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Differences in cardiometabolic risk markers among ethnic groups in Queensland, Australia

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Abstract

Very little is known about the cardiometabolic risk of migrants who settle in Australia. This study investigated differences in cardiometabolic risk markers among ethnic groups attending a tailored healthy lifestyle program in Queensland, Australia; and differences in these markers between those living in Australia for shorter versus longer periods of time. Baseline data collected between October 2014 and June 2017 from the Living Well Multicultural—Lifestyle Modification Program were used. People living in ethnic communities in Queensland who were ≥18 years old, and not underweight were eligible to participate. Independent variables were ethnicity and length of time in Australia. Outcomes were cardiometabolic risk markers including BMI, waist circumference, weight-to-height ratio (WHtR) and hypertension. Analyses were done separately for each independent variable. Linear and logistic regressions were run for continuous and binary outcomes with differences/Odds ratios reported respectively. Multivariable analyses showed that Burmese/Vietnamese had an average BMI lower than Afghani/Arabic (3.7 points), Somalian/Sudanese (4.7 points) and Pacific Islander (11.6 points) ($p < 0.001$) respectively. Differences in waist circumference between Burmese/Vietnamese with Sri Lankan/Bhutanese, Afghani/Arabic, Somalian/Sudanese and Pacific Islander were 6.3, 8.4, 9.1 and 24.0 cm ($p < 0.01$) respectively. Although Burmese/Vietnamese also had lower average WHtR compared to the others, the differences were not significant for Somalian/Sudanese. Moreover, Sri Lankan/Bhutanese and Pacific Islander were more likely to be hypertensive compared to Burmese/Vietnamese ($p < 0.05$). Immigrants living in Australia >5years had on average 1.2 points higher BMI, 2.4cm larger waist circumference, and 0.02 points higher WHtR ($p < 0.05$) compared to those living for ≤5 years. Long-stay immigrants were also more likely to be hypertensive than short-stay immigrants ($p < 0.01$). In conclusion, cardiometabolic risk is significantly different among ethnic groups in Queensland with Pacific Islanders having the highest risk. Immigrants living in Australia >5 years had higher risks compared to those living in Australia for shorter periods of time.

KEYWORDS

BMI, cardiometabolic risk, ethnicity, immigrant, waist circumference, weight-to-height ratio

1 | INTRODUCTION

Australia is one of the most culturally diverse populations in the world with more than one-quarter (26%) of Australians born overseas, and 19% born in countries where English is not the first language (Australian Bureau of Statistics, 2017). There is a disproportionate burden of disease among ethnic groups in Australia with considerable variability depending on country of origin (Anikeeva et al., 2015). Migration from a low-middle income country to an industrialised high-income country has a known detrimental impact on health (Alidu & Grunfeld, 2018). Although there is, for voluntary migrants, a "healthy migrant" effect on arrival; the longer the duration of residence, the higher the prevalence of risk factors that lead to morbidity and mortality from chronic conditions (Commodore-Mensah et al., 2016; Koya & Egede, 2007). There is however, significant variability with respect to this effect. For example, those migrating under family reunification programs are not positively selected on health grounds. Forced migrants or refugees can experience higher risks of physical and psychological factors that could have negative health impacts (Odone, McKee, & McKee, 2018).

Cardiometabolic risk factors are a set of conditions which increase the possibility of developing cardiovascular diseases and diabetes as a result of insulin resistance and atherogenic dyslipidaemia (Ruilope, De La Sierra, Segura, & Garcia-Donaire, 2007). Studies have shown that cardiometabolic risks are different within and between ethnic groups. The differences in risk between groups are thought to be due to differences in body composition and other genetic factors. Socioeconomic status, unhealthy environments, raised stress levels (including related to bias and racism), consumption of unhealthy diets, low levels of physical activity, smoking, unsafe alcohol consumption and poor access to healthcare may explain within and between group differences (Eastwood et al., 2015; El Masri, Kolt, Astell-Burt, & George, 2017; Sanou et al., 2014).

Very little is known about the cardiometabolic risk of migrants who settle in Australia. An analysis of participants in a longitudinal study found that participants born in Western Europe, Eastern and Central Europe and the Middle East and North Africa had higher chronic disease risk than Australian-born participants (Sarich, Ding, Sitas, & Weber, 2015). Men from North Africa, Middle East and Oceania have significantly higher body mass indexes (BMI) and men from North-west Europe, North-east, southern and central Asia had much lower BMIs compared to those who were Australian-born (Menigoz, Nathan, & Turrell, 2016). Those from the UK and Ireland and Sub-Saharan Africa had potentially lower risk, and participants from Oceania and Asia had a similar chronic disease risk to Australian-born participants (Sarich et al., 2015). The odds of type 2 diabetes in migrants compared to Australian-born residents are higher after adjusting for age across all socioeconomic categories (Abouzeid, Philpot, Janus, Coates, & Dunbar, 2013). More recently secondary analyses of large data sets have confirmed a lower risk of chronic conditions among migrants from parts of Asia, with an increasing risk the longer they reside in Australia (Guo, Lucas, Joshy, & Banks, 2015). A number of studies in countries with similar migration histories to Australia, for example, Canada and the United States of America have compared cardiometabolic risks among different ethnic groups. In the United States, compared to whites, African-Americans, Chinese-Americans, Hispanics and South Asians all had higher percentages of metabolic abnormalities while still being within a healthy weight range (Gujral & et al., 2017). Again in the United States, those migrants who had entered the country over ten years ago were more likely to report a history of hypertension, overweight/obesity and diabetes but not hyperlipidaemia (Commodore-Mensah et al., 2016).

Queensland is a large state within Australia, it has 20% of the total population of which 22% were born overseas, and about 11% do not speak English at home (Queensland Government, 2018). It has one of the largest migrant populations of Pacific Islanders that is rapidly growing (Queensland Government, 2013). Data from within Queensland indicate that mortality from total avoidable deaths is higher in the Oceania group (which includes Pacific Islanders) and within this group the Samoan communities have the highest death rates (Queensland Health, 2012). Deaths from diabetes are higher in the Oceania and Southeast European cohorts (Queensland Health, 2012). Those originating from North Africa, Middle East, Southeast Asia and Oceania have higher rates of morbidity associated with diabetes and cardiovascular disease respectively (Queensland Health, 2012). A study among newly arrived Sudanese refugees in Queensland identified that more than half were overweight and obese indicating the need for interventions to prevent excessive weight gain and to reduce risk factors for diabetes and cardiovascular disease (Renzaho, Bilal, & Marks, 2014). Despite the increased risk of hypertension, cardiovascular disease, diabetes, overweight/obesity, members of ethnic communities in Australia are less likely to

What is known about this topic?

- Cardiometabolic risks are different among ethnic groups.
- Migrants who move from low- and middle-income to high-income countries have their health deteriorate over time.

What this paper adds?

- Pacific Islanders had the highest cardiometabolic risk compared to other ethnic groups in Queensland.
- Cardiometabolic risk of ethnic groups in Queensland increased within five years of settling in Australia.
- Apart from physical activity and dietary intake, cardiometabolic risk may be associated with other factors, perhaps stress and/or trauma associated with migration and/or previous refugee experiences.

be proactive in accessing healthcare or in implementing preventative measures (Henderson, Kendall, & See, 2011).

Most available data focus on either specific groups in host countries for example, the South Asian population in the United Kingdom (Welsh et al., 2016); or on generic larger scale groups such as Hispanic, Black, non-Hispanic White, Asian in the USA (Dong, Arnold, Peng, & Wang, 2016). Cardiometabolic risk factors between cultural groups (established and emerging communities) in Australia have not been investigated. This paper seeks to explore the differences in cardiometabolic risk factors among ethnic groups attending a tailored healthy lifestyle program in Queensland, Australia. It also investigates the difference in risk factors for those who have been in Australia for shorter and longer periods of time.

2 | METHOD

2.1 | Study design and population

The Living Well Multicultural—Lifestyle Modification Program (LWM-LMP) was delivered by the Ethnic Communities Council of Queensland (ECCQ). It was a tailored program designed to improve awareness of and create change in behaviours that contribute to cardiometabolic risk for culturally and linguistically diverse communities (CALD) living in Queensland, Australia. The program was implemented in disparate geographical areas in hospital and health services throughout Queensland, with the most programs occuring in the southern metropolitan area of Brisbane (the capital city).

The LWM-LMP program was developed using best-practice principles. It incorporated tailored resources developed in partnership with communities around identified topics (healthy eating, physical activity, chronic disease prevention and self-management, alcohol consumption and smoking cessation). The program was delivered by trained Multicultural Health Workers from each community and utilises a self-management framework and adult learning principles to facilitate behaviour change, and promote health and well-being (Goris, Komaric, Guandalini, Francis, & Hawes, 2012). The LWM-LMP is an eight-week program with two follow-up sessions. Each session is 120 min and includes a physical activity component.

CALD communities targeted in the program included Afghani, Arabic-speaking, Burmese, Pacific and South Sea Islander, Sri Lankan, Sudanese and Vietnamese. These groups were selected based on identified need (either by the auspicing agency ECCQ or the funder Queensland Health) and to ensure a mix of established and emerging communities. People living in these CALD communities who were 18 years old or above, and not underweight were eligible to participate. Recruitment was conducted through newsletters, advertisements in newspapers and on ethnic radio channels, ECCQ and community associations' websites, referrals from health professionals and word-of-mouth. People, who agreed to participate, gave written consent before participating. This study reports on the baseline data collected between October 2014 and June 2017 for the LWM-LMP program.

2.2 | Ethics approval

Ethics approval was granted by Queensland University of Technology Human Research Ethics Committee (1500000028). All participants provided written consent to participate in the program.

2.3 | Measures

2.3.1 | Dependent variables

Weight, height and waist circumference were all measured by multicultural health workers (MHW) following WHO guidelines (World Health Organization, 1995). The same multicultural health worker undertook all measurements within a particular cultural group. Cardiometabolic risk markers including Body Mass Index (BMI), waist circumference, Waist-to-Height ratio (WHtR) (as a predictor of risk associated with deposition of visceral fat) (Ashwell, Gunn, & Gibson, 2012), and hypertension were used as dependent variables in this study. BMI was calculated as weight (kg)/height^2 (m). WHtR was defined as waist circumference (cm) divided by height (cm). Blood pressure (BP) was measured by multicultural health workers. Hypertension is defined in this study as having a systolic BP ≥ 140mmHg or a diastolic BP ≥90 mmHg (American Heart Association, 2018).

2.3.2 | Independent variables

Ethnicity was self-reported by participants and categorised into five main groups based on geographic locations including: Burmese/Vietnamese (Southeast Asia), Sri Lankan/Bhutanese (South Asia), Afghani/Arabs (Middle East), Somalian/Sudanese (Africa) and Pacific Islander.

Time in Australia was self-reported by participants at the beginning of the study. A cut-off of five years was used; those who had lived in Australia for more than five years were considered categorised as long-stay and the remainder were considered short-stay. A wide variety of cut-offs have been used previously but work by Jasso, Massey, Rosenzweig, and Smith (2004) indicates that within five years health may improve, thereafter it can potentially deteriorate.

2.3.3 | Covariates

Covariates were selected based on previous studies (see for example, (Newbold & Danforth, 2003). Demographic characteristics were self-reported by participants. Gender was categorised as "female" or "male". Levels of education included "primary school", "high school", "certificate/diploma", or "bachelor/postgraduate degree". Types of employment were "paid work", "work without pay", "retired/unemployed", or "student". Household types included "living alone with

TABLE 1 Sample characteristics, lifestyle behaviours and cardiometabolic risk markers across ethnic groups

	Burmese/ Vietnamese		Sri Lankan/ Bhutanese		Afghani/ Arabic		Somalian/ Sudanese		Pacific Islander	
	N	% or mean (*SD*)	*N*	% or mean (*SD*)	*N*	% or mean (*SD*)	*N*	% or mean (*SD*)	*N*	% or mean (*SD*)
Demographic characteristics										
Mean age (years)	127	54.8 (16.6)	142	43.7 (13.3)	161	36.9 (11.7)	113	36.4 (11.6)	157	49.2 (13.7)
Mean weight (kg)	126	59.7 (10.9)	140	67.1 (11.9)	161	71.7 (13.8)	112	76.1 (15.6)	156	102.2 (22.2)
Mean height (cm)	127	154.2 (7.7)	140	159.7 (8.1)	161	161.7 (7.7)	113	164.7 (9.0)	156	167.7 (8.1)
Gender	127		142		161		113		157	
Male	30	23.6	65	45.8	30	18.6	26	23.0	68	43.1
Female	97	76.4	77	54.2	131	81.4	87	77.0	89	56.7
Education	113		135		160		96		156	
Primary	19	16.8	35	25.9	25	15.6	55	57.3	16	10.3
High school	49	43.4	18	13.3	43	26.9	20	20.8	72	46.2
Certificate/Diploma	17	15.0	18	13.3	33	20.6	15	15.6	56	35.9
Bachelor/Postgraduate	28	24.8	64	47.4	59	36.9	6	6.3	12	7.7
Employment	126		137		161		112		157	
Paid work	35	27.8	61	44.5	20	12.4	37	33.0	92	58.6
Work without pay	17	13.5	31	22.7	54	33.5	19	17.0	28	17.8
Retired/Unemployed	59	46.8	29	21.2	15	9.3	30	26.8	36	22.9
Student	15	11.9	16	11.7	72	44.7	26	23.2	1	0.6
Household types	123		140		160		111		154	
Living alone with no children	11	8.9	6	4.3	4	2.5	4	3.6	8	5.2
Single parent living with one or more children	24	19.5	13	9.3	13	8.1	22	19.8	19	12.3
Single living with friends or relatives	13	10.6	3	2.1	30	18.8	24	21.6	20	13.0
Couple living with no children	18	14.6	20	14.3	12	7.5	8	7.21	9	5.8
Couple living with children	57	46.3	98	70.0	101	63.1	53	47.8	98	63.6
Time in Australia	127		140		161		113		157	
Five years or less	30	23.6	73	52.1	112	69.6	57	50.4	28	17.8
More than 5 years	97	76.4	67	47.9	49	30.4	56	49.6	129	82.2
Lifestyle behaviours										
Average eating behaviour score	119	5.4 (1.9)	113	5.2 (1.9)	153	3.4 (2.0)	97	3.9 (1.9)	150	4.0 (2.2)
Meeting PA guideline	126		123		161		109		154	

(Continues)

TABLE 1 (Continued)

	Burmese/ Vietnamese		Sri Lankan/ Bhutanese		Afghani/ Arabic		Somalian/ Sudanese		Pacific Islander	
	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)
<150 min/week	80	63.5	76	61.8	107	66.5	61	56.0	102	66.2
≥150 min/week	46	36.5	47	38.2	54	33.5	48	44.0	52	33.8
Cardiometabolic risk										
Mean BMI (kg/m^2)	126	25.1 (4.1)	140	26.3 (4.2)	161	27.6 (5.4)	112	28.1 (5.8)	156	36.3 (7.6)
Mean waist circumference (cm)	126	87.3(10.6)	137	92.4 (10.8)	161	91.6 (13.0)	110	90.9 (14.3)	151	110.9 (14.0)
Mean WHtR	126	0.57 (0.1)	137	0.58 (0.1)	161	0.57 (0.1)	110	0.55 (0.1)	151	0.66 (0.1)
Mean systolic blood pressure (mmHg)	127	125.4 (19.1)	140	125.9 (18.4)	161	122.2 (15.1)	113	124.5 (11.3)	149	136.4 (24.4)
Mean diastolic blood pressure (mmHg)	127	78.1 (11.5)	139	78.4 (11.7)	161	75.9 (9.9)	112	78.8 (9.6)	149	90.3 (16.6)
Hypertension	127		139		161		112		149	
No	92	72.4	97	69.8	134	83.2	92	82.1	67	45.0
Yes	35	27.6	42	30.2	27	16.8	20	17.9	82	55.0

no children", "single parent living with one or more children", "single living with friends or relatives", "couple living with no children" or "couple living with children".

Eating behaviour score was calculated as follows. First, frequencies of having fruit, vegetables, processed meat, fast food, hot chips, salty and sweet snacks, sweetened beverages and type of consumed milk were asked using questions from the Australian National Health Survey (Australian Bureau of Statistics, 2011) and the Queensland Self-reported Health Status Survey. Second, if the frequencies were ≥2 pieces of fruit/day, ≥5 servings of vegetables/day, <1 time/week for processed meat, meals from fast food/takeaway outlets, hot chips/fries, salty snacks, sweet snacks and sweetened beverages, one point was assigned. Otherwise, a zero was given. One point was also given if low fat milk was chosen. Finally, eating behaviour score was calculated as a sum of these points ranging from 0 to 9.

Physical activity (PA): three questions from the Active Australia survey (Australian Institute of Health & Welfare, 2003) were used to identify the time participants spent on walking, moderate and vigorous PA in the last week. The total activity time was calculated as a sum of these times (with vigorous PA time doubled). Participants were identified as meeting the PA guideline when the total activity time is at least 150 min/week and as not meeting the PA guideline when the total time is <150 min/week.

2.4 | Data analysis

Data analyses were conducted using SAS software, v9.4. Descriptive statistics were generated and presented for each ethnic group including frequencies and percentages for categorical variables, means and standard deviation for continuous variables. Linear regressions were run separately for BMI, Waist and WHtR as an outcome whereas logistic regressions were run when hypertension was the outcome. For each marker, separate crude models including either ethnicity or time in Australia were run. Multivariable models including eating and PA behaviours, ethnicity, time in Australia, age, gender, educational qualification, employment status and household type were also run for each marker. Tukey-Kramer adjustment was applied for multiple comparisons between ethnic groups. Estimated differences or odds ratios in the outcomes between ethnic groups and 95% confidence intervals were reported. All p-values were two-sided and considered statistically significant if <0.05.

3 | RESULTS

Among 700 participants, 16% were Somalian/Sudanese, 18% Burmese/Vietnamese, 20% Sri Lankan/Bhutanese and 23% each for Afghani/Arabic and Pacific Islander. About 19% of the participants were recruited from rural areas. Demographic characteristics, eating and PA behaviours and cardiometabolic risk markers across ethnic groups are presented in Table 1. Average age of participants in each group ranged from 36 years for Somalian/Sudanese to 55 years for Burmese/Vietnamese. A majority of the participants in all groups

TABLE 2 Differences or odds ratios (95% CI) in cardiometabolic risk markers among ethnic groups

	BMI[a]		Waist[a]		WHtR[a]		Hypertension[b]	
	Model 1[c] (*n* = 695)	Model 2[d] (*n* = 577)	Model 1 (*n* = 685)	Model 2 (*n* = 572)	Model 1 (*n* = 685)	Model 2 (*n* = 572)	Model 1 (*n* = 688)	Model 2 (*n* = 572)
Burmese/Vietnamese	0	0	0	0	0	0	1	1
Sri Lankan/Bhutanese	1.2 (−0.6, 3.1)	2.1 (−0.2, 4.4)	5.1 (0.8, 9.3)*	6.3 (1.2, 11.4)**	0.012 (−0.015, 0.040)	0.038 (0.006, 0.070)**	1.1 (0.5, 2.4)	3.1 (1.1, 9.0)*
Afghani/Arabic-speaking	2.4 (0.6, 4.2)**	3.7 (1.4, 5.9)***	4.3 (0.2, 8.4)**	8.4 (3.5, 13.3)***	<0.001 (−0.026, 0.027)	0.033 (0.002, 0.064)*	0.5 (0.2, 1.2)	1.4 (0.5, 4.3)
Somalian/Sudanese	3.1 (1.1, 5.1)***	4.7 (2.2, 7.2)***	3.6 (−0.9, 8.1)	9.1 (3.5, 14.6)***	−0.014 (−0.042, 0.015)	0.027 (−0.007, 0.062)	0.6 (0.2, 1.4)	2.6 (0.8, 9.0)
Pacific Islander	11.3 (9.4, 13.1)***	11.6 (9.5, 13.6)***	23.5 (19.4, 27.7)***	24.0 (19.4, 28.5)***	0.095 (0.068, 0.121)***	0.111 (0.082, 0.139)***	3.2 (1.6, 6.5)***	4.4 (1.7, 11.1)***

[a]Differences in BMI, Waist, or WHtR between the other groups and the Burmese/Vietnamese group are reported. [b]"No hypertension" is the reference. Odds Ratios for each group compared to the Burmese/Vietnamese group are reported. [c]Model 1 provides crude differences or Odds Ratios. [d]Model 2 provides differences or Odds Ratios adjusted for eating and physical activity behaviours, time in Australia, age, gender, education, employment type and household type. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

were female ranging from 54% for Sri Lankan/Bhutanese to 81% for Afghani/Arabic. More than half of Sri Lankan/Bhutanese and Afghani/Arabic had a degree above high school whereas only about one-fifth of Somalian/Sudanese did. A majority of Pacific Islanders had paid work; nearly half of Burmese/Vietnamese and Afghani/Arabic were respectively retired/unemployed and students. For all ethnic groups, the most common household type was couples living with or without children. Less than one-third of Afghani/Arabic had lived in Australia for more than five years whereas most Burmese/Vietnamese and Pacific Islanders had lived in Australia for more than five years.

On average, Burmese/Vietnamese had the highest eating behaviour scores of 5.4 whereas Afghani/Arabic had the lowest of 3.4. Percentages of participants meeting the PA guideline were from 33.5% (Afghani/Arabic) to 44% (Somalian/Sudanese). On average, Pacific Islanders had the highest BMI, waist circumference, WHtR and blood pressure among the groups. Although Burmese/Vietnamese had the lowest average BMI and waist, Somalian/Sudanese had the lowest WHtR whereas Afghani/Arabic had the lowest percentage of those with hypertension.

Differences in cardiometabolic risk markers among ethnic groups are presented in Table 2. Bivariate analyses showed that on average, Burmese/Vietnamese participants had significantly lower BMI than Afghani/Arabic, Somalian/Sudanese and Pacific Islanders participants by 2.4 ($p < 0.01$), 3.1 ($p < 0.001$) and 11.3 points ($p < 0.001$) respectively. Differences in waist circumference between Burmese/Vietnamese with Sri Lankan/Bhutanese, Afghani/Arabic and Pacific Islanders were 5.1 cm ($p < 0.05$), 4.3 cm ($p < 0.01$) and 23.5 cm ($p < 0.001$) respectively. However, only Pacific Islanders showed significantly higher mean values of WHtR (0.095, $p < 0.001$) and higher odds of being hypertensive (OR = 3.2, $p < 0.001$) compared to Burmese/Vietnamese.

Multivariable analyses controlled for eating and PA behaviours, time in Australia, age, gender, education level, employment status and household type showed similar results for BMI as those in bivariate analyses. Adjustment for the covariates did not substantially alter the estimates of waist circumference for all groups, except for the Somalian/Sudanese, which increased from 3.6 to 9.1 ($p < 0.001$) (Table 2). The differences in WHtR between Burmese/Vietnamese with Sri Lankan/Bhutanese ($p < 0.01$) and Afghani/Arabic ($p < 0.05$) were also significant. Burmese/Vietnamese were also less likely to be hypertensive compared to Sri Lankan/Bhutanese (OR = 3.1, $p < 0.05$) and Pacific Islanders (OR = 4.4, $p < 0.001$).

Table 3 describes cardiometabolic risks between those staying in Australia for ≤5 years (short stay) and >5 years (long stay). On average, long-stay immigrants had higher BMI, waist circumferences, WHtR and blood pressure compared to short-stay immigrants. Proportions of immigrants with hypertension were 38.8% and 18.2% for long-stay and short-stay immigrants respectively.

Differences in cardiometabolic risks between long-stay and short-stay immigrants are presented in Table 4.

Bivariate and multivariable analyses showed significant differences in cardiometabolic risks between two groups. After controlling

TABLE 3 Cardiometabolic risks between those staying in Australia for long and short time

	Long stay (>5 years)		Short stay (≤5 years)	
	N	% or mean (*SD*)	*N*	% or mean (*SD*)
Average BMI (kg/m^2)	396	30.2 (7.6)	297	27.1 (5.6)
Average waist circumference (cm)	390	97.9 (15.8)	293	91.3 (13.6)
Average WHtR	390	0.61 (0.09)	293	0.56 (0.08)
Average systolic blood pressure (mmHg)	390	130.4 (20.8)	298	122.5 (15.5)
Average diastolic blood pressure (mmHg)	389	82 (14.4)	297	78.2 (11.4)
Hypertension				
No	238	61.2	243	81.8
Yes	151	38.8	54	18.2

TABLE 4 Differences or Odds Ratios (95% CI) in cardiometabolic risks between long-stay and short-stay groups

	Model 1[c]		Model 2[d]	
	n	Estimate	*n*	Estimate
BMI[a]	693	3.08 (2.06, 4.11)***	577	1.16 (0.09, 2.22)*
Waist[a]	683	6.62 (4.37, 8.87)***	572	2.38 (0.03, 4.74)*
WHtR[a]	683	0.043 (0.030, 0.056)***	572	0.015 (<0.001, 0.029)*
Hypertension[b]	686	2.86 (1.99, 4.09)***	572	2.02 (1.23, 3.35)**

[a]Differences in BMI, Waist, or WHtR between long-stay versus short-stay groups are reported. [b]"No hypertension" is the reference. Odds Ratios for long-stay group compared to short-stay group are reported. [c]Model 1 provides crude differences or Odds Ratios. [d]Model 2 provides differences or Odds Ratios adjusted for eating and physical activity behaviours, ethnicity, age, gender, education, employment type and household type. *p < 0.05, **p < 0.01, ***p < 0.001.

for eating and PA behaviours, ethnicity, age, gender, education, employment type and household type, immigrants living in Australia >5 years had on average 1.16 points higher in BMI, 2.38 cm larger in waist circumference, and 0.015 points higher in WHtR (p < 0.05) compared to those living for ≤5 years. Long-stay immigrants were also more likely to be hypertensive than short-stay immigrants (OR = 2.02, p < 0.01).

4 | DISCUSSION

In this study, we found that Pacific Islanders living in Queensland had the greatest cardiometabolic risk and participants from Vietnam/Myanmar had the lowest, among a range of ethnic groups who began a chronic condition prevention and management program. There were subtle variations in risk between different ethnic groups depending on the tool used. Finally, cardiometabolic risk increased within five years of settling in a high income country and this risk may be mediated by factors other than PA and dietary intake.

In this sample, compared to the Burmese/Vietnamese who had the lowest cardiometabolic risk, Pacific Islanders had the greatest risk across all markers (BMI, waist circumference, WHtR and hypertension) after controlling for the sociodemographic factors, length of time in Australia, as well as eating and PA behaviours. Pacific Islanders who included those from Samoa, Tonga, Cook Islands and other island nation states, also have significant cardiometabolic risk in their countries of origin. BMI has been increasing in Oceania (in particular among women) (Finucane et al., 2011) as has blood pressure (Danaei et al., 2011; Lehtimäki, Uusitalo, & Collaboration, 2018).

All ethnic groups in this study had reasonably high mean WHtR ranging from 0.55 (Somali/Sudanese) to 0.66 (Pacific Islander) (Table 1). This indicates that all participants were exhibiting some level of cardiometabolic risk (cut-off is 0.5 and above) (cut-off is 0.5 and above) (Ashwell & Hsieh, 2005). Obesity and in particular central obesity is recognised as one of the leading risk factors for the development of chronic conditions. WHtR has been identified as being more predictive of early cardiometabolic risk than BMI or waist circumference alone (M. Ashwell & Gibson, 2016). This is especially the case given the ethnic differences in body composition and controversy over BMI cut-offs indicative of heightened risk. BMI cut-offs for Asian populations, that indicate heightened risk for public health action are currently 23 kg/m^2 (WHO Expert Consultation, 2004). Likewise, waist circumference cut-offs indicating elevated risk are lower for Asian populations at 90c m or more for men (compared to 94 cm for non-Asian populations) and 80 cm or more for women (this is the same for all women regardless of ethnicity). More recent data are indicating much lower cut-offs for Asian men and women (82.5 and 73.5 respectively) (Ponnalagu, Bi, & Henry, 2018) and for Sub-Saharan Africans where for women it

stands at about 80cm but for men is much lower at around 81 cm (Ekoru et al., 2018). For Pacific Islanders, there has also been discussion on the appropriate cut-off points for BMI, given that Pacific Islanders have a lower percentage of fat at higher BMIs. However, diversity within the Pacific Island group and lack of comprehensive data make determining differential BMI cut-offs difficult (Merriman & Wilcox, 2018). Previous research appears to indicate that WHtR (with a cut-off of 0.5 and above indicating elevated risk), despite some variations in sensitivity and specificity to be an adequate screener for cardiometabolic risk across ethnic groups (Kazlauskaite et al., 2017; Ware et al., 2014).

Regardless of country of origin, and after taking into account sociodemographic factors as well as eating and physical activity behaviours – those who had been in Australia for longer than 5 years had increased cardiometabolic risk. This concurs with a range of studies in high income countries that as acculturation occurs the "healthy migrant effect" wanes. For example, in a multiethnic sample in the USA, length of time those who had been in the USA for longer than 15 years were more likely to display cardiovascular disease risk factors but were also less likely to be sedentary (Koya & Egede, 2007). In a study of Asian migrants in Australia, indications were that the longer the time spent in Australia (that is, greater than 10 years) cardiovascular disease risk increased and that Asian were less likely to be overweight. They also found that PA increased with length of time (Guo et al., 2015). In another secondary analysis of longitudinal data, indications were that migrant men who had been in Australia for greater than 15 years were at heightened risk (Menigoz et al., 2016). Care needs to be taken with these interpretations as the ethnic groupings were large which could mask or distort findings in sub-groups (Parackal, Stewart, & Ho, 2017).

This study has found that cardiometabolic risk could increase much sooner on settlement. This could reflect changes in cardiometabolic risk in countries of origin (Danaei et al., 2011; Finucane et al., 2011). Given that chronic conditions have an increased global incidence and prevalence and the role of early life programming in establishing disease risk, it is highly likely that cardiometabolic risk is present on arrival and/or manifests very rapidly thereafter (World Health Organization, 2017). In addition, it was unknown how long migrants and/or refugees had spent in other high income transition countries and this may impact on the time spent in country before risk manifests.

The other finding in this study is the increase in cardiometabolic risk after controlling for sociodemographic factors as well as dietary intake and PA behaviours. Changes to PA (which in most cases gets better on acculturation) and dietary habits (which tend to move away from healthier traditional diets) are most commonly implicated in the increase in risk after settlement. However, the increase in cardiometabolic risk remained after controlling for these factors as well as for education and income. This could indicate that while changes in lifestyle are important, there may exist other factors that contribute to the inflammatory process. These factors could include stress, experiences of discrimination, cultural stigma, and marginalisation while in Australia, poorer working and living environments, dealing with previous and current trauma, lack of social support and poor access to healthcare due to cultural and language barriers (Chen, Hall, Ling, & Renzaho, 2017; Lassetter & Callister, 2009; Yoshida et al., 2018). Ensuring that settlement proceeds smoothly and dealing with the effects of trauma may be vital in improving long-term physical health outcomes. Stress and trauma-related issues may need to be investigated in more depth as a potential contributing factor to the inflammatory processes related to chronic disease.

This study had a number of strengths. First, groups while combined were kept as unique as possible in order to pick up nuances that may be missed in larger analyses of secondary data. In addition, the groups represented here provide information on established as well as emerging ethnic communities in the Australian context. All the data were collected in the participant's first or preferred language, therefore minimising the potential for loss of understanding. In addition, there was not a reliance on self-reported data but rather anthropometric and blood pressure was measured by a trained MHW. There are a number of limitations. The nature of our sample makes it difficult to generalise results to the entire immigrant population. This cross-sectional study included participants at the baseline of a chronic condition prevention and management program. Thus, the sample is potentially skewed towards those with ongoing health issues. Likewise, there were significantly higher numbers of women in the sample, suggesting that the sample may not be representative of the entire ethnic community. Although we have controlled for level of education and employment status in our multivariable analysis, we did not have income data and therefore were not able to control for this factor in the analysis. However, we believe that education level and employment status are correlated with income and could be used to represent socioeconomic status. Finally, the length of time in Australia did not cover length of time in a transitioning country which could potentially increase risk and self-reported data on PA and dietary intake may be subject to recall bias.

5 | CONCLUSIONS

Cardiometabolic risk is highest in the Pacific Islander groups in Queensland and as such there should be a strong focus in these communities on programming that will facilitate access to culturally appropriate healthcare systems that will optimise health. Cardiometabolic risk potentially begins much earlier in the settlement process than previously expected. Cardiometabolic risk may be associated with other factors apart from PA and dietary intake that could include stress and/or trauma associated with migration and/or previous refugee experiences. Holistic care that is tailored needs to be developed and put into place. In particular, programmes that potentially focus on chronic condition outcomes but that minimise stress associated with migration and acknowledge trauma should be developed.

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REFERENCES

Abouzeid, M., Philpot, B., Janus, E. D., Coates, M. J., & Dunbar, J. A. (2013). Type 2 diabetes prevalence varies by socio-economic status within and between migrant groups: Analysis and implications for Australia. *BMC Public Health*, *13*, 252–252. https://doi.org/10.1186/1471-2458-13-252

Alidu, L., & Grunfeld, E. (2018). A systematic review of acculturation, obesity and health behaviours among migrants to high-income countries. *Psychology & Health*, *33*(6), 724–745. https://doi.org/10.1080/08870446.2017.1398327

American Heart Association. (2018). Understanding blood pressure readings. Retrieved from http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/KnowYourNumbers/Understanding-Blood-Pressure-Readings_UCM_301764_Article.jsp#.Wm5oZa6WY-c.

Anikeeva, O., Bi, P., Hiller, J. E., Ryan, P., Roder, D., & Han, G.-S. (2015). Trends in migrant mortality rates in Australia 1981–2007: A focus on the National Health Priority Areas other than cancer. *Ethnicity & Health*, *20*(1), 29–48. https://doi.org/10.1080/13557858.2014.883368

Ashwell, M., & Gibson, S. (2016). Waist-to-height ratio as an indicator of 'early health risk': Simpler and more predictive than using a 'matrix'based on BMI and waist circumference. *BMJ Open*, *6*(3), e010159. https://doi.org/10.1136/bmjopen-2015-010159

Ashwell, M., Gunn, P., & Gibson, S. (2012). Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systematic review and meta-analysis. *Obesity Reviews*, *13*(3), 275–286. https://doi.org/10.1111/j.1467-789X.2011.00952

Ashwell, M., & Hsieh, S. D. (2005). Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *International Journal of Food Sciences and Nutrition*, *56*(5), 303–307. https://doi.org/10.1080/09637480500195066

Australian Bureau of Statistics. (2011). National Nutrition and Physical Activity Survey 2011–12: Questionnaire. Retrieved from Canberra: http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/734DF823586D5AD9CA257B8E0014A387/$File/national%20nutrition%20and%20physical%20activity%20survey%202011-12%20questionnaire.pdf.

Australian Bureau of Statistics. (2017). Census of Population and Housing: Reflecting Australia - Stories from the Census, 2016 2071.0. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/2071.0

Australian Institute of Health and Welfare. (2003). The active Australia survey: A guide and manual for implementation, analysis and reporting. Retrieved from https://www.aihw.gov.au/reports/physical-activity/active-australia-survey/contents/table-of-contents

Chen, W., Hall, B. J., Ling, L., & Renzaho, A. M. N. (2017). Pre-migration and post-migration factors associated with mental health in humanitarian migrants in Australia and the moderation effect of post-migration stressors: Findings from the first wave data of the BNLA cohort study. *The Lancet Psychiatry*, *4*(3), 218–229. https://doi.org/10.1016/S2215-0366(17)30032-9

Commodore-Mensah, Y., Ukonu, N., Obisesan, O., Aboagye, J. K., Agyemang, C., Reilly, C. M., … Okosun, I. S. (2016). Length of residence in the united states is associated with a higher prevalence of cardiometabolic risk factors in immigrants: A contemporary analysis of the National Health Interview Survey. *Journal of the American Heart Association*, *5*(11), https://doi.org/10.1161/jaha.116.004059

Danaei, G., Finucane, M. M., Lin, J. K., Singh, G. M., Paciorek, C. J., Cowan, M. J., … Ezzati, M. (2011). National, regional, and global trends in systolic blood pressure since 1980: Systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5·4 million participants. *The Lancet*, *377*(9765), 568–577. https://doi.org/10.1016/S0140-6736(10)62036-3

Dong, B., Arnold, L. W., Peng, Y., & Wang, Z. (2016). Ethnic differences in cardiometabolic risk among adolescents across the waist–height ratio spectrum: National Health and Nutrition Examination Surveys (NHANES). *International Journal of Cardiology*, *222*, 622–628. https://doi.org/10.1016/j.ijcard.2016.07.169

Eastwood, S. V., Tillin, T., Dehbi, H.-M., Wright, A., Forouhi, N. G., Godsland, I., … Chaturvedi, N. (2015). Ethnic differences in associations between fat deposition and incident diabetes and underlying mechanisms: The SABRE study. *Obesity*, *23*(3), 699–706. https://doi.org/10.1002/oby.20997

Ekoru, K., Murphy, G. A. V., Young, E. H., Delisle, H., Jerome, C. S., Assah, F., … Sandhu, M. S. (2018). Deriving an optimal threshold of waist circumference for detecting cardiometabolic risk in sub-Saharan Africa. *International Journal of Obesity*, *42*(3), 487. https://doi.org/10.1038/ijo.2017.240

El Masri, A., Kolt, G. S., Astell-Burt, T., & George, E. S. (2017). Lifestyle behaviours of Lebanese-Australians: Cross-sectional findings from the 45 and up study. *PLoS One*, *12*(7), e0181217. https://doi.org/10.1371/journal.pone.0181217

Finucane, M. M., Stevens, G. A., Cowan, M. J., Danaei, G., Lin, J. K., Paciorek, C. J., … Bahalim, A. N. (2011). National, regional, and global trends in body-mass index since 1980: Systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9· 1 million participants. *The Lancet*, *377*(9765), 557–567.

Goris, J., Komaric, N., Guandalini, A., Francis, D., & Hawes, E. (2012). Effectiveness of multicultural health workers in chronic disease prevention and self-management in culturally and linguistically diverse populations: A systematic literature review. *Australian Journal of Primary Health*, *19*(1), 14–37. https://doi.org/10.1071/PY11130

Gujral, U. P., Vittinghoff, E., Mongraw-Chaffin, M., Vaidya, D., Kandula, N. R., Allison, M., … Kanaya, A. M. (2017). Cardiometabolic abnormalities among normal-weight persons from five racial/ethnic groups in the united states: A cross-sectional analysis of two cohort studies. *Annals of Internal Medicine*, *166*(9), 628–636. https://doi.org/10.7326/M16-1895

Guo, S., Lucas, R. M., Joshy, G., & Banks, E. (2015). Cardiovascular disease risk factor profiles of 263,356 older Australians according to region of birth and acculturation, with a focus on migrants born in

Asia. *PLoS One*, *10*(2), e0115627. https://doi.org/10.1371/journal.pone.0115627

Henderson, S., Kendall, E., & See, L. (2011). The effectiveness of culturally appropriate interventions to manage or prevent chronic disease in culturally and linguistically diverse communities: A systematic literature review. *Health & Social Care in the Community*, *19*(3), 225–249. https://doi.org/10.1111/j.1365-2524.2010.00972.x

Jasso, G., Massey, D., Rosenzweig, M., & Smith, J. (2004). Immigrant health: Selectivity and acculturation. In N. B. Anderson, R. A. Bulatao, & B. Cohen (Eds.), *Critical perspectives on racial and ethnic differences in health in late life* (pp. 227–266). Washington, DC: National Academies Press.

Kazlauskaite, R., Avery-Mamer, E. F., Li, H., Chataut, C. P., Janssen, I., Powell, L. H., & Kravitz, H. M. (2017). Race/ethnic comparisons of waist-to-height ratio for cardiometabolic screening: The study of women's health across the nation. *American Journal of Human Biology*, *29*(1). https://doi.org/10.1002/ajhb.22909

Koya, D. L., & Egede, L. E. (2007). Association between length of residence and cardiovascular disease risk factors among an ethnically diverse group of United States immigrants. *Journal of General and Internal Medicine*, *22*, 841–846. https://doi.org/10.1007/s11606-007-0163-y

Lassetter, J. H., & Callister, L. C. (2009). The impact of migration on the health of voluntary migrants in western societies: A review of the literature. *Journal of Transcultural Nursing*, *20*(1), 93–104. https://doi.org/10.1177/1043659608325841

Lehtimäki, T., Uusitalo, H., & Collaboration, N. R. F. (2018). Contributions of mean and shape of blood pressure distribution to worldwide trends and variations in raised blood pressure: a pooled analysis of 1018 population-based measurement studies with 88.6 million participants. *International Journal of Epidemiology*, *47*(3), 872–883. https://doi.org/10.1093/ije/dyy016

Menigoz, K., Nathan, A., & Turrell, G. (2016). Ethnic differences in overweight and obesity and the influence of acculturation on immigrant bodyweight: Evidence from a national sample of Australian adults. *BMC Public Health*, *16*(1), 932. https://doi.org/10.1186/s12889-016-3608-6

Merriman, T. R., & Wilcox, P. L. (2018). Cardio-metabolic disease genetic risk factors among Māori and Pacific Island people in Aotearoa New Zealand: Current state of knowledge and future directions. *Annals of Human Biology*, *45*(3), 202–214. https://doi.org/10.1080/03014460.2018.1461929

Newbold, K. B., & Danforth, J. (2003). Health status and Canada's immigrant population. *Social Science & Medicine*, *57*(10), 1981–1995. https://doi.org/10.1016/S0277-9536(03)00064-9

Odone, A., McKee, C., & McKee, M. (2018). The impact of migration on cardiovascular diseases. *International Journal of Cardiology*, *254*, 356–361. https://doi.org/10.1016/j.ijcard.2017.11.084

Parackal, S., Stewart, J., & Ho, E. (2017). Exploring reasons for ethnic disparities in diet- and lifestyle-related chronic disease for Asian sub-groups in New Zealand: A scoping exercise. *Ethnicity & Health*, *22*(4), 333–347. https://doi.org/10.1080/13557858.2016.1246424

Ponnalagu, S., Bi, X., & Henry, C. J. (2018). Is waist circumference more strongly associated with metabolic risk factors in Asians than waist-to-height ratio? *Nutrition*, https://doi.org/10.1016/j.nut.2018.09.005

Queensland Government. (2013). Pacific Islander and Maori population size and distribution. Retrieved from https://www.health.qld.gov.au/multicultural/health_workers/pac-island-pop.

Queensland Government. (2018). Diversity figures. Retrieved from https://www.dlgrma.qld.gov.au/resources/multicultural/communities/diversity-figures-report.pdf.

Queensland Health. (2012). Summary of health data on culturally and linguistically diverse populations in Queensland. Retrieved from https://www.health.qld.gov.au/__data/assets/pdf_file/0033/388527/health-data-summary.pdf.

Renzaho, A. M. N., Bilal, P., & Marks, G. C. (2014). Obesity, type 2 diabetes and high blood pressure amongst recently arrived sudanese refugees in Queensland, Australia. *Journal of Immigrant and Minority Health*, *16*(1), 86–94. https://doi.org/10.1007/s10903-013-9791-y

Ruilope, L. M., De La Sierra, A., Segura, J., & Garcia-Donaire, J. A. (2007). The meaning of cardiometabolic risk in hypertensive patients. *US Endocrinology*, *1*, 60–63. https://doi.org/10.17925/USE.2007.00.1.60

Sanou, D., O'Reilly, E., Ngnie-Teta, I., Batal, M., Mondain, N., Andrew, C., … Bourgeault, I. L. (2014). Acculturation and nutritional health of immigrants in Canada: A scoping review. *Journal of Immigrant and Minority Health*, *16*(1), 24–34. https://doi.org/10.1007/s10903-013-9823-7

Sarich, P. E. A., Ding, D., Sitas, F., & Weber, M. F. (2015). Co-occurrence of chronic disease lifestyle risk factors in middle-aged and older immigrants: A cross-sectional analysis of 264,102 Australians. *Preventive Medicine*, *81*, 209–215. https://doi.org/10.1016/j.ypmed.2015.09.004

Ware, L. j., Rennie, K. l., Kruger, H. s., Kruger, I. m., Greeff, M., Fourie, C., … Schutte, A. e. (2014). Evaluation of waist-to-height ratio to predict 5 year cardiometabolic risk in sub-Saharan African adults. *Nutrition, Metabolism and Cardiovascular Diseases*, *24*(8), 900–907. https://doi.org/10.1016/j.numecd.2014.02.005

Welsh, P., Cezard, G., Gill, J. m., Wallia, S., Douglas, A., Sheikh, A., … Sattar, N. (2016). Associations between weight change and biomarkers of cardiometabolic risk in South Asians: Secondary analyses of the PODOSA trial. *International Journal of Obesity*, *40*(6), 1005. https://doi.org/10.1038/ijo.2016.35

WHO Expert Consultation. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *The Lancet*, *363*(9403), 157–163.

World Health Organization. (1995). Physical status: The use of and interpretation of anthropometry, Report of a WHO Expert Committee. Retrieved from http://apps.who.int/iris/bitstream/10665/37003/1/WHO_TRS_854.pdf

World Health Organization. (2017).Noncommunicable diseases: progress monitor 2017.. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/258940/9789241513029-eng.pdf;jsessionxml:id=762BABC54DA5A6D6C5AEAE75AA690FF6?sequence=1

Yoshida, Y., Broyles, S., Scribner, R., Chen, L., Phillippi, S., Jackson-Thompson, J., … Tseng, T.-S. (2018). Social support modifies the negative effects of acculturation on obesity and central obesity in Mexican men. *Ethnicity & Health*, 1–12. https://doi.org/10.1080/13557858.2018.1492708

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