Title: The Effectiveness of Living Well Multicultural – Lifestyle Management Program among Ethnic Populations in Queensland, Australia.

Abstract

Issue: Some migrant groups have higher risks of deaths and chronic diseases due to barriers associated with socioeconomic disadvantage, social isolation, racism, language, poor access to health services, and low levels of health literacy. However, few culturally-tailored interventions have targeted ethnic groups in Australia. This study evaluated the effectiveness of the Living Well Multicultural-Lifestyle Management Program (LWM-LMP) in Queensland, Australia.

Methods: The LWM-LMP was originally co-designed with the targeted communities. Participants aged ≥ 18 years were eligible to participate without a fee. The evaluation was a quasi-experimental design without a control group was conducted with data collected at baseline, the end of the program, and after-program follow-up at week 14. The program lasted eight weeks with one group-based session of 120 minutes delivered each week in local community venues. Each session also included time to undertake physical activity (PA). Eating and PA behaviours were self-reported. Weight, height, waist circumference, and blood pressure were measured using standard protocols.

Results: Participants were more likely to consume ≥2 servings of fruit/day, five servings of vegetable/day, low fat milk, processed meat, fast food, hot chips/fries, salty snack, sweet snack, sweet beverages less than once per week, and meet the PA recommendation of ≥150 minutes/week (p-values<0.001) at week eight. Weight, BMI, waist circumference, waist-to-height ratio, and blood pressure were also improved at week eight. Many of the changes were sustained at week 14.

Conclusions: The LWM-LMP was effective in improving participants' lifestyle behaviours and cardio-metabolic indicators.

So what: Engaging targeted communities in designing interventions focussed on healthy personal behaviours helps with delivery and implementation. Behavioural interventions should be culturally-tailored to increase their effectiveness.

Key words: ethnic, cultural diversity, intervention, lifestyle, weight, waist circumference, blood pressure

Introduction

Australia as one of the most multicultural countries in the world has an obligation to ensure all of its residents have access to health resources to enable a healthy and active life. Certain ethnic communities in Australia have a higher burden of disease than the general Australian population with higher rates of all-cause mortality and hospitalisations due to chronic disease.(1)Recent research indicates a high prevalence of chronic disease risk factors in recently arrived humanitarian entrants.(2)With nearly 12% of Australians born overseas, not speaking English at home or speaking it poorly(3),it is imperative that members of culturally and linguistically diverse (CALD) communities are able to access culturally-tailored resources to facilitate changes in diet and physical activity behaviours to prevent and improve health conditions.(4)

Personal behaviours including diet, physical activity, smoking cessation and safe alcohol consumption are key factors influencing the prevention and management of chronic conditions. However, very little is known about the dietary and physical activity patterns of migrants and refugees living in Australia. There are small studies investigating individual groups in small geographical areas but these are neither recent nor representative.(5-8)Recently a qualitative study of South Asians living in Australia identified "hybrid" eating patterns, that is a combination of traditional and other diets.(9)International literature reports improvements in some practices for some groups on migration for example, increased consumption of fruit and vegetables and decreased consumption of deep fried foods.(10) However increases in more detrimental practices such as increased consumption of red meat, convenience foods, sugar sweetened beverages and dining out have also been reported.(10) Migration from a low-middle income country to an industrialised, high income country has previously been described as having a detrimental impact on chronic condition risk factors.(11-13)The longer the duration of residence, the higher the prevalence of risk factors (including weight), in particular the worsening of dietary and physical activity habits, that lead to morbidity and mortality from chronic conditions.(14-16) That food habits change on migration is without question, however, the direction of those changes and their impact on health, is less clear.(17, 18)

Reviews of combined diet and physical activity programs targeting those at higher risk of diabetes indicate they are effective in reducing cardiometabolic risk.(19) However, it is

increasingly recognised that a one-size-fits-all approach may not be successful in securing behaviour change especially in relation to eating and physical activity. For members of CALD communities, barriers associated with socioeconomic disadvantage, social isolation, racism, language, poor access to health services (prevention and treatment), and low levels of health literacy increase the risk of poor health outcomes.(4) Studies have examined the effectiveness of culturally adapted or culturally-tailored lifestyle modification programs.(20, 21) A review of interventions tailored specifically to immigrant groups in high income countries, designed to reduce the risk of obesity and obesity-related diseases identified key success factors as culturally appropriate facilitators, language, location and messaging.(22, 23)

Queensland has a diverse CALD population but with lower numbers (11% speaking a language other than English at home) than Victoria (26%) and New South Wales (25%).(24) Uniquely, Queensland has the highest diaspora of Pacific Islanders outside of New Zealand.(25) Health data indicates that mortality from avoidable causes is higher in the Oceania group (which includes Pacific and South Sea Islanders); and within this group the Samoan communities have the highest death rates.(26) Those originating from North Africa, Middle East, south-east Asia and Oceania have higher rates of morbidity associated with diabetes and cardiovascular disease respectively.(26) A study among newly arrived Sudanese refugees in Queensland identified that more than half were overweight and obese indicating the need for programs to prevent excessive weight gain and to reduce risk factors for diabetes and cardiovascular disease.(27) Cardiometabolic risk factors differ significantly between ethnic groups living in Queensland and risk appears to increase for those living in Australia for five or more years.(28)Despite the increased risk of chronic conditions, members of CALD communities are less likely to be proactive in accessing health care and have fewer options available for the implementation of preventative measures.(4) Given the lack of critical mass of individual communities and the high burden of disease; programs that facilitate changes to personal behaviours for chronic disease prevention and management need to cater for a diverse range of backgrounds but still be individually culturally relevant.

This study evaluates the effectiveness of the Living Well Multicultural – Lifestyle Management Program a culturally-tailored program to promote personal behaviours that ameliorate risk factors for and facilitate management of chronic disease in ethnic communities in Queensland, Australia.

Method

Study design

This was a pragmatic evaluation study that used a pre-post-test design with data collected at baseline, the end of an eight-week program, and after-program follow-up at week 14. The study did not include a comparison group for a number of reasons. First, people in some ethnic communities can form close networks making it difficult to control for cross-contamination between intervention and control groups, unless these groups are geographically distant. In addition, members of many ethnic communities can be hard to reach and therefore generating challenges for recruitment and engagement of participants. Funding, when available, is usually directed to resourcing programs to ensure cultural suitability (content and language) rather than necessarily investing in evaluation. These factors consequently limited the feasibility of a comparison group.

The evaluation sought to answer the following questions:

1. Who participated in the LMW-LMP (Reach)?
2. Was the program effective in changing personal behaviours (diet, physical activity, smoking, alcohol consumption)?
3. Was the program effective in reducing cardiometabolic risk?
4. Were there any differences in effectiveness of the program across ethnic groups?

Intervention

The Living Well Multicultural Lifestyle Modification Program (LWM-LMP), implemented by the <removed for blind review>, aimed to improve the knowledge and awareness of and change behaviours associated with a range of behaviours related to chronic disease among ethnic communities in Queensland, Australia. The program was delivered between October 2014 and June 2017.Targeted communities included Afghani, Arabic-speaking, Burmese (Myanmar), Bhutanese, Pacific and South Sea Islanders, Sri Lankan, Somali, Sudanese, and Vietnamese. A mix of emerging and established communities identified by either <removed for blind review> or Queensland Health as having higher chronic disease risk were targeted.

People from these communities who were at least 18 years old were eligible to participate without a fee. As sessions were delivered in CALD languages, the ability to speak English was not a criteria for inclusion. Recruitment was conducted using distributed printed materials in both English and in the respective languages of each community, the <removed for blind review> website and newsletters, advertisements in ethnic community newspapers and on radio channels, referrals by health professionals, and word-of-mouth. Participants provided written consent if they agreed to participate.

LWM-LMP was developed in consultation with the respective communities and Multicultural Health Workers (MHWs) based on the specific needs of each community. The program also applied a self-management framework and adult learning principles to facilitate behaviour change. The main program lasted eight weeks with one group-based session of 120 minutes delivered each week in local community venues. The content of the sessions are provided in Table 1. Each session included time to undertake physical activity that incorporated a program that could be undertaken at home. Participants were asked to establish individual goals after the completion of each session.

INSERT TABLE 1 HERE

The culturally-tailored sessions were delivered by MHWs who were bicultural, had overseas or Australian qualifications in health and at least half had a Certificate IV in Primary Health and Community Care (Multicultural). All MHWS were formally trained to ensure consistent and effective delivery of the program, received training in evaluation and in the administration of the evaluation tool to improve reliability. <Removed for blind review> staff monitored fidelity of the program with each MHW reviewed at least once program during delivery.

Ethical approval

Ethical approval was granted by <removed for Blind Review> Human Research Ethics Committee (1500000028).

Measurements

Face-to-face data collection was conducted by bilingual MHWs at baseline (Week 1), when the program was completed (Week 8), and at Week 14 to assess whether participants were able to maintain the changes after completing the program. An additional phone follow-up was also undertaken at Week 26 but not reported here. A structured questionnaire was used to collect data on demographic characteristics and eating and physical behaviours of participants. The evaluation tool was developed in consultation with MHWs, communities and <removed for blind review> staff and underwent rigorous content and face validity. The tools needed to strike a balance between cultural appropriateness and understanding and being able to compare results with the general Australian population. Questions were drawn from those that had previously been used and validated at the population level within Australia and were related to the content of the program. Questionnaires were translated into five languages, Arabic, Farsi, Samoan, Vietnamese and Myanmar. MHWs for these groups translated any qualitative responses back into English. For the remaining four communities, Sudanese, Tamil, Bhutanese and Somali the English version was used with MHWs translating as required. The Bhutanese and Somali participants were illiterate in their first language and so the data was collected by MHW interview.

Demographic characteristics including age in years, ethnic group (which were subsequently categorised for analysis into Burmese/Vietnamese, Sri-Lankan/Bhutanese, Afghani/Arabic-speaking, Somalian/Sudanese, Pacific Islander by geographical proximity), sex (male or female), highest level of education (primary, high school, certificate/diploma, or Bachelor/Postgraduate degree), employment status (paid work, work without pay, retired/unemployed, or student), and household types (living alone with no children, single parent living with children, single living friends/relatives, couple living with no children, or couple living with children) were self-reported by the participants.

Previously validated short dietary questions were modified. The stem of the questions remained with culturally appropriate examples added. For example, when asking about sweet snacks, in addition to confectionary, sweet cakes and pies, traditional foods such as oil cakes, baklava, wattappam and sticky rice cakes were added. Participants were asked about the frequencies of consuming healthy foods such as fruit, vegetables, and low fat milk as well as unhealthy ones including processed meat, fast food, hot chips, salty and sweet snacks, and sugar sweetened beverages.(29-31)Those who had at least two servings of fruit and five

servings of vegetables per day as indicated by the Australian Guide to Healthy Eating, were considered as meeting the recommendations for fruit and vegetable consumption.(32)

Questions based on the Active Australia Survey were used to assess the level of PA among participants.(31, 33)The questions were adapted by adding in culturally-tailored examples. These questions asked about minutes of walking continuously, moderate, and vigorous activities per day as well as the number of days per week participants engaged in these activities in the last week. The amount of time was calculated for each category with the amount time for vigorous PA doubled as per recommendations. The sum of these times was the total amount of time spent on moderate-vigorous physical activity (MVPA) in a week. Participants who engaged in at least 150 minutes of MVPA per week was considered to meet the PA guideline.(34)A majority of validated diet and physical activity tools have not been validated in CALD communities within the Australian context.

For smoking and alcohol consumption, questions based on the WHO smoking surveillance questionnaire (35) and the National Drug Household Survey(36) were used respectively. The questions were designed to elicit lifetime risk of drinking alcohol, types of alcohol consumed and alcohol consumed at a single sitting. Based on feedback from MHWs these questions were simplified. Under-reporting of smoking and alcohol consumption has been noted for migrant communities in particular amongst cultural groups practicing religions which prohibit alcohol consumption and amongst women (37). Alcohol consumption was reported and if consumed, how often and how much.

Cardiometabolic risks including weight (kg), waist circumference (cm), and diastolic and systolic blood pressure (mmHg) were measured by MHWs using standard protocols.(38)Height (m) was also measured in order to calculate Body Mass Index (BMI) as weight (kg)/height $(m)^2$. Waist-to-height ratio (WHtR) was calculated as waist circumference (cm)/height (cm).(39, 40) A WHtR $\geq$ 0.5 is increasingly being used as a simple tool to identify early health risk, it is independent of ethnicity and is more predictive than BMI and WC. (41)

An Excel database was developed to facilitate the collection and input of data. All MHWs were trained in the collection and inputting of the data. An <removed for blind review> staff member oversaw the data collection, queried missing and implausible data entries.

Data analyses

SAS software, v9.4 was used to perform statistical analyses. Frequencies and percentages were reported for categorical variables. Mean and standard deviation were reported for continuous variables. Differences in sample characteristics at three time points were tested using chi-square tests (for sex, ethnic group, education level, employment status, and household types) and ANOVA (for age). Generalised Estimating Equations (GEE) were used to assess improvements in eating and PA behaviours over the three time points. Changes in cardio-metabolic risks including BMI, waist, WHtR, and hypertension at three time points were also tested using GEE. Two models were run. Model 1 provided crude differences or odds ratios (OR) between time 2 vs. time 1, and time 3 vs. time 2 with 95%CI for each outcome. Model 2 provided the estimates adjusted for demographic characteristics. Post-hoc adjustment using Tukey-Kramer was applied for multiple comparisons between three time points. All p-values are two-sided and considered statistically significant if less than 0.05.

Results

Program Reach

A total of 49, eight-week programs were completed across nine CALD communities in seven hospital and health services within Queensland. The number of participants in each group ranged from 8-27. Overall attrition was 19.8% (the number of participants at baseline versus the number at week eight) with the higher attrition in the Bhutanese group (41.3%) and the lowest amongst the Arabic-speaking groups (3.3%). Completion of the program was considered undertaking seven and more sessions of the possible eight; 58% of participants completed the program. Among participants with complete data, about 74% attended at least seven sessions. There were no statistically significant differences between participants who enrolled, completed or were followed up. For eating and physical activity behaviours, a total number of 700 (97.9%) participants completed baseline data; 561 (80.1%) and 457 (65.3%) participants had complete data at week 8 and week 14 respectively. Cardiometabolic data were available for 695 participants at baseline, 563 participants (81.0%) at week 8 and 457 participants (65.8%) at week 14.

Average age of participants was 44 years (SD=15) and a majority of the participants were female (70%) (Table 1). Demographic characteristics including age, sex, education level, employment status and household types were not different across three time points. Although percentages of ethnic groups were different across three time points (p=0.05), the difference was not significant between baseline at immediately after the program (week eight) (p=0.36).

INSERT TABLE 2 HERE

Changes to personal behaviours

Table 3 shows eating and physical activity behaviours of participants at three time points. At baseline, just over half (52.3%) of participants met the recommendation regarding consumption of two or more serves of fruit per day and about one-third (36.7%) participated in at least 150 minutes of MVPA per week. Between one-third and one-quarter of participants were consuming unhealthy foods including processed meat, fast food/take away, hot chips/fries, salty snacks, sweet snacks and sugar-sweetened beverages, up to three times a week. However, less than 5% met the vegetable consumption recommendation of at least five servings of vegetables per day; and only one-quarter consumed low fat milk. After the program, at least two-thirds of participants had improved healthy eating and PA behaviours with the exception of vegetable consumption. Nearly one-fifth met the recommendation of five servings of vegetables per day. However, over three-quarters of participants increased their vegetable serves by at least one serve (76.7%).

INSERT TABLE 3 HERE

Statistical tests presented in Table 4 showed that after completing the program at week eight, compared to baseline, participants were more likely to consume at least two servings of fruit/day, five servings of vegetable/day, low fat milk, reduced consumption of processed meat, fast food, hot chips/fries, salty snack, sweet snack, sweet beverages to less than once per week, and meet the physical activity recommendation of at least 150 minutes/week (p-values<0.001). Moreover, six weeks after the program completed, these changes were not only sustained but kept improving for some behaviours including increased consumption of

fruit, decrease in consumption of sweet snacks, and beverages, and increased physical activity (p-values<0.01). Similar results were obtained after controlling for age, sex, ethnicity, education level, employment status, and household type.

INSERT TABLE 4 HERE

Limited data was collected on smoking and alcohol consumption, with missing data at 49% for alcohol consumption and 56% for smoking status. About one-fifth of participants indicated drinking alcohol with 30% of these indicating unsafe alcohol consumption. A majority of these were from the Pacific Islander cultural group. By the end of the program two-thirds (64%) if those not drinking safely were now doing so. For smoking only 7.5% (n=41) participants indicated that they smoked. By the end of the program about one-quarter of the smokers had indicated they had quit smoking (26.8%), an additional quarter had reduced their smoking and 15% had not reduced their smoking but had made an attempt to quit.

Changes to cardiometabolic risk

Table 5 show changes in cardiometabolic risks over time. At baseline, participants had a BMI, waist circumference, and WHtR of 76.2kg, 28.9kg/m^2, 95.1cm, and 0.59 respectively. The proportion of participants with hypertension at baseline was 29.9%. On average, participants were 0.72kg lighter in weight (p<0.001), 0.25 points lower in BMI (p<0.001), 1.42 points lower in waist circumference (p<0.001), and 0.01 points lower in WHtR (p<0.001) at completion of the program. Participants were also less likely to have hypertension at week eight compared to baseline (OR=0.74, p<0.01). After adjusting for demographic characteristics, the differences were 0.75kg for weight, 0.27 points for BMI, 1.48 points for waist circumference, and 0.01 for WHtR (all p-values<0.001). Adjusted OR was 0.69 for hypertension (p<0.01). The results also show that positive changes in these cardio-metabolic risks continued after the program ended. Compared to week eight, on average, participants had 0.48kg lower in weight (p<0.001), 0.18 points lower in BMI (p<0.001), 0.62 points lower in waist circumference (p<0.001), and 0.004 points lower in WHtR (p<0.001) at week 14. Likewise, participants were less likely to have hypertension at week 14 compared to week eight (OR=0.70, p<0.01). Adjusted differences were 0.53kg for weight, 0.20 points for BMI, 0.68 points for waist circumference, 0.004 points for WHtR (all p-values<0.001). Adjusted OR was 0.69 (p<0.05).

INSERT TABLE 5 HERE

Ethnic group differences

Table 6 shows crude differences for each ethnic group. At week eight, improvement was observed for all ethnic groups in nearly all outcomes. However, at week 14, some ethnic groups appeared not to be able to sustain the changes in some behaviours. Particularly for Pacific Islander peoples, there seemed to be a decrease in low fat milk consumption and an increase in consuming hot chips, sweet snacks, and processed meats although their cardiometabolic factors kept improving compared to week eight. Sri-Lankan/Bhutanese seemed to be less active and consumed more fast food/take away and hot chips compared to week eight. Their cardiometabolic factors also seemed to be worse at follow up compared to immediately after the completion of the program.

INSERT TABLE 6 HERE

Discussion

The delivery of an eight-week intensive program that incorporated physical activity successfully changed eating and physical activity behaviours of participating CALD communities. The improvement was modest but sustainable for BMI and central adiposity. Participants were successfully able to increase fruit and vegetable consumption and reduce consumption of unhealthy food. Some communities found these behaviours more difficult to sustain (although this was not statistically significant) and this may be due to how culturally significant certain food items are within the diet and/or other social and environmental factors that impact on these behaviours. The variations in cardiometabolic risk and the contributing personal behaviours between ethnic communities has been reported elsewhere.(28)

This is the first known evaluation of a multicultural program targeting personal behaviours likely to impact on chronic disease, in Australia. Other programs in Australia have focussed on individual CALD communities. For example, a 12 week program for Pakistani women (n=50) in Melbourne utilised 12 weekly modules led by a bicultural, trained nutritionist who also provided individual dietary counselling (three hours face-to-face and one hour on the telephone).(42) The intervention resulted in a significant increase in physical activity (measured), and significant decreases in BMI (1.2 points and 1.4 points at week 12 and week

24 respectively), systolic and diastolic blood pressure (-10 and -6 from baseline to week 24 respectively). These were unadjusted for other potential contributors. No other known Australian interventions were identified. The change in BMI was comparable to our intervention at 24 weeks.

In other countries, there has been a strong focus on minimising chronic disease risk among South Asian communities in the UK (43) and the USA.(44) An intervention in the UK (n=84) utilised 15 dietitian consultations over a three-year period resulting in a 0.6 point decrease in BMI and a 1.89 point decrease in waist circumference. Simple written advice about diet and lifestyle made no difference but a tailored, moderate-intensity intervention targeted at those at high risk was successful.(43)The intervention in the USA (n=36) was a 12-week program with weekly text reminders, led by a bicultural facilitator. Twenty minutes of physical activity was embedded in eight of the sessions. This intervention described significant changes in dietary behaviours and a reduction in waist circumference (1.45 points at the end of the intervention) that was maintained at follow-up. There were no differences in primary outcomes with the control group, possibly due to intervention diffusion between groups.(44)

Other interventions have been described in the USA with "minority" groups including Hispanic, Somali and Sudanese participants,(45) Samoan participants in New Zealand(46) and Iraqi participants in Sweden.(47) These interventions used twelve weekly home visits plus twelve phone calls for six months, thirty-one church based sessions over twelve months, and finally a series of seven group sessions over a four-month period. The Samoan and Iraqi interventions demonstrated similar decreases in BMI (0.2 and 0.6 respectively compared with 0.5 in this study) and similar waist circumference reduction (0.7 and 0.35 respectively compared to 0.6 unadjusted or 0.7 adjusted at week 24). The attrition rate for this program (20%) compared favourably with attrition rates for similar programs which ranged from 25% to 66%. (42, 44, 45, 47)

The significant amount of missing data related to smoking and alcohol consumption makes it difficult to draw any conclusions regarding the effectiveness of the program on these behaviours. Recent analysis of the Australian National Drug Strategy Household Survey (2013) indicated 11% of CALD adults were drinking alcohol and of these 8.3% presented with a high risk of alcohol-related harm.(48) Only 13% of the same sample identified as daily

smokers.(48). There is potentially a strong social desirability bias with respect to alcohol consumption and smoking especially in communities where these practices are proscribed by religion or culture. More work needs to be undertaken to ascertain the validity of the questions commonly used among different population groups and if bias can be reduced through different modalities of data collection.

The current eight-week culturally-tailored program appears to have performed comparably with other longer, more intensive interventions.(42-47) While a cost-benefit analysis was not undertaken it was facilitated by non-specialist MHWs, who delivered an eight-week group program in a community setting which is more cost-effective than specialist (dietitian) delivering individual coaching sessions. Some of the changes were difficult to maintain after the program completed and engagement with participants post-program may assist in maintaining longer-term commitment.

This study has a number of strengths and limitations. The strengths are the large sample size across a diversity of ethnic groups who participated in an eight-week program with minimal attrition. The tailored program delivered by a bicultural health worker from the targeted community was an additional strength. Weight, waist circumference and blood pressure were all measured by trained MHWs at baseline, end of program and six weeks after program completion. As the evaluation design was pragmatic, the limitations included that there was no control group. The program did not have a wait list and the risk of intervention diffusion was considered too high to recruit a comparable group to act as a control. The program did not reach an equal proportion of men and while ethnic diversity was taken into consideration with the design and implementation of the program, gender differences also need to be included. There was a possibility that participants were part of the same household but this could not be taken into consideration in the analysis. The large volume of missing data related to smoking and alcohol consumption brings into question the validity of these results. Dietary data was collected via short questions rather than using more comprehensive methodologies and physical activity was self-reported rather than objectively measured. The use of short questions and self-report physical activity attempted to reduce participant and MHW burden as part of the pragmatic design. These questions have not been validated in the individual CALD communities within the Australian context. Finally, only blood pressure was directly measured as an indicator of hypertension. More direct indicators of chronic

conditions such as blood glucose levels, glycosylated haemoglobin, blood lipids could not be collected.

Conclusions

A culturally-tailored eight-week program targeting physical activity, eating, smoking and alcohol consumption behaviours delivered by bicultural multicultural health workers from individual communities and utilising community engagement and was effective in reducing the risk of chronic conditions. Maintaining behaviour change for participants could be problematic and additional culturally-tailored support and longer-term engagement after completion of the program should be considered.

References

1. Anikeeva O, Bi P, Hiller JE, Ryan P, Roder D, Han G-S. Trends in migrant mortality rates in Australia 1981–2007: a focus on the National Health Priority Areas other than cancer. Ethnicity & Health. 2015;20(1):29-48.
2. Chandra M, Duri A, Smith M. Prevalence of chronic disease risk factors in 35- to 44-year-old humanitarian arrivals to New South Wales (NSW), Australia. Australian Journal of Primary Health. 2019;25(19-23).
3. Australian Bureau of Statistics. Census of Population and Housing: Reflecting Australia - Stories from the Census, 2016 Canberra: ABS; 2017 [Available from: http://www.abs.gov.au/ausstats/abs@.nsf/mf/2071.0.
4. Henderson S, Kendall E, See L. 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. 2011;19(3):225-49.
5. Renzaho AMN, Burns C. Post-migration food habits of sub-Saharan African migrants in Victoria: A cross-sectional study. Nutrition & Dietetics. 2006;63(2):91-102.
6. Hsu-Hage BHH, Ibiebele T, Wahlqvist ML. Food intakes of adult Melbourne Chinese. Australian Journal of Public Health. 1995;19(6):623-8.
7. Perkins KC, Ware R, Felise Tautalasoo L, Stanley R, Scanlan-Savelio L, Schubert L. Dietary habits of Samoan adults in an urban Australian setting: a cross-sectional study. Public Health Nutrition. 2015;19(5):788-95.
8. Gallegos D, Nasim S. Exploring weight status, dietary intake and acculturation in South Asian women living in Brisbane, Queensland. Nutrition & Dietetics. 2011;68(4):285-90.
9. Gupta SS, Teede H, Aroni R. Spicing up your advice for South Asian and Anglo-Australians with type 2 diabetes and CVD: Do cultural constructions of diet matter? Appetite. 2018;120:679-97.
10. Lesser IA, Gasevic D, Lear SA. The association between acculturation and dietary patterns of South Asian immigrants. . PloS one 2014;9.2 (e88495).
11. Commodore-Mensah Y, Ukonu N, Cooper LA, Agyemang C, Himmelfarb CDJJoI, Health M. The Association Between Acculturation and Cardiovascular Disease Risk in Ghanaian and Nigerian-born African Immigrants in the United States: The Afro-Cardiac Study. 2018;20(5):1137-46.
12. Commodore-Mensah Y, Ukonu N, Obisesan O, Aboagye JK, Agyemang C, Reilly CM, et al. 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. 2016;5(11).
13. Jin K, Gullick J, Neubeck L, Koo F, Ding D. Acculturation is associated with higher prevalence of cardiovascular disease risk-factors among Chinese immigrants in Australia: Evidence from a large population-based cohort. European Journal of Preventive Cardiology. 2017;24(18):2000-8.
14. Koya DL, Egede LE. 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 2007;22:841–6.
15. Menigoz K, Nathan A, Heesch KC, Turrell G. Ethnicity, length of residence, and prospective trends in body mass index in a national sample of Australian adults (2006–2014). Annals of Epidemiology. 2018;28(3):160-8.
16. Menigoz K, Nathan A, Heesch KC, Turrell GJPo. Neighbourhood disadvantage, geographic remoteness and body mass index among immigrants to Australia: A national cohort study 2006-2014. 2018;13(1):e0191729.
17. Popovic-lipovac A, Strasser B. A Review on Changes in Food Habits Among Immigrant Women and Implications for Health. Journal of Immigrant and Minority Health. 2015;17(2):582-90.
18. Sanou D, O'Reilly E, Ngnie-Teta I, Batal M, Mondain N, Andrew C, et al. Acculturation and nutritional health of immigrants in Canada: A scoping review. Journal of Immigrant and Minority Health. 2014;16(1):24-34.

19. Balk EM, Earley A, Raman G, Avendano EA, Pittas AG, Remington PL. Combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: A systematic review for the community preventive services task force. Annals of Internal Medicine. 2015;163(6):437-51.
20. Nam S, Janson SL, Stotts NA, Chesla C, Kroon LJJoCN. Effect of culturally tailored diabetes education in ethnic minorities with type 2 diabetes: a meta-analysis. 2012;27(6):505-18.
21. Scarton L, Velazquez I, O'Neal LJ, Iyerm S, Cannady T, Choate A, et al. Developing a culturally tailored multigenerational intervention to prevent and manage type 2 diabetes in American Indian families living in rural settings: Findings from a focus group study. 2019;42(3):226-33.
22. Lagisetty PA, Priyadarshini S, Terrell S, Hamati M, Landgraf J, Chopra V, et al. Culturally Targeted Strategies for Diabetes Prevention in Minority Population:A Systematic Review and Framework. 2017;43(1):54-77.
23. Goris J, Komaric N, Guandalini A, Francis D, Hawes E. 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 2012;19(1):14-37.
24. Queensland Government. Diversity Figures Brisbane: Department of Local Government, Racing and Multicultural Affairs; 2018 [Available from: https://www.dlgrma.qld.gov.au/resources/multicultural/communities/diversity-figures-report.pdf.
25. Queensland Government. Pacific Islander and Maori population size and distribution 2013 [Available from: https://www.health.qld.gov.au/multicultural/health_workers/pac-island-pop.
26. Queensland Health. Summary of Health Data on Culturally and Linguistically Diverse Populations in Queensland Brisbane: Queensland Health 2012 [Available from: https://www.health.qld.gov.au/__data/assets/pdf_file/0033/388527/health-data-summary.pdf
27. Renzaho AMN, Bilal P, Marks GC. Obesity, Type 2 diabetes and high blood pressure amongst recently arrived Sudanese refugees in Queensland, Australia. Journal of Immigrant and Minority Health. 2014;16(1):86-94.
28. Gallegos D, Do H, To QG, Vo B, Goris J, Alraman H. Differences in cardiometabolic risk markers among ethnic groups in Queensland, Australia. Health and Social Care. 2019;https://doi.org/10.1111/hsc.12745.
29. Australian Bureau of Statistics. National Nutrition and Physical Activity Survey 2011-12: Questionnaire. Canberra: ABS; 2011.
30. Queensland Health. Self-reported Health Status 2014: Preventive Health Indicators Queensland Brisbane 2014.
31. Gallegos D, Do H, To QG, Vo B, Goris J, Alraman H. Eating and physical activity behaviours among ethnic groups in Queensland, Australia. Public Health Nutrition. in press;In press.
32. National Health and Medical Research Council, Department of Health and Ageing. Australian Guide to Healthy Eating Canberra: Department of Health and Ageing; 2017 [Available from: https://www.eatforhealth.gov.au/guidelines/australian-guide-healthy-eating.
33. Australian Institute of Health and Welfare. The Active Australia Survey: a Guide and Manual for Implementation, Analysis and Reporting. Canberra AIHW; 2003.
34. Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee Scientific Report. Washington, DC: U.S. Department of Health and Human Services; 2018.
35. Global Adult Tobacco Survey Collaborative Group. Tobacco Questions for Surveys: A Subset of Key Questions from the Global Adult Tobacco Survey (GATS). Atlanta, Georgia; 2011.
36. Commonwealth Department of Health. National Drug Strategy Household Survey 2013 Canberra: Commonwealth Department of Health; 2013 [Available from: http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129548125.
37. Lee SK, Sulaiman-Hill CMR, Thompson SC. Alcohol experiences and concerns of newly arrived migrant women. Sage Open. 2014;4(2):2158244014530727.

38. World Health Organization. Physical status: The use of and interpretation of anthropometry, Report of a WHO Expert Committee 1995 [Available from: http://apps.who.int/iris/bitstream/10665/37003/1/WHO_TRS_854.pdf.
39. Ashwell M, Gunn P, Gibson S. 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. 2012;13(3):275-86.
40. Ashwell M, Hsieh SD. 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. Int J Food Sci Nutr. 2005;56.
41. Ashwell M, Gibson S. 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. 2016;6(3):e010159.
42. Kousar R, Burns C, Lewandowski P. A culturally appropriate diet and lifestyle intervention can successfully treat the components of metabolic syndrome in female Pakistani immigrants residing in Melbourne, Australia. Metabolism. 2008;57(11):1502-8.
43. Bhopal RS, Douglas A, Wallia S, Forbes JF, Lean MEJ, Gill JMR, et al. Effect of a lifestyle intervention on weight change in south Asian individuals in the UK at high risk of type 2 diabetes: a family-cluster randomised controlled trial. The Lancet Diabetes & Endocrinology. 2014;2(3):218-27.
44. Patel RM, Misra R, Raj S, Balasubramanyam A. Effectiveness of a Group-Based Culturally Tailored Lifestyle Intervention Program on Changes in Risk Factors for Type 2 Diabetes among Asian Indians in the United States. Journal of Diabetes Research. 2017;2017:13.
45. Wieland ML, Hanza MMM, Weis JA, Meiers SJ, Patten CA, Clark MM, et al. Healthy Immigrant Families: Randomized Controlled Trial of a Family-Based Nutrition and Physical Activity Intervention. 2018;32(2):473-84.
46. Bell AC, Swinburn BA, Amosa H, Scragg RK. A nutrition and exercise intervention program for controlling weight in Samoan communities in New Zealand. International Journal Of Obesity. 2001;25:920.
47. Siddiqui F, Kurbasic A, Lindblad U, Nilsson PM, Bennet L. Effects of a culturally adapted lifestyle intervention on cardio-metabolic outcomes: a randomized controlled trial in Iraqi immigrants to Sweden at high risk for Type 2 diabetes. Metabolism. 2017;66:1-13.
48. Rowe R, Gavriel Ansara Y, Jaworski A, Higgs P, Clare PJ. What is the alcohol, tobacco, and other drug prevalence among culturally and linguistically diverse groups in the Australian population? A national study of prevalence, harms, and attitudes. Journal of Ethnicity in Substance Abuse. 2018:1-18.

Table 1: Content of the LWM-LMP

Session	Topic
1	Introduction and pre-program screening
2	Physical activity education, tobacco cessation and alcohol consumption + HEAL home exercise*
3	Culturally tailored nutrition session 1^+ HEAL home exercise
4	Culturally tailored nutrition session 2+ HEAL home exercise
5	Culturally tailored nutrition session 3+ HEAL home exercise
6	Chronic disease (choose one from: Type 2 diabetes, asthma and COPD, chronic kidney disease, cardiovascular disease) + HEAL home exercise
7	Australian healthcare system+ HEAL home exercise
8	Post- program screening
Follow up 1	Face to face at week 14 from the starting date
Follow up 2	Telephone at week 26 from the starting date

*HEAL is the session and home exercise components of the Healthy Eating Activity and Lifestyle Program accredited by Exercise and Sports Science Australia

^ Each of these sessions varied from group to group but included as a guide: introduction to the Australian Guide to Healthy Eating, serve sizes, shopping tips, reading food labels, healthy fast food, recipe modification, food safety, heart health

Table 2 : Characteristics of the sample over time

Demographic	Time 1		Time 2		Time 3		p-value*
	n	% or Mean (SD)	n	% or Mean (SD)	n	% or Mean (SD)	
Average age (years)	700	44.2 (15.1)	561	44.4 (15.1)	457	44.2 (14.9)	0.96
Sex	700		561		457		
Male	219	31.3	165	29.4	135	29.5	0.72
Female	481	68.7	396	70.6	322	70.5	
Ethnic groups	700		561		457		
Burmese/Vietnamese	127	18.1	101	18.0	69	15.1	
Sri-Lankan/Bhutanese	142	20.3	97	17.3	85	18.6	
Afghani/Arabic-speaking	161	23.0	155	27.6	148	32.4	0.05
Somalian/Sudanese	113	16.1	86	15.3	55	12.0	
Pacific Islander	157	22.4	122	21.8	100	21.9	
Education	660		533		438		
Primary	150	22.7	107	20.1	73	16.7	
High school	202	30.6	170	31.9	138	31.5	0.31
Certificate/Diploma	139	21.1	114	21.4	95	21.7	
Bachelor/Postgraduate	169	25.6	142	26.6	132	30.1	
Employment	693		556		452		
Paid work	245	35.4	197	35.4	163	36.1	
Work without pay	149	21.5	124	22.3	104	23.0	0.97
Retired/Unemployed	169	24.4	128	23.0	98	21.7	
Student	130	18.8	107	19.2	87	19.2	
Household types	688		552		449		
Living alone with no children	33	4.8	24	4.3	17	3.8	
Single parent living with children	91	13.2	75	13.6	50	11.1	0.96
Single living with friends/relatives	90	13.1	72	13.0	59	13.1	
Couple living with no children	67	9.7	53	9.6	47	10.5	
Couple living with children	407	59.2	328	59.4	276	61.5	

*ANOVA for age and chi-square tests for the other variables.

Table 3: Personal behaviours

	Time 1		Time 2		Time 3	
	n	% or Mean (SD)	n	% or Mean (SD)	n	% or Mean (SD)
Personal behaviours						
Fruits	687		561		457	
<2 servings/day	328	47.7	149	26.6	83	18.2
≥2 servings/day	359	52.3	412	73.4	374	81.8
Vegetables	684		560		443	
<5 servings/day	652	95.3	465	83.0	358	80.8
≥5 servings/day	32	4.7	95	17.0	85	19.2
Milk	682		555		457	
No milk	73	10.7	40	7.2	36	7.9
Full fat/cream	422	61.9	149	26.8	98	21.4
Low fat	187	27.4	366	65.9	323	70.7
Processed meat	671		552		453	
<1 time/week	367	54.7	403	73.0	349	77.0
1-2 times/week	168	25.0	117	21.2	84	18.5
≥3 times/week	136	20.3	32	5.8	20	4.4
Fast food/takeaway	669		552		457	
<1 time/week	408	61.0	408	73.9	341	74.6
1-3 times/week	234	35.0	143	25.9	113	24.7
≥4 times/week	27	4.0	1	0.2	3	0.7
Hot chips/fries	679		554		455	
<1 time/week	378	55.7	386	69.7	323	71.0
1-3 times/week	264	38.9	166	30.0	128	28.1
≥4 times/week	37	5.4	2	0.4	4	0.9
Salty snacks	687		560		457	
<1 time/week	461	67.1	463	82.7	389	85.1
1-3 times/week	167	24.3	77	13.8	63	13.8
≥4 times/week	59	8.6	20	3.6	5	1.1
Sweet snacks	683		560		457	
<1 time/week	324	47.4	371	66.3	331	72.4
1-3 times/week	221	32.4	158	28.2	111	24.3
≥4 times/week	138	20.2	31	5.5	15	3.3
Sweetened beverages	686		556		454	
<1 time/week	433	63.1	441	79.3	402	88.5
1-3 times/week	164	23.9	100	18.0	48	10.6
≥4 times/week	89	13.0	15	2.7	4	0.9
Meeting PA guideline	673		557		457	
<150min/week	426	63.3	185	33.2	106	23.2
≥150min/week	247	36.7	372	66.8	351	76.8

Table 4: Changes in eating and physical activity behaviours over time

	n	OR (95%CI)	n	Adjusted OR[‡] (95% CI)
Fruit (≥2 vs. <2 servings/day)	429		404	
Time 2 vs. Time 1		2.50 (1.97, 3.17)***		2.70 (2.07, 3.52)***
Time 3 vs. Time 2		1.63 (1.21, 2.18)***		1.77 (1.26, 2.47)***
Vegetable (≥5 vs. <5 servings/day)	412		387	
Time 2 vs. Time 1		4.09 (2.59, 6.46)***		4.52 (2.70, 7.57)***

Time 3 vs. Time 2		1.19 (0.87, 1.64)		1.19 (0.82, 1.73)
Milk (Low fat vs. Full fat/No milk)	423		399	
Time 2 vs. Time 1		5.11 (3.95, 6.62)***		5.97 (4.49, 7.94)***
Time 3 vs. Time 2		1.21 (0.97, 1.50)		1.14 (0.90, 1.44)
Processed meat (<1 vs. ≥1 time/week)	414		392	
Time 2 vs. Time 1		2.29 (1.81, 2.90)***		2.85 (2.10, 3.86)***
Time 3 vs. Time 2		1.24 (0.95, 1.62)		1.21 (0.87, 1.68)
Fast food (<1 vs. ≥1 time/week)	409		387	
Time 2 vs. Time 1		1.81 (1.44, 2.26)***		1.97 (1.53, 2.53)***
Time 3 vs. Time 2		1.04 (0.82, 1.32)		1.09 (0.84, 1.42)
Hot chips/fries (<1 vs. ≥1 time/week)	421		400	
Time 2 vs. Time 1		1.91 (1.53, 2.38)***		2.12 (1.65, 2.71)***
Time 3 vs. Time 2		1.10 (0.85, 1.42)		1.09 (0.83, 1.43)
Salty snack (<1 vs. ≥1 time/week)	427		404	
Time 2 vs. Time 1		2.49 (1.88, 3.29)***		2.93 (2.12, 4.02)***
Time 3 vs. Time 2		1.25 (0.86, 1.80)		1.25 (0.85, 1.83)
Sweet snack (<1 vs. ≥1 time/week)	425		402	
Time 2 vs. Time 1		2.25 (1.80, 2.83)***		2.52 (1.97, 3.23)***
Time 3 vs. Time 2		1.44 (1.11, 1.88)**		1.43 (1.09, 1.99)**
Sweet beverages (<1 vs. ≥1 time/week)	420		399	
Time 2 vs. Time 1		2.28 (1.82, 2.87)***		2.53 (1.94, 3.29)***
Time 3 vs. Time 2		1.96 (1.41, 2.71)***		2.02 (1.41, 2.89)***
Physical activity (≥150 vs. <150 min/week)	420		398	
Time 2 vs. Time 1		3.49 (2.74, 4.44)***		3.92 (3.03, 5.08)***
Time 3 vs. Time 2		1.58 (1.21, 2.06)***		1.52 (1.14,2.02)***

*p<0.05, **p<0.01, ***p<0.001

†Odds Ratios adjusted for age, sex, ethnicity, education level, employment status, household type.

Table 5: Description of cardiometabolic risks and changes over ime (95% CI)

	Time 1		Time 2		Time 3	
	n	% or Mean (SD)	n	% or Mean (SD)	n	% or Mean (SD)
Cardiometabolic risks						
Average BMI	695	28.9 (7.0)	561	28.6 (6.8)	457	28.3 (6.6)
Average waist circumference (cm)	685	95.1 (15.2)	558	93.8 (14.8)	457	93.0 (14.9)
Average WHtR	685	0.59 (0.09)	558	0.58 (0.09)	457	0.58 (0.09)
Hypertension	686		563		455	
Yes	205	29.9	133	23.6	81	17.8
No	481	70.1	430	76.4	374	82.2

	Model 1[ǂ]		Model 2[#]	
	n	Estimate	n	Estimate
Weight[1]	433		406	
Time 2 vs. Time 1		-0.72 (-0.91, -0.54)***		-0.75 (-0.94, -0.55)***
Time 3 vs. Time 2		-0.48 (-0.73, -0.24)***		-0.53 (-0.78, -0.28)***
BMI[1]	433		406	
Time 2 vs. Time 1		-0.25(-0.33, -0.18)***		-0.27(-0.35, -0.19)***
Time 3 vs. Time 2		-0.18(-0.28, -0.08)***		-0.20(-0.30, -0.10)***
Waist Circumference[1]	431		405	
Time 2 vs. Time 1		-1.42(-1.79, -1.06)***		-1.48(-1.87, -1.10)***
Time 3 vs. Time 2		-0.62(-0.98, -0.27)***		-0.68(-1.05, -0.32)***
WHtR[1]	431		405	
Time 2 vs. Time 1		-0.009(-0.011, -0.006)***		-0.009(-0.011, -0.007)***
Time 3 vs. Time 2		-0.004(-0.006, -0.002)***		-0.004(-0.006, -0.002)***
Hypertension (Yes vs. No)[2]	429		402	
Time 2 vs. Time 1		0.74(0.60, 0.91)**		0.69(0.54, 0.89)**
Time 3 vs. Time 2		0.70(0.54, 0.90)**		0.69(0.50, 0.94)*

[1]Differences in means are reported

[2]Odds Ratios are reported.

[ǂ]Model 1 provides crude differences or Odds Ratios

[#]Model 2 provides differences or Odds Ratios adjusted for age, sex, ethnicity, education level, employment status, household type.

*p<0.05, **p<0.01, ***p<0.001

Table 6. Changes in personal behaviours and cardiometabolic risks for each ethnic group

Community	Burmese/ Vietnamese	SriLankan/ Bhutanese	Afghani/ Arabic	Somalian/ Sudanese	Pacific Islander
Week 8 vs Week 1					
Weight (kg)	-0.23	-0.70	-0.99	-0.45	-1.03
BMI	-0.10	-0.23	-0.38	-0.20	-0.37
Waist Circumference (cm)	-0.76	-1.00	-1.24	-1.34	-2.71
WHtR	-0.005	-0.006	-0.008	-0.009	-0.016
% hypertension	-6.3	-8.2	-7.6	-6.1	-5.1
% meeting guideline					
PA	31.3	46.9	37.9	4.3	29.3
Fruit	6.2	26.8	25.5	8.5	21.2
Vegetable	4.6	1.5	8.3	29.8	18.8
% low fat milk	24.6	33.8	54.6	37.0	45.5
% consuming <1 times/week					
Fast food	10.94	20.31	11.51	4.65	12.37
Hot Chips	4.61	18.18	15.97	14.89	22.68
Salty snack	10.77	5.88	32.41	18.75	13.13
Sweet snack	20.00	-2.98	37.93	23.40	22.22
Soft drink	4.69	10.77	25.87	19.15	23.23
Processed meat	9.6	10.0	28.5	29.8	21.2
Week 14 vs Week 8					
Weight (kg)	-0.03	0.13	-0.72	-0.70	-0.79
BMI	-0.01	0.07	-0.27	-0.21	-0.34
Waist Circumference (cm)	0.05	0.61	-1.08	-1.63	-0.87
WHtR	0.000	0.004	-0.007	-0.009	-0.006
% hypertension	-4.7	-5.5	0	4.1	-18.2
% meeting guideline					
PA	6.25	-1.56	9.66	17.02	5.05
Fruit	4.61	8.45	14.49	10.64	3.03
Vegetable	-6.15	17.39	-1.39	0	10.59
% low fat milk	3.1	0	4.9	2.2	-4.0
% consuming <1 times/week					
Fast food	-1.56	-12.50	2.88	4.65	12.37
Hot Chips	10.77	-6.06	5.56	2.13	-1.03
Salty snack	1.54	7.36	6.21	4.16	1.01
Sweet snack	7.70	11.94	13.1	6.38	-2.02
Soft drink	4.69	0	10.49	12.76	9.09
Processed meat	3.2	6.7	5.6	0	-4.1

Green: positive change; Red: negative change; Yellow: no change.