impairment was defined as failing either the left or right ear 'whisper test' administered by a medical practitioner in the team. For the 13 linked participants, information from the DPS medical examination was given priority for determining hearing impairment. Alcohol consumption was frequency and number of drinks/drinking 'until drunk' in the DPS and frequency and grams of alcohol in the ZKHP. These measures were categorized to resemble The Lancet Commission definition of excessive alcohol consumption, which was >21 units of alcohol weekly, or >168g or >17 standard Australian drinks. The lower range limit for the DPS was 16-36 drinks per week, or drinking 'until drunk' at 1-3 times per week. In the ZKHP, the lower limit was 183-320g per week. Living alone was used as a proxy measure for social isolation in this study, and this indicator was only reported in the ZKHP. TBI in the DPS was defined as self-reporting having been hit on the head and knocked out (i.e., Loss of Consciousness, LOC) without a specified time period or having TBI indicated on medical records. In the ZKHP, TBI was self-reporting having been hit on the head and knocked out for 30 minutes or more. This study used the term TBI/Head Injury (LOC) to encompass TBI information from both the DPS and ZKHP. Chronic kidney disease (CKD) was included in post-hoc analyses, as this variable was identified as statistically associated with dementia risk in the DPS.[18] CKD was obtained from medical records in the DPS and urinary ACR in the ZKHP or estimated glomerular filtration rate where ACR was unavailable (Table 1).

Calculate crude and age standardized prevalence of risk factors
The prevalence of risk factors was calculated by summing the number of individuals with the risk in the combined dataset, divided by the number of individuals who had available information about the risk factor. The

Indicator	Age group	Lancet Commission definitions	Dementia Prevalence Survey	Zenadth-Kes Health Partnership
Obesity	45−65	BMI≥30.	Obesity noted in a participant's medical history.	BMI ≥30, measured at the time of the health assessment.
Physical inactivity	>65	No definition provided. The report references 'high' levels of exercise being the most protective in one study. The hazard ratio was 0·62, and the relative risk (1·38) of physical inactivity was the reverse.	N/A	Participants who did not meet Australia's 2014 Physical Activity and Sedentary Behaviour Guidelines of ≥150 minutes of physical activity in the previous week, where 'hard' activity counts for double minutes.
Smoker	>65	No definition provided.	Smoking every day.	Smoking every day.
Low education	<45	No secondary school education, or formal education to a maximum age of 11−12 years. Otherwise said, the proportion of adults who only have a primary school education.	Highest education completed was ≤7 years.	At least "some primary education" was the highest education reported.
Diabetes mellitus	>65	The presence of Type 2 diabetes mellitus.	Diabetes identified from medical examination, review of medical records, or from self-report.	HbA1c ≥6.5% or self-reported diabetes mellitus.
Hypertension	45−65	Systolic BP of 130 mm Hg or higher in midlife from age 40 years.	Hypertension identified from medical examination, review of medical records or from self-report.	Hypertension from blood pressure (i.e., systolic ≥140 mmHg or diastolic ≥90 mmHg) or self-reported hypertension.
Depression	>65	Depression in later life.	PHQ9 ≥10	PHQ9 ≥10
Hearing impairment	45−65	Hearing loss present at a threshold of 25 dB, which is the World Health Organization threshold for hearing loss. The age group >55 years was used because this age was the youngest mean age in which the presence of hearing loss was shown to increase dementia risk.	Hearing impairment from medical examination or medical records, defined as hearing aids, hearing loss/reduction/impairment, or deafness.	Failing either the left or right ear whisper test.
Excessive alcohol	45−65	Drinking more than 21 units (168 g) of alcohol weekly.	Drinking "until drunk" every day or 1-3, or 4-6 times per week, or drinking 4-6 drinks, 4-6 times per week.	Drinking 61 or more grams of alcohol, 3 or more times per week.
Social isolation	>65	Social isolation was not measured directly. Instead, living alone (i.e., no cohabitation) was used a proxy measure.	N/A	No other people living in the household (i.e., living alone).
Traumatic brain injury (TBI)	45−65	TBI of all severities for all cause dementia.	Hit on the head and knocked out, or TBI recorded in medical records.	Hit on the head and knocked out for 30 minutes or more.
Chronic kidney disease			Chronic kidney disease noted in medical history.	Urinary albumin creatinine ratio (UACR) ≥2.5 mg/mmol for males and ≥3.5 for females. Or, where UACR was not available, estimated glomerular filtration rate of <60 mL/min/1.73 m2.

Table 1: − **Definitions of dementia risk factors from the Lancet Commission on dementia prevention, intervention, and care 2017 and 2020 reports, and study variables from the Dementia Prevalence Survey (2015-2018) and the Zenadth-Kes Health Partnership (2016).**
Notes: BMI = Body Mass Index, PHQ9 = Patient Health Questionnaire 9-item, dB = Decibels.

Dementia risk	Relative Risk[a]		Crude prevalence					Age standardized[c]		
	RR	(95%CI)	Prev.	PAF	Com.	aPAF	95% CI	Prev.	aPAF	95% CI
Hypertension	1·60	(1·16—2·24)	57·0	25·5	43·3	10·5	(7·4—13·6)	48·2	9·4	(6·5—12·4)
Diabetes mellitus	1·50	(1·33—1·79)	59·8	23·0	28·4	9·5	(6·5—12·5)	54·6	9·0	(6·1—11·9)
Obesity	1·60	(1·34—1·92)	30·3	15·4	46·5	6·3	(3·8—8·8)	38·9	8·0	(5·2—10·7)
Smoker (daily)	1·60	(1·15—2·20)	18·5	10·0	34·2	4·1	(2·1—6·1)	24·2	5·3	(3·0—7·6)
TBI/Head Injury (LOC)	1·84	(1·54—2·20)	14·1	10·6	47·5	4·3	(2·3—6·4)	15·3	4·8	(2·6—7·0)
Hearing impairment	1·94	(1·38—2·73)	15·0	12·4	64·4	5·1	(2·9—7·3)	12·1	4·3	(2·2—6·3)
Physical inactivity[b]	1·38	(1·16—1·67)	24·8	8·6	44·4	3·5	(1·7—5·4)	25·8	3·8	(1·8—5·7)
Low education (≤Grade 7)	1·59	(1·26—2·01)	27·2	13·8	63·5	5·7	(3·3—8·1)	16·3	3·7	(1·8—5·6)
Depression	1·90	(1·55—2·33)	5·4	4·6	29·5	1·9	(0·5—3·3)	-	2·0	(0·5—3·4)
Social isolation[b]	1·57	(1·32—1·85)	7·0	3·8	44·4	1·6	(0·3—2·8)	-	1·6	(0·3—2·9)
Excessive alcohol	1·18	(1·06—1·31)	3·8	0·7	42·6	0·3	(−0·3 to 0·8)	-	0·3	(−0·3 to 0·8)
Total				75·4		52·8	(47·8—57·9)		52·1	(47·1—57·2)

Table 2: Population attributable fractions (PAF%) for dementia in the Torres Strait and Northern Peninsula Area (NPA), based on a sample of 371 First Nations residents aged 40 years and older (2015-2018), PAF estimates provided for crude and age standardized risk prevalence estimates.

Notes: Prev. = prevalence, Com. = communality, aPAF = PAF adjusted for weighted communality, LOC = Loss of Consciousness, TBI = Traumatic Brain Injury.

[a] Relative Risk (RR) based on estimates from The Lancet Commission on dementia prevention, intervention, and care: 2017 and 2020 reports.

[b] Communality estimated as the mean of all other communalities.

[c] Age standardized prevalence is crude prevalence for each risk factor, directly age standardized to the 2016 population aged ≥40 years residing in the Torres Strait Islands Statistical Area Level 2, according to the 2016 Australian Bureau of Statistics Census (https://dbr.abs.gov.au/region.html?lyr=sa2&rgn=315011402). Depression, social isolation and excessive alcohol were not age standardized due to small cell sizes.

DPS was overrepresented by older participants,[17] which skewed the age of the combined study dataset. This bias resulted in proportionally more older people in the study dataset compared to the age distribution of people aged ≥40 years in the Torres Strait, according to the 2016 Australian Bureau of Statistics (ABS) estimated residential population of the Torres Strait Islands Statistical Area Level 2 (SA2).[29] To manage the impact of this bias, the prevalence of each risk factor was directly aged standardized[30] to the 2016 ABS Torres Strait Islands SA2 population aged ≥40 years using five-year age groups.[29] The exceptions were alcohol consumption, social isolation, and depression, which did not meet the Australian Institute of Health and Welfare minimum numerator requirement for age standardization.[30] The crude and age standardized prevalence estimates are presented in Table 2.

In Australia, multiple government and private organizations provide prevalence estimates for diseases and risk factors at national and jurisdictional levels. A search of official publicly available prevalence estimates of dementia risk factors for the Torres Strait region was also conducted to provide a reference point for the prevalence estimates reported in this study. This review also assessed whether public data sources could be used instead of the study dataset. The review indicated there was no single data source that could provide estimates of the dementia risk factors identified by *The Lancet Commission* for residents of the Torres Strait aged ≥40 years. However, multiple data sources could be collated to provide a reference point for the current prevalence estimates, albeit with younger age groups (e.g., ≥18 years) and diverse methods, definitions, and time periods. These estimates are provided in Supplementary Table 2. Where no other data were available, results from previous research projects in the Torres Strait region or national level estimates for First Nations Australians were used.

Communality

Individuals may have several risk factors, so individual PAFs% cannot be summed to derive a total PAF%.[3] To account for the overlap in risk, PAF% estimates are weighted for communality, which measures the proportion of shared variance between risk factors.[27] The more communality a risk factor has, the less individual PAF% it contributes. For this study, communality was calculated in four steps, following examples from previous dementia PAF% studies.[3,4,7,26,27]

Step 1 - A tetrachoric correlation matrix of nine risk factors was created using the Stata command 'tetrachoric'. Tetrachoric correlations use complete case analyses. Physical inactivity and social isolation were excluded from tetrachoric correlations, as these indicators were only available in the ZKHP and had a small number of responses in the combined dataset (100 and 101, respectively).

Step 2 - A principal components analysis was run on the correlation matrix using the Stata command 'pcamat C, n(###) forcepsd mineigen(1)', which generated components, eigenvalues, and eigenvectors.

Step 3 - Eigenvalues ≥1 were retained to ensure only eigenvectors that hold the most information about the data distribution were analyzed.

Step 4 − Communality was calculated as the sum of the square of all factor loadings. The average of all communality estimates for risk factors was applied to physical inactivity and social isolation. Communality was then incorporated into the PAF% calculations in the form of 'weights' (1-communality).

Supplementary Box 2 describes the standard convention for calculating communality and explains in detail how communality was derived for this study.

Obtain relative risk

The estimates of RR for this study were obtained using the two *Lancet Commission* publications.[3,26] These sources used systematic reviews and meta-analyses to obtain RR estimates for the 11 risk factors. Although the authors of *The Lancet Commission* specified these RRs for midlife 45−65 years and later life >65 years, they also suggested these risks might be relevant in other life periods.[3] In practice, PAF% calculations do not adhere to specific age groups (see Supplementary Box 1). The RR for chronic kidney disease (RR=1·52, 95% CI 1·16 −1·99) was obtained from a meta-analysis of prospective studies of albuminuria as evidence of kidney damage and incident dementia.[31]

PAF% analyses

The formulae used for calculating PAF% in this study have been documented elsewhere,[3,4,7,26,27] and are provided for reference in Supplementary Figure 1. The Confidence Intervals (CI) for PAF% estimates were calculated using the standard method for 95% CIs for proportions, where the sample size was the number of participants in the combined dataset.

Role of the funding source

The funding body did not have a role in the study design, data collection, analysis, and interpretation of data, or in the writing of the manuscript, and in the decision to submit the manuscript for publication.

Results

There were 371 participants aged ≥40 years in the study dataset, most were female (63·3%), and the mean age was 62 years (*SD*=11·8, range 40-93). Table 2 shows that diabetes mellitus (54·6%), hypertension (48·2%), obesity (38·9%), and physical inactivity (25·8%) were the most prevalent risks after age standardization. Publicly available data sources provided comparative prevalence estimates for most of the risk factors in this study. However, no sources had comparable age groups, time periods, or sampling methods

to supplement the prevalence estimates obtained from the study dataset (Supplementary Table 2). The exception was social isolation (i.e., lone person households), which was estimated as 19·8% in a 2016 total population ABS Census,[29] compared to 7·0% in the study dataset.

Table 2 shows the RRs for the 11 risk factors ranged from 1·18 for excessive alcohol consumption up to 1·94 for hearing impairment. The communality measures were highest for hearing impairment and low education (64·4% and 63·5%, respectively) and lowest for diabetes mellitus (28·4%). Table 2 shows PAF% calculations using crude and age standardized prevalence estimates. When the PAF% estimates were weighted for communality, the total adjusted PAF% (aPAF%) remained comparable across the two calculations (i.e., 52·8 and 52·1%, respectively). Hypertension, diabetes mellitus, and obesity provided the highest contributions in all analyses, and depression and excessive alcohol consumption the lowest. Figure 1 shows the total adjusted PAF% of the 11 risk factors from analyses using age standardized prevalence estimates.

Post-hoc PAF% analyses were conducted to estimate the contribution of social isolation based on lone person household prevalence estimates from the 2016 total population ABS Census. In these analyses, the age standardized prevalence estimates were used from the study dataset for all indicators except social isolation, which was replaced with the ABS Census estimate (19·8%) (Supplementary Table 3). In these analyses, the aPAF% for social isolation was 4·2%, and the overall aPAF% increased slightly to 53·9%. These post-hoc analyses were extended by adding chronic kidney disease to the list of risk factors (Supplementary Table 4). These analyses showed that chronic kidney disease was the eighth-highest risk factor, accounting for 3·4% of dementia risk. The adjusted PAF% for all other risks was slightly reduced, and the total adjusted PAF%, including chronic kidney disease, was 52·2%.

Discussion

This study combined data from two separate health checks for First Nations residents of the Torres Strait and NPA to estimate the preventable burden of dementia in this population. Analysis of the linked data using PAF% indicated that approximately half (52·1%) of the burden of dementia in this population might be explained by 11 potentially modifiable risk factors after adjusting for shared variance between these risks. The largest contributing risks were hypertension (9·4%), diabetes mellitus (9·0%), obesity (8·0%), and smoking (5·3%). Given the high financial, social, and personal costs associated with dementia, these results make a clear case for government to invest in preventative health now, to reduce the future burden of dementia in this population.
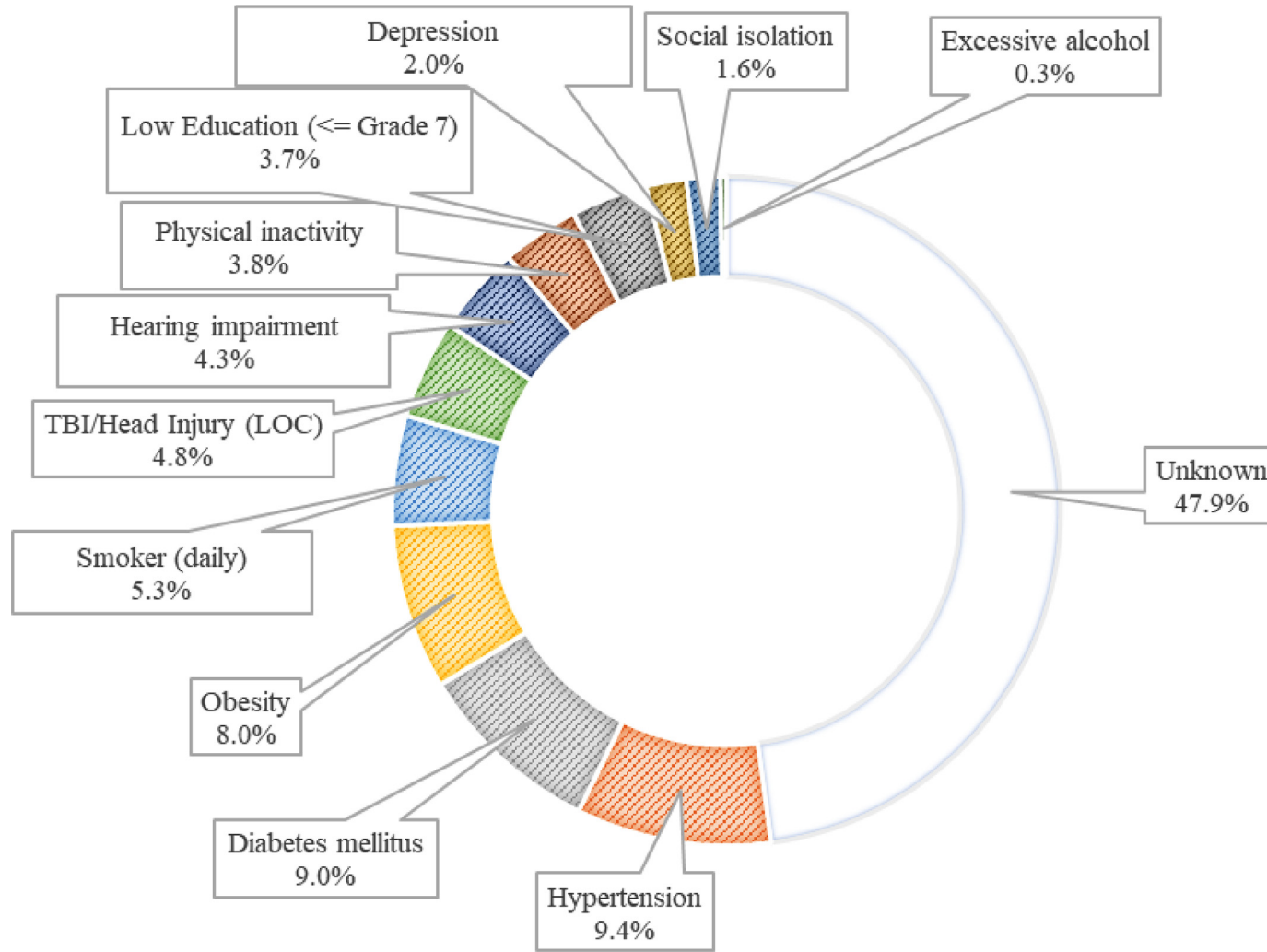
Figure 1. Population attributable fractions (PAF%) for dementia, based on age standardized prevalence estimates of 11 potentially modifiable risk factors, adjusted for communality, in the Torres Strait and Northern Peninsula Area, of Far North Queensland, Australia.

The total dementia PAF% of 52·1% reported here was higher than the 40% global estimate made by *The Lancet Commission* based on 12 risk factors.[3] The total PAF% was also higher than estimates for China (39·5%) and India (41%), which used nine risk factors, although lower than six Latin American countries (55·8%).[7] Our results were consistent with previous estimates from New Zealand using 12 risk factors (47·7%),[5] especially for the Māori population (51·4%). First Nations populations globally experience higher potentially modifiable risk factors for dementia,[32] often related to the consequences of colonization and the erosion of traditional lifestyles.[12] Similarities between our study and the Māori population reflect the excess of modifiable risk factors for dementia in both populations. The contribution of hypertension and diabetes mellitus was higher in the current study than global and New Zealand estimates (Supplementary Table 4). Our results likely reflect the high prevalence of these conditions and their relatively low communality, compared to other dementia risks. The contribution of smoking and TBI was also higher compared to these international estimates. The adjusted PAF% for low education, excessive alcohol consumption, hearing impairment, depression, and social isolation were lower compared to other studies, suggesting these factors could be fostered to remain low in the Torres Strait region, at least relative to other regions (Supplementary Table 4). While our overall adjusted PAF% was similar to a 2017 Australian study (48·4%),[4] the PAF% for several indicators in that study (low education, obesity, and physical inactivity) appear inflated compared with more contemporary research, including our own (Supplementary Table 4). These differences suggest that an update of Australia's dementia PAF% estimates is required. We defined low education based on *The Lancet Commission's* definition, which was 'No secondary school education, or education to a maximum of 11–12 years of age' (Table 1). In Australia, this equates to no education beyond primary school. Had we also included people who commenced but did not complete high school in our definition of low education, then the PAF% for education may have been higher and more consistent with previous estimates for Australia.[4]

The results of this study complement recent work by Russell et al., which examined cross-sectional risks associated with dementia among individual First Nations residents of the Torres Strait and NPA using data from the DPS.[18,33] Russell's study did not show statistically significant associations between hypertension, diabetes mellitus, obesity, and hearing impairment with an individual's risk of having dementia, despite these conditions being highly prevalent in the sample. Similar 'non-association' results have been found among First Nations peoples of the Kimberley region in Western Australia and urban and regional New South Wales,[34-36] where both dementia and these risk factors are prevalent.

While these null results may reflect methodological issues present in the studies (cross-sectional study designs and limited data on treatment of risk factors), they also likely reflect the inability of these study designs to identify the contribution of risk factors that are highly prevalent and, therefore not sufficiently sensitive to differentiate between people who do and do not develop a disease.[37] It is difficult to identify the major determinants of dementia in populations where many of the risk factors are highly prevalent.[38] The current study demonstrates that although these risks are not differentiating between those who develop dementia, they are likely acting at a population level to drive the higher overall rates. Consequently, reducing dementia in this population would require preventative health interventions and health promotion activities that target these major risks at a population level.

Chronic kidney disease was examined in post-hoc analyses, given evidence that this condition was associated with an individual's risk of having dementia in the Torres Strait,[18] and in other populations.[25] The post-hoc results suggested chronic kidney disease made an individual contribution to dementia at a population level. However, the overall weighted PAF% did not increase after adding this condition as a 12th risk factor. This non-change could reflect our varied methods for identifying chronic kidney disease (albuminuria, eGFR, or clinical notes) or overlap with other risk factors. Alternately, because chronic kidney disease is a leading complication of diabetes mellitus, a highly prevalent disease in this population, the contribution of chronic kidney disease to preventable dementia is likely to reflect the diabetes mellitus burden. Not surprisingly, our results indicate that including chronic kidney disease as a risk factor does not improve how much preventable dementia is explained in this population. Similar analyses using data from other populations is required to further examine the impact of chronic kidney disease on dementia at a population level.

The results of this study need to be considered in the context of several major design limitations. While the prevalence estimates and communality were derived from the study sample, the RRs were obtained from meta-analyses of heterogeneous individual studies in other populations. Although this approach is standard in dementia PAF% research (see Supplementary Box 1), our assumption that these RRs will apply to the study population is an important design limitation. This study had a small sample size compared with other PAF% studies that use national surveys, which may have reduced the reliability of our PAF% and communality estimates. The sample was also overrepresented by older people, and it was necessary to age standardize prevalence estimates to reduce this bias.

In this study, each risk factor was derived from at least two different measures, which meant the accuracy of prevalence estimates was contingent on the

completeness and accuracy of multiple indicators. For example, hypertension, diabetes mellitus, and obesity in the DPS relied on completeness of medical records and/or participant willingness to disclose information. Although using multiple potentially incomplete sources may have resulted in an underestimate of these conditions, it is also possible that more sources resulted in improved capture of these conditions. The ZKHP used objective measures for these conditions, presumably resulting in accurate prevalence estimates, although medical records were not available for verification. When data from the DPS and ZKHP were combined, the impact of multiple underlying variations in all measures on the validity of prevalence estimate was unclear, which was a major limitation of this study. Another example was hearing impairment. While the DPS had medical records for this indicator, the 'whisper test' in the ZKHP would be less accurate, and more participants would have been misclassified. When data from the two studies were combined, the inaccuracy of the ZKHP would affect the overall prevalence estimate, although in which direction is unclear. Smoking and education were captured in the DPS and ZKHP using similar methods and would be more comparable. For excessive alcohol consumption, although the DPS and ZKHP used different measures, few people met *The Lancet Commission* criteria, even when subjective responses such as 'until drunk' were categorized into the threshold. These low responses either reflect true low levels of excessive alcohol consumption or participant underreporting in both studies. Our review of alternative publicly available data sources found that none were more suitable than our study data for estimating the prevalence of midlife dementia risk factors in the Torres Strait and NPA (Supplementary Table 2), which highlights the lack of reliable information for estimating disease prevalence in this region.

In this study, we had limited data on physical inactivity and social isolation, and, consequently, we applied the mean communality from all other measures, as per the standard practice in dementia PAF% research (Supplementary Box 1). The PAF% estimate for depression was lower than other risk factors, which may reflect inadequate methods used to assess this risk. For example, while both the ZKHP and DPS used culturally adapted versions of the Patient Health Questionnaire (PHQ-9)[39,40] to screen for depression, these tools have not specifically been validated in the Torres Strait and NPA. As a result, these screening tools may have underestimated the prevalence of depression. Work is currently underway to develop and validate culturally appropriate screening methods for mental health conditions in the region. Similarly, the current study used the number of household occupants as a proxy measure for social isolation. While it is unclear why this estimate (7%) was notably different compared to a 2016 Census estimate for the Torres Strait (19·8%), this discrepancy highlights the limitations of using proxy measures for dementia risk factors. While this method is comparable to *The Lancet Commission's*,[3] future work in the Torres Strait and NPA may include a more refined measure, such as frequency, size, and type of social contact.

The indicators in this study also do not account for unmeasured risks, such as diet and cognitive inactivity. Modifiable risk factors have not completely explained the increased dementia risk in ethnically diverse and socioeconomically disadvantaged populations,[41] suggesting that unmeasured risks, such as dietary patterns and access to health services, may have a mediating effect. For our study, unmeasured risks identified in broader dementia research (e.g., diet, cognitive inactivity, and health service access), or risks specific to First Nations populations (e.g., lack of cultural connection or childhood adversity[42]) may be contributing to the higher dementia rates. While this study has identified important modifiable risk factors that are likely contributing to dementia in a First Nations population, these results are theoretical and do not provide conclusive evidence that reducing these risks will result in dementia decline.

Despite these limitations, this is the first study to apply PAF% analyses to dementia at a smaller 'sub-population' level. It has produced results specific to this population, in contrast to national estimates that are likely to overlook regional differences. The type of geographic level risk estimation in this study provides data for a regional level understanding of dementia risks that will be critical for planning future regional health services and interventions. This information can also guide clinicians to address key dementia risks at the 'sub-population' level, especially the potentially reversible risks. The estimates of communality used in the current study were derived from the same source as the prevalence data and, theoretically, should be more accurate than the methods previously used for some international estimates,[3] and the whole of Australia.[4] Our results also suggest that low education, excessive alcohol consumption, depression, and social isolation may contribute less to dementia in this population compared to other countries. Future government investment could maintain these low levels by promoting their protective opposites (e.g., facilitating access to education or more social contact). Finally, while our overall findings are specific to a smaller regional population, our study suggests that dementia PAF% methods may be generalizable to other small populations where dementia is highly prevalent.

The findings of this study indicate that high quality prospective studies into culturally appropriate diet and physical activity measurement and interventions in the Torres Strait and NPA are required. However, it is imperative that developing diet and activity tools are co-designed, culturally appropriate, and location specific. Further research into interventions to address chronic

disease in these populations will need to be community-driven and consider the holistic conceptualizations of health held by First Nations peoples, addressing the broader social and cultural determinants of health impacting these communities.

Conclusion

Dementia is, and will remain, a major challenge for First Nations populations. This largely theoretical study estimates that half the burden of dementia in First Nations residents of the Torres Strait and NPA may be due to 11 potentially modifiable risk factors. The results make a clear case for governments to invest in preventative health, health promotion, and education, to reduce the largest contributing factors while fostering protective factors already present. These protective factors include good levels of social contact, low alcohol abuse, and levels of education that are improving across generations.

Contributors

F.T. conceived the research, obtained approvals to combine study data from two projects, assisted with data collection for these projects, analyzed the data, interpreted the results, and prepared the manuscript. S.R., R.Q., M.M., S.C., S.T., L.H., B.S., and G.M. assisted with data collection and interpretation of the data and contributed to the manuscript. S.T. and B.S. provided cultural advice and assisted with stakeholder consultations before and during data collection. A.E. provided statistical advice. L.H. and S.R. verified the underlying data. E.S. and R.M. provided medical advice, oversaw the projects, and reviewed the manuscript.

Data sharing statement

The data that support the findings of this study is sensitive. These data are not publicly available due to privacy and ethical restrictions. The data are available on request from the corresponding author. Additional institutional approvals, such as ethics approval, would be required to enable sharing of these data. Requests to access the datasets should be directed to fintan.thompson@jcu.edu.au.

Editor note

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Declaration of interests

The authors have no conflict of interest to declare.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.lanwpc.2022.100532.

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