Health Risk Factors in Aboriginal Community Controlled Health Services: An exploration of prevalence, clustering, screening options and intervention preferences

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DECLARATIONS

Statement of originality

I hereby certify that to the best of my knowledge and belief this thesis is my own work and contains no materials previously published or written by another person except where due references and acknowledgements are made. It contains no material which has been previously submitted by me for the award of any other degree or diploma in any university or other tertiary institution. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository**, subject to the provisions of the Copyright Act 1968.

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Natasha Noble Date

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Finally, thank you so much to my fellow PhD colleagues who have provided so much support, advice, friendship and humor over the last five or so years.

LIST OF PUBLICATIONS INCLUDED AS PART OF THIS THESIS

Paper one

Noble, N. E., Paul, C. L., Carey, M. L., Sanson-Fisher, R. W., Blunden, S. V., Stewart, J. M., & Conigrave, K. M. (2014). A cross-sectional survey assessing the acceptability and feasibility of self-report electronic data collection about health risks from patients attending an Aboriginal Community Controlled Health Service. *BMC Medical Informatics and Decision Making*, 14(1), 34.

Paper two

Noble, N., Paul, C., Carey, M., Blunden, S., & Turner, N. (2015). A randomised trial assessing the acceptability and effectiveness of providing generic versus tailored feedback about health risks for a high need primary care sample. *BMC Family Practice*, *16*(1), 95.

Paper three

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Paper four

Noble, N. E., Paul, C. L., Turner, N., Blunden, S. V., Oldmeadow, C., & Turon, H. E. (2015). A cross-sectional survey and latent class analysis of the prevalence and clustering of health risk factors among people attending an Aboriginal Community Controlled Health Service. *BMC Public Health*, 15(1), 666.

Paper five

Noble, N., Paul, C., Sanson-Fisher, R., Turon, H., Turner, N., & Conigrave, K. (2016). Ready, set, go: a cross-sectional survey to understand priorities and preferences for multiple health behaviour change in a highly disadvantaged group. *BMC Health Services Research*, 16(1), 488.

Paper six*

Noble, N., Paul, C., Conigrave, K., Lee, K., Blunden, S., Turon, H., Carey, M., & McElduff, P. (2015). Does a retrospective seven-day alcohol diary reflect usual alcohol intake for a predominantly disadvantaged Australian Aboriginal population? Substance Use & Misuse, 50(3), 308-319.

*****This paper is included as an Appendix as it is relevant to the thesis but does not form one of the chapters***

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ABSTRACT

Aboriginal and Torres Strait Islander Australians have a substantially lower life expectancy and greater burden of chronic disease than their non-Indigenous Australian counterparts. The current health status of Indigenous Australians can be linked to a history of colonization and dispossession, as well as to past and ongoing racism and discrimination. While acknowledging the need to address such broader social determinants of health, there is also significant potential to improve the health of Aboriginal and Torres Strait Islander Australians through reducing the disproportionate prevalence of key health risk behaviours among this population, such as smoking, poor diet, excess alcohol and physical inactivity. Primary care is an important setting for the delivery of preventive health care, and Aboriginal Community Controlled Health Services (ACCHSs) are well placed to provide primary care for Aboriginal communities. A range of preventive care interventions have shown success in modifying health risk behaviours in non-Indigenous healthcare settings. However, such strategies are not well tested in Aboriginal health. Therefore this thesis aimed to explore the acceptability of strategies including point-of-care screening, and the provision of patient feedback, in the ACCHS setting. The need for primary care to address 'lifestyles' or patterns of interrelated health risks is also being increasingly recognized. In order to inform the provision of more holistic preventive care, this thesis also explored the clustering patterns of key health risk behaviours among ACCHS clients. Patient preferences for addressing their health risks, including whether health risks should be addressed individually, sequentially or simultaneously, and the types of support that would be most helpful, were examined. Implications of the results of these studies for the delivery of appropriate and effective primary care for Aboriginal and Torres Strait Islander Australians are discussed. Based on these

findings and drawing on the existing literature, a multi-component, community-based intervention aimed at reducing multiple health risk behaviours is also proposed.

THESIS OVERVIEW

This thesis by publication is comprised of an introduction, five papers, and a discussion. An additional paper which is relevant to, but does not form part of this thesis, is included as supplementary material in Appendix 6. At the time of submission, all papers have been published in peer reviewed journals.

The **Introduction** provides an overview of the social determinants of health framework and places the health status of Aboriginal and Torres Strait Islander Australians in the context of social and economic disadvantage. The prevalence rates of key health risks among this population, and in comparison to non-Indigenous Australians, are presented. The introduction briefly outlines both the general and indigenous-specific literature on the clustering of health risk behaviours, discusses how health risk clustering information can inform the design of primary care interventions, and examines evidence for the success of multiple health behaviour change (MHBC) interventions. Potential opportunities for improving the health of Indigenous Australians through primary care strategies are identified and explored in each of the thesis papers.

Paper one ("*A cross-sectional survey assessing the acceptability and feasibility of self-report electronic data collection about health risks from patients attending an*

Aboriginal Community Controlled Health Service"), reports on the acceptability and feasibility of implementing electronic health risk screening using a touchscreen laptop computer for patients attending an ACCHS. The study consent rate, proportion of participants able to complete the survey before their General Practitioner (GP) appointment, and participant feedback on the survey, indicated that electronic health risk screening was both feasible and acceptable in this setting. The results of Paper one therefore suggest that electronic health risk screening is a potentially feasible approach towards ensuring consistent and systematic identification of risk factors across ACCHS patients, while reducing the burden on healthcare providers to undertake risk assessment.

The collection of electronic health risk data described in Paper one allows the generation of point-of-care feedback which can be tailored to the health risks of individual patients. In **Paper two** ("*A randomised trial assessing the acceptability and effectiveness of providing generic versus tailored feedback about health risks for a high need primary care sample*"), the acceptability and preliminary effectiveness of providing generic compared to tailored feedback on self-reported health risk behaviours among patients attending an ACCHS was explored. Participants who completed the health risk screening survey were provided with either tailored or generic feedback and asked to complete an exit survey after their GP appointment. Although patients were more likely to show the tailored feedback to their GP, there was no difference in terms of the number of health risk topics discussed during the appointment, or number of additional actions taken by the GP, according to the type of feedback received. The results of Paper two indicate that providing ACCHSs

patients with either tailored or generic health risk feedback is feasible and acceptable, while further research is needed to establish the relative effectiveness of generic compared to tailored health risk feedback.

Health risk behaviours rarely occur in isolation. Therefore, preventive care approaches to achieving health behavior change will benefit from understanding of how such risks tend to co-occur or cluster. **Paper three** ("*Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors*") was an international, systematic review, which aimed to identify how smoking, nutrition, alcohol, and physical activity risk behaviours can be expected to co-occur, and whether clusters of health risks vary according to sociodemographic characteristics. Paper three found evidence of significant clustering of health risks, with most included studies reporting both 'healthy' and 'unhealthy' clusters of people. There was also a strong relationship between risky alcohol use and smoking, and a tendency for males and those with greater levels of social disadvantage to show riskier health behavior patterns. However, significant methodological diversity made comparisons across studies difficult. Data about the clustering of health risks among disadvantaged and indigenous groups, including for Indigenous Australians, was also extremely limited.

Therefore, **Paper four** ("*A cross-sectional survey and latent class analysis of the prevalence and clustering of health risk factors among people attending an Aboriginal Community Controlled Health Service*"), examined the clustering of key

health risk behaviours among people attending a ACCHS. Latent class analysis resulted in three clusters, which were characterized by a high probability of engaging in risk taking behaviours such as smoking, risky alcohol use and drug use (cluster one), being inactive, overweight and depressed (cluster two), or being overweight with a poor diet (cluster three). The three clusters were characterised by unique sociodemographic characteristics including gender, age, employment status, and exposure to violence. The results of Paper four suggest that people attending an ACCHS would benefit from interventions which target one of three specific combinations of related health risk behaviours. If further research identifies similar clustering patterns, the results can also be used to design and tailor primary care programs which cater to the client groups most likely to need them.

Given that health risk behaviours are highly likely to co-occur, changes across multiple, interrelated health risk behaviours are needed in order to prevent chronic disease and produce overall improvements in health. The results of Paper 4 help to inform the development of MHBC approaches, by establishing which health behaviours are most likely to cluster among particular subgroups of ACCHS clients. However, MHBC interventions remain largely untested in Aboriginal communities. Therefore, **Paper 5** ("*Ready, set, go: a cross-sectional survey to understand priorities and preferences for multiple health behaviour change in a highly disadvantaged group*") aimed to explore a range of consumer perspectives on key aspects of MHBC approaches for ACCHS clients. Despite having multiple health risks, most participants reported only wanting to make one health behaviour change. Of participants who reported wanting to make multiple changes, almost half preferred to

only address one health change at a time. Preferences for types of support included assistance from healthcare providers and support groups, rather than telephone or internet based help, or receiving written materials. Results suggest that an appropriate approach to MHBC for ACCHSs will therefore involve long-term, individualised case management, which provides choice about which health change to start with, as well as multiple opportunities for change over time. A stepped care approach to offering support would also help to maximize intervention effectiveness and efficiency at a minimal cost.

The **Discussion** draws together the main findings across studies and considers the implications of these for preventive care services delivered by ACCHSs. The series of studies described are among the first to explore the appropriateness of strategies including electronic health risk screening and point-of-care provision of health risk feedback, as well as to examine the clustering of common health risks, and consumer preferences for addressing multiple health risks, in the Australian Aboriginal healthcare setting. Following a discussion of key study limitations, the discussion concludes by proposing a future intervention aimed reducing the prevalence of SNAPO (smoking, nutrition, alcohol, physical activity and overweight) health risks among Aboriginal communities. The intervention incorporates key findings from the thesis studies, includes design features to ensure methodological rigor, and emphasises community control and ownership over the proposed project.

INTRODUCTION

Health and health inequalities

Good health is a basic human right[1] and is fundamental to happiness and well-being.[2] It also plays a key role in economic development and productivity.[2] Ensuring good health for all can be seen as an issue of social justice.[3]

Individuals at a lower social or economic position tend to have worse health and a lower life expectancy than those at a higher position,[4] a phenomenon which has been described as the 'social gradient in health'.[5] Inequalities in health exist both between and within countries.[5] For example, the difference in average life expectancy between Sierra Leone and Japan is almost 50 years.[5] Within Australia, in 2001-2007 there was a six year gap in life expectancy between those in the richest compared to the poorest quintile of income, and a five year gap in life expectancy between those with a junior high school education and those with a degree or diploma.[6]

A significant gap in life expectancy is seen between the indigenous and non-indigenous peoples of developed countries including Australia, Canada, the United States of America (USA) and New Zealand,[7] with Australia having the largest gap among these.[8,9] In 2011, the difference in life expectancy for Indigenous and non-Indigenous Australians was estimated to be 11.5 years for males and almost 10 years for females.[10] This reduced slightly to 10.6 years for Australian Indigenous males and 9.5 years for females born in 2010-2012.[11]

Chronic disease and the burden of disease associated with social disadvantage

Chronic diseases such as cardiovascular disease (CVD), cancer and type 2 diabetes are the leading causes of death worldwide, and their prevalence is projected to continue to rise as the world's population ages.[12] The social gradient in health is reflected in the occurrence of chronic disease, where prevalence increases with rising levels of socioeconomic disadvantage.[13] Among many indigenous groups, chronic diseases are a significant health issue.[14] For example, CVD is the leading cause of death for Canadian Aboriginal people, with a prevalence rate 2.5 times higher than for non-Aboriginal Canadians.[14] Chronic heart disease is the leading cause of death for American Indians and Alaskan Natives in the US.[14]

For Indigenous Australians, chronic disease is one of the key contributors to poor health, both in terms of mortality and burden of disease. In terms of 'potential years of life lost', a measure which takes into account age at death, and gives greater weight to deaths at younger ages, almost 80% of the mortality gap between Indigenous and other Australians aged 35–74 years is due to chronic disease, including CVD and diabetes.[10] Based on disability adjusted life years, which accounts for years of life lost due to death, and years of 'healthy' life lost due to disability caused by non-fatal disease, Indigenous Australians have a burden of disease and injury which is 2.5 times greater than for the general Australian population.[15] The leading cause of this health gap is CVD, followed by diabetes and mental disorders (largely substance use disorders).[15] Other factors including suicide, road traffic accidents and homicide or violence also contribute significantly to the burden of disease and injury.[15]

In addition, the burden of chronic disease is exacerbated by ‘multimorbidity’: that is, the presence of multiple (two or more) chronic diseases in one individual.[16,17] The likelihood of multimorbidity increases with age, and is also associated with socioeconomic deprivation.[16] Recent studies have found that the prevalence of multimorbidity is higher among Aboriginal people from Australia[18] and Canada,[19] compared to their non-Indigenous counterparts. In addition, multimorbidity tends to occur at younger ages among these indigenous population groups.[18,19]

The social determinants of health

The social determinants of health model recognises that inequalities in health arise from inequalities in society.[4] Although the causal pathways are not fully understood, the poorer health experienced by socially and economically disadvantaged groups can be attributed to a number of factors. Such groups are more likely to engage in health risk behaviours and therefore to have a worse risk factor profile than those who are more advantaged.[20] For example, in Australia, those in the lowest quintile of socioeconomic disadvantage are almost twice as likely to smoke, and 1.7 times more likely not to exercise, than those in the top quintile.[21] Disadvantaged groups are also more likely to have lower levels of health literacy,[22] make less use of health services, and experience higher levels of psychosocial stress,[5,20] further contributing to poorer health.[23]

Indigenous people are over-represented among the poor and disadvantaged worldwide.[7] This is due largely to the impact of colonisation, which disrupted and destroyed cultures and has resulted in widespread disempowerment, marginalization

and poverty.[24,25] Many indigenous groups experience multiple forms of disadvantage including social exclusion, economic disadvantage and psychological stress. For example, the Indigenous people of Australia have on average, lower incomes, higher rates of unemployment, lower educational attainment and more overcrowded households than their non-Indigenous counterparts.[26] Similar patterns of unemployment, lower education and poverty are seen among indigenous groups from Canada, New Zealand and the USA.[8] Social and economic disadvantage continues to be perpetuated by contemporary factors such as racism.[7,27] Many indigenous people are also impacted by transgenerational trauma and loss as a result of the forced removal of Aboriginal children from their families.[28,29] Disadvantage can become entrenched, with childhood disadvantage also compromising health in adult life. This cycle can start before birth, with poor nutrition or exposure to drugs or alcohol affecting fetal development and increasing vulnerability to diseases in adulthood. After birth, childhood is a formative period for adopting health behaviours, such as smoking, physical activity and diet. Disadvantaged families are more likely to experience financial stress and parental separation, which impacts on the emotional well-being and coping styles of children.[30] Some of the broad influences on health from the social determinants model are illustrated in Figure i.1.

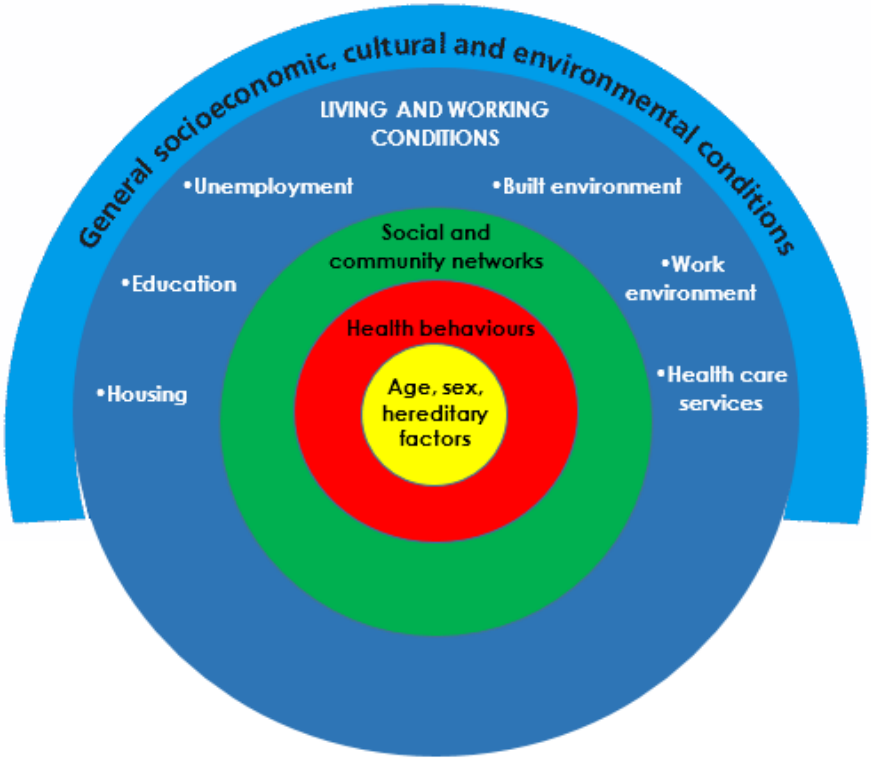

Figure i.1: Key determinants of health

[adapted from Dahlgren and Whitehead 1992][31]

Indigenous Australians are a particularly vulnerable and disadvantaged group who experience a high burden of disease and a significant gap in life expectancy compared to their non-Indigenous counterparts. For many indigenous communities, the built and social environment can be seen to shape behaviours such as smoking, diet and physical activity.[22] For example, among Indigenous Australians, smoking is a largely shared and normalised behaviour;[32,33] and some food choices (such as fats and salt) are influenced by strong symbolic links to family, past, and country.[34] The need for

physical activity to be communal rather than done for the individual has been reported for indigenous populations from Australia[34] and the US.[35]

Such cultural and social patterning of behaviours suggests that indigenous groups, as well as other groups who are disadvantaged and vulnerable, are likely to require specific and tailored strategies in order to impact on health behaviours and reduce health inequalities. Indeed, the effectiveness of health behaviour interventions has been shown to depend on factors including age, gender, ethnicity and other population-specific variables.[36] Therefore generic interventions may not be successful when applied across different population settings.[37]

The role of the healthcare system in health inequalities

As illustrated in Figure i.1, the availability and quality of healthcare services is only one of numerous influences on health, and many of the solutions to addressing the social determinants of health lie outside the healthcare sector. However, there is substantial evidence that the provision of more and better quality primary care can improve health and reduce disparities in health across racial and socioeconomic groups.[23] At the same time, the healthcare system can potentially play a role in exacerbating health inequities. For example, a greater supply of primary care physicians does not ensure that all subgroups will access primary care[23] and the 'inverse care law' describes the lack of availability of good quality healthcare among more deprived communities where health care needs are greater.[38] Patients in such deprived areas tend to experience poorer access, shorter consultation times, a lack of

empathy, and stressed GPs. Such factors can serve to confound attempts to narrow health inequalities through primary care.[39]

This thesis is focused on primary care approaches to assessing and addressing the clustering of health risks for Indigenous Australians, as an illustration of an approach which is likely to be appropriate for other groups of socially disadvantaged and vulnerable people. Given this focus, the remainder of the introduction presents health risk and related data primarily for Aboriginal and Torres Strait Islander Australians, with data for other indigenous and socially disadvantaged groups reported more briefly where appropriate.

Key Health Risks for Indigenous Australians

Chronic diseases are characterised by complex causality and are often associated with multiple, shared risk factors.[40] Key lifestyle risk factors which contribute to the development of chronic disease include tobacco smoking, physical inactivity, poor diet, and risky alcohol consumption;[41] collectively referred to as 'SNAP' behavioural risk factors (Smoking, Nutrition, Alcohol and Physical activity),[42] or 'SNAPO' risk factors if obesity is included.[43] High Body Mass Index (BMI), blood pressure and cholesterol are additional, biomedical risk factors for chronic disease, which can also be caused or exacerbated by SNAP behaviours.[41]

Vos et al., 2009 examined the contribution of 11 common health risk factors to the burden of disease for Indigenous Australians.[44] The top risk factors contributing to the

health gap were tobacco, high BMI, physical inactivity, high blood cholesterol, alcohol, high blood pressure, and low fruit and vegetable intake.[44] If Indigenous and non-Indigenous Australians experienced the same prevalence rates of all 11 risk factors examined in the study (which included, in addition to those listed above, illicit drugs, domestic violence, child sexual abuse and unsafe sex), approximately half of the overall Indigenous health gap could be avoided.[44]

Prevalence of key risk factors among Aboriginal and Torres Strait Islanders

The following section provides a brief overview of the prevalence of the key behavioural health risk factors identified as contributing to the burden of disease and injury among Indigenous Australians. A summary of this data is also given in Figure i.2.

Smoking

In 2012-13, 41% of Aboriginal and Torres Strait Islanders aged 15 years and over were current smokers.[45] Daily smoking rates were higher in remote areas than in non-remote areas (50% compared to 38%), mainly due to higher smoking rates among younger Indigenous people. Despite a progressive decline in smoking rates (for example, from 49% in 2002), Indigenous Australians were 2.6 times more likely than non-Indigenous people to be current daily smokers (after adjusting for differences in the age structure of the two populations).[45]

Overweight or obesity

In 2012–13, two-thirds (66%) Indigenous Australians aged 15 years or older were classified as either overweight (29%; based on a BMI of 25-29.9kg/m^2) or obese

(37%; BMI ≥30kg/m^2).[46] Indigenous Australians were 1.2 times more likely to be overweight or obese, and 1.6 times more likely to be obese, than non-Indigenous Australians (age-adjusted).[46]

Physical inactivity

Survey results from 2004-2005 indicated that 75% of Indigenous people aged 15 years and over living in non-remote areas were sedentary or had low levels of physical activity in the last year.[40] Indigenous people living in non-remote areas were 1.5 times more likely to be sedentary than non-Indigenous from non-remote areas (after age-adjustment).[40]

Fruit and vegetable consumption

In 2012–13, less than half (42%) of Aboriginal and Torres Strait Islander people aged 15 years and over met the requirements for two or more serves of fruit per day, and only 5% met the requirements for five or more serves of vegetables per day.[46] For non-Indigenous Australians, the equivalent figures were 50% meeting the guidelines for daily serves of fruit and 7% meeting those for vegetables.[47]

Alcohol

The prevalence of harmful alcohol consumption among Indigenous Australians varies according to study methodology and how harm or risk has been defined.[48] Data from 2004-2005 indicated that 55% of Indigenous people aged 18 years and over were drinking at short-term risky/high risk levels (based on the number of drinks consumed on any day in the last week), and 17% at long-term risky/high risk levels (based on the number of drinks consumed per day and the total for the week).[26] This compared to approximately 39% and 13% of non-Indigenous adults, respectively.[49] The

concepts of short-term and long-term ‘risky’ and ‘high-risk’ levels of drinking no longer apply with the release of new guidelines in 2009.[50,51] Taking into account differences in methodology across surveys, Wilson et al., 2010 suggest that the prevalence of harmful alcohol use in the Indigenous population is about twice that of the non-Indigenous population.[48]

Illicit drug use

Data from 2013 indicated that approximately 24% of Indigenous people aged 14 years and over had used illicit drugs in the past 12 months, compared to 13% of non-Indigenous respondents.[52]

Depression

Although it was not considered in the analysis by Vos et al., 2009, depression is increasingly recognised as a risk factor for cardiovascular disease.[53] In addition, depression is associated with low socioeconomic status and multimorbidity of chronic disease.[16] Nationally, 27% of Indigenous adults reported high or very high levels of psychological distress in 2004-05, based on five questions from the Kessler Psychological Distress Scale-10 (K10).[54] Indigenous Australians were twice as likely to report high/very high levels of psychological distress as non-Indigenous Australians.[54] Data from a number of smaller studies suggests that around 25% of Indigenous people experience moderate or severe levels of depression.[55,56]

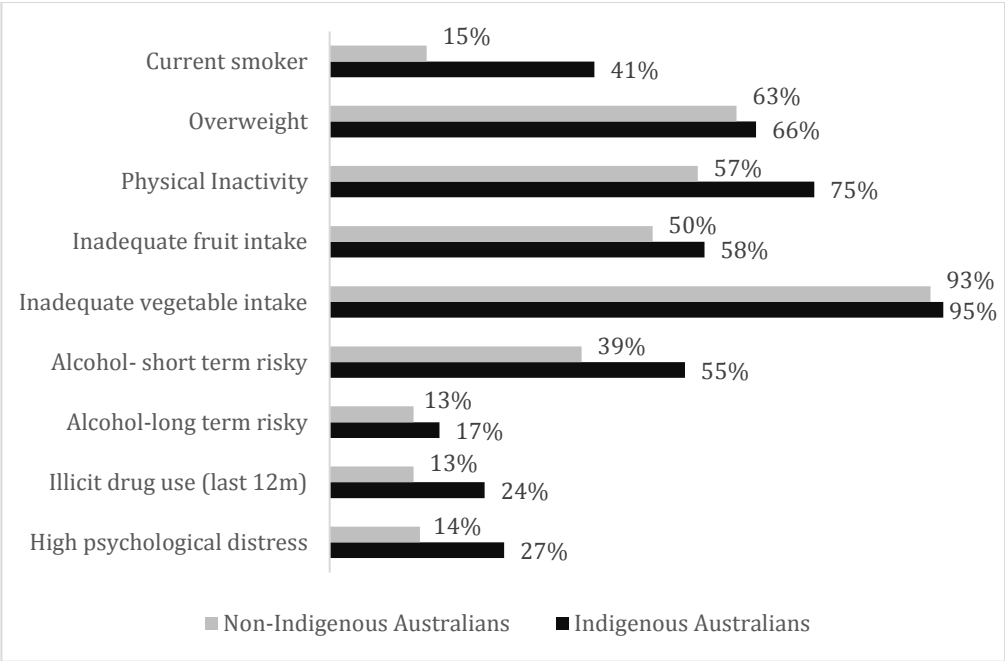

Figure i.2: Summary of the prevalence of key risk factors for Indigenous and non-Indigenous Australians

Patterns of key health risks among indigenous groups globally

Similar patterns of health risk prevalence are observed for other indigenous groups worldwide. For example, smoking rates among indigenous populations from New Zealand, Canada, and the USA far exceed those of their non-indigenous counterparts.[33] The indigenous populations of New Zealand and the USA have higher rates of obesity and excess alcohol consumption, and consume less fruit and vegetables, than the general population.[57] Hypertension is more common among indigenous Australians and New Zealanders, and high cholesterol more common among indigenous Americans, while indigenous people from Australia and America exhibit greater rates of sedentary behaviour.[57] Obesity and substance abuse are also significant health problems in each of these populations.[8] Some indigenous groups appear more prone than the non-indigenous population to 'lifestyle diseases' (for example Type 2 diabetes and heart disease) caused by rapid change to traditional

lifestyles and urbanization, including changes to diet, infant feeding practices and decreased physical activity.[7]

Many of the lifestyle and biomedical risk factors described above are potentially preventable or modifiable through changes in behaviour or by the use of medical interventions.[26,58] Thus there is considerable potential to reduce the burden of disease experienced by indigenous populations worldwide,[58] and by Indigenous Australians specifically,[15] by targeting change in common behavioural health risk factors. The need to address the broader factors which drive disadvantage should not be overlooked. However, effecting change in the social, economic and cultural conditions which contribute to the disadvantage experienced by indigenous and other vulnerable groups will require significant time and investment.[59] It is therefore also important to focus on the role that primary healthcare systems can play in achieving health benefits for disadvantaged and indigenous communities in the shorter term. The much higher disease burden among the indigenous population suggests that appropriate primary care strategies can potentially achieve large health gains for Indigenous Australians.[15]

Co-occurrence of multiple health risk factors

As the data above illustrate, the prevalence of risk factors which contribute to the burden of disease is disproportionately high among Indigenous compared to non-Indigenous Australians. However, data about the prevalence of single health risks do not reflect the tendency for adults to engage in multiple risky behaviours, nor consider the synergistic effects of multiple risk factors on disease risk.[60,61]

It is increasingly acknowledged that health impacts are magnified when more than one risk factor is present.[62] As the numbers of risk factors increase, both the likelihood of developing a chronic disease,[63] and the risk of death related to cardiovascular disease,[64] increase. Among the general Australian population, having five or more risk factors was associated with a three-fold increased likelihood of chronic obstructive pulmonary disease for men, and a three-fold increased likelihood of stroke for women, compared to those with two or less risk factors.[41] Therefore, it is particularly important to go beyond simply noting high rates of separate behaviours, in order to begin to identify patterns of health behaviours.

It is also evident that individuals tend to engage in more than one risk behaviour at any time. For example, among Australians aged 15 years and over, over half had two or three of eight risk factors.[41] Some common associations between risky behaviours include higher rates of daily smoking among those who consume alcohol at risky levels, and among those with insufficient levels of physical activity.[41] Similar patterns have been reported for Aboriginal and Torres Strait Islander peoples. For example, Indigenous Australians who drank alcohol at risky levels were more likely to be current smokers, and not to eat fruit and vegetables, than those who did not drink at risky levels.[27]

Social disadvantage is associated with a higher prevalence of multiple risk factors. Australian data shows that almost half (46%) of those who live in the most disadvantaged areas report having four or more risk factors, compared to less than

one-third (27%) of people living in areas of least disadvantage, where risk factors included smoking, physical inactivity, high blood pressure, insufficient consumption of fruit and vegetables, and consumption of whole milk.[65] General practice data from 2001-08 indicated that Aboriginal and Torres Strait Islander patients were nearly four times more likely to be overweight, to be current daily smokers *and* to consume alcohol at risky levels, when compared to all patients.[66] Indigenous patients were less than half as likely as non-Indigenous patients to have none of these risk factors.[66]

Clustering of health risk factors

Clustering of health risk behaviours can be defined as a pattern or combination of behaviours which occurs more frequently than would be expected based on the prevalence of the separate risk factors.[67,68] The expected combined prevalence is calculated as the product of the individual risk factor prevalences,[69] as illustrated in the following example from Tobias et al., 2007: "If the prevalence of smoking is 20% and the prevalence of drinking is 30%, then by the laws of probability the expected joint prevalence of [smoking + drinking] is 6%. If the observed prevalence exceeds the expected prevalence, clustering is said to occur."[69] Clustering implies that the co-occurrence of the risk factors is not independent, but instead reflects a common and more distal determinant.[69]

While the data presented so far provide an indication of the prevalence of multiple risk factors, they do not provide information about the specific clusters of health risk behaviours likely to be seen among indigenous or other disadvantaged groups. Examining the clustering of health risk behaviours is important for at least two key

reasons. Firstly, identifying clusters of health risk factors and associated demographics may allow identification of 'high risk' individuals or subgroups who are most in need of medical or intervention efforts. Secondly, identification of which health risks tend to cluster together is important for the development of health prevention strategies and interventions which aim to address more than one risk factor, in order to prevent chronic disease and improve overall health.

Clustering of health behaviours tends to be observed at the ends of the risk spectrum, with larger than expected proportions of people having all, or none, of a range of risk factors.[67] This has been characterised broadly as 'health promoting' and 'health compromising' health behaviour typologies.[70] Despite a recent proliferation of literature examining the clustering of health risk behaviours,[60,71,72] it is difficult to identify whether risk factors cluster in a consistent way across populations, due to variations in the types of risk factors that have been examined, how risk levels are defined, and in the analytical methods used to identify clustering patterns.[60,73] Furthermore, the literature examining the patterns of clustering of behavioural or lifestyle risk factors in indigenous populations, including for Aboriginal and Torres Strait Islander Australians, and for other socially disadvantaged groups, is very limited.

Only one study examining clustering of health risk behaviours among a specifically indigenous population was identified in the literature. Burke et al., 2007 assessed smoking, dietary behaviours and alcohol consumption among more than 500 Aboriginal Australians from Western Australia.[74] Using a cluster analysis procedure,

two clusters were identified. Those in the “worse” cluster were significantly more likely to be current smokers, to consume alcohol at hazardous levels, and to consume more take away foods than those in the “better” cluster. Levels of physical activity did not differ between clusters.[74] The worse cluster was associated with a hazard ratio of 2.3 for all-cause mortality compared to the better cluster.[74] The two clusters were of approximately equal size, however more than half of the sample did not fall into either of the identified clusters.

Two other studies examining the clustering of health risk behaviours were identified with samples which included a proportion of indigenous people. In the first, which examined risks among pregnant women, Indigenous Australians made up the majority of the cluster of women labelled as having a ‘high vulnerability’ to poor birth outcomes.[75] This cluster was characterised by high rates of current smoking, risky alcohol consumption, obesity, and experience of domestic violence, as well as other indicators of lower socioeconomic status, including public housing, lower levels of education and higher dependence on social security.[75] The second study was a national New Zealand health survey with a sample of approximately one-third indigenous New Zealand Maori.[69] Almost twice as many Maori people had four unhealthy behaviours (smoking, alcohol consumption, physical activity, and fruit and vegetable intake) compared to the whole sample. However, there was less clustering of unhealthy behaviour patterns among the Maori subsample than other ethnic groups, when comparing the observed versus expected prevalence of risk factor combinations.[69]

Two studies of health risk clustering focused on or included a socially disadvantaged population. Factor analysis of health behaviours among a sample of Australian social and community welfare clients resulted in two factors: one based on substance use (including smoking and alcohol consumption), and the other on poor levels of physical activity and nutrition.[76] The second study, also using factor analysis, explored health (smoking, diet, and exercise) and delinquency behaviours (such as drug use and aggression) among a sample of Dutch residents and immigrants.[77] The latter are considered to be relatively socially disadvantaged compared to residents.[77] Different clustering patterns emerged for residents and immigrants, with residents characterised by three clusters (based on healthy behaviours, alcohol, and delinquency behaviours), and immigrants showing two clusters (based on alcohol, and delinquency behaviours/ smoking).[77]

The social gradient in health could be partly explained by greater clustering of risk factors by socioeconomic position.[78] However, several cluster analyses have not supported this hypothesis. In the national New Zealand health survey mentioned above, Tobias et al., 2007 concluded that clustering of unhealthy behaviours makes little or no contribution to the disparity in health between Maori and non-Maori New Zealanders[69]; rather, it appears that the higher prevalence of health risk factors among Maori peoples explains the difference in health. Ebrahim et al., 2004 made a similar conclusion when considering a sample of older British women, where no difference in the extent of clustering of health risks was observed across four social class groups.[78] Hence it is not clear whether differential clustering plays a role in the health inequalities experienced by socially disadvantaged or indigenous groups. However, it

is likely that socially disadvantaged groups, including indigenous peoples, will exhibit *different* patterns of health risk clusters compared to the general population, as a result of underlying differences in the prevalence of many common risk factors, and the unique social and environmental context in which these health behaviours take place. Existing data about the clustering of health risk factors among Aboriginal and Torres Strait Islander Australians is limited to a single study. Further research into the clustering of key health risks for this population, including a broad range of relevant risk factors (such as depression and illicit drug use, in addition to core SNAP risk factors), would therefore add significantly to the literature in this area and help to inform the development of future interventions aimed at addressing multiple, inter-related risk behaviours.

How can clustering information inform the design of health interventions?

Health promotion and preventive health interventions tend to target single risk factors rather than addressing multiple risks.[73,79] However, the prevention and management of many chronic diseases requires attention to multiple behavioural risk factors.[79] Cluster analysis approaches to the occurrence of health behaviours can potentially provide an understanding of how some behaviours are related, and therefore about the most effective approaches to prevention.[60,68,73] This will be particularly important for developing programs which aim to facilitate change across a range of risk factors, such as programs designed to prevent or reduce the impact of chronic disease.[80,81]

Some risk behaviours are likely to derive in part from common psychological or behavioural patterns.[82-85] For example, de Vries et al., 2008 suggest that addressing

behaviours such as smoking and alcohol consumption require restraint, while behaviours such as physical activity and fruit and vegetable consumption require active engagement.[86] Intervention approaches may therefore need to be tailored according to whether they aim to achieve restraint from, or engagement with, certain behaviours.[86] The use of clustering data as the basis for selecting behaviours to be addressed in multiple risk or lifestyle interventions is likely to result in more effective interventions, given that inter-related behaviours will be addressed.[86]

Cluster analysis can provide a basis for the development of interventions which are tailored to target particular clusters of co-occurring risks, with different intervention strategies implemented for different clusters of health risks.[86] Alternatively, information about clustering of risk factors may be helpful in intervention attempts to reduce a single behaviour. For example, if smoking and alcohol are known to cluster, an intervention focused on smoking cessation might also consider how alcohol consumption impacts upon smoking.[73] For socially disadvantaged groups including Indigenous Australians, a more holistic approach which is informed by clustering data, and which considers the individual within their social and cultural context, may represent a particularly patient-centred and culturally appropriate approach to prevention and health promotion.[87]

Can we address clusters of health behaviours?

There has been some debate regarding whether it is feasible to address multiple health risks, whether it is acceptable to patient groups, and how such an approach might be efficiently achieved.[84,88] The study of strategies which address multiple health

behaviour change is an emerging area of research which recognises the potential benefits of addressing more than one health behaviour at a time.[82] Because unhealthy behaviours tend to co-occur, targeting more than one behaviour may result in greater overall health benefits.[83] Therefore multiple behaviour change interventions have the potential to have a greater impact on public health than single-behaviour interventions.[71] The multiple intervention approach also represents an efficient approach which capitalises on generally limited contact opportunities with healthcare staff.[82] In addition, through co-variation, effective change in one treated behaviour potentially increases the odds of effective action on a second or additional targeted behaviour/s.[88]

There is some evidence to support the effectiveness of multiple health behaviour change interventions.[88] A number of large population-based interventions targeting smoking, high fat diet, and high-risk sun exposure reported significant reductions in these health risks, and achieved similar smoking cessation rates to comparable studies targeting smoking cessation alone.[85] Nigg et al., 2002 cite a number of smaller studies (with less than 100 participants) in which the addition of physical activity to interventions addressing smoking cessation resulted in better quit rates, lower rates of relapse, and lower weight gain following quitting.[89] A study of over 300 female smokers reported that intervening for diet and exercise, as well as smoking, did not adversely affect smoking cessation rates.[90] A sequential approach, in which smoking was addressed first, followed by weight management through diet and exercise, achieved the best outcomes.[90] In contrast, a simultaneous intervention was more effective than sequential counselling, and usual care, in achieving smoking cessation

and reducing salt intake, although an increase in physical activity was targeted but not achieved among a sample of almost 300 hypertensive African Americans.[91] The evidence in support of multiple health behaviour change interventions is not definitive[92] and a recent Cochrane review found that while such interventions resulted in small reductions in risk factors including blood pressure, cholesterol and smoking, they did not impact on overall coronary heart disease mortality or morbidity.[93]

Along with these mixed findings, much remains unknown about multiple health behaviour change, including the optimal number of behaviours to intervene for, how to select behaviours for change to give the greatest impact on health, when to intervene simultaneously versus sequentially, and how to achieve synergies to improve multiple health behaviours.[84] In addition, the potential treatment burden associated with multiple health behaviour interventions[83,86] as well as the demanding nature of designing and delivering such interventions,[88] may limit the appropriateness of this approach for disadvantaged or vulnerable populations. Financial hardship, poorer education and lower health literacy means that many such groups have fewer resources to drawn on in coping with or addressing health risks.[22,94] In the case of Indigenous Australians, the feasibility and acceptability of implementing multiple health behaviour interventions is yet to be examined.

Potential opportunities for improving the health of Indigenous Australians – the importance of primary care

As illustrated by the social determinants of health model (see Figure i.1), addressing the health disadvantages experienced by Indigenous Australians will require long-term change in the social and economic conditions they experience.[95] For example, educational attainment, employment, housing, racism, and connection to family, community, country and culture, are identified as key areas in addressing the gap in health between Indigenous and non-Indigenous Australians.[95] However, in the shorter term, the much higher disease burden experienced by Indigenous Australians suggests that appropriate primary care strategies can help to achieve health gains for this population.[15] The delivery of clinical preventive health services, including screening and counselling interventions to encourage behaviour change, have been shown to improve health outcomes for the general population.[96] However, the effectiveness of the many such strategies has not been evaluated specifically for Australian Aboriginal communities.[97,98] If the health of Indigenous Australians is to reach equality with non-Indigenous Australians, there is a need to determine the acceptability, feasibility and effectiveness of primary care strategies such as health risk screening, provision of feedback, and tailored support services, for Aboriginal communities.

Aboriginal Community Controlled Health Services

Access to mainstream primary healthcare services by Indigenous Australians is limited by a range of cultural and financial barriers.[99,100] Aboriginal Community Controlled Health Services (ACCHSs) are designed to overcome some of these barriers by providing culturally appropriate healthcare through local community

governance of services.[101] ACCHSs aim to provide both preventative health services and clinical care, and are generally the first point of contact for the Aboriginal community with the healthcare system.[101] Approximately 80% of patients attending an ACCHS are Indigenous,[102] and 50% of the Indigenous population of Australia attend an ACCHS for their healthcare.[103] ACCHSs therefore represent a highly appropriate setting in which to explore strategies for improving preventive healthcare for Australian Indigenous communities.

ACCHS clients include a proportion of non-Indigenous Australians. ACCHS aim to address potential issues of affordability by 'bulk billing' (i.e. not charging their patients a fee for service).[104] It was assumed that the majority of the non-Indigenous patients access an ACCHS because of this, and that these patients face similar social and economic circumstances as Aboriginal patients. Therefore it was also assumed that Aboriginal and non-Aboriginal patients have comparable patterns of health risks and healthcare needs. Data collected as part of this thesis confirmed that the non-Indigenous and Indigenous patients of ACCHSs shared very similar patterns of health risks and socioeconomic disadvantage (see Appendix 7.1). While this thesis is focused on examining and addressing health risks of Indigenous Australians, the inclusion of all patients attending an ACCHS (i.e. both Indigenous and non-Indigenous people) means that the results have relevance not only for Aboriginal people but potentially for socially disadvantaged and vulnerable populations more broadly. In addition, this information will be important for ACCHSs in addressing the needs of their entire client base.

Screening and brief intervention

Brief interventions in primary care can effectively address some of the most common and important risk behaviours,[105] including SNAP lifestyle risks.[106] In order to provide brief interventions for common risk behaviours, healthcare providers need to be aware of their patient's risk status. However, primary care providers often miss opportunities for prevention, in particular for Aboriginal and Torres Strait Islander patients.[96,107-109] For example, agreement between patient self-report and General Practitioner (GP) assessment of risk status among those attending an ACCHS was reasonable for smoking, but poor for harmful alcohol consumption and for physical inactivity[110].

Although clinical practice guidelines recommend that patients are routinely screened for lifestyle and other risk factors,[96,106] this may not occur due to a range of factors, including lack of clinician time,[111,112] and the need to focus on acute rather than preventive care.[113] Reliance on medical records to identify risk may be inadequate for a number of reasons, including patient risk status not being recorded or updated consistently.[107,114] In the Australian Indigenous healthcare setting, there are likely to be additional barriers to the routine assessment of risk factors. Smoking rates among Indigenous health workers are high, such that they may be disinclined to discuss smoking status and cessation with patients.[115,116] Some Indigenous health workers also reported reluctance to ask about their patient's alcohol use, as this was considered to be a private and sensitive issue.[117] Competing and frequently acute healthcare needs are a further barrier to prioritization of behavioural health risk

assessment and preventive care, especially for Indigenous Australians[118] and also for socially disadvantaged groups more generally.[22]

Routine screening within Indigenous primary care therefore offers a potentially efficient and systematic means of providing risk status information to healthcare providers. An approach in which data is electronically collected directly from patients can reduce the time demands on GPs and other healthcare staff, ensure consistency in the collection of data across risk factors and patients, and potentially assist with privacy or sensitivity concerns (by allowing patients to provide information in a less personal, non-face-to-face manner). Electronic data collection methods have proved acceptable in mainstream primary care settings for collecting a range of self-report information including tobacco, alcohol and drug use.[119] However, the feasibility and acceptability of such an approach to the collection of health risk data has not been tested in the Aboriginal healthcare setting.

Providing health risk feedback to patients and GPs

The collection of electronic health risk data allows the generation of feedback which can be tailored to the health risks of individual patients. Generic feedback refers to information which is broadly applicable to the general population, while tailored feedback is customized to the specific risk status of the person.[120] Research suggests that tailored feedback is an effective component of health behaviour interventions, including those targeting smoking, alcohol, nutrition and cancer screening.[121,122] Tailored feedback for patients appears to help in the initiation of health-protective behaviours, and is generally more effective than generic feedback.[121-123] The

provision of feedback to healthcare providers, including prompts or reminders, can also increase the delivery of preventive care, although with modest effectiveness.[124,125] Feedback or prompts can bring the physician's attention to a necessary clinical action.[124] Again, the acceptability and feasibility of providing feedback about health risks to patients and their GPs has not been tested in the ACCHS setting.

Development and delivery of multiple health behaviour interventions in primary care

Increasingly, primary care guidelines are recommending screening and management of multiple 'lifestyle' risk factors, including smoking, overweight, physical inactivity, and poor diet.[126,127] Improved identification and management of individuals at high risk of CVD could provide a major opportunity to reduce burden of disease for Indigenous people.[109] Tobias et al., 2007 also advocate more generally for clinical level interventions to be targeted towards the proportion of the population with multiple lifestyle risk factors.[69] Primary care providers need to know about the extent of clustering and the composition of health risk clusters among their clients in order to develop and deliver multiple health behaviour interventions which address interrelated risk factors. The availability of cluster data for ACCHSs patients would allow healthcare services to focus their efforts on subgroups of individuals or subsets of risk factors where the need and potential benefit is the greatest, and to better plan for the service needs of their clients.

Consumer preferences for addressing multiple risk factors

Multiple health behaviour change (MHBC) interventions are associated with an increased response burden for participants, as a result of trying to change several behaviours at once.[89] The 'burden of treatment' is a recognized phenomenon that particularly affects those with multiple chronic conditions or multimorbidity.[94] Given that Indigenous Australians tend to experience multiple forms of disadvantage, including psychosocial and financial stress,[128] there is a potential risk that multiple health behaviour change interventions may be too demanding or too much of a burden for this population.[83,129] A consumer perspective on approaches to MHBC is therefore needed. The various social and cultural influences on health risk behaviours,[130] poorer access to healthcare,[20] and lower levels of health literacy[22] of Indigenous and other socially disadvantaged groups compared to less disadvantaged groups, mean it is critical to gain an understanding of how behaviour change might best be supported in these communities. For example, there may a maximum number and preferred order of behaviours that individuals feel able to manage, and differing incentives, for trying to make multiple health behaviour changes.[89] Furthermore, asking consumers is consistent with providing patient-centred care, which respects and responds to the needs and preferences of individual patients.[131]

Asking consumers about their intensions and readiness to change is also central to the effectiveness of lifestyle interventions.[132] Intervention approaches which are tailored to a participant's stage of change are associated with improved participation and treatment success.[133] The behavioural medicine literature suggests that people are more likely to achieve behaviour change when they actively participate in the choice

of change to be made,[92,134] while behavioural choice theory holds that participants achieve better treatment outcomes when allowed to choose the type of intervention.[135] Therefore, an Indigenous perspective about readiness and priorities for behaviour change, and preferred approaches to addressing specific health risk profiles, is needed in order to develop effective and culturally appropriate interventions to improve the health of this population.

Study aims

The current thesis addresses a number of key gaps in the literature around the design and delivery of preventive care in Indigenous primary healthcare settings. Specifically, the aims of this thesis were:

a) To explore, among a sample of people attending an ACCHS:
    a. The feasibility and acceptability of collecting electronic health risk status information for patients attending an ACCHS while they wait for their appointment (Paper one);
    b. The acceptability and preliminary effectiveness of providing tailored compared to generic feedback about health risks to patients and their GPs (Paper two);
b) To identify whether SNAP health risk behaviours cluster in a consistent way, and any sociodemographic characteristics associated with particular clusters, across the international literature (Paper three);
c) To examine the prevalence and clustering of health risk behaviours and any associated sociodemographic characteristics among people attending an ACCHS (Paper four); and

d) To examine, for those attending an ACCHS, priorities, preferences and preferred types of support services for addressing multiple health risk behaviours (Paper five).

An understanding of the appropriateness of electronic approaches to health risk screening and provision of feedback, clustering of risk factors and an Indigenous perspective about addressing these risk factors, will add to the evidence base for the development of culturally appropriate and patient-centred interventions for Indigenous Australians and others attending an ACCHS.

A note on terminology

For the remainder of this thesis, the term 'Aboriginal' is used when referring to the study sample, given that the sample was drawn from two ACCHSs located in New South Wales (NSW), Australia. This is the recommendation of the NSW Department of Health in recognition that Aboriginal people are the original inhabitants of NSW.[136] When referring more broadly to the national Indigenous population, the terms 'Indigenous' or 'Aboriginal and Torres Strait Islander people' are used.

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PAPER ONE

A cross-sectional survey assessing the acceptability and feasibility of self-report electronic data collection about health risks from patients attending an Aboriginal Community Controlled Health Service

Introduction to Paper One

In order to provide preventive care, healthcare providers need to be aware of the risk status of each of their patients. General practice guidelines recommend that patients are routinely screened for health risk behaviours. However, there are a number of reasons why such screening may not take place. The most frequently reported barrier to routine screening is a lack of clinician time. Other barriers which are of particular relevance for Aboriginal and Torres Strait Islander patients include a need to focus on acute rather than preventive care, and health professionals' reluctance to ask about 'sensitive' health risks such as smoking, alcohol use or body weight. Electronic patient-completed screening for health risks while patients wait for their appointment, is one approach which could help to overcome many of these barriers. However, such approaches to screening have not been tested in an Aboriginal healthcare setting. In Paper one, the acceptability and feasibility of an electronic health risk survey completed in the waiting room on a touch screen computer, was assessed among patients attending an Aboriginal Community Controlled Health Service for a general practice appointment.

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A cross-sectional survey assessing the acceptability and feasibility of self-report electronic data collection about health risks from patients attending an Aboriginal Community Controlled Health Service.

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Abstract

Background: Aboriginal Australians experience significantly worse health and a higher burden of chronic disease than non-Aboriginal Australians. Electronic self-report data collection is a systematic means of collecting data about health risk factors which could help to overcome screening barriers and assist in the provision of preventive health care. Yet this approach has not been tested in an Aboriginal healthcare setting. Therefore, the aim of this study was to examine the acceptability and feasibility of a health risk questionnaire administered on a touch screen laptop computer for patients attending an Aboriginal Community Controlled Health Service (ACCHS).

Methods: In 2012, consecutive adult patients attending an ACCHS in rural New South Wales, Australia, were asked to complete a health risk survey on a touch screen computer. Health risk factors assessed in the questionnaire included smoking status, body mass index, and level of physical activity. The questionnaire included visual cues to improve accuracy and minimise literacy barriers and was completed while participants were waiting for their appointment.

Results: A total of 188 participants completed the questionnaire, with a consent rate of 71%. The mean time taken to complete the questionnaire was less than 12 minutes. Over 90% of participants agreed that: the questionnaire instructions were easy to follow; the touch screen computer was easy to use; they had enough privacy; the questions were easy to understand; they felt comfortable answering all the questions.

Conclusions: Results indicate that the use of a touch screen questionnaire to collect information from patients about health risk factors affecting Aboriginal Australians is feasible and acceptable in the ACCHS setting. This approach has potential to improve

identification and management of at-risk individuals, therein providing significant opportunities to reduce the burden of disease among Aboriginal Australians.

Keywords: Australia; Aboriginal; touch screen questionnaire; health risk factors; screening

Background

As for other Indigenous populations worldwide,[1] Aboriginal and Torres Strait Islander Australians experience significantly poorer health and younger mortality than other Australians.[2,3] The high prevalence of modifiable risk factors, such as smoking and high body mass, contributes significantly to this health gap.[3-8] Cancer screening rates are also known to be low.[9,10] Therefore, the potential to reduce the disease burden experienced by Aboriginal and Torres Strait Islander Australians by targeting change in these common risk and screening behaviours is considerable.[11]

Aboriginal Community Controlled Health Services (ACCHSs) are services designed to provide culturally appropriate health care to Aboriginal communities.[12] Approximately 50% of the Aboriginal population of Australia access ACCHSs for their health care,[13] making ACCHSs an appropriate setting in which to address the risk status of Aboriginal Australians.

The provision of preventive care requires the identification of at-risk patients.[14] However, reliance on medical records to identify at-risk patients may be limited by the accuracy and completeness of such records.[14-16] Significant gaps in the recording of risk factor status in Aboriginal and Torres Strait Islander health settings have been identified.[14,16,17] For example, across more than 60 Indigenous community health centres, weight and body mass index were not recorded for an average of 45% and 78% of patients respectively, while only 28% of patients were identified as smokers, relative to known higher smoking rates in sampled communities.[17] Such inconsistencies in detecting or recording data for at-risk patients may be due to the time required for screening, and privacy or sensitivity concerns.[17,18] For example, many Aboriginal health workers are themselves smokers, and may feel uncomfortable

assessing the smoking status of their patients and providing cessation advice.[19,20] The need to prioritise across a complex array of health and other problems facing many Aboriginal patients is a further challenge to achieving regular assessment of modifiable health risks and the provision of preventive health care. [14,21]

Electronic data collection utilising portable devices offers a potentially effective means of collecting self-reported risk factor information from patients. Electronic data collection is preferred by patients,[22,23] reduces missing values compared to paper and pencil methods,[24] allows tailoring of questions to minimise patient burden, and has the potential for automatic entry of data into medical records.[22,25]

The acceptability of computer based approaches to health data collection has been explored in a limited sample of indigenous and/or socially disadvantaged populations worldwide. For example, an audio touch screen computer-assisted self-interviewing questionnaire, used to collect lifestyle risk data, was well accepted by a cohort of American Indians; although lower educational levels and infrequent computer use in the past year were predictors of useability problems.[26] A touch screen kiosk providing smoking cessation information was also successful in engaging a sample of low-literacy, underserved, Mexican-American primary care patients.[27]

Studies specifically in the Aboriginal healthcare setting are uncommon. One study utilised a laptop questionnaire to collect risk and resilience data,[22] and another employed touch activated hand held computer devices to collect data about condom use,[28] from Aboriginal

youth. However neither study reported survey consent or completion rates. Hunter and colleagues reported on the acceptability of a touch screen kiosk in two Indigenous-specific settings (a health clinic and a Centrelink office serving a discrete Aboriginal community) which provided visual, audio and printed information about musculoskeletal disorders and diabetes.[29] Of note was the importance of including non-text-based information and culturally appropriate graphics to promote acceptability for this population.[29]

Electronic data collection therefore holds potential as an efficient and systematic means of collecting data about health risk factors to assist in the provision of preventive health care for Aboriginal people. An electronic approach to health risk data collection would overcome some of the key barriers for health service staff such as limited time and sensitivity restraints. However, it has not been tested for this purpose in an Aboriginal health setting. The aims of this study were therefore to examine the acceptability and feasibility of an electronic health risk questionnaire administered on a touch screen laptop computer for adult patients attending an ACCHS. Feasibility and acceptability were assessed in terms of: i) patient consent rates and consent bias; ii) survey completion rates; iii) time taken to complete the questionnaire; iv) the proportion of patients needing assistance to complete the questionnaire; and v) patient feedback on the survey.

Methods

Study design and setting

A health risk questionnaire was administered using a touch screen laptop to patients attending an ACCHS in regional New South Wales (NSW). The acceptability data presented here were

part of a larger cross-sectional study about the prevalence of a range of health risk factors. Questionnaires were completed anonymously to minimise response bias and encourage participant consent. Data collection occurred over approximately nine weeks in early 2012. Ethics approval for the project was granted by the Human Research Ethics Committees of the University of Newcastle and the Aboriginal Health and Medical Research Council of NSW (see Appendix 8.1).

Questionnaire development

The questionnaire was designed with a year seven school reading age, and included pictures and limited text in order to minimise reading demands. For example, a visual illustration was presented when asking patients about timing of their last blood pressure test (Figure 1.1); a standard drinks chart, plus the number of standard drinks in common bulk packages of alcohol was shown to assist in answering questions about alcohol consumption. Input into the design of the questionnaire and survey recruitment methods was sought from collaborators experienced in Aboriginal health research and during pilot testing with Aboriginal ACCHS staff and patients.

Figure 1.1: Example of a visual description included in the touch screen questionnaire to minimise literacy barriers

Participants

All patients attending the ACCHS for a general practice (GP) appointment, aged 18 years or older, not too sick to participate and able to provide informed consent were eligible. All patients including Aboriginal and non-Aboriginal patients were invited to participate and all participants gave informed consent (see Appendix 8.2 for the study flyer used to inform participants about the study and the study information statement provided to participants; participant consent was implied by completion of the touch screen survey).

Procedure

Patients were approached by a Research Assistant (RA) and invited to complete the touch screen questionnaire in a quiet section of the waiting room while waiting for their appointment. A non-Aboriginal RA was present to set up and oversee survey administration. An Aboriginal RA assisted with approaching patients for approximately half of the recruitment period (due to logistical recruitment problems and low patient throughput on some days). Participants were able to exit the questionnaire if called in for their appointment prior to completion. Results for interrupted questionnaires were included if at least 75% of the questionnaire was completed (with unanswered responses recorded as missing). A RA offered assistance with questionnaire completion as required, and noted whether participants received assistance (none/ some assistance/ interview style). A RA also recorded the estimated age and gender of non-consenting patients in order to assess consent bias.

Measures

The touch screen questionnaire included demographic questions (age, gender, Indigenous and marital status, highest level of education, source of income, overcrowding and exposure to physical or emotional violence) and items assessing the health risk status of participants (body mass index, smoking status, alcohol consumption, level of physical activity, consumption of fruit and vegetables, alcohol intake, drug use, depression and adherence with screening guidelines; see Appendix 8.4 for a copy of the health risk survey items). Measures were either previously validated or drawn, where possible, from Indigenous specific surveys such as the National Aboriginal and Torres Strait Islander Health Survey and Social Survey.[30-32] The questionnaire also included five acceptability statements; participants were asked to indicate whether: the instructions were easy to follow; the touch screen was easy to use; they had enough privacy; the questions were easy to understand; they felt comfortable answering all the questions (yes/ no/ not sure). Participants were also asked whether they would be willing to complete a similar survey at future appointments. The survey was modified for the final 32 participants in order to identify whether for future surveys, participants would be happy for their doctor to see a copy of their questionnaire responses.

Materials

Digivey Survey Suite software (CREOSO Digivey Survey Centre, Arizona, USA) was used to design and administer the touch screen questionnaire. The RA demonstrated how to navigate through the questionnaire using the ‘next’ or ‘back’ buttons. Participants could skip questions by touching the ‘next’ button. Branching algorithms were used to tailor questions to individual participants (for example, only females over 50 years of age were asked about breast cancer screening).

Statistical Analyses

Chi-square analysis was used to compare the age groups, gender and Aboriginal status of consenting and non-consenting participants. Aboriginal status of consenting participants was only recorded for participants who completed the questionnaire, and not for non-consenters or those who exited the questionnaire before completion; therefore the Aboriginal status of the final complete sample was compared to the proportion of total active Aboriginal and non-Aboriginal patients usually attending the ACCHS. Aggregate data on the Aboriginal status of all adult patients who had attended the Service at least three times in the last two years was extracted from ACCHS medical records for comparison.

Parametric tests (*t*-tests and one-way ANOVA) were used to compare the time taken to complete the questionnaire for Aboriginal and non-Aboriginal participants and across age groups. Fisher's exact test (where cells had small expected frequencies) was used to compare the acceptability of the questionnaire, assistance required to complete the questionnaire, and willingness to complete a similar survey in the future, for Aboriginal status and across age groups.

Results

i. Consent rates and consent bias

Approximately 330 eligible patients attended the ACCHS during the recruitment period. Figure 1.2 illustrates the number of participants at each stage of recruitment and survey completion. A total of 296 eligible patients were approached and 210 consented to complete the questionnaire, giving a consent rate of 71%. There was no difference in consent rate

associated with the different RAs. The gender and approximate age groups of consenting and non-consenting participants are shown in Table 1.1.

Table 1.1: Demographics of consenting study participants and non-consenting patients

	Consenting patients (n=210) n (%)	**Non-consenting patients (n=86) n (%)**	**Total patients (consenting and non-consenting)**	**Medical record data**	***p*-value**
Gender					0.17
Male	82 (67%)	41 (33%)	123 (100%)	-	
Female	128 (74%)	45 (26%)	173 (100%)	-	
Age					0.61
<35yrs	76 (73%)	28 (27%)	104 (100%)	-	
35-54yrs	82 (72%)	32 (28%)	114 (100%)	-	
≥55yrs	52 (67%)	26 (33%)	78 (100%)	-	
Indigenous status[a]					<0.01
Aboriginal[b]	135	-	n/a	1056	
Non-Aboriginal	53	-	n/a	193	

[a] Indigenous status was only recorded for 188 participants who completed the survey. The Indigenous status of participants who consented but did not complete the survey was not recorded, and the Indigenous status of non-consenters was also not recorded.
[b] The sample included 1 participant who identified as Torres Strait Islander and 3 participants who identified as both Aboriginal and Torres Strait Islander. For simplicity, the term 'Aboriginal' is used to refer to all participants who identified as being of either Aboriginal and/or Torres Strait Islander origin.

There were no significant differences in the gender ($\chi^2(1, N = 296) = 1.87, p = .17$) or age ($\chi^2(5, N = 296) = 2.13, p = .83$) of consenting and non-consenting patients. However, non-Aboriginal patients were significantly overrepresented in the final sample compared to the proportion of non-Aboriginal patients usually attending the ACCHS, $\chi^2(1, N = 1437) = 18.69, p < 0.01$.

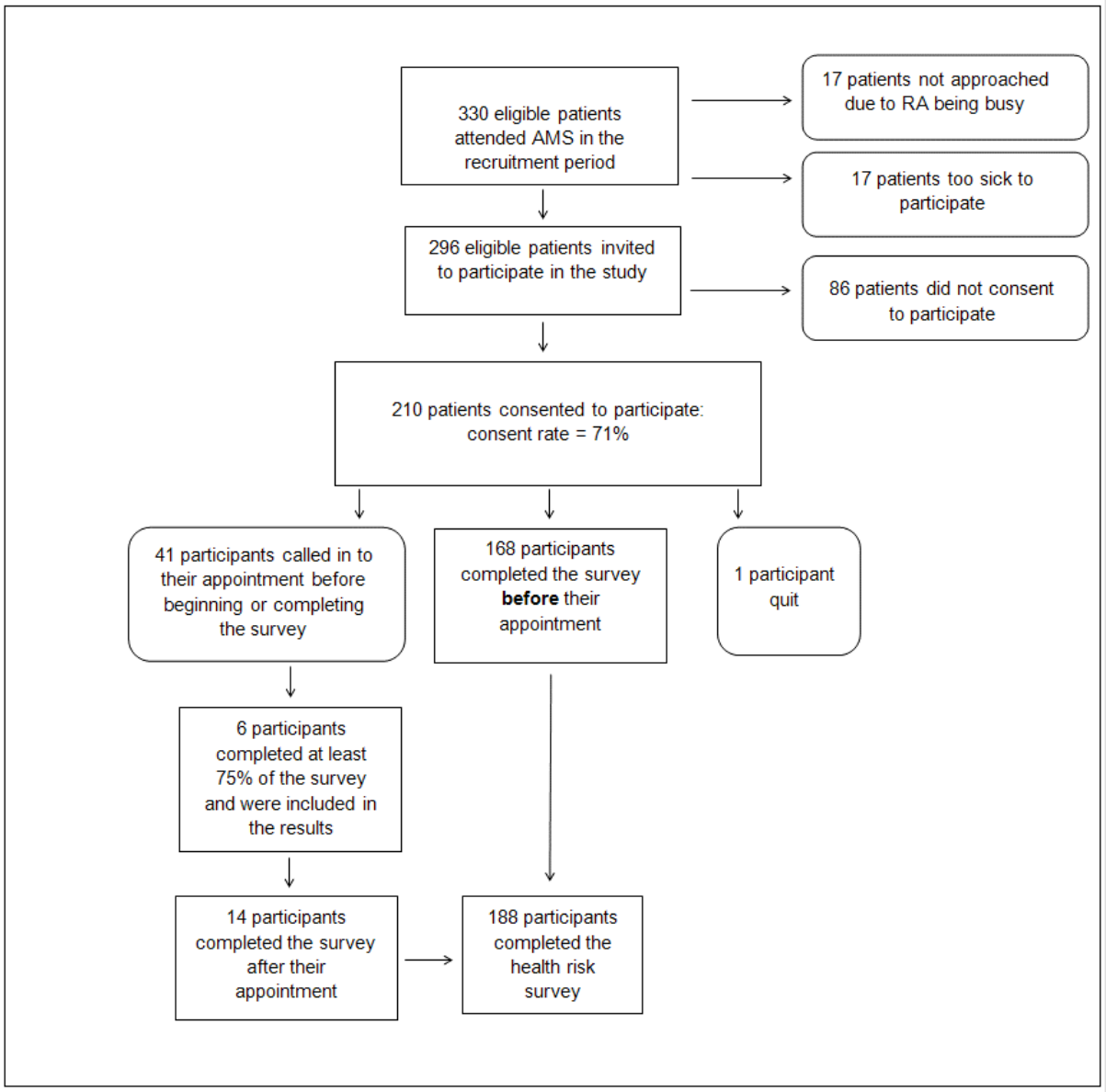

Figure 1.2: Flow diagram of patient recruitment

ii. Completion rates and missing data

Of the 210 participants who consented to the survey, a total of 168 participants (80%) completed the questionnaire before attending their appointment (see Figure 1.2). Complete data were available for all participants, except for missing depression data for one participant

who chose to skip all depression screening questions, and three participants who accidently skipped one of the nine depression screening items.

iii. Time taken to complete the questionnaire

Questionnaire duration for those who completed the questionnaire before their appointment (n = 168) could only be extracted for 165 participants due to a technical problem. The mean time taken to complete the questionnaire was 11 mins 8 secs (SD = 4 min 56 sec), and 85% of participants completed the questionnaire in less than 16 mins. Aboriginal participants (n = 117) took significantly more time to complete the questionnaire (M = 11 mins 43 sec, SD = 5min 5 sec) than non-Aboriginal participants (n = 48; M = 9 mins 41 sec, SD = 4min 15 sec), $t(163) = 2.44$, $p = .016$. Older participants also took longer to complete the questionnaire than younger participants ($F(5, 159) = 7.62$, $p < .01$). For example, the mean time taken by participants aged under 25 (n = 29) was 9 mins 10 sec (SD = 3min 51 sec), while for those aged over 65 (n = 13) the mean time was 16 mins 30 sec (SD = 6min 47 sec).

iv. Assistance sought/accepted in completing the questionnaire

Of the 206 participants who began the questionnaire (see Figure 1.2), 75% (n = 154) completed the questionnaire without assistance, 19% accepted some assistance (n = 39), and 6% completed the questionnaire in an interview style (n = 13). The proportion of participants who sought or accepted assistance with completing the questionnaire, across Aboriginal status and age groups, is shown in Table 1.2.

Table 1.2: Proportion of participants seeking/accepting assistance with the questionnaire by Aboriginal status and age group

	No assistance	**Some assistance**	**Interview style**	
	n (%)	**n (%)**	**n (%)**	***p* - value**
Indigenous status[a]				0.5
Aboriginal[b] (*n* = 135)	98 (73%)	27 (20%)	10 (7%)	
Non-Aboriginal (*n* = 53)	43 (81%)	8 (15%)	2 (4%)	
Age group				<.01
<35yrs (*n* = 73)	64 (88%)	9 (12%)	0	
35-54yrs (*n* = 82)	63 (77%)	14 (17%)	5 (6%)	
≥55yrs (*n* = 51)	27 (53%)	16 (31%)	8 (16%)	

[a] Indigenous status was only available for participants who completed the questionnaire (*n* = 188).
[b] The sample included 1 participant who identified as Torres Strait Islander and 3 participants who identified as both Aboriginal and Torres Strait Islander. For simplicity, the term 'Aboriginal' is used to refer to all participants who identified as being of either Aboriginal and/or Torres Strait Islander origin.

Assistance with questionnaire completion did not differ significantly between Aboriginal and non-Aboriginal participants (Fisher's exact test $p = .5$), but did differ between age groups (Fisher's exact test $p < .01$). After grouping participants into three age groups, almost half of those participants aged 55 years and over sought or accepted assistance with the questionnaire (either some assistance or interview: 47%), compared to 12% of those aged under 35yrs and 23% of those aged 35-55 years.

v. Participant feedback on the acceptability of the touch screen questionnaire

Questionnaire acceptability questions were completed by 181 participants. The proportion of participants who responded positively ('yes' response) to these items, according to Aboriginal status, are shown in Figure 1.3. There were no significant differences in

agreement with any of the statements between Aboriginal and non-Aboriginal participants, or across age groups (for those aged under 35yrs, 35-55yrs and over 55yrs; Fisher's exact test: all *p*s > .05).

Ninety-six percent of participants indicated that they would be willing to complete a similar questionnaire at future ACCHS visits, either 'sometimes' (44%), 'most of the time' (19%) or 'every time' (33%). Willingness to complete a future questionnaire did not differ significantly between Aboriginal and non-Aboriginal participants (Fisher's exact test $p = .90$) or across age groups (between those aged under 35yrs, 35-55yrs and over 55yrs; Fisher's exact test $p = .94$). Finally, of the subsample of participants ($n = 32$) who were asked whether, for future questionnaires, they would be willing for their doctor to see a copy of their questionnaire answers, 91% ($n = 29$) indicated 'yes'.

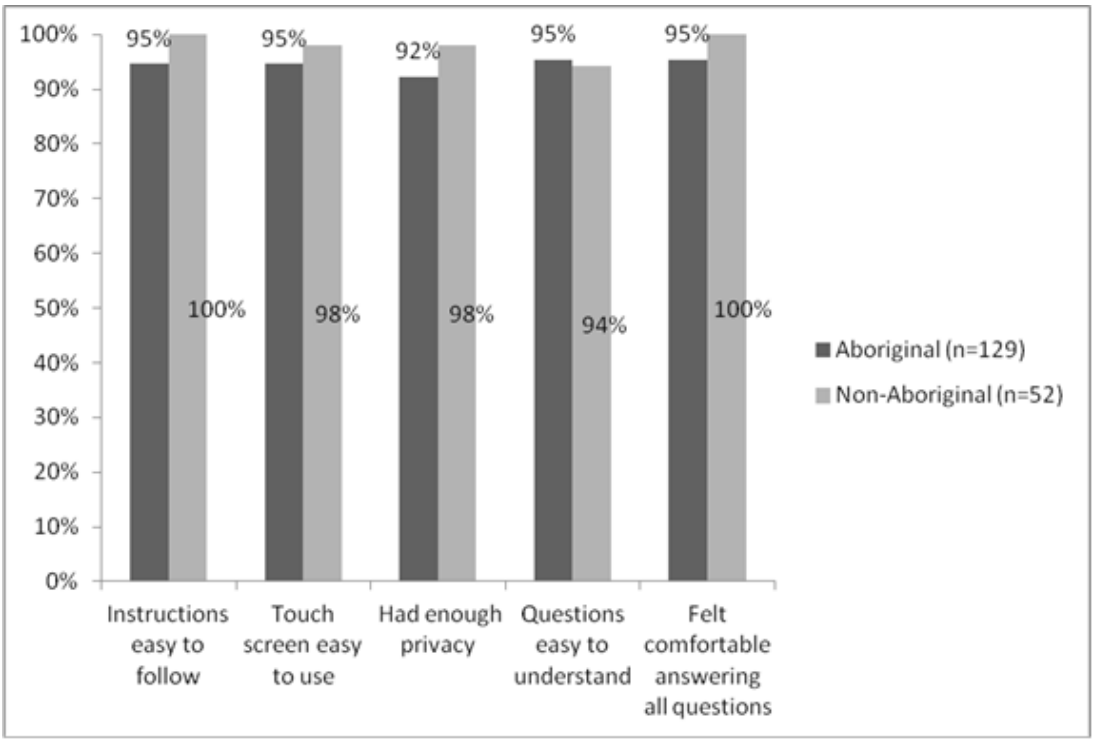

Figure 1.3: Percentage of Aboriginal and non-Aboriginal participants who agreed with each of the survey acceptability items

Discussion

Study results indicate that a large majority of patients who attended the ACCHS were willing and able to complete the touch screen health risk questionnaire. The consent rate was high (71%), and did not appear to differ according to age or gender, although Aboriginal patients were slightly less likely to consent. Missing data was also minimal. The majority of patients (80%) were able to complete the questionnaire in the time that they were waiting to see the doctor, and most patients (75%), independent of their Aboriginal status, were able to complete the questionnaire without any assistance, although older participants were more likely to need some help. Results suggest that an electronic screening approach such as the one used here could be readily incorporated in routine clinical practice during appointment waiting times, requiring minimal staff time for gathering risk factor information, provided sufficient staffing resources were available to encourage patients to complete the questionnaire and assist if needed. The potential clinical utility of this approach is further supported by the high degree of acceptability of the questionnaire, and the high proportion of patients who indicated that they would be willing to complete a similar questionnaire at future appointments (96%), and for their doctor to see their results for future questionnaires (91%). Perhaps most encouraging was the high proportion of participants who agreed that they felt comfortable answering all the questions, despite the inclusion of questions about potentially sensitive issues such as smoking, alcohol consumption and illicit drug use.

Several study limitations should be noted. The questionnaire was completed anonymously, and therefore consent rates and acceptability levels may not reflect patients' responses had the questionnaire results been linked to their medical record or otherwise available to their doctor or health worker. Clearly this is an important consideration if such a system were to be

implemented in routine clinical practice. The other major limitation relates to the validity of self-reported health risk factor information. Although validated measures were used wherever possible,[33-35] many show only moderate sensitivity and specificity (such as short measures of physical activity and diet) and the validity of most measures for use in the Aboriginal population has not been specifically established. While validation was outside the scope of this study, an exploration of the appropriateness and accuracy of such measures would be an important consideration for the clinical utility of the questionnaire results. Additional study limitations relate to the generalisability of the results given that the study was conducted in a single ACCHS in a rural but non-remote setting. In more remote communities, literacy issues or less computer experience may impact on questionnaire acceptability and utility. However, the use of a touch screen with graphics and multimedia options such as those used in audio computer-assisted self-interviewing methods,[36] or the multimedia Queensland 'HITnet' program for Indigenous communities[37] could help to overcome these barriers.

This study confirms that the use of a touch screen laptop survey is both feasible and acceptable for the systematic collection of risk factor status and screening adherence among adult patients attending an ACCHS. The observed consent rate, acceptability of the questionnaire, and willingness to complete similar future questionnaires, suggest that this approach is a potentially sustainable one which could be implemented more widely as part of routine practice in the ACCHS setting, subject to a comprehensive evaluation of the validity of the health risk data collected. If results were linked directly into patient medical records, this would assist healthcare providers with the systematic identification of at-risk patients, reduce the burden on providers associated with risk assessment, and leave more time available for the provision of preventive care. Provided that collected data are reliable,

questionnaire results could provide a starting point for providers to initiate discussion about potentially sensitive issues such as smoking, alcohol or drug use. Screening is also likely to raise personal awareness among patients about their health risks and screening needs.

Conclusions

This study has provided evidence for the potential acceptability and usefulness of an electronic health risk assessment tool for use with patients of ACCHSs. Ultimately, this kind of systematic approach to risk factor assessment has the potential to improve the identification and therefore the management of at-risk individuals, therein providing a significant and much needed opportunity to reduce the burden of disease among Aboriginal Australians.

Competing interests: The authors have no competing interests to declare.

Author Contributions: NN developed the study materials, conducted data collection, undertook analysis and interpretation of the data, and drafted the manuscript. CP made substantial contributions to the study conception and design, provided support during data collection, and assisted with drafting and revision of the manuscript. MC made substantial contributions to the study conception and design, and provided critical feedback and revision of the manuscript. RSF made substantial contributions to the study design, facilitated data collection and revised the manuscript. SB provided feedback on study design and specific study materials, facilitated data collection, and revised the manuscript. JS and KC provided input into the study design, materials and specific survey items, and provided critical

feedback and revision of the manuscript. All authors gave final approval of the version to be published.

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PAPER THREE

Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors.

Introduction to Paper Three

Papers one and two identified the potential for improving preventive care in the primary care setting by using electronic screening and feedback. 'SNAP' risk factors (Smoking, Nutrition, Alcohol and Physical activity) are particularly suited for such screening, given the general reliance on self-reporting of these behaviours in primary care consultations. SNAP risk factors are highly prevalent among general practice patients, are associated with the risk of development of numerous chronic diseases, and also tend to be interrelated. The need to manage such risk factors collectively rather than in isolation in primary care is increasingly being recognised for both Indigenous and non-Indigenous Australians. Despite a growing body of literature examining the clustering of health risk behaviours, there is little consensus about which SNAP health risks can be expected to cluster together and whether clustering patterns are associated with particular population subgroups. A better understanding of: i) the extent of clustering of these health risk behaviours; ii) which specific behaviours can be expected to co-occur and iii) any patient characteristics associated with different clusters of SNAP risks, is therefore needed. Such information would allow for the development and delivery of approaches or interventions which better address interrelated risk factors, and also allow healthcare services to focus their efforts on subgroups of individuals at the greatest risk.

Paper three, therefore, explored the international literature on the clustering of SNAP health risks, with the aim of identifying which SNAP health risks have been reported to cluster together, and any associations between specific health risk clusters and sociodemographic variables. Paper three included studies of socially disadvantaged samples, such as Aboriginal Australians, with the aim of identifying patterns of clustering of SNAP health risks for such

groups and whether these patterns differed to those seen among less disadvantaged groups. However, given the limited number of papers specific to social disadvantage and Aboriginal Australians in particular, as well as a range of methodological issues described below, the authors acknowledge that the conclusions of the review require further exploration with Aboriginal people.

This paper was published in *Preventive Medicine.* The statements of contribution from co-authors are shown in Appendix 3.

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Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors.

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Abstract

Objective: There is a growing body of literature examining the clustering of health risk behaviours, but little consensus about which risk factors can be expected to cluster for which sub-groups of people. This systematic review aimed to examine the international literature on the clustering of smoking, poor nutrition, excess alcohol and physical inactivity (SNAP) health behaviours among adults, including associated sociodemographic variables.

Method: A literature search was conducted in May 2014. Studies examining at least two SNAP risk factors, and using a cluster or factor analysis technique, or comparing observed to expected prevalence of risk factor combinations, were included.

Results: Fifty-six relevant studies were identified. A majority of studies (81%) reported a 'healthy' cluster characterised by the absence of any SNAP risk factors. More than half of the studies reported a clustering of alcohol with smoking, and half reported clustering of all four SNAP risk factors. The methodological quality of included studies was generally weak to moderate. Males and those with greater social disadvantage showed riskier patterns of behaviours; younger age was less clearly associated.

Conclusion: Clustering patterns reported here reinforce the need for health promotion interventions to target multiple behaviours, and for such efforts to be specifically designed and accessible for males and those who are socially disadvantaged.

Key words: clustering, cluster analysis, multiple risk factors, health behaviours, SNAP risk factors

Introduction

Behavioural risk factors including smoking, poor nutrition, excess alcohol consumption and physical inactivity, collectively known as 'SNAP' risk factors,[1] are among the major causes of morbidity and mortality in high income and increasingly also in lower income countries.[2-4] These risk factors contribute to the development of chronic diseases such as cardiovascular diseases and cancer,[5] which are among the leading causes of death worldwide.[6]

Health risk behaviours typically co-occur or cluster together.[7-11] There is evidence of a synergistic effect of risk factors, where combinations of lifestyle risk behaviours are more detrimental to health than their cumulative individual effects.[10,12,13] Despite this, many public health intervention strategies focus on health behaviours in isolation.[9,14] The WHO recently recommended an approach to prevention of chronic disease which focuses on tackling multiple modifiable risk factors.[15]

Clustering is a pattern of health behaviours that is more prevalent than expected on the basis of individual prevalence rates.[16] Information about whether, and which, risk factors cluster together can help inform the development of effective and holistic preventive health interventions.[8,11,17] Such information can also facilitate the identification of vulnerable population groups for targeting of health promotion strategies.[10,13,16] Because of the possible synergistic effects of multiple risk behaviours, multiple behaviour change interventions have a potentially greater impact on public health than interventions aimed at single risk factors.[10,17,18]

While relatively detailed information about the prevalence of single health risk factors is available, a more modest literature addresses clusters of lifestyle-related health factors and their demographic correlates.[12,13,19] Clustering at both ends of the spectrum has been reported, with larger numbers of individuals than expected exhibiting all, or none, of a range of risk factors.[14] The existing literature is highly heterogeneous, and there remains little consensus about which risk factors might be expected to commonly cluster together. Multiple SNAP risks appear to be more prevalent among men, younger age groups, and those with lower levels of education and socioeconomic status;[8,11,16] however, the prevalence of multiple risk factors has also been reported to be higher among women compared to men,[10] or to be similar across age groups.[16] The association between demographic variables and clustering of health risk behaviours therefore also remains unclear.

A fundamental challenge in examining 'clustering' lies in how to analyse multiple risk behaviours[9] and the existing literature is characterised by the use of diverse analytical approaches.[12,17] Methods of clustering aim to investigate associations between co-occurring risk factors. Some common methods of cluster analysis include unsupervised learning approaches, where observed patterns of response to multiple items are used to infer un-observed (latent) structure in the data; Examples include cluster, latent class, and factor analysis.[9] The ratio of observed prevalence (O) of co-occurring risk factor combinations compared to predicted or expected prevalence (E) assuming independence of the risk factors, (O/E) is an additional statistical approach to representing the magnitude of the association between risk factors. The more the O/E ratio deviates from one, the more strongly the behaviours are associated.[20]

Given the growing body of literature on clustering, possible synergistic effects of multiple risk behaviours, and potential benefits of targeting health interventions towards co-occurring risks, it is timely to review the existing literature on clustering of key health risk behaviours. The aims of this current systematic review were therefore to describe the international literature on the clustering of modifiable SNAP health risk behaviours, including specifically:

a) the number of papers which have explored clustering, by country and sample type;
b) the number of papers which examined each possible combination of at least two SNAP risk factors and the types of clustering analyses used;
c) which SNAP health risks have been reported to cluster together; and
d) sociodemographic variables associated with SNAP health risk clusters.

Methods

Literature search

A literature search was conducted in MEDLINE, CINAHL, and PsychINFO databases in May 2014. A combination of the following search terms was used:

1. Cluster terms: *Cluster analysis* (MESH) OR *cluster** OR *clustering* OR *clustered* OR *co-occur* OR *co-occurrence*; AND
2. Health risk terms: *Smoking* (MESH) OR *smoking* OR *smoke** OR *Tobacco* (MESH) OR *tobacco* OR *Alcohol Drinking* (MESH) OR *alcohol* OR *Diet* (MESH) OR *diet** OR *fruit* OR *vegetable** OR *Exercise* (MESH) OR e*xercise* OR *sedentary* OR *physical adj activity* OR *physical adj inactivity*; AND
3. *Health adj1 risk** OR *health adj1 behaviour** OR *risk adj1 behaviour** OR *Life Style* (MESH) OR *lifestyle*

The search was limited to humans, adults (aged ≥18 years) and English language (no time limit imposed). The reference lists of included papers published in the last three years (from 2011), and a scoping review of statistical approaches to analysis of multiple health-related behaviours,[9] were cross-checked for any additional relevant studies.

Inclusion/exclusion criteria

Papers were included if they: a) reported on the clustering of at least two 'SNAP' health risk behaviours (smoking, poor nutrition, excess alcohol consumption, physical inactivity); papers could also include additional, non-SNAP risk factors; b) included an adult (aged ≥18 years) or predominantly adult sample; and c) used one or more of the following methods of analysis: unsupervised cluster analysis techniques including hierarchical agglomerative methods (e.g. nearest neighbour/single linkage, Ward's method), non-hierarchical or k-means clustering methods,[21] or Latent Class Analysis/ Mixture models;[22] factor analysis or Principal Components Analysis;[23] and O/E ratios. No limitations were placed on the inclusion of special populations in study samples.

Included statistical methods of analysis were based on those described as clustering by McAloney et al., 2013.[9] Papers with a predominantly non-adult sample (e.g. age 14-21yrs), or where results were not reported separately for adults, and non-data based papers (e.g. reviews, commentaries, letters) were excluded. Results for studies of the same or similar datasets were reported only once. Papers reporting on the co-occurrence (not clustering) of SNAP risk factors were noted but not examined further, including those reporting on: a) prevalence of multiple risk factors using a risk factor 'score' or 'index'; b) co-occurrence of

risk factors (prevalence only) without probability rules; c) pair-wise associations among multiple risk factors only; d) co-occurrence of *healthy*, or *low risk* SNAP behaviours.

Data extraction and coding

Paper titles and abstracts were coded against the inclusion criteria by one author (NN). As a large number of papers were identified, a random subsample of 10% of titles and abstracts was cross-checked by a second author (HT). Characteristics of relevant studies including the country, setting, participants, SNAP risk factors and measurement, type of analysis, sociodemographics, and brief description of the study results, were extracted by one author (NN), with a random 10% subsample cross-coded by a second author (CP). A brief assessment of the risk of bias of included studies was undertaken using two relevant components of the EPHPP Quality Assessment Tool for Quantitative Studies:[24] Component A) Selection bias; and Component E) Data collection methods. Three authors completed this assessment (CP, HT, NN), with 10% of studies cross-coded by all three authors to ensure consistency. Despite the different approaches to analysis of clustering included in this review, for simplicity all presented results are referred to as 'clusters' or 'clustering', even when reporting factors, latent classes, or O/E risk factor combinations.

Description of SNAP risk factor clusters: The content of the clusters reported in each study were coded and agreed upon by two reviewers (NN, HT), based on the description given by study authors. For example, if the authors described the cluster as having an 'above average' or 'moderately high' prevalence of risk factors, or the cluster was described as being 'low in healthy behaviours', or 'majority did not meet guidelines', the cluster was considered to be characterised by these risk factors. For factor analysis, the correlation between risk factors

was assumed to hold for both healthy and unhealthy SNAP behaviours. Therefore a factor reported as ‘healthy nutritional habits, healthy physical exercise’ was coded as a clustering of poor diet and low physical activity. For O/E ratios, reporting was limited to the three risk factor combinations with the highest O/E ratios >1. Details about the most frequently included ‘other’ (non-SNAP) risk factors were also extracted.

Proportion of studies reporting each possible combination or cluster of risk factors: To combine results across studies examining different sets of risk factors, the total number of studies reporting each possible combination of risk factors (no risk factors, single risk factors only, each pair, each combination of three, and the combination of all four risk factors) was reported, as a proportion of the total number of studies in which each combination of risk factors could possibly have been found. A visual representation of the types and frequency of SNAP risk factor clusters reported across studies was generated using the social network analysis software NetMiner 4 (Cyram International, www.netminer.com).

Sociodemographics associated with different health risk clusters: For papers using O/E ratios, sociodemographics associated with the highest cumulative number of multiple risk factors were extracted. For clustering studies, the ‘most’ risky cluster reported per study was identified (by the review authors), and key sociodemographic variables significantly associated with this cluster extracted (including age, gender, education level and socioeconomic status). The ‘most’ risky cluster was defined as that with the largest total number of multiple SNAP risk factors. If a single study reported two or more clusters with an equally high number of SNAP risk factors, demographics associated with each of the most risky clusters were extracted. A combined socioeconomic status (SES) variable was derived

from measures including employment status (employed versus unemployed, blue vs white collar, shift vs day workers), income, personal wealth, and area of residence.

Results

The search identified 1142 studies, of which 56 articles were identified as relevant and included in the review. Figure 3.1 shows a summary of the inclusion/exclusion results, and Tables 3.1-3.3 give a detailed description of each of the studies included in the review, with SNAP risk factors that were used to characterise each cluster, factor or O/E combination shown in bold. Key demographic variables associated with clusters are also reported in Tables 3.1-3.3.

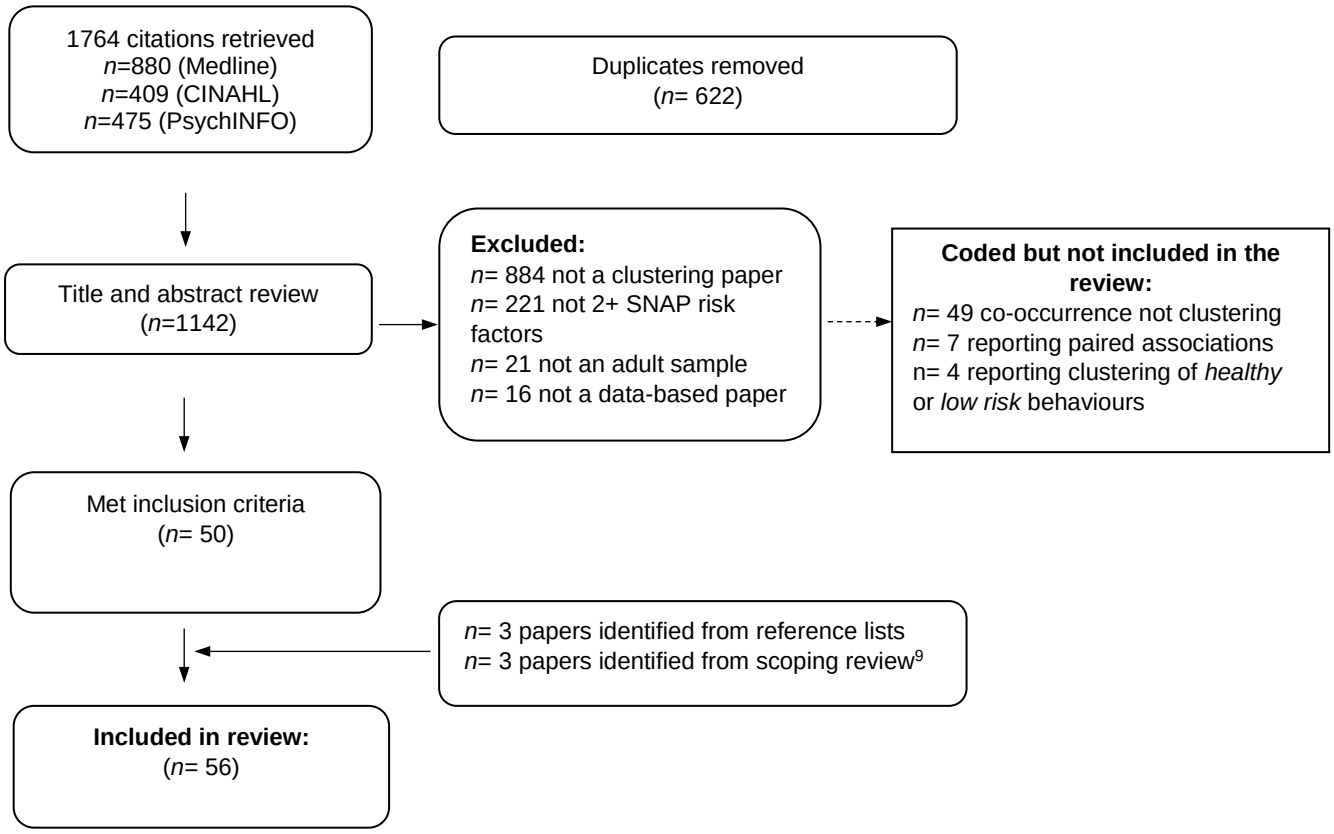

Figure 3.1: Flow chart of inclusion/exclusion of review studies (May 2014)

For the 10% of titles and abstracts that were cross-checked for inclusion in the review, there was a high level of agreement (97%) for inclusion/exclusion between the two reviewers (kappa=0.84). Agreement between the two authors on the description of clusters was also high, with any discrepancies resolved by discussion.

Table 3.1: Detailed description of cluster analysis and latent class analysis studies included in the review

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
Alati et al., 2007 Australia	Melbourne Women's Midlife Health Project Cross-sectional community sample of women (49-59yrs) Data collection: random telephone digit dialling; face-to-face interview n= 387 (all female); RR=71%- 56% (initial and follow-up)	Alcohol: no. alcoholic drinks in last 7 days PA: times per month/week Smoking: never, ex, current Other risk factors: BMI Self-rated health General symptoms Well being Hassle frequency Stress	Age Education Amount of paid work Marital status	6 clusters: *1. Older, happy workers* [17%]: Above average **alcohol** intake, few smokers, highest wellbeing and above average SR health; *SoDs:* Older, below average education, highest amount of paid work *2. Educated workers* [10%]: Mostly non-drinkers, low **PA**, few smokers, low BMI, high wellbeing and highest SR health, above average stress; *SoDs*: Average age, most highly educated *3. Healthy lifestyle cluster* [33%]: Mostly non-smokers and non-drinkers, highest PA, lowest BMI, slightly above average well-being; *SoDs*: Youngest cluster *4. Not employed smokers* [11%]: Low alcohol intake, high proportion of **smokers**, slightly above average wellbeing and slightly below average SR health, low stress; *SoDs:* Average age, average education, lowest amount of paid work *5. Unhealthy lifestyle cluster* [7%]: Highest **alcohol** intake, second highest proportion of **smokers**, lowest **PA**, highest BMI, average wellbeing, lowest SR health; *SoDs:* Average age, least educated, lowest no. children *6. Stressed cluster* [22%]: Average alcohol intake and proportion of smokers, high number of health-related symptoms, high hassles/ stress, lowest well-being; *SoDs*: Average age
Becue-Bertaut et al., 2007 Croatia	Croatian Health Survey Random sample of patients registered in GP clinics from 13/20 Croatian countries (18yrs+) Data collection: face-to-face household visit and SR survey n= 5048 (61% female); RR= approx. 80%	Alcohol: not stated Diet: open ended question: 'What did you eat yesterday'? (all meals and beverages recorded) PA: not stated Smoking: not stated Other risk factors: General Health (GH) score Self-assessed health Use of healthcare systems	Gender Age Education Economic status (ES)	7 clusters: *1. Cluster 1* [11%]: Drinkers/former drinkers, former smokers, physically inactive, poor/fair SR health, low GH score; *SODs:* Male, older, below average ES, low-mid education *2. Cluster 2* [16%]: Drinkers/former drinkers, smokers/former smokers, walking/running, good/fair SR health, mod GH score; *SODs:* Male, mid-age, average ES, mid-high education *3. Cluster 3* [14%]: Drinkers, smokers/former smokers, sport/running, excellent/v good SR health, high GH score; *SoDs:* Male, younger, high ES, mid education *4. Cluster 4* [17%]: Non-drinkers, non-smokers, physically inactive, poor SR health, low GH score; SoDs: Female, older, low ES and education *5. Cluster 5* [10%]: Non-drinkers, non-smokers, physically inactive, good/fair SR health, medium GH score; *SoDs:* Female, older, low ES and education *6. Cluster 6* [18%]: Occasional drinkers, smokers, walking; good/fair SR health, mod GH score; *SoDs:* Female, mid age, average ES, mid-high education *7. Cluster 7* [15%]: Occasional drinkers, smokers, walking, excellent/v good SR health, high GH score; *SoDs:* Female, younger, average ES, mid education

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
				→Note: inclusion of risk factors in clusters could not be quantified due to the unclear classification of risk factors used by the authors: e.g. drinkers/former drinkers, smokers/former smokers
Bondy et al., 1998 Canada	Ontario Health Survey National community based sample (35-64yrs) Data collection: face-to-face interview and SR survey n=6060 (50% female); RR=86%	Alcohol: 7 day diary; frequency of drinking/last 12m; frequency of 10+ drinks/occasion in last 12m; SMAST Diet: % energy from fat PA: total physical activity level (energy expenditure units) Smoking: non, current Other risk factors: BMI Self-rated (SR) health No. of health problems Visited GP in last 12m	Age Marital status Household income Separate analysis by gender	MALES: 9 clusters *1. Yuppies1* [16%]: Frequent low volume alcohol intake, fall on healthy side of behaviours, **not very physically active**, good SR health; *SoDs*: Young, well-educated, high income *2. Special event drinkers* [13%]: High frequency binge **drinking**, low frequency and total volume of alcohol; *SoDs:* Average age, education and income *3. Yuppies2* [5%]: Moderate alcohol intake, positive health behaviours, high PA; high SR health; *SoDs*: Young, well-educated, high income *4. Active middle-agers* [4%]: Low volume frequent drinkers, healthy diet, good BMI and high PA; *SoDs:* Older, moderate income and education *5. Gourmands* [17%]: Frequent low volume alcohol, higher BMI, higher fat **diet**, poorer SR health; *SoDs:* None reported *6. Problem drinkers* [10%]: **Smokers** and reported symptoms of problem drinking; *SoDs:* Similar to average total sample *7. Poor and unwell* [4%]: High frequency of heavy **drinking**, moderate volume and low frequency alcohol use, high **smoking**, overweight, poor SR health; *SoDs*: Older, low education and income, not married *8. No check-ups* [14%]: Average risk behaviours, least likely to have seen GP in last yr and to report health problems; *SoDs*: Similar to sample norms *9. Over-doers* [17%]: High recent intake of **alcohol**, low frequency drinking, high fat **diet**, overweight; *SoDs*: None reported FEMALES: 8 clusters *1. Older and wiser* [30%]: Frequent low volume alcohol intake, some SR health problems; *SoDs*: Oldest cluster *2. Hard drinkers* [21%]: Frequent binge **drinking**; *SoDs:* older, lower education and income *3. Yuppies* [41%]: High frequency low-volume alcohol, good SR health; *SoDs:* Young, high income *4. Alcohol Problems* [1%]: Most frequent **drinkers** but low volume, some symptoms of alcohol problems; *SoDs*: None reported *5. Jocks* [6%]: High PA; *SoDs*: None reported

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
				6. Weekenders [1%]: Low frequency high volume alcohol intake, least likely to have seen GP in last yr; *SoDs*: Young *7. Negative* [<1%]: **Smokers**, some symptoms of alcohol problems, overweight, high fat **diet**, poor SR health; *SoDs:* Lowest education and income, unmarried *8. Educated jocks* [<1%]: High/ moderate PA, infrequent high volume **alcohol**, report symptoms of alcohol problems; *SoDs:* Highest education, average age
Braunstein et al., 2001 USA	Cross-sectional sample of General Motors employees (majority aged 45-55yrs) Data collection: approached in work place; health risk appraisal and biometric screening n= 16,879 (20% female); RR= not reported	Alcohol: not stated [risky: >14 drinks/week] PA: not stated [risky: <once/week] Smoking: current smoker Other risk factors: BMI No. of illness days Seat belt use Biological factors Psychological factors (self-rated health, stress) Disease (diabetes)	Gender Age Casual/ salaried employees	4 clusters: *1. Risk-taking* [40%]: High proportion of risky behaviours (**smokers**, **alcohol** and poor safety belt usage), high no. illness days; *SoDs*: All similar to sample average *2. Low risk* [19%]: No notable risks, average BMI; *SoDs*: Most salaried employees *3. Biometrics* [18%]: Highest prevalence of high BP, cholesterol and weight problems; *SoDs*: Older cluster, more males *4. Psychological* [23%]: Relatively high prevalence of **smoking** and high BP, high prevalence of psychological factors (e.g. high stress, low life satisfaction), poor SR health and high no. illness days; *SoDs*: More females
Burke et al., 2007 Australia	Random sample of Aboriginal Australians (15-88yrs) Data collection: Community Health Client Register of Health Department; interviewer-administered survey n=514 (50% female); RR= not reported	Alcohol: diary for last two 48-hr drinking periods [heavy drinkers: ≥150 or ≥100 g/day for men/women] Diet: FFQ PA: frequency of exercise raising a sweat/ breathing heavily Smoking: never, ex, current	Separate analysis by gender	MALES: 2 clusters *1. Worse cluster male* [53%]: Higher proportions of **smokers**, heavy **drinkers**, poor **diet** (consumption of takeaway foods, lower rates of trimming fat from meat and higher egg consumption) *2. Better cluster male* [47%]: Less smokers, non or moderate drinkers, better diet FEMALES: 2 clusters *1. Worse cluster female* [56%]: **Smokers**, heavy **drinkers**, poor **diet** (consumption of takeaway foods, high rates of adding salt and consumption of processed meats) *2. Better cluster female* [44%]: No current smokers, non or moderate drinkers, better diet PA did not differ significantly between clusters

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
Cameron et al., 2011 Australia	READI study Random sample of women with a child aged 5-12yrs from urban/rural socioeconomically disadvantaged suburbs (18-45yrs) Data collection: Australian Electoral Roll; mail-out survey n=549 (all female); RR= 47%	Diet: usual serves of fruit and veg/day; Frequency of energy dense foods in last month PA: IPAQ Other risk factors: Sedentary/sitting behaviour	Age No. of children Self-rated health BMI Education level	5 clusters: *1. Fruit and vegetable eaters who don't sit* [24%]: High fruit and vegetable consumption and low sitting time; *SoDs:* Highest education *2. Physical activity enthusiasts* [18%]: Highly physically active; *SoDs:* High self-rated health *3. Sedentary sitters* [7%]: Highest levels of sitting; *SoDs*: None significant *4. Low on fruit and vegetable and physical activity* [33%]: Low levels of **fruit and vegetable** consumption and **PA**; *SoDs:* Highest self-rated health *5. Poor diet and little physical activity* [17%]: **High-energy dense food/drink,** low **fruit/vegetable** consumption, and low **PA**; *SoDs*: None significant
Conry et al., 2011 Ireland	Survey of Lifestyle, Attitudes and Nutrition National random sample of residential addresses (18yrs+) Data collection: face-to-face interview n =7,350 (51% female); RR=62%	Alcohol: AUDIT-C score [hazardous/problem drinking: score 6+] Diet: FFQ [categorised by DASH scores from poor to excellent] PA: IPAQ Smoking: former, never, current	Gender Social class Age Self-rated health Quality of life (QoL) Mental health	6 clusters: *1. Healthy Lifestyle cluster* [9.3%]: High levels of PA, never smokers, excellent diet, majority (33%) moderate alcohol or non-drinkers; *SoDs:* Women, aged 65yrs+, highest social class, highest levels of energy vitality, lowest psychological distress, high QoL and self-rated health *2. Former Smokers* [21%]: Former smokers (98%), highest PA, more than half were moderate drinkers and 40% had a good diet; *SODs:* More men, fewer members of highest social class, average energy vitality and QoL, above average distress *3. Temperate cluster* [15%]: Moderate PA, never smokers, moderate drinkers, mainly good diet but no high DASH scores; *SoDs*: More men, fewer highest social class, more likely to be aged 18-29yrs and 30-44 years, average energy vitality and psychological distress, high QoL and self-rated health *4. Physically Inactive* [18%]: Lowest **PA**, majority current **smokers** (54%) and 41% reported hazardous **drinking**, majority poor **diet** (76%); *SoDs*: More likely to be men, aged 18-29yrs, less likely to be in the highest social class, high psychological distress *5. Multiple Risk Factor* [17%]: Moderate PA, majority current **smokers**, mixed drinking with 40% moderate and 40% problem **drinkers**, varied diet, over half reporting poor **diet** scores and no high scores; *SoDs:* More likely to be men, aged 18-29yrs, less likely to be in highest social class, highest psychological distress, poor SR health

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
				6. Mixed Lifestyle [20%]: All never smokers, moderate PA, over half reported poor **diet**, over half were non-drinkers but 46% problems **drinkers** (score 6-12); *SoDs*: More likely to be men, aged 18-29yrs, less likely to be in the highest social class, average energy, psychological distress and SR health
de Bouraud-huij et al., 1999 Belgium	Random sample of city residents from 3 age groups: 16-25yrs, 35-45yrs and 50-65yrs Data collection: self-report survey and face-to-face interview (for leisure time PA) n= 2390 [51% female]; CR=53-60% (by age group)	Alcohol: no. drinks/week PA: at work: time spent standing, walking, lifting or other strenuous); Leisure: MLTPAQ Smoking: No. cigarettes/day Other risk factors: BMI: Continuous Hour slept/night	Sex Age Occupation Education Work status Living situation Separate analysis by age group	2 clusters per age group: *1. Unhealthy* 16-25yrs [26%]: More **smokers** (majority regular smokers), more **alcohol** use (average 3-6 drinks/week), more PA at work, less hrs sleep and higher BMI; SoDs: More men 35-45yrs [45%]: More **smokers** (majority regular smokers), more **alcohol** use (average 3-6 drinks/week), more PA at work, less hrs sleep; SoDs: More men 50-65yrs [26%]: More **smokers** (majority regular smokers), more **alcohol** use (average 3-6 drinks/week), more PA at work, less hrs sleep and higher BMI; SoDs: More men *2. Healthy* 16-25yrs [74%]: Smoke and drink less (majority non-smokers, average 2- 3.5 drinks/week), less active at work, more hrs sleep; *SoDs*: Younger, more females, higher education or still studying, living at home 35-45yrs [55%]: Smoke and drink less (majority non-smokers, average 2- 3.5 drinks/week), less active at work (scores 0.5-2 per age group) more hrs sleep; *SoDs*: Higher education and work status (white vs blue collar) 50-65yrs [74%]: Smoke and drink less (majority non-smokers, average 2- 3.5 drinks/week), less active at work (scores 0.5-2 per age group), more hrs sleep; *SoDs*: More females
de Vries et al., 2008 Netherlands	Dutch SMILE study Cross-sectional sample of adult recruited through 8 health centres (mean age 51yrs) Data collection: mailed survey using address recorded with GP	Alcohol: Dutch QFVQ: [recommendation: ≤3 (men) or ≤2 (women) drinks/day Diet: FFQ [recommendation: 2+ pieces fruit, 200+gms veg/day] PA: days/week of 10mins of 15 activities converted to mins/day [recommendation: 30+mins on 5 days/week] Smoking: non, daily, occasional	Separate analysis by level of education reported the same cluster results	3 clusters: [Prevalence not reported] *1. Unhealthy*: Low probabilities of adhering to all recommendations (low probabilities for **PA** and **fruit and veg**, **alcohol** and **smoking**) *2. Healthy*: High probabilities for adherence with PA and alcohol recommendations, moderate probabilities of adhering with the norm for smoking and diet *3. Poor nutrition*: Low probability for adhering with **PA** and **diet** recommendations, high adherence with smoking and alcohol norms →Higher educated group showed higher adherence to health behaviour norms than the lower educated group

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	n= 9449 (58% female); RR=not reported			
Dodd et al., 2010 UK	Cross-sectional sample of university students (mean age 23yrs) Data collection: students recruited in classes; self-report survey n= 410 (75% female); RR=not reported	Alcohol: number of episodes of binge drinking [≥4 or ≥5 drinks per occasion for females/ males] in last 7 days Diet: usual serves of fruit and veg per day PA: LTEQ Smoking: non, occasional, regular Other: Psychological stress	Age BMI Religion Ethnicity Yr of study On/off campus	3 clusters: *1. Unhealthy/high risk* [46%]: Low **PA**, low **fruit and vegetable** intake, relatively high percentage of occasional/regular **smokers**, lowest binge drinking, high psychological stress; *SoDs*: Female, higher proportion of Asian/ Asian British/ Black/ Black British students *2. Moderately healthy/moderate risk* [21%]: Moderate PA, fruit and vegetable intake and psychological distress, reported binge **drinking** >2 times, largest percentage of **smokers**; *SoDs*: Males, higher proportion of white students *3. Healthy/low risk* [33%]: High PA, high fruit and veg intake, moderate alcohol consumption, higher percentage of non-smokers than other clusters, low psychological stress; *SoDs*: n/a (reference group)
French et al., 2008 Australia	Cross-sectional community survey collected at 4 time points (16-69yrs) Data collection: face-to-face and telephone interview n= 8668 (50% female); RR=51%	Alcohol: number of drinks per day over last week [unsafe drinker: ≥5 or ≥3 drinks on any day for females/ males] Diet: usual serves of fruit and veg per day [low consumption: <2 serves or <2 cups of fruit/ vegetables] PA: number of days of general or moderate exercise over last week [inadequate: <5 or <3 days of general/ moderate PA] Smoking: current, non-smoker Other: Poor sun protection	Gender Age Income Residence (metro/ rural)	4 clusters: *1. Safe* [47%]: Mostly '**safe**' behaviours; *SoDs*: Mostly female, 40yrs+, high income *2. Moderate* [24%]: Non-smokers, mostly safe drinkers, largest proportion of inadequate **PA** and low **fruit and vegetable** consumers, high proportion with unsafe sun protection practices; *SoDs*: Majority young males, one-third aged < 29yrs, greatest proportion of metro residents, average income *3. Risky smokers* [22%]: All **smokers** and most exhibited the **other risk** behaviours; *SoDs*: Younger, equal males/females, more rural residents, lowest income *4. Risky drinkers* [7%]: All unsafe **drinkers** and high proportion exhibiting **other risky** behaviours, greater proportion with poor sun protection and fewer low vegetable consumers than cluster 3; *SoDs*: Majority 40 yrs+, males, more rural residents, highest income
Fu et al., 2004	Cross-sectional sample of patients with CHD	Alcohol: ≥50g ethanol/day (yes/no)	n/a	4 clusters: [Prevalence of clusters not reported] *1. Hypertension*: High SBP and DBP

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
China	recruited from consenting hospitals in major cities (mean age 64yrs) Data collection: extracted from consenting patient medical records n=4800 (42% female); RR= not reported	PA: ≤90mins/week (yes/no) Smoking: ≥5 cigarettes/day (yes/no) Other: BMI SR stress Biological (BP, Total Cholesterol, HDL, glucose, hypertension) Family history of CHD		*2. **Smoking** and **alcohol*** *3. Glucose and cholesterol*: also overweight *4. Stress and **PA***: also overweight
Funderburk et al., 2008 USA	Department of Veteran Affairs database of medical centres and outpatients; patients with an encounter from 2001-2005 (mean age 62yrs) Data collection: extracted from medical records n=10043 (4% female); RR=n/a (12% of patients with complete records)	Alcohol: AUDIT-C [risk: score ≥4] Smoking: never, former, current Other: Depression (using GHQ) PTSD BP	Age Gender Marital status No. chronic diseases	3 classes: *1. Class 1* [89%]: healthier, close to one-third met all the health guidelines; *SoDs*: more likely to be married, older age *2. Class 2* [7%]: moderately high to high likelihood of **smoking**, depression, and moderate likelihood for alcohol and PTSD risk; *SoDs*: more likely to have 3+ chronic diseases *3. Class 3* [5%]: higher likelihood for **alcohol** and **smoking** risk, and high BP; lower likelihood of depression and PTSD; *SoDs*: more likely to be males
Gilligan et al., 2009 Australia	Cross-sectional survey of pregnant women (≥36 weeks gestation) attending antenatal clinics at single hospital (16yrs+)	Alcohol: usual frequency of consumption; quantity per day in last month Smoking: never, ex, current Other: BMI	Age Ethnicity Residence Marital status Parity and gravidity etc.	3 clusters: *1. High- vulnerability* [22%]: Highest proportion classified as **obese** and **smokers**, lowest proportion of regular drinkers but highest proportion who had **consumed 5+ drinks/day** in last month, highest proportion experienced domestic violence; *SoDs*: High proportion of Indigenous women, very remote residence, youngest and smallest proportion of married women, lowest level of education, social security as main source of income, rental housing

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	Data collection: approached in clinic; interviewer-administered survey n= 437 (all female); RR=86%	Domestic violence Partner smoking status Partner alcohol intake Illness/complications		*2. Low- vulnerability* [50%]: Lowest rates of smoking and drinking 5+ drinks/day in last month, low rates of domestic violence and pre-existing conditions; *SoDs*: Highest proportion of non-indigenous women, aged 25yrs+, urban residence, mostly married or de facto, highest rates of tertiary education, employment and private rented or owned/being purchased homes *3. Moderate-vulnerability* [28%]: Moderate proportion of **smokers**, high proportion classified as overweight; *SoDs*: most markers of low SES mid-way between those of the other clusters, except high proportion of teenage mothers
Glanz et al., 1998 USA	National sample and supplementary sample targeting minority/low SES participants (sample age not reported) Data collection: two mail out surveys n=2910 (% female not reported) RR=71%-77% (initial & follow-up)	Alcohol: usual frequency and usual no. drinks/drinking day Diet: usual serves of fruit and veg/day; frequency of eating desserts PA: days/week of 20min of vigorous exercise; days/week of mod exercise and usual amount of time Smoking: no. cigarettes/day Other: Weight control actions Cognitions Risk perceptions	n/a	7 clusters: *1. Physical fantastics* [24%]: Non-smokers, moderate alcohol, routine PA, healthy diet, watch their weight *2. Active attractives* [13%]: Non-smokers, higher **alcohol**, intend to but don't always achieve PA and healthy diet *3. Tense but trying* [10%]: **Smokers** (but trying to quit), moderate alcohol, average PA and diet *4. Decent dolittles* [24%]: Non-smokers and non-drinkers, low **PA**, poor **diet,** and overweight *5. Passively healthy* [15%]: Non-smokers, moderate alcohol, good PA but high fat **diet** and unconcerned about diet *6. Hard living hedonists*[6%]: **Smoke** and **drink** heavily, poor **diet**, good PA *7. Non-interested nihilists* [7%]: **Smoke** heavily, poor **diet** and **PA**, mod alcohol
Greene et al., 2011 USA	Project WebHealth (randomised controlled trial) Cross-sectional sample of students with a BMI ≥18.5 from 8 universities (18-24yrs)	Diet: National Cancer Institute Daily Fruit and Vegetable Screener PA: IPAQ Other: BMI Fitness Cognitive and	Separate analysis by gender	3 clusters: *1. Psychosocially Secure* Men: [34%]: Lowest **fruit and veg intake** and least vigorous **PA**, lowest BMI, low level of weight-related concerns, relatively high eating competence scores and low psychological stress Women: [34%]: Lowest BMI; low level of weight-related concerns, relatively high eating competence scores and low psychological stress *2. Behaviourally Competent* Men: [33%]: Highest fruit and veg intake and highest level of vigorous PA, BMI healthy (but higher than Cluster 1), high levels of eating competence and low cognitive restraint scores Women: [26%]: Highest fruit and veg intake and highest level of vigorous PA, BMI healthy (but higher than Cluster 1), high levels of cognitive restraint *3. High Risk*

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	Data collection: online SR survey and physical assessment n=1,689 (63% female); RR= 40%	behavioural components of eating behaviour Eating Competence Emotional/ Psychological stress		Men: [33%]: Least fit; highest BMI, highest emotional eating scores and levels of psychological distress Women: [40%]: Lowest intake of **fruit and veg** and lowest **PA**, highest BMI, highest emotional eating scores and levels of psychological distress
Hagoel et al., 2002 Israel	Cross-sectional sample of women from 8 primary care clinics (50-74yrs) Data collection: women invited to attend mammogram by letter; telephone interview 8-10 weeks later n= 1075 (all female); RR=93%	Diet: perception of fruit, veg and fat intake PA: usual frequency (none, intermittent, consistent) Smoking: never, ex, current Other: Periodic medical check-ups Attitude to medical examination	Age SES (based on area of residence) Ethnic origin Education Working outside the home Marital status Religiosity	3 clusters: *1. Health promoting* [44%]: Adoption of healthy behaviours such as healthy diet, PA and non or ex-smoking, at least one check-up in last 12m; *SoDs*: More likely to belong to high SES group, have higher education levels, and work outside the home *2. Inactive* [40%]: Very low **PA**, all non-smokers (mostly never smokers), less often undergo medical check-ups; *SoDs*: More likely to belong to low SES group, have lower education levels, least likely to work outside the home, higher percentage of older and non Israeli-born women *3. Ambivalent* [15%]: Less health promoting behaviours than cluster 1, few **exercise** regularly and almost half not at all, high proportion of **smokers** and ex-smokers, less healthy **diet** than other 2 clusters, less check-ups than cluster 1; *SoDs*: Almost evenly divided between the three SES groups, mid education levels, likely to work outside the home
Heroux et al., 2012 USA	Aerobics Center Longitudinal Study Cross-sectional survey of patients of a medical clinic (aged 20-84yrs) Data collection: medical history, SR	Alcohol: no. drinks in last week; risk: heavy drinking (≥8/ ≥15 drinks/week for men/ women) Diet: 3-day diet record [unhealthy: index score, lowest quintile] PA: frequency and duration of PA over last 3 months [inactive: no activity Smoking: current, non-smoker	Analysis adjusted for age and gender	2 classes: *1. Class 1 (unhealthy)* [38%]: Higher probability of engaging in all four **unhealthy behaviours**, in particular unhealthy diet *2. Class 2* [62%]: Healthier behaviours

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	survey and physical examination n= 13621 (% female not reported); RR= not reported	<u>Other:</u> Chronic disease Cardiovascular fitness		
Hwang et al., 2005 South Korea	Cross-sectional sample of full time employees at two airplane maintenance factories (19-56yrs) Data collection: health records, health survey and physical examination n= 2616 (5% female); RR= not reported	<u>Alcohol:</u> usual frequency of drinking <u>PA</u>: usual frequency of exercise <u>Smoking:</u> current, ex, never <u>Other:</u> BMI Blood pressure Glucose Cholesterol Stress	Age Gender Work section	4 classes: <u>*1. Cluster 1 [49%]:*</u> High probability of **drinking** >1-2 times/week, highest probability of **smoking**, good PA; *SoDs*: Shift workers <u>*2. Cluster 2* [34%]:</u> Lowest probability of drinking >1-2 times/week, of being overweight, high probability of **smoking**, lowest **PA**, highest stress; *SoDs*: Younger, female <u>*3. Cluster 3* [15%]:</u> High probability of **drinking** >1-2 times/week, highest probability of being overweight and having high BP, lowest probability of smoking, highest stress; *SoDs*: Older, day workers <u>*4. Cluster 4* [3%]:</u> Highest probability of **drinking** >1-2 times/week, moderate-high probability of being overweight, **smoking**, highest PA; highest blood glucose and cholesterol; *SoDs*: Older, day workers
Laska et al., 2009 USA	Mailed random sample of University undergraduate students (mean age 22yrs) Data collection: mailed survey n=2023 (62% female); RR=66%	<u>Alcohol:</u> frequency of binge drinking (≥5 drinks) in past 2 weeks [binge: ≥1 occasion] <u>Diet:</u> daily servings of fruits and vegetables in the past week [unhealthy: < 5 daily servings]; Usual frequency of fast food [unhealthy: several times+/week <u>PA:</u> number of days of ≥20 min mod/vigorous exercise in past week [unhealthy: <3 days/week] <u>Smoking:</u> smoking in past 30 days, no smoking	n/a	MALES: 4 classes <u>*1. Class 1 (poor lifestyle, low risk)* [9%]:</u> characterised by poor lifestyle factors (**physical activity**, **diet**) but low risk behaviours (alcohol use, risky sexual behaviour), high probability of poor stress management and insufficient sleep <u>*2. Class 2 (higher risk)* [34%]:</u> high probability of risk behaviours including binge **drinking** <u>*3. Class 3 (moderate lifestyle, low risk)* [51%]:</u> lowest probabilities of poor diet, smoking, binge drinking, intoxicated sex and drunk driving <u>*4. Class 4 (classic jocks)* [6%]:</u> lowest probability of inadequate PA, high probability of **smoking**, relatively high probabilities of binge **drinking**, intoxicated sex and drunk driving, inadequate sleep and highest probability of unhealthy weight control behaviours FEMALES: <u>*1. Class 1 (poor lifestyle, low risk)* [40%]:</u> poor lifestyle factors (e.g. **diet**, **PA**, sleep, stress), unlikely to engage in risky behaviours <u>*2. Class 2 (higher risk)* [24%]:</u> highest probability of **smoking**, binge **drinking**, intoxicated sex and drunk driving, more likely to report poor **diet** and inadequate sleep

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
		Other: Risky sexual behaviour Drunk driving Unhealthy weight control behaviours Stress management Sleep		*3. Class 3 (moderate lifestyle, low risk)* [20%]: lowest probability of risk behaviours including smoking, binge drinking and poor sleep, variable in diet and physical activity *4. Class 4 (health conscious)* [15%]: lowest probability of poor exercise and diet, moderate probabilities of binge **drinking** and poor stress management, low probability of smoking and poor stress management, highest probability of unhealthy weight control
Lucini et al., 2011 Italy	Convenience sample of multinational company employees (largest age group: 45-54yrs) Data collection methods: intranet invitation; online self-report health survey n= 683 (28% female); RR not reported	Alcohol: glasses/week PA: estimated mins of exercise per week Smoking: non, current and no. cigarettes/day Other: Stress Control perception Absenteeism	Gender Age Metabolic syndrome (MeS) Working status Illness	7 clusters: *1. Alcohol* [13%]: Highest levels of **alcohol**, mostly non-smokers; mostly non-absentees, mixed perception of control; *SoDs*: More males, senior white collar workers, managers, with preclinical or MeS, aged >54yrs *2. Smoking* [15%]: Highest levels of **smoking**, mostly **non-physically active**, non-drinkers, non-absentees, control perception mixed; *SoDs*: <35yrs *3. High stress* [13%]: Non-smokers, mostly **non-physically active**, highest levels of stress and mostly low perception of control; *SoDs:* More females, junior white collar workers, 35–44yrs, with illness, without MeS *4. Physically Active* [8%]: Highest levels of PA, mostly non-smokers, non-drinkers, non-absentees, mostly lower levels of stress; *SoDs:* More blue collar and junior white collar workers, <35yrs, no illness, without MeS *5. High control* [29%]: Mostly non-smokers, non-absentees, highest levels of control, lower levels of stress; *SoDs*: More senior white collar workers and managers, aged 45–54 yrs *6. Low stress and control* [19%]: Mostly non-smokers, non-absentees, lowest levels of stress and control; *SoDs*: <55yrs, with illness *7. Absenteeism* [3%]: Mostly nonsmokers and non-drinkers, highest levels of absenteeism, highly variable stress and control perception; *SoDs:* Females, older (>55yrs), blue and junior white collar workers, with illness
Lv et al., 2011 China	Community Interventions for Health study Random sample from one city (18-64yrs) Data collection: home visit and face-to-face interview	Diet: usual days per week eating fruit and veg and usual no. serves on any day when consumed [low: ≤3 or ≤2 serves]; Eating out of the home: no. times in last week PA: IPAQ [low: no PA reported] Smoking: never, former, occasional, daily	Age Gender Education Marital status Type of work Household assets	3 clusters: *1. Unhealthy/high-risk* [26%]: High prevalence of current daily **smoking**, low or moderate level of **PA**, low **fruit and veg** consumption, and more occurrences of eating out in last week; *SoDs:* More likely to be male, aged 40-49yrs, lowest education levels *2. Moderately healthy/moderate-risk* [31%]: No current daily smoking, low or high level of PA, and intermediate fruit and veg consumption and frequency of eating out; *SoDs:* More likely to be female, aged 18-39yrs, higher assets than healthy profile *3. Healthy/low-risk profile* [43%]: No current daily smoking, mod-high level of PA, high fruit and veg and fewest times of eating out; *SoDs:* More likely to be female, aged 50-64 yrs

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	n= 2016 (52% female); RR= 47%			
McLernon et al., 2012 UK	Aberdeen Prospective Osteoporosis Screening Study Sample of women aged 50-62yrs (no further details reported) Data collection: not reported n=3218 (all female); RR= not reported	<u>Diet:</u> FFQ for last 12 months: fruit and veg intake in g/day <u>PA:</u> number of hours of heavy/ moderate/ light/ activities and sleep in past 24hrs for a working and non-working day <u>Smoking:</u> pack years	Age Area of residence Height Weight Alcohol consumption	3 clusters: <u>*1. Cluster 1* [27%]:</u> Low smoking, high fruit and vegetable intake and high PA; *SoDs*: Women from more affluent areas <u>*2. Cluster 2* [50%]:</u> Low smoking, low **fruit and vegetable** intake and low **PA**; *SoDs*: Women from more affluent areas <u>*3. Cluster 3* [23%]:</u> High **smoking** and low **fruit and vegetable** intake; *SoDs*: Women from more deprived areas, more likely to report both 0 and >1drink/day than other clusters
Norton et al., 2012 USA	Cache County Memory Study Convenience community-based sample of local residents aged 65yrs+ (subsample without functional impairment/ dementia) Data collection methods: all residents invited; face-to-face	<u>Alcohol</u>: FFQ [current consumer: ≥2 times per week] <u>Diet:</u> frequency of 142 foods in last yr [healthy: DASH score > median] <u>PA:</u> usual hrs of any exercise per week in last 12m [active: ≥5hrs/week + ≥1 occasion of mod-vigorous activity/week] <u>Smoking:</u> current, non smoker <u>Other:</u> Church attendance	Age Gender Education APEO genotype	4 classes: <u>*1. Unhealthy-Religious* [12%]:</u> High probability of non-smoking, very low probability of **PA**, low consumption of alcohol, and poor **diet**, low social interaction, frequent church attendance; *SoDs:* More males, lower education <u>*2. Unhealthy-Non-Religious* [11%]:</u> High probability of **smoking**, poor **diet**, low probability of **PA**, higher probability of **alcohol** consumption, low probability of social interaction, infrequent church attendance; *SoDs:* More males, lower education <u>*3. Healthy-Moderately Religious* [39%]:</u> Moderate-high probabilities of: **smoking**, **alcohol** consumption, healthy diet and PA; high probability of social interaction, frequent church attendance; *SoDs:* More males, lower education <u>*4. Healthy-Very Religious* [40%]:</u> Non-smokers, moderate-high probabilities of healthy diet and PA, very low probability of alcohol consumption, high social interaction and frequent church attendance; *SoDs:* More females, higher education →Age and APEO genotype were not significantly associated with class membership

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	interview or mail SR survey n= 2491 (49% female); RR=90%	Social interaction		
Patterson et al., 1994 USA	Nationwide Food Consumption Survey National random sample (21yrs+) Data collection: self-report diary/survey n=5484 (52% female); RR=35%	Alcohol: usual no. drinks/week Diet: 24hr recall and 2 day records [diet quality score based on cholesterol, fruit and veg etc: 0 (healthy) - 16 (poor)] PA: frequency of regular exercise and strenuous leisure time activity Smoking: usual no. cigarettes/ day	Age Gender Race Education Income	7 clusters: *1. Health promoting* [10%]: Best mean diet score, very high PA, little or moderate alcohol and little smoking; *SoDs:* Higher income and education *2. Good diet* [25%]: Good diet, very **sedentary**, low alcohol, low smoking; *SoDs:* Older, most females, more Black Americans *3. Fitness* [17%]: Poor **diet**, very high PA, low alcohol, low smoking; *SoDs*: Younger, higher education *4. Passive* [25%]: Worst **diet** quality, low **PA**, slightly better than average smoking and alcohol behaviour; *SoDs:* More Black Americans, lower income and education *5. Drinker* [5%]: Fair PA, higher **alcohol** than recommended, little but some smoking; *SoDs:* More males, higher income *6. Smoker* [16%]: Poor **diet**, sedentary **PA** levels, low alcohol and high **smoking**; *SoDs:* Lower income and education *7. Hedonic* [2%]: Fair to poor diet, moderate PA, very heavy **drinking** and high levels of **smoking**; *SoDs*: Younger, males
Quintiliani et al., 2010 USA	Cross-sectional convenience sample of college women (18-22yrs) Recruitment and data collection method: recruited via email; online survey n= 1463 (all female); RR= 31%	Alcohol: no. days of ≥1 drink in last 30 days Diet: PrimeScreen: no. serves of fruit and veg per day PA: average mins/day of mod-vigorous exercise Smoking: non, current Other: Sexual intercourse Non-use of protective measures during sexual intercourse Cervical cancer screening	n/a	3 clusters: *1. Higher risk, lower maintenance behaviours* [43%]: Higher levels of at-risk behaviours including **smoking** and frequent **drinking**, lower levels of maintenance behaviours (**fruit and veg** intake and **PA**), highest percentage of reporting ever having had sexual intercourse, lowest Pap screening *2. Lower risk, lower maintenance behaviours* [36%]: Lower levels of maintenance behaviours (**fruit and veg** intake and **PA**), lower levels of smoking and drinking compared to cluster 1, low pap screening *3. Intermediate risk, higher maintenance behaviours* [21%]: Intermediate levels of drinking and smoking, higher levels of fruit and veg intake and PA

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
Rebholz et al., 2012 Switzerland	Swiss Childhood Cancer Survivor Study National sample of survivors of childhood cancer; age and gender matched controls (20-35yrs) Data collection: mailed questionnaire (survivors) and telephone interview (controls) n= 835 survivors & 1670 controls; (47% female both samples); RR= 63% (survivors)-66% (controls)	Alcohol: usual frequency of drinks/week; Frequency of binge drinking in last yr (≥8 or ≥6 drinks/occasion for males/ females) Diet: average serves of fruit and veg per day PA: usual intensity of exercise or sporting activity Smoking: yes/no Other: Cannabis use Skin examination Sun protection	Gender Age Marital status Parenthood variables Income Education Migration background	4 classes: *1. Risk-avoiding* [42-44% survivors/ controls]: Did not, or only to minor extent, engage in risk behaviours, reported PA, good vegetable and fruit consumption, sun protection and skin exams; *SoDs*: More females *2. Moderate drinking* [39-28%]: Similar diet to cluster 1, but higher PA and **alcohol** consumption, including binge drinking; *SoDs:* More males, highest education, higher income *3. Risk-taking* [14-12%]: Engaged in all assessed risk behaviours including **smoking**, **alcohol** including binge drinking, and drug use, reported lower **PA** and **diet** compared to clusters 1 & 2; *SoDs:* More males, higher income *4. Smoking* [5-16%]: Most likely to **smoke** but lower alcohol including binge drinking, low **PA** and **diet**; SoDs: Migrant background →clusters varied little with respect to sun protection and skin examination
Reedy et al., 2005 USA	North Carolina Strategies to Improve Diet, Exercise, and Screening Health Communications Study Population-based sample of colorectal cancer patients and	Diet: Modified Block FFQ for no. serves of fruit and veg in last month [guidelines: ≥5 serves/day] PA: 7-day PA recall: mins/day of light, mod and hard PA [guidelines: ≥150mins/week] Other: Multivitamin use BMI	Age Gender Education Ethnicity Other disease Self-rated health Self-efficacy	5 clusters: *1. Healthy choices* [11%]: Majority meet guidelines for all health behaviours (fruit and veg intake and PA), have healthy weight and taking multivitamins regularly; *SoDs*: More likely to be older, white, more highly educated, have higher income, higher self-efficacy for fruit and veg intake *2. Eating well* [29%]: Most reported eating 5+ serves of fruit and veg per day, but low in other behaviours (poor **PA**, multivitamin use and high BMI); *SoDs*: Higher self-efficacy *3. Physically active* [10%]: All met PA guidelines, low in other behaviours (poor **diet**, multivitamin use, high BMI); *SoDs*: More likely to be males and white *4. Average Americans* [44%]: Majority did not meet guidelines for **fruit and veg** or **PA**, but just over half had a healthy BMI and took multivitamins regularly; *SoDs*: Similar to overall sample

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	matched controls (50yrs+) Data collection: recruitment not reported; telephone survey n= 595 (51% female); RR=54%			*5. Most challenged* [7%]: Did not meet guidelines for any **risk factors**, all overweight or obese; *SoDs*: More likely to be women, Black, lower educated, lower income, with more comorbidities, and with low perceived health
Schneider et al., 2009 Germany	Living an Active Life study Random sample from one state (50-70yrs) Data collection: random phone numbers selected; computer assisted telephone interview n= 2002 (51% female); RR=21%	Alcohol: amount consumed over past weekend and last week day [excess consumption: ≥10 or ≥20 g/day for men/women] Diet: consumption of variety of foods over last 12m [unhealthy: non-daily consumption of fruit or veg] PA: frequency and duration of regular exercise [inactive: <1hr/week] Smoking: daily, occasional, no	Gender Age Partnership status Social class (lower/middle-upper)	5 clusters: *1. No Risk Behaviours* [25%]: One quarter of cluster reported no alcohol consumption or smoking, no unhealthy behaviours reported by this cluster; *SoDs:* Reference group *2. Physically Inactive* [21%]: Insufficient **PA**, none smoked regularly or drank excess alcohol, all had a healthy diet; *SoDs:* More likely to be male and not to have a partner *3. Fruit and Vegetable Avoiders* [18%]: All reported an unhealthy **diet** and majority reported inadequate **PA**; *SoDs:* More likely to be male and not to have a partner *4. Smokers with Risk Behaviours* [13%]: All current **smokers**, plus majority reported inadequate **PA** and/or an unhealthy **diet**; *SoDs:* More likely to be lower social class, male, aged 50-59 vs 60+, and not to have a partner *5. Drinkers with Risk Behaviours* [23%]: Individuals in this cluster had unfavourable behaviours for all four **risk factors**; *SoDs:* More likely to be male
Slater et al., 1991 USA	Stanford Five City Project (mean age 37yrs) Data collection: randomly selected households;	Alcohol: frequency of consumption Diet: 9 items assessing dietary habits including control of intake of salt, fats [unhealthy/poor: not defined]	Age Gender Education Income Household size Marital status Ethnicity	7 clusters (2 clusters dropped due to small numbers) *1. Healthful adults* [26%]: Healthy diet, non-smokers, low vigorous PA but higher walking, high household support and low health worry; *SoDs:* More females, high income and majority white and married *2. Unhealthful adults* [21%]: Very heavy **smokers** and **drinkers**, with a relatively unhealthy **diet**, peers smoke, low health concern; *SoDs:* More males, mid income, low-mid education *3. Worried older adults* [16%]: Low alcohol and **PA**, poor **diet**, low household support, high health worry; *SoDs:* Older, low income and education

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	interviewer administered survey n= 2502 (53% female); RR= not reported	PA: positive responses to list of mod and vigorous activities [low: not defined] Smoking: one or more cigarettes per day Other: Cognitive/attitudinal items Social influence items Demographic variables		*4. Healthful talkers* [4%]: Healthy diet and high vigorous PA, less walking, non-smokers and drinkers, frequent discussion of health issues with others; *SoDs:* Younger, high education and income, equal males and females *5. Healthful young adults* [17%]: Healthy diet, vigorous PA and walking, non-smokers, high household support and non-smoking peers; *SoDs*: More males, younger, mid-level education, low income *6. Unhealthful young adults* [13%]: Poor **diet** and low **PA**, non-smokers and non-drinkers, low household support; *SoDs*: Slightly more females than total sample, youngest cluster, low-mid income and low education *7. Young athletes* [3%]: Non-smoking and high PA, non-smoking peers; *SoDs*: More males, younger, high income, low-mid education
Verger et al., 2009 France	Decennial Health Survey National random household sample (18yrs+) Data collection: 3 face-to-face home visits and SR survey n=17355 (52% female); RR= 58%	Alcohol: usual frequency and frequency of binge drinking (6+ drinks/occasion [regular drinkers: ≥4-5 days/week; binge drinkers: ≥6 drinks/occasion at least twice/ month] Diet: brief qualitative FFQ for fruit and green veg intake PA: regular engage in sporting activity: yes/no Smoking: current, non-smoker	Age Gender Profession Income BMI Depression	5 clusters: *1. Cluster 1* [41%]: Individuals with a relatively healthy lifestyle; *SoDs:* Mainly women *2. Cluster 2* [18%]: Highest proportion (100%) of non-daily **fruit and green veg** consumers; *SoDs:* Mostly younger women, more likely to have depression *3. Cluster 3* [17%]: Highest proportion (100%) of regular **alcohol** consumers; *SoDs:* Older, high BMI and higher socio-professional categories *4. Cluster 4* [16%]: 100% **smokers**; *SoDs:* Young, low income and low qualifications, second most likely to have probable depression *5. Cluster 5* [8%]: 100% frequent binge **drinkers**; *SoDs:* Mostly males, young, low income and low qualifications, most likely to have probable depression →PA did not differ largely between samples
Weir et al., 2000 USA	Random national sample (18yrs+) with hypertension Data collection: selected from panel of respondents plus	Alcohol: no. times drink alcohol/year Diet: number of serves of fruit and veg/day PA: no. times/week of moderate or strenuous activity Smoking: no. cigarettes/day	Age Gender Marital status Ethnicity Education Income	4 clusters: *1. Group A* [39%]: Most likely to eat a good diet and exercise routinely, moderate alcohol intake and less likely than average to smoke, most knowledgeable about hypertension, very good SR health; *SoDs*: Best educated and most ethnically diverse *2. Group B* [16%]: Average diet, less likely to **exercise** regularly, consume **alcohol** more frequently than A and C, least likely to report problems taking medications; *SoDs*: More women

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Socio-demographics (SoDs)*	*Description of cluster [% of sample] and associated sociodemographics (SoDs)*
	supplementary sample of minority and low income groups; linked mail and telephone survey N= 727 (56% female); RR= 61%	 Other: Bo Attitudinal and self-efficacy statements related to alcohol, diet, physical activity, smoking, weight, BP, medications	Employment status	*3. Group C* [22%]: Lack of **exercise**, lowest rates of smoking and alcohol intake, highest BMI, high BP; *SoDs*: More women; *4. Group D* [23%]: Poor **diet**, most likely to be **smokers** and consume **alcohol** more frequently than A and C, highest BP, least knowledge about hypertension; *SoDs*: Younger males

List of abbreviations used in Table 3.1: A, Alcohol; AUDIT-C, Alcohol Use Disorders Identification Test; BMI: Body Mass Index; CAPI, Computer Assisted Personal Interview; CATI, Computer Assisted Telephone Interview; CR, Consent Rate; D, Diet; DASH, Dietary Approaches to Stop Hypertension guidelines; FFQ, Food Frequency Questionnaire; GP: General Practitioner/Practice; IPAQ, International Physical Activity Questionnaire; LTEQ, Leisure-time Exercise Questionnaire; MAQ, Modifiable Activity Questionnaire; MET, Metabolic equivalents; MLTPAQ, Minnesota Time Physical Activity Questionnaire; NZ PAQ-SF, New Zealand Physical Activity Questionnaire Short Form; PA, Physical activity; QFVQ, Quantity-Frequency-Variability Questionnaire; RFs, Risk Factors; RR, Response Rate; S, Smoking; SMAST, Short Michigan Alcohol Screening Test.

Table 3.2: Detailed description of factor analysis or principle component analysis studies included in the review

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
Antoine-Jonville et al., 2010 France	Convenience sample of university students (median age 20yrs) Data collection: approached in public spaces on campus; SR survey n=202 (all female); CR=79%;	Diet: FFQ including saturated fatty acids, omega-3, fruit and veg intake etc [global score: food impact on coronary risk] PA: MAQ [PA level and energy expenditure calculated from sports, occupational, and overall leisure-time physical Activity] Other: BMI	n/a	4 factors [85% of variance explained] *1. Factor 1*: Number occupational activities, energy expenditure from sports, % of energy expenditure from sports, **physical activity** level *2. Factor 2*: Energy expenditure from occupational activities, total energy expenditure in MAQ, **physical activity** level *3. Factor 3*: Points attributed for **fruits and vegetables**, omega-3, FFQ global score *4. Factor 4*: BMI

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
Benzies et al., 2011 Sweden	Individual Development and Adaptation Program Longitudinal follow-up of school-based cohort recruited at age 10 (now 43yrs) Data collection: face-to-face interview and SR survey n=285 (all female); RR=89%	Alcohol: how often, and how much on a typical day Diet: usually consume: low fat dairy, low fat meat, high fibre bread, snacks between meals (never/always) PA: how often usually do exercise (never/ 3+times per week) Smoking: how often and usual no. cigarettes per day Other: Breast self-examination Mammogram Gynecological health examination "Do you think about eating healthy?"	n/a	5 components: [% variance explained not reported] *1. Healthy eating:* **Diet**- eats low-fat dairy, low-fat meat, high-fiber bread, thinks about eating healthy; *2. Addictive behaviours*: **Smoking** (frequency and number) and volume of **alcohol** consumed; *3. Component 3*: Snacks between meals and frequency of **alcohol** intake (negative) *Component 4:* Frequency of **alcohol** intake (negative) and breast self-examination; *5. Component 5*: **PA**, cervical screening and mammogram;
Bryant et al., 2013 Australia	Cross-sectional sample of Social and Community Welfare clients (mean age 44yrs) Data collection: face-to-face recruitment; SR touch screen survey n= 383 (45% female); CR= 69%	Alcohol: modified AUDIT-3 [unhealthy: ≥4 or ≥3 drinks/week for males/females] Diet: serves of fruit and veg per day [unhealthy: <2 or <5 fruit/ veg] PA: total time spent walking/ mod/ vigorous PA in last 7 days [unhealthy: <150 minutes of activity or <5 sessions of activity/week] Smoking: daily, occasional, no Other: Sun protection	Gender Age Aboriginal or Torres Strait Islander status Household income Employment Marital status Education	2 factors: [% variance explained not reported] *1. Substance use factor*: **Smoking** and **alcohol** consumption; *SoDs*: Males, younger and lower education *2. Physical activity/nutrition factor*: **Physical activity** and **fruit and vegetable** consumption; *SoDs*: none significant
Chao et al., 1990 USA	Random sample of adults attending a single GP selected	Alcohol: number of drinks per week: 0-7, 8-15, or 16+	Age Sex Race Marital status	No factor with an eigenvalue >1 emerged, indicating insufficient correlation among risk factors to form a statistically significant and stable factor

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
	from database (18yrs+) Data collection: phone call and mail-out survey n=147 (63% female); RR=66%	PA: self-described level of activity with guidelines (from vigorous to sedentary) Smoking: current, non-smoker Other: Self-reported weight Seat belt use Amount of sleep	Education Occupation Current employment Self-rated health	
Liang et al., 1999 USA	Behavioural Risk Factor Surveillance System National random sample (18yrs+) Data collection: random digit dialling telephone survey n= 4455 (58% female); RR= 82%	Alcohol: no. drinks/day Diet: serves of fruit and veg per day PA: minutes/month Smoking: no. cigarettes/day Other: Frequency of seatbelt use Driving after drinking Time since last medical check-up, cholesterol test, mammogram, breast examination, and pap test	Separate analysis by gender and age group	MALES: 3 factors per age group [% variance explained not reported] 18-24yrs *1. Factor 1*: Driving after drinking *2. Factor 2:* **Smoking**, **drinking** and seatbelt non-use *3. Factor 3:* Medical and cholesterol check-up 25-39yrs *1. Factor 1*: Driving after drinking *2. Factor 2*: **Smoking** *3. Factor 3:* Medical and cholesterol check-up 40-45yrs *1. Factor 1*: **Drinking** *2. Factor 2:* **Smoking** and seatbelt non-use *3. Factor 3:* Medical and cholesterol check-up 55yrs+ *1. Factor 1*: **Drinking** *2. Factor 2:* **Smoking** and insufficient **fruit/vegetable** consumption *3. Factor 3:* Medical and cholesterol check-up FEMALES: 18-24yrs *1. Factor 1*: **Drinking** and driving after drinking *2. Factor 2:* **Smoking**, insufficient **fruit/vegetable** consumption and seatbelt non-use *3. Factor 3:* Medical check-up, pap test and breast exam 25-39yrs *1. Factor 1*: **Smoking** *2. Factor 2*: **Fruit and vegetable** consumption and infrequent cholesterol check *3. Factor 3:* Medical check-up, pap test and breast exam 40-45yrs *1. Factor 1*: **Smoking**

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
				2. Factor 2: Mammography and cholesterol check *3. Factor 3:* Medical check-up, pap test and breast exam 55yrs+ *1. Factor 1*: Seatbelt non-use *2. Factor 2:* **Smoking** *3. Factor 3:* Medical check-up, pap test, breast exam, mammogram and cholesterol check →risk-taking behaviours formed prominent clusters among younger people
Navarro-Silvera et al., 2011 USA	National sample of patients aged 30-79yrs diagnosed with esophageal or gastric cancer between 1993-1995; age and gender matched controls Data collection: Patients recruited through tumour registries; controls recruited through random digit dialling; face-to-face interview n= 1782 (687 controls; % female not reported); RR= 81%- 74% (patients, controls)	Alcohol: no. drinks/day Diet: FFQ for 19 food groups Smoking: no. cigarettes/day Other: BMI Gastroesophageal reflux disease (GERD) symptoms	Analysis adjusted for gender age, race, income, education	6 components [explained 48% of the variance] *1. Meat/Nitrite*: loaded heavily on nitrite, high-nitrite meats, and red meats, **high-fat dairy**, vitamin C, refined grains, fibre, poultry, and **starchy vegetables** *2. Fruit/Vegetable:* loaded heavily on raw **vegetables** and **fruits** *3. Smoking/Alcohol*: loaded most heavily on **alcohol** and **cigarette** use *4. Meat Alternate:* characterised by heavy loading on **legumes** and meat alternates *5. GERD/BMI:* GERD symptoms, adult BMI, whole **grains** and **low-fat dairy** *6. Fish/Vitamin C:*
Pyorala et al., 2000 Finland	Helsinki Policemen Study (second examination) Sample of men employed by the Police Department (34-64yrs)	PA: leisure time PA questionnaire Smoking: current, non-smokers Other: BMI Skin fold Physical fitness Biological (BP, cholesterol, glucose)	n/a	3 factors [explained 54% of the variance]: *1. Insulin resistance:* BMI, skinfold, AUC insulin, maximal O2 uptake, AUC glucose, mean blood pressure and triglycerides *2. Lipids:* Strong loadings for cholesterol and triglycerides *3. Lifestyle:* **Smoking** (negative loading) and leisure time **PA** (positive loading)

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
	Data collection: not reported n= 970 (no females); RR= 98% (baseline), 99% (second examination)			
Reijneveld et al., 2012 van Nieuwenhu-ijzen et al., 2009 [Studies include same sample][a] Netherland-s	Random national sample of residents including labour and former colony immigrants (19-40yrs) (n=2943, including 247 immigrants) Data collection: web-based survey n= 2943, including 247 immigrants (40-52% female); RR= 73%	Alcohol: no. days of drinking/week, usual no. drinks/day; heavy drinkers [not defined] Diet: fruit and veg intake no. days/week x no. portions/day; breakfast: no. days/week PA: no. days and time/day in last week of light, mod or vigorous activity Smoking: no. cigarettes/day Other: Unsafe sex Missing breakfast Hrs of sleep Delinquency Drug use Aggression Red light walking/driving	Separate analysis by indigenous status	INDIGENOUS DUTCH: 3 clusters [% variance explained not reported] *1. Alcohol:* Drinking **alcohol** and unsafe sex *2. Health-enhancing behaviour*: Healthy **nutritional** habits (having breakfast, sufficient fruit and vegetables), light physical **exercise**, **smoking (negative)**, and enough sleep *3. Rule-breaking behaviour*: Delinquency, physical and verbal aggression, drug abuse and unsafe traffic behaviour LABOUR IMMIGRANTS: 2 clusters *1. Alcohol/Unsafe*: **Alcohol** drinking, vigorous physical activity, unsafe sex and no sleep *2. Rule breaking behaviour/**smoking*** IMMIGRANTS FROM FORMER COLONIES: 2 clusters *1. Alcohol*: **Alcohol**, vigorous physical activity, unsafe traffic behaviour *2. Rule-breaking/**smoking***:
Shephard et al., 1996 Canada	Convenience sample from one city and surrounds (14-68yrs) Data collection: invited by radio announcement; clinical examination and interview	Alcohol: consumption yes/no PA: workplace activity (rarely/never- all the time); frequency (never/rarely-3+ times/week) and intensity (light-intense) of leisure time activity Smoking: yes/no Other: Body fat Coffee intake	Analysis adjusted for age and socioeconomic status Separate analysis by gender	4 factors [explained 65% of the variance] *1. Factor 1*: Heavily loaded by assessments of **PA**, body fat (negative) *2. Factor 2*: Abstinence from **alcohol**, tea and coffee, accumulation of body fat *3. Factor 3*: Body fat loaded most strongly on factor 3 *4. Factor 4*: **Smoking** in men and tea consumption in women

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
	n= 350 (51% female); RR= not reported	Tea intake		
Tsai et al., 2011 Taiwan	Cross-sectional sample of patients from medical centre (20yrs+) Data collection: SR survey and physical examination n=579 (37% female); CR=95%	Alcohol: frequency/week PA: frequency/week Smoking: no. cigarettes/day Other: BMI WC BP Blood tests (cholesterol, platelets)	n/a	4 factors: [Explained 51% of the variance] *1. Metabolic factor*: Waist circumference, triglycerides, uric acid and HDL *2. Factor 2*: White blood cells and platelets *3. Lifestyle habits factor*: **Smoking** and **alcohol** consumption *4. Factor 4*: High fasting blood glucose and **PA**
Tseng et al., 2008 Taiwan	National Survey of Taiwan on Knowledge, Attitude, and Practice of Health Promotion National random sample of residents aged 15yrs+ Data collection: interview n=26755 (49% female); RR= 82%.	Alcohol: drinks per month Diet: days per week of intake of fruits or vegetables PA: minutes per week Smoking: cigarettes per day Other: Betel nut chewing Use of prevention services (BP, cholesterol, FOBT etc) Tooth brushing	Separate analysis by age and gender	MALES: 2 factors per age group [% variance not explained] ≤24yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing 25-39yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing, use of preventive services 40-54yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing, use of preventive services ≥55yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing, use of preventive services FEMALES: ≤24yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing 25-39yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing 40-54yrs *1. Factor 1 (risky)*: **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing ≥55yrs

Author, year, country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of factors [proportion of variance explained] and associated sociodemographics (SoDs)*
				1. Factor 1 (risky): **Smoking**, **alcohol** drinking, betel nut chewing *2. Factor 2 (protective):* high **PA**, good **diet**, tooth brushing, use of preventive services

[a]The initial sample for van Nieuwenhuijzen et al.,2009 included those aged 12-40 (n=4395), however only the adult proportion of the sample (19-40yrs, n=3497) was included in the review, and this sample overlaps with that in Reijenveld et al., 2012.

List of abbreviations used in Table 3.2: A, Alcohol; AUDIT-C, Alcohol Use Disorders Identification Test; BMI: Body Mass Index; CAPI, Computer Assisted Personal Interview; CATI, Computer Assisted Telephone Interview; CR, Consent Rate; D, Diet; DASH, Dietary Approaches to Stop Hypertension guidelines; FFQ, Food Frequency Questionnaire; GP: General Practitioner/Practice; IPAQ, International Physical Activity Questionnaire; LTEQ, Leisure-time Exercise Questionnaire; MAQ, Modifiable Activity Questionnaire; MET, Metabolic equivalents; MLTPAQ, Minnesota Time Physical Activity Questionnaire; NZ PAQ-SF, New Zealand Physical Activity Questionnaire Short Form; PA, Physical activity; QFVQ, Quantity-Frequency-Variability Questionnaire; RFs, Risk Factors; RR, Response Rate; S, Smoking; SMAST, Short Michigan Alcohol Screening Test.

Table 3.3: Detailed description of Observed/Expected prevalence ratio (O/E) studies included in the review

Author, year, Country	*Sample description and setting*	*SNAP risk factor measures and other variables included in analysis*	*Sociodemographics (SoDs)*	*Description of 3 risk factor combinations with highest O/E ratio [observed prevalence] and associated sociodemographics (SoDs)*
Chou et al., 2008 Hong Kong	National sample of older adults from Census household records (60yrs+) Data collection: face-to-face interview n= 4812 (51% female); RR=75%	Alcohol: no. of days drink/week [heavy drinking: >4 days/week] Diet: usual serves of fruit and veg per week [low intake: <7 pieces fruit/week or <1 bowl veg/day] PA: no. days/week and usual duration [low PA: <30mins on 3+ days/week] Smoking: current, non	Gender Age Marital status Economic status Education level Household type Household tenure Separate analysis by gender SoDs explored in association with cumulative number of risk factors	MALES: *1. **Smoking**, heavy **drinking**, lack of **PA** and lack of **fruit and vegetables*** [1%] *2. **Smoking** and heavy **drinking*** [2%] *3. **Smoking**, heavy **drinking** and lack of **fruit and veg*** [1%] FEMALES: *1. **Smoking**, heavy **drinking** and lack of **PA*** [<1%] *2. **Smoking**, heavy **drinking** and lack of **fruit and veg*** [<1%] *3. **Smoking** and lack of **PA*** [1%] *SoDs*: Being male, older aged, higher levels of education and homeownership was associated with a higher number of risk factors; Employment was associated with a lower number of risk factors
Del Duca et al., 2012 Brazil	Lifestyle and Leisure Habits of Industrial Workers study National random sample of workers from large, medium	Alcohol: no. drinks/week and consumption of 5+ drinks/occasion in last 30 days (yes/no) [high consumption: >7 or >14	Gender Age Education Marital status Income	MALES: *1. **Physical inactivity**, low **fruit and veg** intake, **smoking** and high **alcohol** consumption* [3%] *2. **Smoking**, high **alcohol** consumption, low **fruit and veg** intake* [4%] *3. **Physical inactivity**, **smoking** and high **alcohol** consumption* [1%]

	and small industrial companies (most frequent age group: ≤29yrs) Data collection: SR survey completed in groups under supervision n=47477 (30% female); CR=91%	drinks per week for males/ females or any intake of 5+ drinks/occasion] Diet: no. of days/week of fruit and veg intake [low intake: ≤4 days per week] PA: regular physical activity in leisure time (yes/no) Smoking: current, non-smokers	Separate analysis by gender SoDs explored in association with cumulative number of risk factors	FEMALES: *1. Physical **inactivity**, low **fruit and veg** intake, **smoking** and high **alcohol** consumption* [2%] *2. **Smoking** and high **alcohol** consumption* [<1%] *3. **Smoking**, high **alcohol** consumption, low **fruit and veg*** [1%] *SoDs*: Men had higher odds of presence of 1-4 unhealthy behaviours than none; Younger workers were more likely to have more unhealthy behaviours than no unhealthy behaviour compared to those >50yrs; There was a trend of unhealthy behaviour accumulation with decreases in income and education levels
Kok et al., 1982 Netherland -s	Random national sample (18-64yrs) Data collection: face-to-face home interview n= 1951 (54% female); RR=77%	Diet: diet history recall [poor diet: high % energy from fat and alcohol, low fibre] PA: mins/week [low PA: none or <90mins walking, <75mins cycling or <60mins sport] Smoking: current, non-smokers Other: BMI	Gender Age Marital status Family size Urbanisation Education Income Occupation Perceived CVD risk Health attitudes SoDs explored in association with cumulative number of risk factors	*1. **Smoking**, poor **diet**, low **PA** and obesity* [1%] *2. Poor **diet**, low **PA**, obesity* [1%] *3. None of the risk factors* [20%] *SoDs*: Males, low education and low occupation status were associated with having 3-4 RFs compared to no RFs
Laaksonen et al., 2001 Finland	Health Behaviour Among Finnish Adult Population project National random sample aged 15-64yrs (subsample of those aged 20-64 from 1991-1998) Data collection: mailed survey n= 22745 (% female not reported); RR=68-84% (across years)	Alcohol: units per week [excess: ≥8 or ≥5 for males/females] Diet: times per week of eating fresh vegetables, using butter, drinking whole milk, slices of bread per day [poor diet: 2 or more of- veg <3 times/week, using butter or whole milk, eating < 5 slices bread/day] PA: leisure time physical activity (at least 30 mins) [low: <once/ week]	Age Educational level Marital status	MALES: *1. **Smoking**, excess **alcohol**, poor **diet** and low **PA*** [2%] *2. **Smoking**, excess **alcohol** and low **PA*** [5%] *3. **Smoking**, poor **diet** and low **PA*** [2%] FEMALES: *1. **Smoking**, excess **alcohol**, poor **diet** and low **PA*** [1%] *2. **Smoking**, excess **alcohol** and low **PA*** [3%] *3a. **Smoking**, poor **diet** and low **PA*** [1%]*and =* *3b. **Smoking** and excess **alcohol*** [7%] *SoDs*: differed little between risk factor combinations

		Smoking: daily/occasional, non-smoker		
Lee et al., 2012 Korea	Korean Longitudinal Study of Aging National random sample (subsample of those aged 65yrs+ selected) Data collection: face-to-face household survey using CAPI n= 4165 (58% female); RR= 89%	Alcohol: drinks per day and week [excess: >3 drinks/day or >7 drinks/week] PA: usual frequency and duration of regular exercise [low PA: <150 mins/week] Smoking: current, non-smokers Other: BMI	Gender Age Marital status Family structure Education Income Occupation Physical/Cognitive function Separate analysis by gender SoDs explored in association with cumulative number of risk factors	MALES: *1. **Smoking**, excess **alcohol**, low **PA** (healthy BMI)* [10%] *2. Overweight only* [4%] *3. Heavy **alcohol** and overweight* [2%] FEMALES: *1. All risks: **smoking**, excess **alcohol**, low **PA** and overweight* [<1%] *2. **Smoking**, excess **alcohol** and overweight* [<1%] *3. **Smoking**, excess **alcohol** and low **PA**, (healthy BMI)* [<1%] →Being male, older age, not married, living alone, low levels of education, income, wealth and lifetime of manual labour or unemployment, was associated with fewer healthy lifestyles
Pirie et al., 2000 USA	Cross-sectional sample of pregnant women attending for antenatal appointment (18yrs+) Data collection: mailed letter based on clinic lists; telephone survey n= 7489 (all female); RR= 87-91% per clinic	Alcohol: no. drinks per week currently and prior to pregnancy Smoking: no. cigarettes per day prior to pregnancy and in last 7 days currently day prior to pregnancy and in last 7 days Other: Caffeine intake	n/a	*1. **Alcohol**, **smoking** and caffeine* [3%] *2. None of the risk factors* [29%] *3. **Smoking** and caffeine* [8%]
Poortinga et al., 2007 UK	2003 Health Survey for England National random sample (16-64yrs) Data collection: household based survey n=11492 (55% female); RR= not reported	Alcohol: amount consumed on highest drinking day in last 7 days [heavy drinking: ≥8/6/day for men/women] Diet: fruit and veg intake yesterday [poor intake: <5 portions] PA: no. days in last 4 weeks of 30+ mins of mod/vigorous exercise [low PA: <5 days/week] Smoking: current, non-smokers	Gender Age Social class Household type Economic status Household tenure Separate analysis by gender SoDs explored in association with cumulative number of risk factors	MALES: *1. **Smoking**, heavy **drinking** and poor **fruit and veg** intake* [5%] *2. None of the risk factors* [6%] *3. **Smoking**, heavy **drinking**, poor **fruit and veg** intake and low **PA*** [6%] FEMALES: *1. **Smoking**, heavy **drinking** and poor **fruit and veg** intake* [2%] *2. None of the risk factors* [7%] *3. **Smoking**, heavy **drinking**, poor **fruit and veg** intake and low **PA*** [5%] *SoDs*: Men, lower social class households, singles, and unemployed people were more likely to have a higher number of lifestyle risk factors; Older age groups and homeowners were less likely to have a higher number of lifestyle risk factors

Schuit et al., 2002 Netherland-s	MORGEN study Cross-sectional sample aged from 3 towns (20-59yrs) Data collection: 2 surveys and medical examination n= 16789 (54% female); RR= 44%	Alcohol: glasses of alcohol per day [excess alcohol: >2/3 for women/men] Diet: FFQ serves of fruit and veg per day [low intake: <350 g] PA: minutes per week of at least moderate intensity [low PA: <30 mins/day] Smoking: ≥1 cigarette/month	Age Education Living arrangements Self-rated health status Change in health Separate analysis by gender SoDs explored in association with cumulative number of risk factors	MALES: *1. **Smoking**, excess **alcohol** intake, low **fruit and veg** and low **PA*** [4%] *2. **Smoking**, low **fruit and veg** and low **PA*** [4%] *3. None of the RFs* [10%] FEMALES: *1. **Smoking**, excess **alcohol** intake, low **fruit and veg** and low **PA*** [2%] *2. **Smoking**, low **fruit and veg** and low **PA*** [2%] *3. None of the RFs* [13%] *SoDs*: The number of risk factors was higher among subjects with a low education, those who were unemployed, those living without a partner (men only), those who had lower self-rated health, and those who reported that their health was worse than 1 year ago
Shankar et al., 2010 UK	English Longitudinal Study of Ageing Subsample from annual national cross-sectional survey (50yrs+) Data collection: face-to-face interview and SR survey n= 11214 (54% female); RR= 67-74% (per data collection wave)	Alcohol: units of alcohol consumed/week over last 12m [excess: >21 or >14 units for men/ women] PA: usual frequency of mild, mod or vigorous exercise in leisure time; occupational activity [inadequate PA: <once/week mod or vigorous PA and sedentary job] Smoking: current, non-smokers	Age Gender Illnesses Marital status Education Wealth Subjective social status SoDs explored in association with cumulative number of risk factors	*1. **Smokers** and excessive **alcohol** intake* [2%] *2. **Smokers**, excessive **alcohol** intake and inadequate **PA*** [1%] *3. Excessive **alcohol** intake* [7%] *SoDs*: Women and older participants were more likely to report one health risk versus 2-3 risks; All measures of SES were inversely associated with the number of health-risk behaviours
Tobias et al., 2007 New Zealand	New Zealand Health Survey Stratified national sample of residents (15yrs+; including 33% Maori) Data collection: face-to-face interviews n=10241 (61% female) RR=not reported	Alcohol: AUDIT score [unhealthy: score ≥8] Diet: serves of fruit and veg per day [unhealthy diet: <5 serves/day] PA: not stated [inadequate PA: <150 mins/week at moderate intensity] Smoking: daily, non-smokers	Age Gender Ethnicity Deprivation SoDs explored in association with cumulative number of risk factors	*1. **Smoking**, unhealthy **alcohol** drinking, unhealthy **diet** and inadequate **PA*** [1%] *2. **Smoking**, unhealthy **drinking**, unhealthy **diet*** [5%] *3. **Smoking**, unhealthy **drinking**, inadequate **PA*** [4%] *SoDs*: Females were less likely than males to show an unhealthy lifestyle, but were more likely to report smoking + insufficient physical activity; Maori or Pacific Islanders tended to have a higher prevalence for all unhealthy behaviour patterns; the gradient in unhealthy behaviour patterns across the deprivation quintiles was unclear
Williden et al., 2012	Convenience sample of employees of 9 professional	Diet: NZ Nutrition Survey- serves of fruit and veg per	Age Gender	No health behaviour clusters were observed (as shown by similar observed and expected prevalence rates for all combinations)

New Zealand	organisations (computer-based work; 18-65yrs) Data collection: email invitation; online health risk assessment survey n= 1296 (66% female); RR= 36%	day in last 7 days [unhealthy diet: <3 serves veg or <2 serves fruit] PA: NZ PAQ-SF [inactive: <30min on 5+ days/week] Other: BMI	Ethnicity	
Wu et al., 2007 Taiwan	Cross-sectional sample of military conscripts (age not reported) Data collection methods: structured SR survey n= 3913 (% female not reported-possibly all male); RR= not reported	Alcohol: drinks per week [current drinker: ≥2 drinks of liquor or equivalent per week] Smoking: current (>1 cigarette per day), non-smoker Other: Betel nut chewing	Education level Residential province SoDs explored in association with cumulative number of risk factors	*1. **Smoking**, **alcohol** and betel nut chewing* [9%] *2. None of the risk factors* [45%] *3. **Smoking** and betel nut chewing* [11%] *SoDs*: Lower education and place of residence was associated with aggregation of risk factors

List of abbreviations used in Table 3.3: A, Alcohol; AUDIT-C, Alcohol Use Disorders Identification Test; BMI: Body Mass Index; CAPI, Computer Assisted Personal Interview; CATI, Computer Assisted Telephone Interview; CR, Consent Rate; D, Diet; DASH, Dietary Approaches to Stop Hypertension guidelines; FFQ, Food Frequency Questionnaire; IPAQ, International Physical Activity Questionnaire; LTEQ, Leisure-time Exercise Questionnaire; MAQ, Modifiable Activity Questionnaire; MET, Metabolic equivalents; MLTPAQ, Minnesota Time Physical Activity Questionnaire; NZ PAQ-SF, New Zealand Physical Activity Questionnaire Short Form; PA, Physical activity; QFVQ, Quantity-Frequency-Variability Questionnaire; RFs, Risk Factors; RR, Response Rate; S, Smoking; SMAST, Short Michigan Alcohol Screening Test.

a) Number of papers by country and sample type

The number of SNAP clustering studies by country, and special populations included in the sample, are shown in Table 3.4. The majority of studies were based in the USA, followed by Australia, the Netherlands and the UK. Most of the samples were community-based (n = 29), with the remainder being primary care or hospital based (n = 10), employee samples (n = 7), university students (n = 5), or 'other' (n = 5; e.g. cancer survivors, community welfare recipients,). The majority of studies included a mixed gender (n = 45), while nine had female only, and two male only, samples. Most looked at a broadly adult age range (n = 32, although seven study samples started at age 14-16yrs), nine focused on a younger sample (e.g. university students,), eight on older samples (all 50yrs+ or older), and five were restricted to a specific age group or age range (e.g. those aged 45-54yrs). An additional two studies did not report sample age range.

b) Which risk factors have been examined and the types of analysis used

The combination of SNAP risk factors (and most frequently reported non-SNAP risk factors) explored across studies, separated by number of risk factors, are shown in Table 3.5. Ten studies included two SNAP risk factors, 16 included three risk factors, and 30 studies included all four SNAP risk factors.

Table 3.4: Number of clustering papers by country of study and any specific sample population groups (May 2014)

Country	**No. of studies**	**Specific/special populations included in sample**	**References**
Australia	6	Aboriginal sample, pregnant women, post-menopausal women	13,25-29
Canada	2		30,31
China	2	Coronary heart disease patients	32,33
Finland	2	Policemen	34,35
France	2		36,37
Korea	2		20,38
Netherlands	5	Dutch residents plus labour and former Dutch colony immigrants	16,19,39-41
New Zealand	2	Approx. 40 % Maori and Pacific Islanders	42,43
Taiwan	3	Military conscripts	44-46
UK	4		10,47-49
USA	16	Colorectal cancer patients and matched controls, hypertensive patients, oesophageal and gastric cancer patients and matched controls, pregnant women	17,50-64
Other	10	Childhood cancer survivors	14,65-73

Table 3.5: SNAP and non-SNAP risk factors included in clustering studies (May 2014)

	Alcohol	**Diet**	**Physical Activity**	**Smoking**	**Non-SNAP risk factors**	**No. studies**	**References**
2 SNAP RFs	✓			✓	BMI[a], Other[b]	4	29,46,52,60
		✓	✓		BMI[a], Stress[c], Other[b]	5	28,36,43,54,62
			✓	✓	Biological[d], BMI[a]	1	35
3 SNAP RFs		✓	✓	✓	BMI[a], Screening[e], Other[b]	4	33,39,48,70
	✓	✓		✓	BMI[a], Other[b]	1	57
	✓		✓	✓	BMI[a], Biological[d], Sleep[f], Self-reported health, Stress[c], Other[b]	11	20,25,31,32,38,44,49-51,68,71
4 SNAP RFs	✓	✓	✓	✓	BMI[a], Biological[d], Sleep[f], Self-reported health, Stress[c], Other[b]	30	10,13,14,16,17,19,26,27,30,34,37,40-42,45,47,53,55,56,58,59,61,63-67,69,72,73

[a]BMI: included Body Mass Index and similar measures such as body weight, body fat;
[b]Other: included a range of measures such as aggression, betel nut chewing, church attendance, chronic disease/family history of disease, domestic violence, drink driving, seat belt use, unprotected sex etc;
[c]Stress: included measures of psychological stress, distress, and 'frequency of daily hassles';
[d]Biological: included biological measures such as blood pressure, cholesterol, blood glucose;
[e]Screening: included pap testing, mammography, cholesterol, skin examination, visits to a General Practitioner or having medical check-up, and use of healthcare systems;
[f]Sleep: included hours of sleep and perception of 'number of nights of getting enough sleep to feel rested'.

Risk factors included in cluster studies

Smoking and physical inactivity were the most frequently examined SNAP risk factors (n = 51 studies), followed by alcohol (n = 46) and diet (n = 40 studies). Commonly included non-

SNAP risk factors were Body Mass Index (n = 18), stress (n = 8), screening/ health care use (n = 8), biological factors (n = 7) such as cholesterol and blood pressure, sleep behaviour (n = 5), and self-rated health (n = 4).

Studies varied widely in how SNAP RFs were defined (see Tables 3.1-3.3). For example, measures of alcohol included: quantity-frequency measures,[19] a seven-day diary,[30] amount drunk in last two 48hr drinking periods,[27] number of glasses per week,[71] number of days of drinking in the last 30 days,[61] frequency of binge drinking,[55] and the Alcohol Use Disorders Identification Test (AUDIT) scores.[26] Similar variation was seen for diet and physical inactivity. Smoking was the most consistently defined, with most studies assessing current versus ex- or non-smoking. However, a number of studies included a measure of cigarette consumption,[68] defined smoking in pack years,[48] or defined smokers as those who smoked daily[33] or > 5 cigarettes per day.[32]

Types of clustering analysis

Thirty-two studies used a cluster or latent class analysis method.[9,13,14,17,19,25,27-30,32,33,37,38,47,50,52-55,58,59,61-65,68,70-73] Twelve studies used factor or principal component analysis,[26,31,35,36,40,41,44,45,51,56,57,66] and 12 studies examined the O/E prevalence ratios of combinations of risk factors.[10,16,20,34,39,42,43,46,49,60,67,69]

c) ***Description of the types health risk clusters which have been found***

Description of clusters

Fifty-two studies were included in the description of clusters. Four studies were excluded: one reported on a similar dataset of already included study;[41] two studies found no significant

clustering of risk factors;[43,51] and one study's results could not be used to determine the presence/absence of SNAP risk factors.[65]

Proportion of studies reporting each possible combination or cluster of risk factors

The number of studies in which each cluster of risk factors was reported (from none, single risk factors only, pairs, combinations of three, and all four risk factors), as a proportion of the total number of studies in which each combination of risk factors was possible, are shown in Table 3.6. The most frequently reported clustering was the absence of any of the examined SNAP risk factors (81% of studies; nb: such clusters were sometimes characterised by the presence of additional, non-SNAP risk factors as listed in Table 3.5). This was followed by the clustering of alcohol and smoking only (56%), all four SNAP risk factors (50% of studies), and poor diet with low physical activity (44% of studies). The combination of high alcohol and physical inactivity, and alcohol with poor diet, was rarely reported; excess alcohol, poor diet and physical inactivity was not reported. Substantial variation in the size of the clusters across studies is shown in Tables 3.1-3.3.

Table 3.6: Number of studies reporting each cluster of risk factors as a proportion of the total number of studies in which each combination was possible (May 2014)

Cluster of SNAP risk factors	**No. of studies/ total (%)**	**References**
Absence of SNAP risk factors	42/52 (81%)	10,13,14,16,17,19,20,25,27-33,35-37,39,40,44,46-48,50,52-56,58-64,68,70-73
Alcohol	15/43 (33%)	20,25,30,31,37,38,40,49,53,55,56,59,66,71,72
Diet	9/37 (24%)	30,36,37,53,56,57,59,62,66

Physical activity	13/47 (28%)	25,30-32,36,44,59,62,64,66,70,71,73
Smoking	13/48 (27%)	25,29-31,35,37,40,46,50,52,53,56,60
Alcohol + Diet	2/29 (7%)	14,30
Alcohol + Physical activity	1/38 (3%)	64
Alcohol + Smoking	24/43 (56%)	20,26,29,30,32,34,38,44-47,49,50,52,55-60,66-69
Diet + Physical activity	16/36 (44%)	13,19,26,28,39,45,48,53-55,58,59,61-63,73
Diet + Smoking	3/33 (9%)	30,48,56
Physical activity + Smoking	3/43 (7%)	38,67,71
Alcohol + Diet + Physical activity	0/28 (0%)	-
Alcohol + Diet + Smoking	10/29 (35%)	10,14,27,42,53,55,63,64,67,69
Alcohol + Physical activity +Smoking	7/38 (18%)	20,25,34,42,49,67,69
Diet + Physical activity +Smoking	11/32 (34%)	16,33,34,39,40,47,53,59,70,72,73
Alcohol + Diet + Physical activity +Smoking	14/28 (50%)	10,13,14,16,17,19,34,42,58,61,67,69,72,73

Clustering results are illustrated visually in Figure 3.2. Circle size is proportional to the number of times each cluster was reported across studies (as a proportion of the total number of studies in which each combination was possible), and therefore illustrates the relative frequency of each cluster of health risk behaviours. Lines connect the different risk factor clusters that were reported within a single study. These connecting lines indicate that the

majority of studies reported multiple clusters based on different combinations of SNAP risk factors. Detail about the number of clusters reported in each study, which ranged from none,[43,51] up to nine,[30] is available in Tables 3.1-3.3.

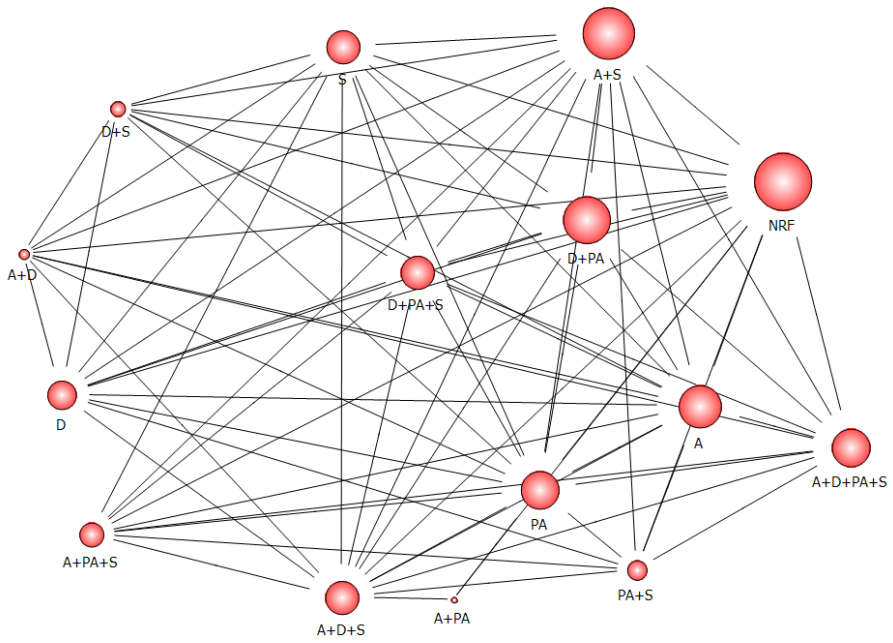

Figure 3.2: Health risk clustering results of included studies (May 2014)

Abbreviations for Figure 2: A, Alcohol; D, Diet; PA, Physical activity; NRF, No SNAP risk factors; S, Smoking

d) Sociodemographics (SoDs) associated with clusters

The sociodemographic characteristics associated with the 'most' risky cluster in each study are shown in Table 3.7, as a proportion of the number of studies which included each SoD variable. A total of 34/52 studies reported sociodemographic results. Eighteen papers which did not examine sociodemographics of clusters were excluded.[17,27,31,32,35,36,40,41,44,45,53-57,60,61,66]

Not all studies included all SoD variables: some papers were limited to all female or all male samples; others conducted analysis separately for gender or age.[30,68]

Table 3.7: Number of studies reporting an association between the most risky cluster and sociodemographic variables as a proportion of the total number of studies which included each variable (May 2014)

Sociodemographics (n= total number of studies examining variable)	**No. of studies (%)[a]**	**References**
Age (n=29)		
Younger	9 (31%)	10,13,14,26,29,49,64,69,71
Older	5 (17%)	13,20,30,38,67
Mid	1 (3%)	33
Not significant/same as sample average	16 (55%)	25,26,28,34,39,42,47,50,52,58,59,62,63,70,72,73
Gender (n=24)		
Male	18 (75%)	10,13,14,20,26,33,39,42,49,52,58,63,64,67-69,72,73
Female	2 (8%)	47,62
Not significant/same as sample average	6 (25%)	13,26,38,50,59,71
Education level (n=23)		
Lower	16 (70%)	16,19,20,25,26,29,30,33,39,46,49,58,59,62,68,69
Higher	1 (4%)	67
Mid	2 (9%)	63,70
Not significant/same as sample average	5 (22%)	26,28,34,63,64,70,72
SES (n=24)		
Lower	14 (58%)	10,13,14,16,20,29,30,39,48,49,59,62,67,69
Higher	3 (13%)	13,48,72

Mid	1 (4%)	[16,26,63]
Not significant/unclear	8 (33%)	[33,42,50,64,68,70,71,73]

[a]Percentages do not add to 100% as those studies reporting two or more 'most risky' clusters could report more than one association for each sociodemographic variable.

Male gender and lower levels of education showed the most consistent relationship with more risky clusters (reported in 75% and 70% of studies respectively). Lower SES and younger age tended to be associated with more risky clusters, although there were more non-significant findings for these variables. A number of the studies reporting an association between more risky clusters and older age were samples from Asian countries[20,38,67] and were comprised of already older (60yrs+) samples.[20,67] For those studies reporting an association between more risky clusters and a higher SES, the risky cluster either included higher alcohol intake[13,72] or did not include smoking.[48]

Methodological quality of included studies

The majority of included studies were rated as moderate (54%) or weak (34%) for sample selection bias, with few studies achieving a strong rating. Study samples were likely to be representative of the target population, but many had consent/participation rates of less than 80%, resulting in a moderate or weak rating for selection bias. While more studies were rated as strong for data collection methods (34%), the majority were rated moderate (18%) or weak (48%), as they either did not use valid and reliable data collection measures, or validity and/or reliability of measures were not reported.

Discussion

We identified 56 studies exploring the clustering of SNAP health risk behaviours across a range of countries and samples. Studies based in the US, Australia, Europe and the UK were dominant, with developing countries less often represented. Samples including ethnic minorities or indigenous groups were noticeably absent, with only three such studies identified.[27,40,42] Poor diet was less often included in studies than smoking and physical inactivity. Individual studies varied widely in which and how many SNAP risk factors were included, and in how risk was assessed and defined.

Despite significant variability in the types of clusters reported, some consistent patterns emerged. A large proportion of studies (81%) reported a relatively 'healthy' cluster characterised by the absence or low prevalence of any of the examined SNAP risk factors. More than half of the studies reported a clustering of alcohol with smoking, and half reported clustering of all four SNAP risk factors. Results reinforce previous findings of a strong relationship between risky behaviours related to alcohol and smoking,[10,17,74] and lack of association between excess alcohol and physical inactivity.[16,74] The idea of clustering at both ends of the spectrum, i.e. groups of individuals exhibiting all, and other groups none, of the explored risk factors,[14] was also supported. Sociodemographic associations also tended to confirm previous findings that males and those with greater social disadvantage show riskier health behaviours;[8,11,16] while younger age was less clearly associated with risk clustering than previously indicated.[11]

Implications of the methodological diversity in the literature

Although patterns of health risk clustering might have varied according to the study setting or sample (for example, for older versus younger adults, special populations such as cancer survivors, or across countries), this was difficult to identify given the broad inclusion criteria of the review. Differences in selection and measurement of risk factors and diverse definitions of risk highlight an overall lack of consistency in studies which all aim to describe the clustering of common health risk behaviours.[12,75] Similarly, diversity in analysis of clusters underscores a lack of consensus in the definition of clustering itself.[9] Such inconsistencies in methodology make drawing firm conclusions about which risk factors can be expected to cluster, and for which sub-groups, somewhat difficult. Expert agreement on the definition of SNAP health risks, as well as the most appropriate statistical approaches to cluster analysis, would benefit this field of research and allow more detailed comparisons between studies to be made. Although the quality of included studies was generally not strong, selection bias and data collection issues were not likely to be a major issue for interpretation of study results. The majority of studies included a sample likely to be representative of their target population, but did not achieve the 80% or higher consent rate needed for a strong rating for selection bias. The majority of studies rated poorly on data collection methods as they relied on simple self-reporting of health risk behaviours for which validity and/or reliability were not available or reported. Although such measures may tend to underestimate prevalence, for many health risk behaviours, self-report remains the most widespread and feasible method of collection.[76]

Implications for practice

Broadly, our findings confirm the clustering of two types of behaviours suggested by de Vries et al., 2008: addictive behaviours (such as smoking and alcohol) which will require

restraint or abstinence to avoid, and health promoting behaviours (physical activity and good diet) which require active engagement.[19] Smoking appears to be predictive of other health risk behaviours,[74] as evidenced by the presence of smoking in the most commonly reported clusters. The clustering patterns reported here suggest a common underlying cause of health behaviours, supporting the need for behavioural interventions to target multiple behaviours, and for health prevention efforts to take a holistic approach rather than focusing on single isolated behaviours. Specific behaviours such as smoking and risky alcohol consumption appear likely to co-occur and therefore require intervention approaches which take into account the interactive nature of these behaviours. A growing field of research addresses the most effective approach to multiple health behaviour change.[18,77] Results of this review suggest that such efforts and interventions need to be designed and accessible in particular for socially disadvantaged groups and males.

Limitations

There are a number of limitations to this review. Firstly, including a wide variety of statistical 'clustering' methods necessitated combining results from very different analyses (such as factor, latent class and cluster analysis). Similarly, results were combined regardless of sample type, sampling methods and precision of risk factor assessment, and methodological quality of included studies was generally not strong. Inclusion of younger participants in a number of papers may have influenced cluster results, and the decision to include only the risk factor combinations with the highest three ratios from O/E papers means some results were not captured. However, it was our intention to reflect the current state of the clustering literature for key health risk behaviours, and attempt to summarise the results of papers that describe health risk 'clustering'. A second key limitation relates to the extraction of the

clustering results. Inclusion of risk factors in the make-up of each cluster was potentially subjective, as we relied on the description of clusters/ factors/ combinations given by study authors, where descriptions ranged from 'relatively high', to 'above average', to 'the majority not meeting healthy guidelines'. Similar subjectivity applies to clusters characterised by the absence of SNAP risk behaviours, which could include meeting specific healthy SNAP guidelines, or displaying *relatively* healthy behaviours (e.g. 'the lowest levels of smoking or alcohol consumption'). Thirdly, our approach to identifying sociodemographics of the most risky cluster/s per study means that we combined variables associated with potentially very different clusters (e.g. those associated with high alcohol intake or smoking, compared to poor diet and physical inactivity). Some caution in interpreting these results is therefore required.

Conclusion

Despite the evident need for greater consistency in approaches to analysis of clustering, some common patterns in terms of which risk behaviours go together, and who tends to exhibit less healthy behaviours, emerge from the literature. Clustering of alcohol and smoking, and of the four SNAP risk factors, is relatively common. Such patterns reinforce the need for health promotion interventions to take a holistic approach towards targeting multiple behaviours, and for such efforts to be specifically designed and accessible for males and socially disadvantaged groups.

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PAPER TWO

A randomised trial assessing the acceptability and effectiveness of providing generic versus tailored feedback about health risks for a high need primary care sample.

Introduction to Paper Two

Opportunities for the delivery of preventive care in general practice are often missed due to patients not being detected as at-risk. Paper one described the collection of electronic health risk data from patients attending an Aboriginal Community Controlled Health Service (ACCHS). The knowledge that such a technique is feasible and acceptable for use in the ACCHS setting may provide a stepping stone for healthcare providers to efficiently identify the risk status of their patients and improve the provision of preventive care. Prior research suggests that tailored feedback is an effective component of interventions aimed at improving health behaviours such as smoking, nutrition and alcohol consumption, with tailored feedback generally being more effective than generic feedback. Feedback can help patients to initiate health-protective behaviours, as well as prompt healthcare providers to deliver appropriate preventive care. However, the acceptability and value of providing feedback to patients and providers has not been tested in the Aboriginal healthcare setting. The collection of electronic health risk data from patients attending an ACCHS as described in Paper one allows point-of-care feedback to be generated, which can be tailored to the health risks of individual patients. Paper two pilot tested the acceptability and preliminary effectiveness of providing feedback to patients attending an ACCHS. Feedback was either generic (including recommendations from national guidelines, regardless of the risk status of the patient), or tailored to the specific risk status of the patient. Patients were provided with the feedback prior to their appointment, and told that they could show the feedback to their doctor if they wanted, or to ask their doctor or health worker if they had any questions about it.

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A randomised trial assessing the acceptability and effectiveness of providing generic versus tailored feedback about health risks for a high need primary care sample

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Abstract

Background: Tailored feedback has been shown to be effective for modifying health risk behaviours and may aid the provision of preventive care by general practitioners (GPs). However, provision of tailored patient feedback for vulnerable or socially disadvantaged groups is not well explored. The aims of this study were to examine the acceptability and effectiveness of providing generic compared to tailored feedback on self-reported health risk behaviours among a high need sample of people attending an Aboriginal Community Controlled Health Service (ACCHS).

Methods: Participants attending two ACCHSs in regional New South Wales completed a touch screen health risk survey and received either generic or tailored health risk feedback. Participants were asked to complete an exit survey after their appointment. The exit survey asked about feedback acceptability and effectiveness. Self-reported ease of understanding, relevance and whether the generic versus tailored feedback helped patients talk to their GP was compared using Chi-square analysis; The mean number of survey health risks talked about or for which additional actions were undertaken (such as provision of lifestyle advice or referral) was compared using t-tests.

Results: 87 participants completed the exit survey (36% consent rate). Tailored feedback was rated as more relevant and was more likely to be shown to the participant's GP than generic feedback. There was no difference in the mean number of health risk topics discussed or number of additional actions taken by the GP by type of feedback.

Conclusions: Tailored and generic feedback showed no difference in effectiveness, and little difference in acceptability, among this socially disadvantaged population. Completing a health risk survey and receiving any type of feedback may have overwhelmed more subtle differences in outcomes between the generic and the tailored feedback. Future work to

rigorously evaluate the longer term effectiveness of the provision of tailored health risk feedback for Aboriginal Australians, as well as other high need groups, is still needed.

Trial Registration: Australian New Zealand Clinical Trials Registry ANZCTRN12614001205628. Registered 11 November 2014.

Key words: Social disadvantage, Aboriginal Australians, health risk behaviours, lifestyle risk factors, feedback, tailored, generic

Introduction

High burden of disease associated with modifiable lifestyle risk behaviours

Chronic diseases including cardiovascular disease, cancer and diabetes, are the leading cause of death and morbidity worldwide.[1] Modifiable risk factors such as smoking, poor nutrition, high blood pressure and cholesterol, physical inactivity and excess alcohol, are key contributors to the development of these chronic diseases.[2,3] The potential to improve population health and reduce the burden of chronic disease through preventing or reducing lifestyle and biomedical risk factors is therefore significant.

High risk groups need assistance to address risk factors

For a range of cultural and historical reasons, socially disadvantaged groups, including many indigenous populations, tend to show a higher prevalence of lifestyle risk factors compared to the general population.[4,5] For example, smoking rates among indigenous populations from Australia, New Zealand, Canada, and the United States (US) far exceed those of their non-indigenous counterparts.[6] In Australia, risk factors including smoking, alcohol misuse, physical inactivity and excess weight also show a distinct association with socioeconomic status, with those in the lowest quintile of socioeconomic disadvantage being almost two times more likely to smoke, and 1.7 times more likely not to exercise, than those in the top quintile.[7] Therefore, there is a need to reduce the prevalence of modifiable risk factors for such populations, if inequities in health outcomes are to be addressed.

Primary care as a key setting for prevention and management of modifiable risk factors

Primary care is generally the front-line for health care in most countries, and is therefore well placed to address patient risk factors.[8] Each healthcare visit represents a potential opportunity for the delivery of preventive healthcare services.[9] However, rates of delivery of preventive care in general practice remain low.[10] Data indicate that risk factors such as excess alcohol, smoking and being overweight are not detected by General Practitioners (GPs) for a significant proportion of general practice patients.[8,11,12]

Lack of practitioner time is one of the most frequently reported barriers to risk factor detection in the primary care setting.[13] Techniques which enable healthcare providers to efficiently identify patient risk factors may therefore improve provision of preventive care. Routine screening and delivery of point-of-care feedback is one technique which may help prompt both healthcare providers and patients to engage in preventive care. The use of such feedback is well tested in some settings. For example, the provision of tailored health risk feedback to individuals appears to influence change across a range of behaviours including alcohol, smoking and nutrition.[14-16] Similarly, decision support systems which provide recommendations for clinicians have shown benefits for preventive care such as screening, counselling and identification of at-risk behaviours.[17] However, the acceptability and effectiveness of providing health risk feedback to socially disadvantaged or vulnerable population groups is not as well explored.

Tailored versus generic feedback

Feedback can range from simple advice to more intensive or tailored information.[14] Generic feedback contains information which is broadly true for an entire population, such as warnings about alcohol consumption in pregnancy; while tailored feedback is derived from personal information provided by the individual, for example providing information about an individual's level of drinking compared to a reference group or recommended safe level.[14,18] Tailored health risk feedback contains less redundant information than generic feedback, and is therefore more likely to be read and remembered by individuals.[19] Evidence also suggests that targeting multiple rather than single health behaviours does not diminish the effectiveness of feedback.[20,21] The use of pictures that are closely linked to text in health education information has also been found to increase attention and recall, particularly for those with lower literacy levels.[22]

Aims of the current study

Aboriginal Community Controlled Health Services (ACCHSs) aim to provide culturally appropriate primary care to Aboriginal people,[23] with the majority of those attending being of Aboriginal or Torres Strait Islander origin (74-85%).[24] Aboriginal Australians, and potentially also other non-Aboriginal people attending ACCHSs, are an example of a socially disadvantaged group with disproportionately high prevalence of modifiable risk factors,[25] for whom the acceptability and effectiveness of provision of health risk feedback has not previously been explored. The aims of the current study were therefore to examine, among patients attending an ACCHS:

a) The acceptability of providing generic or tailored feedback on self-reported health risk behaviours, as assessed by i. reported ease of understanding; ii. perceived relevance of the information; and iii. likelihood of the information helping patients to talk to their GP about any relevant survey risk factors; and

b) The effectiveness of tailored feedback compared to generic feedback, for prompting discussion or action on relevant risk factors (such as referral or follow-up) during the consultation between the GP and patient.

Methods

Study design and setting

People attending two ACCHSs in regional New South Wales (NSW, Australia) were invited to complete an anonymous, cross-sectional health risk survey administered on a touch screen computer. Previous work by the authors confirmed that the touch screen survey was highly acceptable to participants in this setting.[26] Appointment sessions (morning or afternoon) were randomised to either the intervention (tailored feedback) or control (generic feedback) condition using a computer algorithm embedded within software developed for the study. The software was run prior to each session to determine session condition. Approximately equal numbers of sessions were randomised to each condition. Randomisation by session was used to minimise contamination between feedback conditions arising from patients potentially sharing their feedback. In general, morning session patients did not overlap with afternoon patients due to a lunch break between sessions. Study recruitment took place over four months in 2012 and 2013. Ethics approval for the study (see Appendix 8.1) was granted

by the University of Newcastle (reference: H-2011-0153) and the Aboriginal Health and Medical Research Council of NSW (reference: 806/11).

Participants

Adults (≥18 years) attending the ACCHS for a GP appointment, who were physically and mentally able to provide informed consent and complete the survey, were eligible to participate (see Appendix 8.2 and 8.3 for the study flyer and participant information statements provided to eligible participants at site 1 and site 2 respectively; consent to participate was implied by completion of the touch screen survey). Aboriginal and non-Aboriginal people were invited to take part. GPs were informed about the study in person (either via individual [site 1] or group [site 2] meetings) and their consent assumed through agreement of the Chief Executive Officers of the participating services. GPs were shown examples of the two types of feedback but did not receive any specific training regarding responding to the feedback.

Procedure

Participants were approached by a Research Assistant (RA) in the waiting room and invited to complete a health risk survey while waiting for their appointment. Assistance to complete the survey was offered as required. An Aboriginal RA undertook patient recruitment for half of the recruitment period. Participants were asked to have their weight and height measured (optional), and were able to end the survey if called in for their appointment. After completing the survey, participants were offered printed generic or tailored feedback (depending on session randomisation) and asked to complete a brief exit survey after their GP

appointment. An identification slip given to participants was used to link their health risk and exit survey data. Participants were told that they could show the feedback to their doctor if they wanted, and instructed to ask their doctor or health worker if they had any questions about the feedback. It was not possible to blind participants, healthcare providers or researchers to allocation to intervention condition. A flow chart showing participant recruitment and allocation is shown in Figure 2.1.

Measures

Health risk survey: Details about the health risk survey have been published elsewhere[26] (and survey items are included in Appendix 8.4). Briefly, the survey assessed self-reported risk factor status for up to 11 key health risks including: body mass index, smoking status, alcohol consumption, physical activity, fruit and vegetable intake, depression, drug use, and time since last screening for blood pressure, cholesterol, diabetes or HbA1c for those with diabetes, and cancers (including cervical, breast and colorectal cancers, according to participant age and gender).

Exit survey: Participants were asked to complete an eight-item exit survey presented on a second touch screen computer immediately after their GP appointment (see Appendix 8.5 for a list of the exit survey items). The exit survey asked participants to self-report any of the 11 health risks that they had talked to their GP about during their appointment (including '*none of these*' and '*I prefer not to say*' options). Participants were also asked whether the feedback (called the 'checklist') helped them to talk about any of these topics (*Yes- I gave the checklist to the doctor/ Yes- the checklist gave me some ideas about what to ask the doctor/ No- I*

didn't use the checklist/ Not sure), and whether any additional actions were taken by their GP (*Gave me information (e.g. a website or pamphlet)/ Helped me plan changes to my lifestyle/ Organised a follow-up appointment for me/* etc.). For the latter two questions a picture illustrating the health risk topics from the survey was shown and participants were asked to answer just for these topics. Finally, participants were asked to evaluate the feedback by indicating whether it: 'was easy to understand', 'was relevant to me', and 'will help me improve my health' (*Yes/ No/ Not sure*).

Health risk feedback

Generic feedback included basic lifestyle recommendations and test screening intervals (for those at average risk) based on national guidelines,[27-30] for the 11 risk factors covered in the survey. For example, generic feedback recommendations for smoking were: "*If you are a smoker, quitting smoking will improve your health. Talk to your doctor or health worker about ways to quit*". Tailored feedback was generated by comparing each participant's survey responses to national guidelines or other accepted cut-offs, and displayed only those factors for which the participant was at-risk. Tailored feedback showed the participant's current status compared to the guidelines (e.g. "*Your weight = 100kg. A healthy weight for you = 88kg*", calculated using a Body Mass Index of 25kg/m^2 and participants' measured height), and listed any screening tests for which the participant was overdue.

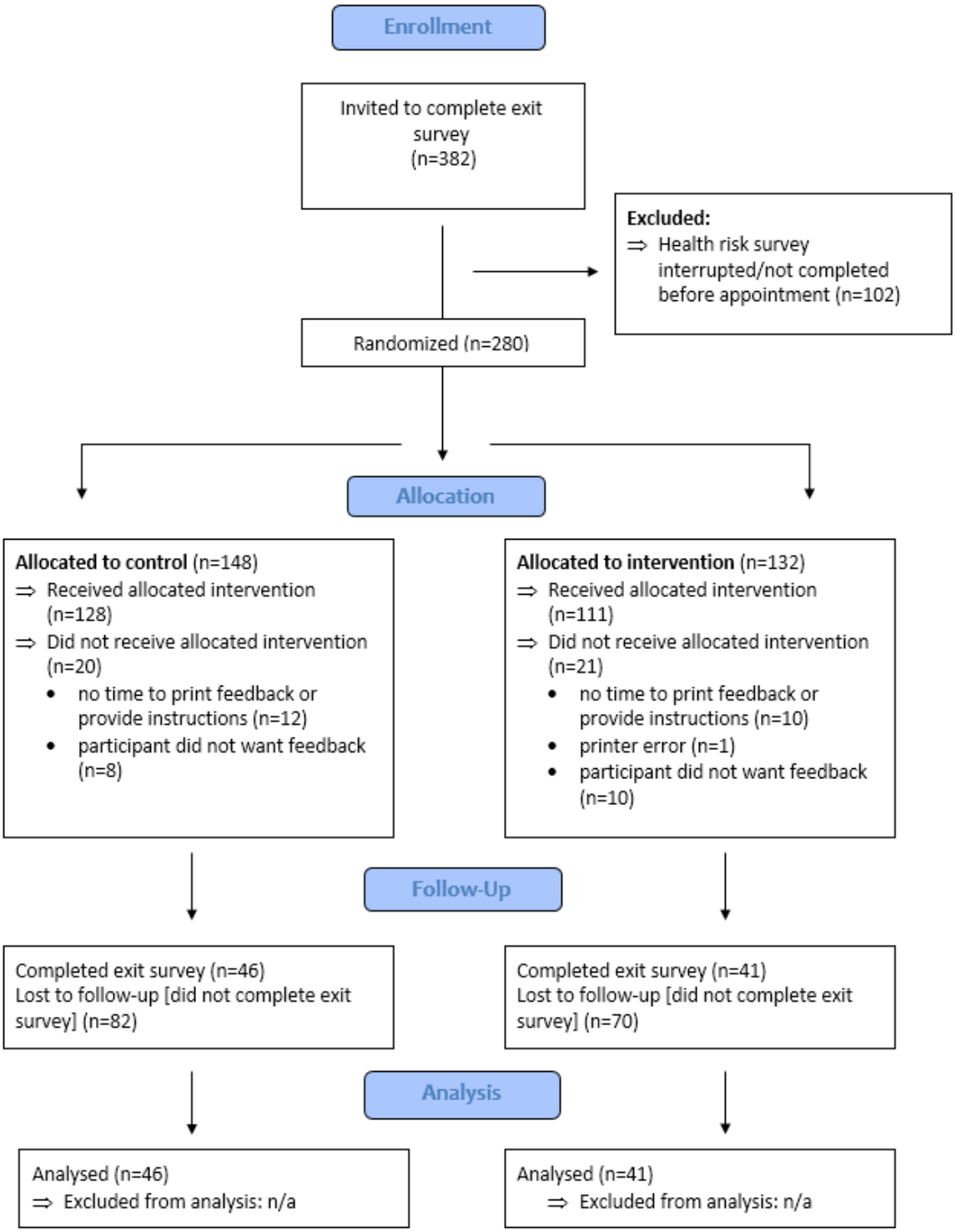

Figure 2.1: Flow chart of participant recruitment and allocation

Both types of feedback included simple advice for improving each risk factor, and used pictures, colour and minimal text to maximise appeal.[22] Feedback design and content was based broadly on public health guidelines (e.g.[30,31]), as well as input from project collaborators with expertise in Indigenous health and from staff at participating ACCHSs. Examples of the generic and tailored feedback are included in Appendix 8.6. At the second site only, a separate 'GP prompt sheet' was added to the tailored feedback for patients, based on recommendations from staff at this service. Participants were instructed that they could give this sheet to their doctor if they wanted. The GP prompt sheet consisted of a separate page showing any health topics that a participant indicated they would like more advice about or help with (see also Appendix 8.6).

Analysis

Simple proportions and chi-square tests (or Fisher's exact tests for small cell sizes) were used to assess consent bias and to compare proportions of participants agreeing with statements about the acceptability of the feedback and whether the feedback was useful during their appointment. The mean number of health topics discussed and mean number of actions undertaken for those who received the generic versus the tailored feedback were compared using *t*-tests. Due to the low response rate (see below), results for the tailored feedback at both sites (with and without the additional GP prompt sheet) were combined and analysed as a single intervention condition.

Results

Sample

The overall consent rate for the health risk survey was 69%. There were no significant differences between the age and gender of consenters and non-consenters (p's > .05; data not shown). Non-Aboriginal people were significantly more likely to consent, compared to the proportions of total active Aboriginal and non-Aboriginal patients registered in the clinical records of the ACCHSs, $\chi 2$ (1, N = 4091) = 9.71, p = 0.002. Demographic data confirmed that the total sample represented a broadly socially and economically disadvantaged group, with 66% reporting Centrelink (government welfare) as their source of income, and the majority of the sample (56%) having a highest education level of year 10 or below, compared to approximately 35% of the general Australian population (data not shown).[32]

Of the 239 participants who were given the feedback, 87 completed the exit survey (36% consent rate). Of these, 46 participants (53%) received the generic and 41 participants the tailored feedback. The demographic characteristics of those who completed the exit survey are shown in Table 2.1. There were no significant differences between participants who did and did not complete the exit survey in terms of age, gender or Aboriginal status (all p's >.05, data not shown).

Table 2.1: Demographic characteristics of participants completing the exit survey by group allocation (n = 87)

Demographics	**Generic feedback (n=46) n (%)**	**Tailored feedback (n=41) n (%)**	**All exit survey completers (n=87) n (%)**
Gender			
Male	17 (37%)	18 (44%)	35 (40%)
Female	29 (63%)	23 (56%)	52 (60%)
Age			
<35yrs	15 (33%)	11 (27%)	26 (30%)
35-54yrs	17 (37%)	15 (37%)	32 (37%)
≥55yrs	14 (30%)	15 (37%)	29 (33%)
Aboriginal status			
Aboriginal	34 (74%)	28 (68%)	62 (71%)
Non-Aboriginal	12 (26%)	13 (32%)	25 (29%)
Level of education[a]			
Yr 10 or below	25 (54%)	25 (61%)	50 (58%)
Yr 12	6 (13%)	3 (7%)	9 (10%)
TAFE/Other	6 (13%)	6 (15%)	12 (14%)
University/Tertiary	9 (20%)	6 (15%)	15 (17%)
Employment status			
Employed	15 (33%)	17 (42%)	32 (37%)
Unemployed/ supported	31 (67%)	24 (59%)	55 (63%)

[a] 1 missing value

Patient assessment of the generic and tailored feedback

The percentage of participants agreeing with statements assessing the two types of feedback (i.e. those responding ‘yes’) are shown in Figure 2.2. Participants were significantly more

likely to agree that the tailored feedback was 'relevant to me' compared to the generic feedback, Fisher's exact: $\chi^2(1, N = 87) = 5.22$, $p = .03$, while agreement did not differ for the other statements (*p*s >.05).

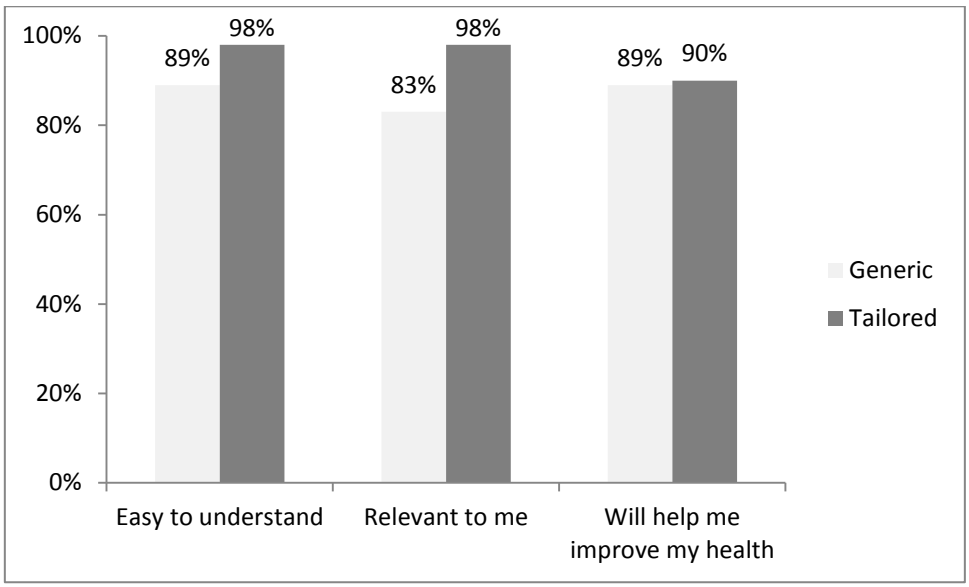

Figure 2.2: Assessment of the generic and tailored feedback (% who responded 'yes' to acceptability statements; n=87)

Usefulness of the feedback

For those who reported talking to their GP about any of the health risks in the survey (n = 38 generic, n = 32 tailored), participants were asked whether the feedback checklist helped them during their appointment. Responses are shown in Table 2.2. Significantly more participants who received the tailored feedback reported showing this to their GP than those who received the generic feedback, Fisher's exact $\chi^2(2, N = 70) = 7.30$, $p = .03$.

Table 2.2: Proportion of participants using the feedback to talk to their GP about survey health risks

Use of feedback during GP appointment	Generic feedback n (%)	Tailored feedback n (%)
I gave/showed the feedback to the doctor	2 (5%)	9 (28%)
The feedback gave me some ideas about what to ask the doctor	14 (37%)	11 (34%)
I didn't use the checklist/not sure	22 (58%)	12 (38%)

Effectiveness of generic versus tailored feedback

The average number of survey health topics talked about during the appointment was 2.85 (SD = 2.33). The majority of participants (82%) reported talking to their GP about at least one of the survey health risks in their appointment, regardless of whether or not they reported using the feedback. The mean number of topics discussed did not differ between those who received the generic (M = 2.87, SD = 2.39) versus the tailored feedback (M = 2.83, SD = 2.28; $t(85) = 0.08$, $p = .94$). There was also no difference in the average number of additional actions related to survey health risks taken by the GP (such as help plan changes to lifestyle, gave me information, organised a follow-up appointment) between participants who received the generic versus tailored feedback ($t(85) = 0.85$, $p = .40$).

Discussion

Tailored feedback was rated as 'more relevant', and was more likely to be shown to the GP than the generic feedback. Given that the tailored feedback included personalised risk factor information, it is not surprising that it was rated as more relevant. Almost two-thirds of

participants given the tailored feedback indicated that they either showed the feedback to their GP or it gave them some ideas about what to ask the doctor, compared to less than half of those who received generic feedback. Anecdotally, the tailored feedback prompted a greater response from participants than the generic feedback, including several who were surprised by their recommended healthy weight, and one participant who commented that seeing her depression score prompted her to bring this up with her GP. However, participants did not rate the tailored feedback as any more likely to help them improve their health, or any easier to understand, than the generic feedback.

The type of feedback did not appear to influence interaction with the GP in terms of the number of health risks talked about or other actions offered. An average of almost three health survey topics was discussed for all participants completing the exit survey regardless of type of feedback given, and an average of 36% of these participants indicated that their GP helped them to plan changes to their lifestyle during their appointment (data not shown). It is likely that GPs within the ACCHS setting are already discussing relevant health risks with their patients, as indicated by the majority of participants who reported discussing at least one survey health risk, independently of whether they showed the feedback to their GP. Alternatively, it may be that the process of screening by completing the health risk survey (as suggested by McPhail et al., 2014),[33] and being provided with feedback, prompted discussion, even if the feedback was not shown to the GP and/or the participant did not report using the feedback.

In contrast to previous findings such as those reported by de Vries et al., 2008[34] and Skinner et al., 1999[16] tailored feedback did not outperform generic feedback in this study. In a meta-

analysis of tailored health behaviour change materials, tailored interventions with more than one contact with participants (for example, providing three feedback letters at different times)[34] had significantly larger effect sizes than those with only one point of contact.[18] Also, materials which were tailored to multiple concepts such as participants' stage of change, and/or self-efficacy, as well as behaviour, were more effective than those tailored on behaviour alone.[18] Thus a more intensive approach to the provision of tailored feedback, such as one tailored to stage of change, or to patient and/or health practitioner perception of risk,[35] in addition to behaviour, and using an outcome measure not limited to immediate interaction between the participant and their GP, may have revealed a differential effectiveness of the two types of feedback for people attending an ACCHS. Alternatively, it may be that providing generic feedback to participants provides enough of a trigger to prompt discussion with the GP in this setting.

There were a number of limitations to this study. Firstly, the poor overall response rate and small sample who completed the exit survey substantially limit the power of the study to detect any differences between feedback types. Despite the exit survey being as brief as possible, the majority of participants indicated when invited that they would not have time to complete the exit survey after their appointment. Participants attending the ACCHSs often waited for a long time, came with others, and/or had others waiting for them to finish their appointment. In this setting, an exit survey may not be an effective way to obtain post-appointment data. Alternatively, some kind of incentive may need to be offered to encourage participation. It is likely that those who completed the exit survey had a greater interest in their health, and therefore the results may over-report the usefulness of both the generic and tailored feedback. Secondly, an objective measure of the interaction between patient and GP

(e.g. audio-recording) would also have allowed more systematic identification of relevant health risk discussions (which was limited to any relevant risk a patient reported talking to their doctor about, regardless of the nature or depth of the discussion) or actions. Thirdly, there were inconsistencies in providing feedback and inviting participants to complete the exit survey, due to time constraints, participants not wanting feedback, and incomplete surveys (for which tailored feedback could not be generated). These inconsistencies limit the generalizability of the results as not all eligible participants were invited to complete an exit survey and provide data about the feedback. Lastly, a key limitation involves possible contamination between feedback conditions based on morning or afternoon appointment sessions. As the same practitioners saw patients presenting with both types of feedback, it is possible that advice or action in response to one type of feedback spilled over to patients receiving the other. However, attempting to randomise feedback on another basis would have introduced additional sources of bias such those arising from differences between practitioners or practices.

Conclusions

Both generic and tailored feedback on multiple risk behaviours appeared to be largely acceptable to this sample of people attending an ACCHS, who are broadly representative of a population experiencing social and economic disadvantage. Tailored feedback was no more effective in prompting health risk discussion or action between participants and their GP than generic feedback. Almost 90% of participants agreed that either type of feedback would help them improve their health. It is likely that the impact of completing the health risk survey, together with receiving some form of feedback, overwhelmed more subtle differences in outcomes between the generic and the tailored feedback, especially given the small sample

size and limited outcome measures. Future work to rigorously evaluate acceptability and longer-term effectiveness of the provision of tailored health risk feedback for Aboriginal Australians, as well as other high need groups, is still needed. Future work may also consider tailoring of feedback to additional concepts such as stage of change or self-efficacy as well as behaviour, and exploring the impact of providing repeated feedback contacts, in assessing feedback effectiveness.

Additional files:

Additional file 1: CONSORT 2010 checklist for randomised trials.
Additional file 2: Health risk survey (text version).
Additional file 3: Exit survey (text version).
Additional file 4: Example of the generic and tailored feedback.

List of abbreviations: ACCHS: Aboriginal Community Controlled Health Service; GP: General Practitioner; NSW: New South Wales

Competing interests: The author(s) declare that they have no competing interests

Author contributions: NN developed the study materials, conducted data collection, undertook analysis and interpretation of the data, and drafted the manuscript. CP made substantial contributions to the study conception and design, provided support during data collection, and assisted with drafting and revision of the manuscript. MC made substantial contributions to the study design and development of feedback materials, and assisted with drafting and revision of the manuscript. SB and NT provided feedback on study design and specific study materials, facilitated and provided assistance with data collection, and provided critical feedback and revision of the manuscript. All authors have given final approval for this version of the manuscript to be published.

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PAPER FOUR

A cross-sectional survey and latent class analysis of the prevalence and clustering of health risk factors among people attending an Aboriginal Community Controlled Health Service.

Introduction to Paper Four

The literature reviewed in Paper three identified that some health risk behaviours are very likely to co-occur or cluster, and that some population groups may be more likely to report specific groups of behaviours. Much of the disproportionate burden of disease experienced by Aboriginal Australians is due to a high prevalence of modifiable health risk factors, including smoking, excess alcohol intake, physical inactivity and poor diet. However, there are very limited data available about the how these health risks cluster for socially disadvantaged groups, including Aboriginal Australians. If primary care is to address health risk behaviours in a collective way, rather than in isolation, a better understanding of the clustering of health risks for Aboriginal people is needed. Paper four, therefore, explored the clustering of a set of key health risks, using latent class analysis, among a sample of people attending an Aboriginal Community Controlled Health Service. The health risks examined were high body mass index, smoking, physical inactivity, risky alcohol consumption, poor diet, illicit drug use, depression, and underscreening for a number of biomedical (e.g. blood pressure) and cancer (e.g. colorectal cancer) tests. Demographic characteristics associated with health risk clusters were also identified.

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A cross-sectional survey and latent class analysis of the prevalence and clustering of health risk factors among people attending an Aboriginal Community Controlled Health Service

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Abstract

Background: Indigenous Australians are a socially disadvantaged group who experience significantly poorer health and higher prevalence of modifiable health behaviours than other Australians. Little is known about the clustering of health risks among Indigenous Australians.

Purpose: The aims of this study were to describe the clustering of key health risk factors, such as smoking, physical inactivity and alcohol consumption, and sociodemographics associated with clusters, among a predominantly Aboriginal sample.

Methods: Participants (n = 377) attending an Aboriginal Community Controlled Health Service in regional/rural New South Wales, Australia, in 2012-2013 completed a self-report touch screen health risk survey. Clusters were identified using latent class analysis.

Results: Cluster 1 ('low fruit/vegetable intake, lower risk'; 51%) consisted of older men and women; Cluster 2 ('risk-taking'; 22%) included younger unemployed males with a high prevalence of smoking, risky alcohol, and illicit drug use. Cluster 3 ('inactive, overweight, depressed'; 28%) was characterised by younger to mid aged women likely to have experienced emotional or physical violence.

Conclusions: If future research identifies similar stable clusters of health behaviours for this population, intervention approaches targeting these clusters of risk factors should be developed and tested for Aboriginal and Torres Strait Islander Australians.

Introduction

Aboriginal and Torres Strait Islander health

Socially disadvantaged groups, which includes many indigenous populations, experience poorer health and lower life expectancy compared to those less disadvantaged.[1,2] The health of Aboriginal and Torres Strait Islander Australians, the Indigenous peoples of Australia, reflects this disparity.[2] Although the determinants are complex, one of the potentially modifiable contributors to the health gap is the disproportionately high prevalence of health risk factors including smoking, excess alcohol use, poor diet and physical inactivity.[3] Cancer screening[4,5] and survival[6] rates are also known to be lower among Aboriginal and Torres Strait Islander than non-Indigenous Australians.

Increased health risks associated with multiple risk factors

Health risk behaviours do not occur in isolation, and often co-occur or cluster together.[7-10] Many health risk factors have a synergistic effect, where the combination of unhealthy behaviours increases the risk of disease or mortality more than the effects of the single risk factors.[9,11] Thus there are likely to be sub-groups within any population who are at higher risk of disease or death due to engaging in multiple health risk behaviours.[9]

Potential benefits of identifying clusters of risk factors

Information about whether, and which, risk factors group or cluster together can help inform preventive health efforts to avoid or reduce disease.[8,10] Examining the clustering patterns of multiple modifiable health risk factors and demographics associated with health clusters

allows targeting of health prevention interventions towards co-occurring risk factors and for the subgroups most likely to exhibit these risk clusters.[12,13]

Clustering of health risks among Indigenous Australians

Data about the co-occurrence of risk behaviours among Aboriginal and Torres Strait Islander Australians are largely limited to identifying paired associations[14] or cumulative numbers of risk factors.[15-18] For example, almost three-quarters (72%) of Indigenous adults from non-remote areas reported two or more risk factors including smoking, risky alcohol consumption, physical inactivity and overweight/obesity.[15] Similar rates of multiple risk factors were reported for Indigenous Australians attending an urban Aboriginal Community Controlled Health Service (ACCHS).[17] A more comprehensive understanding of the challenges facing Indigenous people, their communities and health services may be gained by identifying specific clusters of health behaviours. Exploring such patterns through techniques such as latent class analysis allows identification of individuals exhibiting common behaviours as well as characterisation of clusters by demographics.

There is a growing body of literature exploring risk clustering across countries and populations. For example, Verger reported five clusters among French adults, including a relatively healthy cluster and four unhealthy clusters characterised by poor diet, smoking, regular alcohol drinking, and binge alcohol drinking.[19] Among an Australian adult sample, French identified a ‘safe’ and a ‘moderate’ cluster, along with two risky clusters comprised of risky smokers and risky drinkers.[12] Only one previous study has looked at the clustering of health risk factors among Indigenous Australians.[20] Two clusters for Aboriginal adult men and women were reported: a ‘better’, and ‘worse’ cluster- characterised by hazardous alcohol

intake, smoking and poor dietary choices.[20] However, a limited range of risk factors and demographics were included. Given the stark difference health gap between Indigenous and non-Indigenous Australians', exploration of a wider range of health risks and sociodemographics is warranted.

The current study explored the clustering of a comprehensive range of risk factors and associated sociodemographics for a predominantly Aboriginal Australian sample. Depression was included as a 'risk factor' as it is a disease that affects many Aboriginal communities[21] and contributes both directly to the risk of cardiovascular disease (CVD)[22] and to lifestyle behaviours which increase the risk of developing CVD.[23] Differing results of health risk clustering studies across countries and in particular for different ethnic sub-groups[11,24] highlight the need to examine health risk clusters for different social and population groups.[25] Such information will help inform the planning and delivery of holistic preventive care efforts targeted towards co-occurring risk clusters and at-risk sub-groups among people attending ACCHSs, with a focus on Aboriginal Australians.

Aims:

To examine among people attending an ACCHS:

i. The prevalence of self-reported health risk factors including high body mass index (overweight/obese), smoking, physical inactivity, risky alcohol consumption, inadequate fruit and vegetable intake, illicit drug use, depression, and under-screening for blood pressure, blood cholesterol, diabetes, and breast, cervical and bowel cancer;

ii. The clustering patterns of these health risk factors; and

iii. Sociodemographic characteristics (age, gender, Indigenous status, education level, employment status, and exposure to physical or emotional violence in the last 12 months) significantly associated with identified health risk clusters.

Methods

Study design and setting

An anonymous, cross-sectional health risk survey was administered on a touch screen laptop in two ACCHSs in regional and rural New South Wales (NSW). Sites were located in major towns, were staffed by Aboriginal and non-Aboriginal staff including doctors, nurses and allied health workers, and provided both on-site and outreach services to smaller or isolated communities. The two services had approximately 1250 and 2400 active patients (at least 3 visits in the last 2 years) respectively. ACCHSs provide culturally appropriate primary health care to Australian Aboriginal communities,[26] with the majority of people who attend (74 - 86%) being of Aboriginal or Torres Strait Islander origin.[27] The two ACCHSs in this study represent the majority of those in NSW in terms of regional/rural location and patient numbers.[27] Ethics approval for the study (see Appendix 8.1) was obtained from the University of Newcastle (Reference: H-2011-0153) and the Aboriginal Health and Medical Research Council of NSW (Reference: 806/11).

Participants

Adults (≥18 years) attending the ACCHS for a general practice (GP) appointment who were physically and mentally able to provide informed consent and complete the survey were eligible (see Appendix 8.2 and 8.3 for study flyers used to inform participants about the study

and study information statements for sites 1 and 2 respectively; consent to participate was implied by completion of the touch screen survey). Aboriginal[1] and non-Aboriginal people were invited to take part, on the assumption that non-Aboriginal people attending an ACCHS are likely have close ties to the Aboriginal community and are also therefore likely to share similar patterns of lifestyle and health risk behaviours.

Procedure

Participants were approached by a Research Assistant (RA) in the waiting room and invited to complete the survey while waiting for their GP appointment. Assistance to complete the survey was offered as required. An Aboriginal RA assisted with patient recruitment for approximately half of the recruitment period, which occurred over four months in 2012 and 2013. Participants were asked to have their weight and height measured (optional), and were able to exit the survey if called in for their appointment. A RA recorded the estimated age and gender of non-consenting patients to assess consent bias. The survey was pilot tested with ACCHS staff and patients and refined prior to use. Items indicated that the touch screen survey was highly acceptable to people in this setting.[29]

[1] Our sample included two participants of Torres Strait Islander origin and five participants of both Aboriginal and Torres Strait Islander origin. As the study was conducted in New South Wales, we have used the term 'Aboriginal' refer to all of the Aboriginal and Torres Strait Islander participants, following the guidelines of the New South Wales (NSW) Department of Health, in recognition that Aboriginal people are the original inhabitants of NSW.[28]

Materials

The health risk survey was presented using Digivey Survey Suite software (CREOSO Digivey Survey Centre, Arizona, USA). The survey was designed using simple language and included pictures and limited text in order to improve accuracy and minimise reading demands. For example, a picture showing a standard drinks chart and the number of standard drinks in larger alcohol containers (e.g. cask of wine or carton of beer), was displayed to assist in answering questions about alcohol consumption. Survey software used branching algorithms to tailor questions to individual participants.

Measures

Demographics: Age, gender, Indigenous status, highest level of education completed, employment status, and exposure to violence in the last 12 months were self-reported. Exposure to violence was assessed using two items: a) In the last 12 months, did anyone, including people you know, use physical force or violence against you? *(<yes>, <no>)*, from the NATSISS 2008;[30] and b) In the last 12 months, did anyone, including people you know, use emotional violence against you, e.g. insult you, swear or scream at you, or threaten to hurt you? *(<never>, <sometimes>, <often>)*, derived from the HITS screening tool.[31] Those who responded 'yes' to a) and/or 'often' to b) were classified as having been exposed to physical or emotional violence in the last 12 months.

Health risk factors: Key risk factors which contribute to the burden of disease and injury for Aboriginal Australians were included in the health risk survey.[32] The items used to assess health risk factors, and cut-offs used to dichotomise responses as 'at-risk' or not at risk, are shown in Table 4.1. A list of all survey items is also included in Appendix 8.4.

Table 4.1: Description of items used to assess health risk factors, source of items and cut-offs used to classify participants as 'at-risk'

Risk Factor and description of item used to assess risk	**Cut-off used to classify at-risk participants**
Body Mass Index (BMI) Measured height and weight	BMI ≥ 25 kg/m^2 (excluding pregnant women)
Smoking status Single item [33]; 'Which of the following best describes your smoking?'	Current smokers (daily or occasional smokers)
Risky alcohol use Two items based on third question (AUDIT-3) of the AUDIT-C [34,35] modified to current NHMRC guidelines [36]; 'How often do you have more than 2/4 standard drinks in one day/ on one occasion?'	> 2 stand. drinks daily or almost daily; and/or > 4 stand. drinks weekly or more often
Physical inactivity Single item [37]; 'Do you usually do at least half an hour of moderate or vigorous exercise on five or more days a week?'	< 30 mins of exercise on five or more days per week [39]
Fruit and Vegetable Consumption Two items[33]; 'How many serves of fruit/ vegetables do you usually eat each day?'	< two serves of fruit; and/or < five serves of vegetables daily [40]
Depression	PHQ-9 score ≥ 10

Version of the Patient Health Questionnaire (PHQ-9) modified for use with Indigenous Australians[38a]	
Illicit drug use	Any drug use in the last 12 months; including those who responded 'prefer not to answer'
Participants were asked when they last used any illicit or illegal drugs	
Screening for blood pressure, cholesterol, diabetes and cancer: Under-screened	Not screened within recommended intervals for any age/gender appropriate screening test [41], including those who responded 'can't remember'
Participants were asked when they last had their blood pressure, blood cholesterol, and blood sugar (or HbA1c for those with diabetes) checked; and how long ago they had their most recent mammogram, pap test or bowel cancer test[b]	

[a]We selected the modified version of the PHQ-9 as the tool's authors suggested that the unmodified PHQ-9 [42] was unacceptable for use with Aboriginal and Torres Strait Islander people because of its wording and rating scale [38]. However, the authors also proposed including an additional item assessing anger (resulting in a total of 10 items), and in a subsequent validation study, using a cut-off score of 9, for the modified tool [43]. We did not include this additional anger item, nor use the modified cut-off score to classify possible cases of depression. This was due to a lack of psychometrics for the anger item and the small sample size of the scoring validation study (n=34);

[b]Survey programming tailored these questions to the age and gender of participants and adjusted for more frequent screening requirements for those at increased risk. Those with a self-reported history of cervical, breast or colorectal cancer did not answer cancer screening questions.

Analysis

Participants with missing values were removed from analysis. A single 'under-screened' variable was created to dichotomise screening status: any participant who was not screened in accordance with guidelines for *any* of the relevant screening tests was classified as 'under-screened'. For regression analysis, age was re-categorised into three broad groups: 18-34yrs, 35-54yrs and 55+yrs. Analysis was conducted in 2013-2014.

Latent class analysis (LCA) was used to identify clusters of individuals with similar profiles of the eight health risk factors. LCA is a statistical tool used to identify homogeneous, mutually exclusive groups or classes within a heterogeneous population.[44] The latent class model aims to stratify observed variables by an unobserved or latent categorical variable that removes confounding between observed variables.[45] To account for uncertainty in class membership the model assigns each individual a probability of class membership. Each latent class is characterised by its estimated prevalence and the probability of individuals within that class exhibiting each of the health risk outcomes. The latent class regression model permits the inclusion of covariates to predict individuals' latent class membership.[45] Goodness of fit and interpretability of the clusters were used to decide on the optimal number of classes. The LCA model was fit over a range of class numbers and the Bayesian and Akaike Information Criterion (BIC and AIC) generated for each (with lower BIC and AIC suggesting better goodness of fit).[46] LCA analysis were performed in R 3.0.1 using the poLCA package.[45,47] Stata (Statistical Software Release 13 College Station, TX: StataCorp LP) was used for data management and descriptive statistics.

Results

Sample

The consent rate was 69%. There were no significant differences between the age and gender of consenters and non-consenters (*p*'s > .05; data not shown). Non-Aboriginal people were significantly more likely to consent, as compared to the proportions of active Aboriginal and non-Aboriginal patients registered as attending the ACCHSs, $\chi 2$ (1, N = 4091) = 9.71, p = 0.002. There were 377 surveys with complete demographic and risk factor data available for

the LCA (27 surveys were excluded due to missing values; three of these due to refusal to have weight measured). Sample demographics are shown in Table 4.2.

Table 4.2: Demographic characteristics of study participants (n=377)

Characteristics	n (% of sample)
Gender	
Male	149 (40%)
Female	228 (60%)
Age	
18-24yrs	54 (14%)
25-34yrs	68 (18%)
35-44yrs	74 (20%)
45-54yrs	75 (20%)
55-64yrs	78 (21%)
≥65yrs	28 (7%)
Indigenous status	
Aboriginal[a]	302 (80%)
Non-Aboriginal	75 (20%)
Education	
Year 10 or below (Primary, Year 9 or below, Year	218 (58%)
10)	56 (15%)
Year 12	43 (11%)
TAFE[b] course/Other	60 (16%)
University or other tertiary	
Income source	
Unemployed (Centrelink/Supported by family/Other)	248 (66%)
Employed (FT/PT/Casual/ Self Employed)[c]	129 (34%)
Exposure to Physical or Emotional Violence	
No	78 (21%)
Yes	299 (79%)

Data collection site	
Site 1	178 (47%)
Site 2	199 (53%)

[a]Includes 7 participants who identified as either Torres Strait Islander or both Aboriginal and Torres Strait Islander;
[b]TAFE=Technical and Further Education, institutions which provide vocational education and training;
[c]FT= full time, PT= part time employment.

Prevalence of self-reported health risk behaviours

The risk factor profile of the sample is shown in Table 4.3. The most prevalent risk was inadequate fruit or vegetable intake (84%), followed by being overweight or obese (69%), inadequate physical activity, and being under-screened (each 52%).

Table 4.3: Prevalence of self-reported health risk factors among the study sample

Risk factor	n (% of sample, [95% CI])
Inadequate fruit/vegetable intake	316 (84% [80, 88])
Overweight/obese[a]	260 (69% [64, 74])
Inadequate physical activity	197 (52% [47, 57])
Under-screened	194 (52% [47, 57])
Current smoker	170 (43% [38, 48])
Depression (using PHQ9≥10)	132 (35% [30,40])
Risky alcohol intake	88 (23% [19, 28])
Drug use in last 12 months[b]	78 (21% [17, 25])

[a]BMI was measured and pregnant women were excluded. All other risk factors were self-reported;
[b]Includes those who responded 'prefer not to answer', n=15.

LCA Results: Clustering of health risk factors

Models with one to four latent classes were estimated without regression variables. Based on the minimal AIC value, the 3-class model was the best fit for the data [AIC (3 class) = 3688; AIC (2 class =3697)]. The BIC indicated a 2-class model was the best fit [BIC (2 class) =

3753; BIC (3 class) = 3792]. The 2-class model consisted of two groups based on high prevalence of risky health behaviours, or high prevalence of overweight/obesity. The 3-class model presented a richer grouping of risk factors (discussed in detail below), including division of the overweight cluster into a sub-cluster distinguished by depression and lack of physical activity. The 3-class model was deemed to be more interpretable and was therefore decided to be the preferred model. When covariates were included in the latent class regression model, the 3 class model also had the minimal Chi-square goodness of fit value (χ^2 = 274.80), indicating the preferred model on this criterion.[45]

The conditional probabilities of each health risk outcome associated with the clusters are shown in Figure 4.1. Clusters were named to best represent the health risk characteristics of each cluster. The three classes were characterised as follows:

Class 1- Low fruit/vegetable intake, lower risk (51%): had the highest prevalence of poor diet characterised by inadequate fruit or vegetable intake, and a relatively high prevalence of being overweight, although not as high as class 3. Class 1 had the lowest prevalence of other risk factors including smoking, risky alcohol intake, drug use, depression, and under-screening.

Class 2- Risk-taking (22%): had the highest prevalence of behaviours including smoking, risky alcohol and drug use. Class 2 also had a relatively high prevalence of low fruit/vegetable intake, but was associated with the lowest prevalence of inadequate exercise and being overweight.

Class 3- Inactive, overweight and depressed (28%): had the highest prevalence of inadequate physical activity, being overweight and depression. Class 3 had the lowest relative prevalence

of having a poor diet, although the majority of this cluster still reported inadequate fruit and vegetable intake. Class 3 had a low to moderate prevalence of all the other risk factors including smoking, risky alcohol and drug use.

All three clusters were associated with a similar prevalence of under-screening.

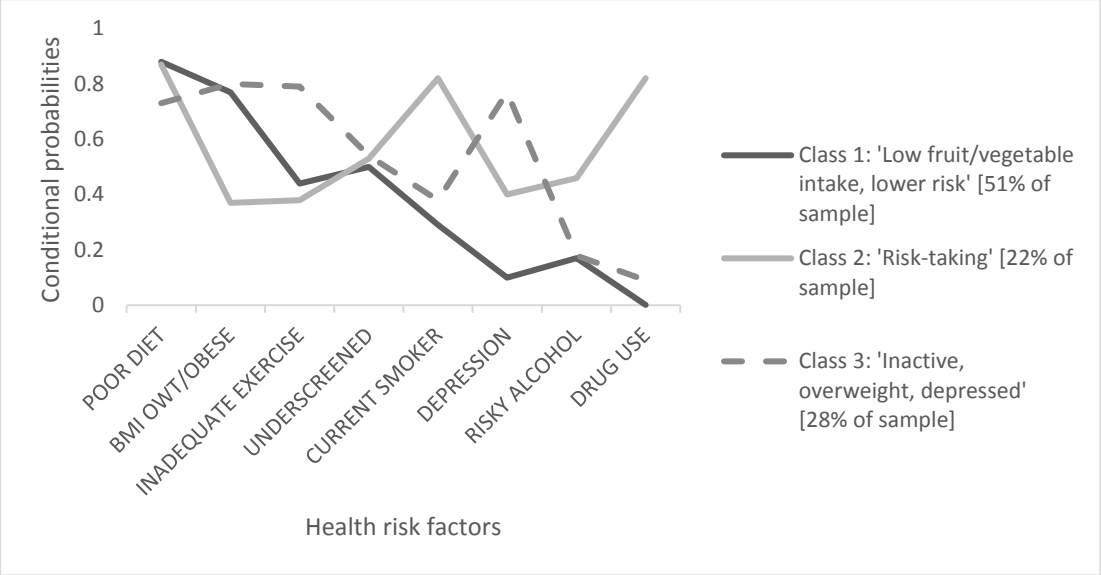

Figure 4.1: Conditional probabilities of each health risk factor associated with class membership

Regression results: Predictors of class membership

Results of the latent class regression model are shown in Table 4.4, with class 1 (*low fruit/vegetable intake, lower risk*) as the reference group. Compared to class 1, classes 2 and 3 were characterised as follows:

Class 2-Risk-taking: had significantly higher odds of being male, being aged less than 55yrs, being unemployed and of having been exposed to violence in the last 12 months. There was a non-significant trend for those in the risky cluster to have Year 10 or below schooling compared to a TAFE/other qualification.

Class 3-Inactive, overweight and depressed: had significantly higher odds of being female and of having been exposed to physical or emotional violence in the last 12 months. There was a non-significant trend towards class 3 having higher odds of being aged 35-54yrs compared to age 18-34yrs.

Table 4.4: Sociodemographic variable odds ratios associated with membership of class 2 (*Risk-taking*) and 3 (*Inactive, overweight and depressed*) relative to class 1 (*Poor fruit/vegetable intake, lower risk*)

	Class 2: *Risk-taking*			**Class 3**: *Inactive, o/wt, depressed*		
Sociodemographics	Odds Ratio	Std. error	*p*-value	Odds Ratio	Std. error	*p*-value
Gender[a]						
Male	3.11	0.46	0.01*	0.21	0.64	0.02*
Age[b]						
35-54yrs	1.40	0.46	0.47	3.35	0.66	0.07
55yrs+	0.17	0.62	<0.01*	0.29	0.73	0.86
Indigenous status[c]						
Non-Aboriginal	1	0.53	0.99	0.84	0.70	0.80
Education level[d]						
Year 12	0.69	0.55	0.51	0.38	0.91	0.28
TAFE/Other	0.20	0.85	0.06	0.37	1.02	0.32
University/ Tertiary	2.37	0.64	0.89	2.61	0.60	0.11
Employment[e]						
Unemployed	2.82	0.51	0.04*	2.48	0.54	0.09
Exposure to violence[f]	30.87	1.19	<0.01*	57.17	1.27	<0.01*
Yes						

Site[g]						
Site 2	0.92	0.40	0.83	0.81	0.47	0.66

[*]Significant predictors of class membership ($p < .05$);
[a] Gender reference group: Female
[b]Age reference group: 18-34yrs
[c] Indigenous status reference group: Aboriginal participants (including 7 participants who identified as both Aboriginal and Torres Strait Islander)
[d] Education level reference group: Year 10 or below
[e] Employment reference group: Employed
[f] Exposure to violence reference group: No; Exposure to violence included having experienced any physical violence, and/or emotional violence often in the last 12 months.
[g] Site reference group: Site 1

Discussion

Three distinct clusters of health risk factors, distinguished by sociodemographic characteristics, were identified within this predominantly Aboriginal sample. Aboriginal status was not a significant predictor of class membership, suggesting the risk patterns observed here are a strong reflection of the overall social disadvantage of the client group of the ACCHSs, and that intervention approaches targeting the clusters reported here would be appropriate for the entire ACCHS client base (and not only for Aboriginal patients).

There is very little previous research exploring the clustering of risk factors among Aboriginal communities. Burke et al., 2007 identified a better and 'worse' cluster for both males and females.[20] Our study confirmed a clustering of alcohol, smoking and poor fruit/vegetable intake, but more strongly for males than for females. Additional clusters based on lower-risk plus poor fruit/vegetable intake, and physical inactivity, overweight, and depression, also emerged. As Burke et al., 2007 did not assess body mass or depression, their study could not have identified these additional clusters of risks factors.

Health risk cluster studies in other populations have tended to report a ‘healthy’ cluster, together with various numbers and types of unhealthy clusters.[12,24,46,48-51] Unhealthy clusters range from those based on primarily on physical inactivity,[48,49] poor nutrition,[19,46,51] risky alcohol,[12,19,24,51] smoking,[12,19,51] to both smoking and risky alcohol.[46] Variable associations with physical inactivity have also been reported: Poortinga et al., 2007 found that higher physical activity clustered with smoking and drinking,[9] while others have reported the opposite.[51] These disparate clustering results emphasise difficulties in comparing across studies using different analytical approaches, risk factors and definitions of risk.[9,11] They further emphasise the potential lack of generalizability of such results, and the importance of conducting research for specific populations, such as Indigenous Australians.

Reported predictors of health risk clusters also vary across studies. Young males tend to be in clusters characterised by smoking and/or risky alcohol,[11,13,19,25,48,51] or to have a greater numbers of risk factors.[8] Women tend to be in healthier clusters, although some studies report female gender associated with clusters characterised by physical inactivity,[11] poor diet,[19] smoking,[12] or even with a more pronounced clustering of risky behaviours than men.[9] Older age tends to be associated with less risky behaviours, as does higher education, income, and other measures of higher socioeconomic status.[8,10-13,25,46,48-53]

Our demographic results are broadly consistent with these previous findings regarding gender and socioeconomic status, although there was no significant relationship between education level and cluster membership. Regarding depression and preventive screening, previous work reports an association between lower psychological distress or depression[8,48,52] and healthier clusters.[19] Lower compliance with preventive screening or medical check-ups was associated

with clustering of other risky behaviours,[54] or with an 'inactive' cluster among a sample of women.[49] In contrast, we found that depression was associated specifically with inactive and overweight women, rather than with more risky behaviours or with poor diet. We found no substantial differences in screening behaviours across clusters.[49,54] However, our measure of under-screening may not have been sensitive enough to reveal differences between clusters.

Limitations

Several study limitations should be noted. Reliance on self-reported risk factor status may affect the accuracy of our results, including potential social desirability bias. Although validated measures were used where possible,[37,43] many show only moderate sensitivity and specificity (such as short measures of physical activity or diet), and most have not been specifically validated for use with Indigenous Australians. The cut-offs used to dichotomise risk status (based on national guidelines) classified a large proportion of the sample as at-risk. Different clustering patterns may have resulted if we had restricted 'at-risk' status to, for example, obese participants, or to the consumption of less than five (vs seven) serves of fruit and vegetables per day. Finally, the small sample size, rural/ regional setting, and inclusion of non-Aboriginal participants, may limit the generalisability of our results to other settings, such as for Aboriginal Australians living in urban areas.

Implications for practice

Our clustering results support the idea that this population could benefit from interventions targeting multiple, related health risk behaviours, either simultaneously or sequentially.[24,51] Alternatively, interventions aimed at addressing single risk factors may need to consider

other risk factors which are likely to be present.[12] The relatively small variation in fruit and vegetable intake and under-screening across the sample suggests that almost all people attending an ACCHS would benefit from improved diet and screening. About a quarter of clients (typically younger, unemployed males), appear most likely to benefit from targeting risky behaviours such as smoking, alcohol and drug use; but with an aim to maintain healthy BMI and exercise levels. About a third of clients, particularly overweight women aged 35-55yrs, may benefit from an intervention approach which targets, or at least considers, the impact of depression and the role of physical or emotional violence on physical activity levels and body weight. Finally, just over half of ACCHS clients, particularly those aged over 55yrs, may require assistance focusing mainly on diet and weight. Our results further suggest that social change focusing on employment and reducing stress and violence may produce additional health benefits for Aboriginal communities. Given these patterns, it should be possible to design and tailor programs which cater particularly to the client groups most likely to need them.

Conclusion

Although multiple behaviour change interventions have shown potential for improving health,[46] evidence about their effectiveness remains limited,[9,55] particularly for Aboriginal and Torres Strait Islander populations.[56] Further research including Aboriginal communities from a diversity of settings is required to establish whether the clustering patterns reported here are generalizable more broadly. If future research identifies similar stable clusters of health behaviours for this population, intervention approaches targeting these three specific clusters of risk factors should be developed and tested for Indigenous Australians.

Conflicts of interest: The authors have no conflicts of interest to declare.

Author contributions: NN developed the study materials, conducted data collection, undertook analysis and interpretation of the data, and drafted the manuscript. CP made substantial contributions to the study conception and design, provided support during data collection, and assisted with drafting and revision of the manuscript. NT and SB provided feedback on study design and specific study materials, facilitated and provided assistance with data collection, and provided critical feedback and revision of the manuscript. CO provided expert advice and oversaw statistical analysis and provided critical feedback and revision of the manuscript. HT made substantial contributions to study implementation and provided critical feedback and revision of the manuscript. All authors have given final approval for this version of the manuscript to be published.

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PAPER FIVE

Ready, set, go: a cross-sectional survey to understand priorities and preferences for multiple health behaviour change in a highly disadvantaged group.

Introduction to Paper Five

As described in Papers three and four, the co-occurrence or clustering of health risk factors is evident in a number of settings, including for clients of Aboriginal Controlled Community Health Services. The need for primary care to manage health risk factors collectively, rather than in isolation, is increasingly being acknowledged. However, there is a potential risk that interventions which aim to address multiple health behaviours may be perceived by participants or patients as being too demanding or overwhelming. This is a particular concern in Aboriginal healthcare settings, as this population already experience multiple forms of disadvantage such as racism, discrimination, economic disadvantage and psychosocial stress. The unique social environment in which health risk behaviours take place for Aboriginal Australians, together with issues of generally poorer access to health care and lower levels of health literacy, also mean that a consumer perspective on how to best support multiple behaviour change in these communities is critical to success. Paper five, therefore, explored various aspects of multiple health behaviour change approaches, including priorities and readiness to change health behaviours, preferences for addressing health risks simultaneously or sequentially, and preferred sources of support for health behaviour change, among a sample of patients attending an Aboriginal Community Controlled Health Service.

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Ready, set, go: Understanding priorities and preferences for assistance with multiple health behaviour change in a highly disadvantaged group. A cross-sectional survey of people attending an Aboriginal Community Controlled Health Service

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Abstract

Background: Socially disadvantaged groups, such as Aboriginal Australians, tend to have a high prevalence and greater clustering of lifestyle risk factors, increasing the risk of disease and underscoring the need for services to address multiple health behaviours. The aims of this study were to explore, among a socially disadvantaged group of people attending an Aboriginal Community Controlled Health Service (ACCHS): a) readiness to change health behaviours; b) acceptability of addressing multiple risk factors sequentially or simultaneously; and c) preferred types of support services.

Methods: People attending an ACCHS in regional New South Wales completed a touch screen survey while waiting for their appointment. The survey assessed participant health risk status, which health risks they would like to change, whether they preferred multiple health changes to be made together, and the types of support they would use.

Results: Of the 211 participants who completed the survey, 94% reported multiple (two or more) health risks. There was a high willingness to change, with 69% of current smokers wanting to cut down or quit, 51% of overweight or obese participants wanting to lose weight and 44% of those using drugs in the last 12 months wanting to stop or cut down. Of participants who wanted to make more than one health change, over half would be willing to make simultaneous or over-lapping health changes. The most popular types of support were help from a doctor or Health Worker, and seeing a specialist, with less than a quarter of participants preferring telephone or electronic (internet or smart phone) forms of assistance. The importance of involving family members was also identified.

Conclusions: Strategies addressing multiple health behaviour changes are likely to be acceptable for people attending an ACCHS, but may need to allow flexibility in the choice of initial target behaviour, timing of changes, and the format of support provided.

Key words: lifestyle risk factors, health behaviour change, readiness to change, social disadvantage, Aboriginal Australians.

Background

Impact of lifestyle risk factors on chronic disease and mortality

Lifestyle risk factors such as smoking, poor nutrition, physical inactivity and excess alcohol are among the leading causes of mortality and disease worldwide.[1,2] These risk factors tend to be more prevalent among socially disadvantaged and indigenous groups,[3-5] for a range of complex cultural and historical reasons.[6] Aboriginal Australians are one example of a socially disadvantaged group for whom key lifestyle changes such as smoking cessation, increased physical activity, reduced alcohol intake and improved nutrition are needed to achieve health equality with the mainstream Australian population.[7,8]

Clustering of health risk behaviours

Health risk behaviours tend to co-occur or cluster together[9-12] with individuals rarely meeting guidelines across multiple behaviours.[13] Socially and economically disadvantaged populations are likely to exhibit a greater number of lifestyle risk factors.[14,15] For example, Aboriginal Australians visiting a General Practitioner were four times more likely to be overweight, daily smokers *and* to consume alcohol at risky levels than other patients.[16] With the rising burden of chronic and cardiovascular diseases worldwide, there is growing recognition that multiple risk factor intervention should be the cornerstone of primary prevention.[14] The clustering of risk factors among socially disadvantaged groups has particular implications for the workload of primary care teams in deprived areas.[14]

Multiple health behaviour change interventions

There is limited but growing evidence supporting the effectiveness of multiple behaviour change (MHBC) interventions.[17] Intervention studies aimed at both diet and physical activity have shown significant improvements for both behaviours,[18] while tailored advice for five behaviours including physical activity, fruit, vegetable and fat intake, and smoking cessation was effective in improving dietary behaviours and physical activity, but not smoking.[19] Women who were successful in increasing exercise levels also showed increased efforts to quit smoking.[20]

However, as an emerging area of public health research, much remains unknown about MHBC, such as the optimal number of behaviours with which to intervene, whether to intervene simultaneously or sequentially, and how to achieve synergies to improve multiple behaviours.[21] A critical issue for health services is the acceptability and effectiveness of MHBC approaches to care. The potential for MHBC approaches to overwhelm or discourage participants[22,23] may be a particular issue for socially disadvantaged populations generally, and for Aboriginal Australians in particular, given that the latter experience higher levels of stressful life events and general psychological distress compared to other Australians.[24,25]

Need for culturally targeted approaches to improving health for disadvantaged and indigenous groups

Understanding consumer perspectives is critical to the design and development of interventions and care models which will achieve high uptake, and therefore, provide a population-level benefit. Consumer perspectives for socially disadvantaged or indigenous groups such as Aboriginal Australians are yet to be explored. Health behaviours among such

groups reflect differences in broad influences such as the social environment.[26] For example, smoking is a largely shared and normalised behaviour for many disadvantaged and indigenous communities.[27,28] Similarly the need for physical activity to be communal or family-oriented, rather than done for the individual alone, has been reported for indigenous populations from Australia[29] and the US.[30] Therefore, tailored approaches to addressing risk behaviours may be needed. Health promotion and prevention strategies aimed at the general population may be less effective in high-risk communities such as Indigenous communities,[31] for reasons including the appropriateness of services and support offered,[28] use of inappropriate language and messages,[31] and limited access to care.[32] A recent review found that culturally-enhanced interventions produced better health outcomes than non-enhanced interventions or usual care, for conditions such as diabetes.[33] Given the different social and cultural influences on health risk behaviours,[34] generally poorer access to care and lower levels of health literacy[26] of Indigenous and other socially disadvantaged groups compared to less disadvantaged groups, it is critical to gain an understanding of how behaviour change might best be supported in these communities.

Need to assess preferences and priorities for health behaviour change

Behavioural medicine literature suggests that people are more likely to achieve behaviour change when they actively participate in the choice of change to be made.[35,36] Although individual priorities for change may not reflect the risk posed by the behaviour, they reflect perceptions of likely success, confidence, what might be least difficult to change, and readiness to change.[36-38] Stage of change models provide one way to assess an individual's readiness to change.[39] Although the evidence is not overwhelming,[40,41] interventions matched to stage of change have shown promise for improving behaviours.[37,39] Intention to change is

generally agreed to be among the most proximal influences over behaviour,[42] and a lack of intention generally leads to lack of behaviour.[43] While intention does not guarantee action, stages of change are nonetheless important in predicting the likelihood of subsequent changes in behaviour.[44] Of particular relevance to MHBC approaches is evidence suggesting success with changing one behaviour enhances motivation or readiness to change additional behaviours.[13]

The development of culturally targeted health interventions addressing some of the major risk factors for socially disadvantaged groups such as Aboriginal Australians would therefore benefit from a better understanding of priorities for behaviour change, readiness to change, and preferences for types of support. The aims of this study were to explore, among participants attending a primary healthcare service targeting an Aboriginal Community:

a) Readiness to change at-risk health behaviours including overweight, smoking, risky alcohol intake, drug use, physical inactivity, poor diet, and depression; and which changes are perceived as being the most difficult to make;
b) The acceptability of addressing multiple risk factors in isolation, sequentially or simultaneously;
c) The types of support services which would be used to help participants to change risky behaviours, and whether services should be offered to individuals alone, or to individuals as well as their support person or wider support network; and
d) Any significant sociodemographic predictors of stage of change and acceptability of making multiple health behaviour changes.

Methods

Setting and participants

An anonymous, cross-sectional health risk survey was administered on a touch screen laptop to people attending a large Aboriginal Community Controlled Health Service (ACCHS) in regional New South Wales (NSW).[45] ACCHSs provide the majority of comprehensive primary health care to Australian Aboriginal communities,[46] with approximately 75-85% of people attending these services being of Aboriginal or Torres Strait Islander origin.[47] ACCHSs also play a role in community support, special needs programs and advocacy.[48] Informed consent was sought from all participants in the study (see Appendix 8.3 for the study flyer used to inform participants about the study and the participant information statement; consent to participate was implied by completion of the touch screen survey). Ethics approval for the research (see Appendix 8.1) was obtained from the University of Newcastle (reference: H-2011-0153) and the Aboriginal Health and Medical Research Council of NSW (reference: 806/11). The study adhered to STROBE guidelines.[49]

Participants and procedure

General details of the study procedure have been reported elsewhere.[50] Briefly, Aboriginal[1] and non-Aboriginal adults (≥18 years) attending the ACCHS for a general practitioner (GP) appointment were invited to complete a questionnaire in the waiting room while waiting for their appointment. An Aboriginal Research Assistant (RA) undertook patient recruitment for half of the recruitment period of two months in 2013 (with a non-Aboriginal RA undertaking

[1] The term 'Aboriginal' is used to refer to the Aboriginal and Torres Strait Islander participants in this study, following the guidelines of the New South Wales Department of Health, in recognition that Aboriginal people are the original inhabitants of NSW.[51]

the remaining recruitment). Participants were able to exit the survey if called in for their appointment.

Measures

The touch screen questionnaire included demographic questions and standardised or validated items assessing health risk status including: body mass index (BMI), smoking, alcohol consumption, level of physical activity, consumption of fruit and vegetables, alcohol intake, drug use, depression and adherence with screening guidelines (see Appendix 8.4 for all health risk survey items). Participant weight and height were measured. Current national guidelines or established cut-off scores were used to classify participants as at-risk.

A series of questions (presented in Table 5.1) assessed preferences and priorities for health behaviour change, including stage of change or willingness to change each of the health risks identified above. These questions are also included in the survey items in Appendix 8.4. Participants were asked about any health changes they wanted to make, regardless of their individual risk status. Given the focus on assessing perceptions of MHBC, participants were asked specifically about whether they would try to make several health changes at once or one at a time, the support services they would use for making these types of changes, and whether services should be offered to individuals or to individuals as well as members of their wider support network including family or friends. To examine whether particular subgroups might be more or less open to MHBC approaches, sociodemographic predictors of willingness to change and preferences for making single or multiple health behaviour changes were also explored.

Table 5.1: Survey items assessing participant priorities for change and preferences for types of support

Item	Response options
1. If you could get help, are there any of these changes you would like to make?	Lose weight Stop or cut down smoking Drink less alcohol Get more exercise Eat more fruit and veg Stop or cut down on drug use Find ways to feel less sad or depressed None of these <*skip to Q9*>
2. When do you think you will try to: <*INSERT response/s from Q1*>?	I'm already trying to < *INSERT response/s from Q1*>* In the next month In the next 2-6 months Sometime, but not in the next 6 months
3. If you could get help (e.g. from your doctor or a health worker), what would be the best way for you to make these changes? <*For those selecting two or more changes in Q1*>	I would finish making one change before I started on the next one Once I started to get somewhere with one change, I would start on the next one I would try to make some or all of these changes at the same time
4. Would you use any of these services to help you make this health change (or changes)? <*For those selecting at least one change in Q1*>	Advice and help from my doctor or Health Worker, who checks how I'm going My doctor or Health Worker arranging for me to see a specialist (like a dietician, exercise coach, counsellor) I arrange to see a specialist myself (like a dietician, exercise coach, counsellor)

	None of these
5. Would you want this help to be: *<For those selecting at least one service in Q4>*	Just for me For me and one support person (like my partner, a parent, sibling or friend) For me and other members of my family or my friends Not sure
6. Would you use any of these services to help you make this health change (or changes)? *<For those selecting at least one change in Q1>*	Go to face-to-face support group meetings with others also trying to change Use a computer to get emails or on-line advice and support Call a telephone support service for advice and support Take home books or DVDs with information and advice Use a phone app and text messages for advice and support None of these
7. Would you want this help to be: *<For those selecting at least one service in Q6>*	Just for me For me and one support person (like my partner, a parent, sibling or friend) For me and other members of my family or my friends Not sure

[*] For depression, this response option was "I'm already getting help"

Stages of change were defined following Prochaska and Velicer 1997[52] and de Vries et al., 2008.[13] 'Precontemplation' (unwilling to change) was defined as either not intending to

change the behaviour (Q1: “none of these”) or not within the next 6 months (Q2: “Sometime, but not in the next 6 months”). ‘Contemplation/preparation’ (thinking about changing) included those intending to change the behaviour in the next month or next two to six months (Q2: “In the next month/ In the next 2-6 months”), and ‘action’ (attempting to change) as those currently changing their behaviour (Q2: “I’m already trying to change…”). Maintenance of behaviour change was not assessed.

Analysis

Any data considered likely to be incorrect for weight (< 35kg or > 200kg) or height (< 145cm or > 200cm) were replaced with missing values. The number of multiple risk factors was calculated for each participant by adding up their number of single risks. Chi-square analysis was used to compare the characteristics of consenting and non-consenting participants, and simple proportions used to describe readiness to change, preferences for types of support and other study variables. Any significant predictors of stage of change, acceptability of making multiple health changes, and preferences for support offered to individuals or wider networks were explored using logistic regression. Predictor variables were gender, age, highest level of education and number of multiple risk factors. A sample size of 200 participants enabled the prevalence of most outcomes to be calculated at the 95% confidence level with a precision level of +/-7%.

Results

Participants and Consent Rate

Of 367 participants approached, 245 (67%) consented to participate. There were no significant differences in the age, gender or Indigenous status of study consenters and non-consenters (all p’s > .05; data not shown). A total of 211 participants completed at least one

of the health risk preference questions and were included in analysis. Other participants were called in for their appointment before completing the survey. The demographics of the sample are shown in Table 5.2. The main source of income for 66% of the sample was Centrelink (government welfare). Educational levels were also low compared to the general population,[53,54] indicating the majority of the sample experienced relative socioeconomic disadvantage.

Table 5.2: Demographic characteristics of the study sample (n = 211)

Demographics	**n (%)**
Sex	
Male	83 (39%)
Female	128 (61%)
Age	
18-24yrs	22 (10%)
25-34yrs	44 (21%)
35-44yrs	39 (19%)
45-54yrs	45 (21%)
55-64yrs	46 (22%)
65yrs+	15 (7%)
Aboriginal status (n=210)	
Aboriginal	182 (87%)
non-Aboriginal	28 (13%)
Highest education level	
Primary school	4 (2%)
Year 10 or below	118 (56%)
Year 12/TAFE	53 (25%)
University/ other tertiary	34 (16%)
Other	2 (1%)
Income source	
Centrelink	139 (66%)
Part time/casual employment	20 (10%)

Full time employment/ self employed	46 (22%)
Other	6 (3%)

Prevalence of risk factors

The prevalence of each risk factor for those with complete data is shown in Figure 5.1.

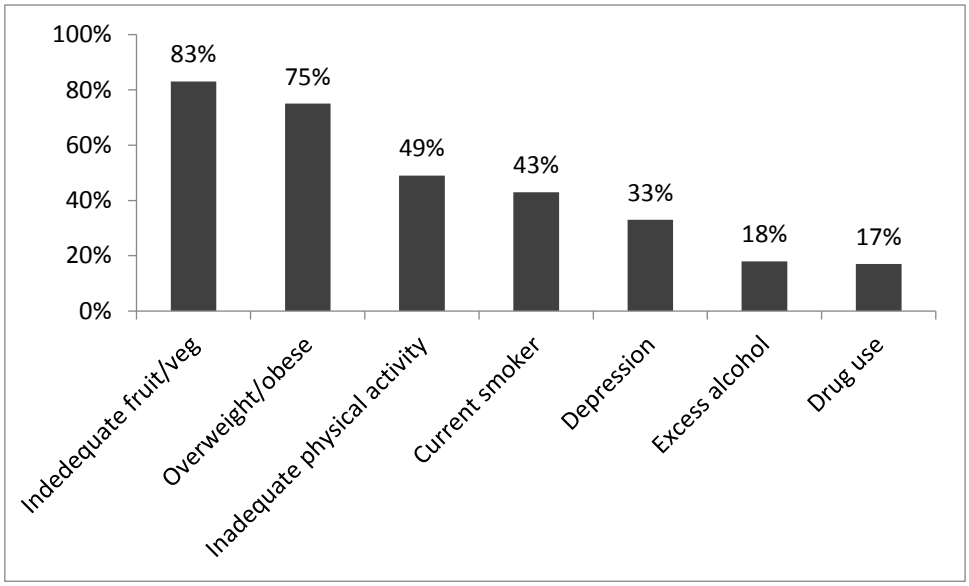

Figure 5.1: Proportion of sample classified as at-risk for each of the health risk factors assessed in the survey

Readiness to change health behaviours

Table 5.3 shows the number of participants who indicated that they wanted to make at least one of the health changes assessed in the survey, and their stage of change, as a proportion of the total number of participants classified as at-risk for each factor.

Table 5.3: Number (percentage) of at-risk participants wanting to make one of the survey health changes and their stage of change

Risk factor (n at-risk)	**n (%)*** **wanting to change [95% CI]***	**Stage of change n (%)* [95% CI]***		
		"Already trying"	**In next 1-6 months**	**"Sometime in the future"**
Low fruit/veg intake (n=170)	39 (23%) [17, 29%]	32 (18%) [13, 25%]	6 (4%) [1, 7%]	1 (0.5%) -
Overweight (n=150)	76 (51%) [43, 59%]	56 (37%) [30, 45%]	15 (10%) [5, 15%]	5 (3%) [4, 6%]
Inadequate exercise (n=100)	38 (38%) [28, 48%]	19 (19%) [11, 27%]	15 (15%) [8, 22%]	4 (4%) [0, 8%]
Smoking (n=89)	62 (69%) [60, 79%]	37 (42%) [31, 52%]	14 (16%) [8, 23%]	11 (12%) [5, 19%]
Depression (n=69)	27 (39%) [27, 51%]	14 (20%) [10, 30%]	9 (13%) [6, 27%]	4 (6%) [1, 11%]
Excess alcohol (n=37)	13 (35%) [19, 51%]	9 (24%) [10, 39%]	1 (3%) [-3, 8%]	3 (8%) [-1, 17%]
Drug use (n=32)	14 (44%) [26, 62%]	10 (31%) [14, 48%]	1 (3%) [-3, 9%]	3 (9%) [-1, 20%]

* As a proportion of the total number of participants who were classified as at-risk for each factor

As shown, smoking had the highest proportion of those at-risk wanting to change, with 69% of current smokers wanting to stop or cut down, and 52% already trying; followed by weight, with 51% of those who were overweight or obese wanting to lose weight, and 37% already trying to do so. The lowest proportion was for those classified as at-risk with poor diet, where 23% indicated wanting to eat more fruit and vegetables and 18% reported already trying to do this.

For at-risk participants across all behaviours, the only significant predictor of readiness to change was the number of multiple risk factors. Those with a greater number of risk factors were more likely to be in the contemplation (already trying to change or wanting to change in the next 1-6 months) than the precontemplation stage (OR = 1.71, SE = 0.30, p = 0.002). Age, gender and level of education were not related to readiness to change.

Acceptability of multiple behaviour change interventions

All survey participants (n = 207) had at least one risk factor, with 94% having two or more and 67% three or more multiple risk factors. Approximately half of participants (51%) reported that there was a single health change that they wanted to make, while 34% reported wanting to make two or more health changes, and 15% no health changes.

Of those participants who were contemplating more than one health change (n = 68; data missing for n = 2), 44% indicated that they would make one change at a time, 32% chose overlapping changes ('once I started to get somewhere with one change I would start on the next'), and 24% indicated they would try to make some or all of the selected health changes at once. None of the selected variables (gender, age, level of education or number of multiple risk factors) were significant predictors of wanting to make changes at once versus one at a time.

Types of support wanted

Any participant who indicated there was at least one health change they wanted to make (n = 176) was asked to select the types of support or help they would use to help them make these

changes. The types of support chosen, as a proportion of those selecting at least one health change, are shown in Table 5.4.

Table 5.4: Number (percentage) of participants selecting each type of support for participants wanting to make at least one health change

Type of support	No. (% [95% CI])[*, **]
Advice and help from doctor/Health Worker	96 (55% [47, 62])
My doctor/Health Worker arranges for me to see a specialist	65 (37% [30, 44])
I arrange to see a specialist myself	19 (11% [6, 15])
Face-to-face support group	86 (49% [42, 57])
Computer emails and online support	22 (13% [7, 17])
Telephone support service	26 (15% [10, 20])
Books or DVDs	30 (17% [12, 23])
Phone 'app'	12 (7% [3,11])
None of these	21 (12% [7,18])

[*] As a percentage of the number of participants who wanted to make at least one health change

[**] Percentages do not add to 100% as participants could choose more than one type of support

The most common health changes that participants would use advice and support from their GP for included losing weight, getting more exercise, and improving diet. Similarly, face-to-face support groups would most commonly be used for losing weight, getting more exercise, improving diet and smoking cessation (data not shown).

Support for individuals only or including family and friends

For participants who chose one of the first three types of support (those related to GP or specialist care; n = 146), the majority indicated that they would like this help to be just for themselves (62%) and about one-third (35%) for themselves plus a support person, or other

members of their family or friends; with 3% not sure. For participants choosing one of the latter non-clinical types of support (such as support groups or DVDs; n = 128), about half wanted this support to be for themselves only (52%), or for themselves as well as a support person or other members of their family or friends (45%), with 3% not sure.

Discussion

There was a high prevalence of risk behaviours among our sample, including two-thirds of participants being overweight or having a poor diet, and almost half being physically inactive or current smokers. This is in line with national data for Indigenous Australians,[16] and other indigenous and disadvantaged populations internationally.[15,55] There was a high degree of readiness to change some behaviours, in particular smoking and being overweight. In contrast, few at-risk participants were contemplating reducing their alcohol consumption, or increasing their physical activity or fruit and vegetable intake. Of note, the latter two behaviours were among the most highly prevalent, but were associated with the least willingness to change. The vast majority (94%) of the sample had multiple health risks, but less than half reported wanted to change more than one risk factor. Of these, more people preferred the idea of addressing one risk at a time than making more than one change at once. Face-to-face support services were the most likely to be used, while electronic approaches (such as smart phone applications or web-sites) were the least popular for making these health changes. Clinical based services (such as GP, specialist) were generally seen as appropriate for individuals, while services such as support groups and educational materials were often preferred to be available to individuals and their wider support network, including a support person or family members and friends.

The majority of smokers in our sample were contemplating or actively trying to quit or cut down (69%), which is broadly similar to findings for Indigenous Australian smokers from remote Northern Territory communities (58% contemplating and 17% attempting to quit)[56] and for women attending an Aboriginal Health Service for ante- or post-natal care (55% contemplating and 13% attempting to quit).[57] Similar rates of cutting down or attempting to quit have been reported for First Nations communities in Canada (46%).[58] In contrast to our results, higher proportions of a sample of at-risk urban Australian Aboriginal adults were contemplating increased fruit intake (76%) and physical activity (80%), compared to increasing vegetable intake (46%) or smoking cessation (23%).[7] The reasons for these differences are not clear.

Our sample showed a general lack of readiness to change diet, increase physical activity and reduce alcohol consumption. Less than a quarter of those with a poor diet reported wanting to eat more fruit and vegetables, which has implications for the 51% of overweight participants reporting wanting to lose weight (although other dietary changes, such as reducing fat intake, were not assessed). Low motivation to change may be due to a lack of awareness of the risks associated with these risks. In support of this idea, over half of the participants from a survey of Aboriginal organisation employees self-reported that they had a 'healthy diet', despite half not eating vegetables, and 66% not eating fruit, on a daily basis.[59] The majority of respondents (72%) believed that they "…already eat enough [fruit and vegetables]". Similarly for alcohol, participants in an urban Aboriginal community were not aware of current or previous drinking guidelines and expressed surprise at the low recommended limits.[60]

Our sample also showed a general reluctance to address multiple risk factors despite almost all participants having multiple risks. For the 34% of this sample who indicated that there were multiple health changes they wanted to make, just over half indicated that they would be willing to make some or all of these changes at the same time, or to start on one change and move on to another once they started to get somewhere with the first. No other work exploring preferences for making health changes sequentially or simultaneously for Aboriginal Australians or other socially disadvantaged groups was identified for comparison. A sequential approach to MHBC, where individuals are able to choose their initial target behaviour, is likely to be the most acceptable. Such approach may also be feasible for those people reporting only wanting to make one change in total. For example, success in changing one gateway behaviour may provide increased motivation and self-confidence to attempt more difficult changes.[61] Although individuals may not choose to start with the highest priority behaviour in terms of health benefit, tailoring interventions to individual priorities may result in greater success in achieving at least one behaviour change, which may in turn increase motivation and confidence to address additional behaviours.[37]

The most popular types of support for those contemplating single or multiple health changes included advice and support from a GP or Health Worker, face-to-face support groups, and seeing a specialist. Support that would be least likely utilised included smart phone applications, web-based approaches and telephone support. These preferences reflect those reported among other Aboriginal communities and socially disadvantaged groups more broadly. For example, face-to-face counselling or group support was preferred for physical activity and smoking among an urban Australian Aboriginal community,[7] and few Aboriginal respondents indicated that they would use written materials or telephone support for addressing alcohol problems.[60] Disadvantaged inner city mothers in the UK preferred home

visits to telephone for postnatal support.[62] Despite this, there is some evidence that telephone or electronic based approaches can be effective for lower income or indigenous groups.[63-65] These findings have major implications for primary care services, as those preferred types of support are also the most costly and time intensive options to deliver. The electronic delivery of support (e.g. via internet or smart phone) would require additional efforts to ensure uptake or access. If not equally accessed or adopted, electronic support initiatives could potentially exacerbate existing health inequalities for already disadvantaged groups.

To our knowledge, no previous studies have explored Aboriginal community preferences for including support persons, family or friends in support strategies for behaviour change. Our results suggest that clinically delivered support is acceptable on an individual level, while community-oriented services such as support groups and educational materials would benefit from including a wider network of close family and/or friends. Lack of family support and sense of social isolation have been reported as significant barriers to dietary change for Aboriginal Australians;[66] while some types of physical activity, such as solitary exercise, or done for the benefit of the individual, were associated with feelings of shame or disconnection from others.[29] These principles are likely to apply to other disadvantaged and indigenous groups where, for example, the social environment has also been recognised as a key influence on behaviours.[28,30] It is therefore likely to be important to offer individuals the choice of having other support persons, including family or close friends, participate in health behaviour change support services or interventions, particularly for those services offered in addition to clinical interactions.

Limitations

Several study limitations should be noted. Firstly our sample was small and drawn from one ACCHS in an inner regional location, which may limit the generalisability of our results, such as to Aboriginal Australians living in urban or remote areas. However, a substantial proportion (43%) of the Australian Aboriginal population live in inner or outer regional areas.[67] Secondly, self-report data was used to assess risk status, health priorities and support preferences. Although validated measures of risk assessment were used where possible, many show only moderate sensitivity and specificity, and most have not been specifically validated for use with Indigenous Australians. In addition, the cut-offs used for risk status, although based on national guidelines, set a low threshold for classification as at-risk (for example, those consuming less than seven serves of fruit and vegetables per day, those who were overweight as well as obese). Finally, preferences or attitudes do not always predict subsequent behaviour.[68] Therefore, preferences indicated in our survey may not necessarily reflect behaviour, were the preferred types or modes of services to be offered. However, preferences hopefully provide, at a minimum, some indication of the likely acceptability of such services in this setting.

Implications for service delivery

A large proportion of people attending an ACCHS were willing, if not already trying, to make positive changes for their health. Further support services for smoking cessation and weight loss offered in the ACCHSs setting are needed to capitalise on the existing motivation and efforts of people to quit and to lose weight; while efforts to decrease alcohol consumption, and increase fruit and vegetable intake and physical activity may need to first focus on raising awareness of current recommendations and the risks associated with these

behaviours. Large benefits may be gained from addressing diet and physical activity, given that these were highly prevalent. GPs or Health Workers were the most preferred source of advice and support for behaviour change, and thus need not feel reluctant in discussing health risk behaviours. Although healthcare providers need to be aware of the significant stressors and pressures which can potentially drive unhealthy lifestyle choices for indigenous and other socially disadvantaged groups,[69] our results indicate this should not be a reason for healthcare providers to avoid giving health risk advice. The option for support services to include support persons, family members or friends was chosen by a significant proportion of participants and is likely to improve health outcomes.

Given the large proportion of those attending the ACCHS indicating there was only one health change that they wanted to make, a sequential, choice-based strategy within the context of a MHBC approach may be appropriate for addressing the high prevalence of multiple risks in this population, and other indigenous and socially disadvantaged groups. Initial success with the first choice of behaviour is likely to increase the motivation and confidence of individuals to tackle additional health changes. A long-term or stepped care management approach will be needed to ensure that other, potentially more difficult health changes, are kept on the agenda. Preferences for face-to-face delivery of support services suggest the need for caution with adoption of electronic approaches to health behaviour change, and underscore the need for adequate resourcing of services such as ACCHSs, which provide preventive care for predominantly socially disadvantaged communities.

Conclusion

Approaches addressing multiple health behaviour changes are likely to be acceptable in ACCHSs as well as other socially disadvantaged primary care settings. However, such approaches may need to allow individual flexibility in choosing an initial target behaviour or behaviours, in timing of subsequent changes, and in the types and format of support provided.

Additional files:

Additional file 1: Table S1. Includes details of the measures used to assess risk factors in the health risk survey, as well as the cut-offs used to define risk status. (DOCX 16 kb)

List of abbreviations: ACCHS(s): Aboriginal Community Controlled Health Service(s); BMI: Body Mass Index; GP(s): General Practitioner(s)

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Authors' contributions: NN developed the study materials, conducted data collection, undertook analysis and interpretation of the data, and drafted the manuscript. CP was responsible for study conception and design, provided support during data collection, and assisted with drafting and revision of the manuscript. RSF contributed to the overall study design and development of survey items, and assisted with drafting and revision of the manuscript. HT, KC and NT provided feedback on study design and specific study materials, NT facilitated and provided assistance with data collection, and all provided critical feedback and revision of the manuscript. All authors have given their approval for this version of the manuscript to be published.

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DISCUSSION

Introduction

Aboriginal and Torres Strait Islander Australians experience poorer health, more chronic disease, and a substantially lower life expectancy than their more advantaged, non-Indigenous peers.[1,2] It is important to acknowledge upstream influences such as dispossession and racism,[3] and the range of living and working conditions outlined by the social determinants model,[4] on Indigenous health. For example, overcrowding has been estimated to account for 30% of the difference in health status between remote Indigenous Australians and non-Indigenous Australians.[5] However, there remains significant potential to reduce the disease burden experienced by Australia's Indigenous peoples by targeting change in modifiable health risks, including excess body weight, high blood pressure, smoking, inadequate physical activity, excess alcohol intake and poor nutrition.[6] These risk factors are estimated to account for more than a third of the total burden of disease experienced by Indigenous Australians.[7]

Aboriginal Community Controlled Health Services (ACCHSs) have a key role to play in preventive health care for Indigenous Australians, as they are generally the first point of contact between Aboriginal communities and the healthcare system.[8] Innovative primary care strategies, such as point-of-care screening, and provision of feedback to patients and providers, have shown some degree of effectiveness for improving preventive health care or modifying health risk behaviours.[9-12] However, these have generally not been evaluated for Australian Aboriginal and Torres Strait Islander people.[13-15] If the health of Indigenous Australians is to reach equity with their non-Indigenous counterparts, there is a need to determine the acceptability and

feasibility of such strategies for improving Aboriginal health. In order for ACCHSs to deliver more efficient and effective preventative healthcare services, there is also a need to explore and understand the clustering of highly prevalent health risk behaviours,[16] and preferences for addressing these, among patients attending these services.

This thesis addressed a number of key gaps in the literature by: exploring, in the ACCHSs setting, the acceptability and feasibility of an electronic approach to health risk assessment (Paper one) and the provision of generic versus tailored health risk feedback to patients and their General Practitioner (GP; Paper two); reviewing the international literature regarding the clustering of SNAP (Smoking, Nutrition, Alcohol, and Physical inactivity) risk behaviours (Paper three); examining the clustering patterns of health risk behaviours and associated socio-demographics among people attending ACCHSs (Paper four); and identifying preferences and priorities of this client group for addressing multiple health risk behaviours (Paper five). This series of studies offers a useful platform for future efforts to improve preventive care and tackle multiple health risk behaviours among Aboriginal Australians, in an effort to reduce the gap in health and life expectancy between Indigenous and non-Indigenous Australians. The findings are also potentially of relevance to other socially disadvantaged and vulnerable groups globally.

Main findings and implications

Finding 1: Electronic data collection using a touch screen computer survey was feasible and acceptable to people in the ACCHS setting (Paper one)

The majority of 188 eligible participants who attended the ACCHS for a GP appointment within the recruitment period were willing to complete a health risk survey on a laptop computer (71%), were able to do so during the time that they were waiting for their scheduled appointment (80%), and with little or no assistance required (75%). Participants reported that they felt comfortable answering all the survey questions including those covering behaviours such as drug and alcohol use. Over 95% of participants reported that they would be willing to complete a similar survey at future ACCHS visits, and more than 90% of a subsample of 32 participants indicated that they would be willing for their GP to see a copy of their survey answers. Experience with data collection for this study suggests that having an Aboriginal person or person known to the community approach patients is likely to increase willingness to take part, as is having the support of front line staff including reception and nurses.

Opportunities for primary prevention among Aboriginal Australians are often missed by primary care providers.[17] Limited time is a frequently cited barrier to risk factor detection in primary care.[18] Detection of risk using patient medical records may not be reliable due to gaps in the recording of health risk status in Aboriginal healthcare settings.[19,20] Additional barriers to detection in the ACCHS setting relate to professionals' reluctance to ask about some specific health risks. For example,

sensitivities about raising smoking, alcohol use and weight issues have been reported by health professionals in populations where these risk behaviours are common.[19,21-24]

The results of Paper one suggest that an electronic health risk screening approach could be readily incorporated into the routine clinical practice of ACCHSs. This would contribute significantly towards consistent and systematic identification of risk factors across patients. A printed or electronic version of the screening results would provide clinicians with a summary of the patient's health risk status for use during their consultation, therein reducing the burden on providers to undertake risk assessment, and leaving more time available for addressing risks and providing preventive care. The screening results would provide a starting point for clinicians to initiate discussion about potentially sensitive issues such as alcohol use, weight, and smoking. Undergoing risk screening prior to their appointment may also raise awareness among patients about their health risks, and improve their receptiveness to any advice provided by the clinician. Electronic approaches further allow the use of interactive multimedia or audio options for patients with eyesight, literacy, language or other barriers.

A number of caveats concerning electronic health risk screening should be noted. Clinic staff may need to provide assistance to older patients (those aged 55 years and over) to complete the screening. Data on ACCHS clients indicates that a relatively small proportion of patients (<10%) are likely to be in this age group.[25,26] For clinics with short waiting times, patients may need to be asked to come in prior to their scheduled appointment to complete the screening. Finally, there were a proportion of

patients who did not complete the health risk screening, including those who were too ill and those who declined to participate. These patients may be those with significant health risks or multimorbidity, and therefore represent those who are most in need of screening and prevention. ACCHS may need to adopt additional strategies to engage these patients in screening.

Finding 2: The provision of either generic or tailored feedback about health risks was acceptable to people attending an ACCHS (Paper two)

The use of electronic screening allows for the provision of point-of-care feedback of results to participants and/or healthcare providers. In the randomized pilot trial reported in Paper two, participants were provided with either generic feedback (based on national guidelines), or feedback tailored to their specific health risks (as assessed by the health risk survey), and given the option of sharing their feedback with their GP during their appointment. After their appointment, 87 participants completed a brief 'exit survey'.

Both types of feedback were highly acceptable to participants. Over 90% of participants rated either type of feedback as being easy to understand, relevant and helpful for improving health. A significantly higher proportion of participants who received the tailored feedback rated it as being 'relevant to me', and reported showing the feedback to their GP, compared to those who received the generic feedback. However, the type of feedback did not appear to influence the interaction between the patient and their GP in terms of the number of health risks talked about, or other actions undertaken by the GP.

The findings of Papers one and two together support the feasibility of electronic data collection and giving feedback to patients or clinicians as a potential means of improving detection and provision of preventive care in the ACCHS setting. Although Paper two did not explore the impact of screening and feedback on behaviour change, the results suggest this an acceptable approach to increasing awareness of risk factors and potentially prompting the GP or other healthcare provider to take action. In clinical practice, separate versions of the feedback could be generated for the patient versus the GP or healthcare provider. The patient feedback could focus on self-management and practical suggestions for improving health behaviours, while the provider feedback could include evidence-based clinical recommendations, prompts for further tests, or referral as appropriate. By asking patients to complete the health risk survey at subsequent ACCHSs visits, and using a unique patient code to link survey data, electronic screening could also be used to monitor the impact of screening and feedback on patient health risk outcomes over time. However, as discussed in more detail below, additional changes across the system, provider and patient levels would be required in order to support GPs and ACCHS staff to provide, and follow-up on, this additional preventive patient care.

Finding 3: Electronic screening and feedback is a relatively low cost approach to risk factor detection

Electronic data collection and feedback described in Papers one and two required equipment including touch screen laptop computers for survey administration and software to generate the tailored feedback. A summary of items used and their approximate cost is given in Table d.1. At current prices, the total cost for screening

and feedback was approximately AUD$6300. Over 400 participants, this equated to a cost of approximately $15/participant. This cost could also be reduced through using less costly equipment such as iPads or tablets, sharing software costs across a multiple ACCHS sites, and screening a larger number of patients. Staffing costs would be minimal, assuming that reception staff or an Aboriginal Health Worker could oversee survey administration within their established role.

Table d.1: Summary of survey equipment and approximate cost

Item	**Approximate cost**
Touch screen laptops x2	$1,300 x 2 = $2,600
Colour printer x1	$400
Router x1	$150
Survey software (Digivey Survey Suite)	$1,500
Feedback software (developed for the study: $100/hr x 15hrs)	$1,500
Paper (approx. 2500 sheets)	$25
Coloured ink cartridge (x2)	$80 x 2 = $160
Total	$6335

A formal analysis would be required to determine the relative cost-effectiveness of this approach compared to others possible strategies. However, for a relatively small cost, practices could implement an electronic risk screening and tailored feedback system for their patients. As noted above, such a system could also be used to monitor health risk outcomes for individuals or across the whole service over time.

Finding 4: The clustering of 'SNAP' health risks is common but the evidence base is limited by methodological issues (Paper three)

Behavioural health risks rarely occur in isolation[27] and as a consequence, preventive care for achieving health behaviour change will benefit from an understanding of how such risks tend to co-occur or cluster.[16] Paper three aimed to identify which of the common 'SNAP' (smoking, nutrition, alcohol and physical inactivity) risk behaviours were most likely to cluster, by reviewing the international literature on the clustering of two or more SNAP risks. Almost all papers (96%) reported some degree of clustering of health risks: 81% reported a 'healthy cluster' characterised by individuals exhibiting none of the examined risk factors; just over half (56%) of the relevant papers (i.e. those which included alcohol and smoking as risk factors) found that alcohol misuse and smoking clustered; and half of the relevant papers (those examining all four SNAP risk factors) reported a cluster characterised by individuals with all SNAP health risks. Paper three therefore confirmed the notion of clustering at both ends of the spectrum ('healthy' and 'unhealthy' across all risk factors)[28] and the strong relationship between risky alcohol use and smoking.[29-31] There was also a tendency for males and those with greater social disadvantage to show riskier health behaviour patterns.[16,32,33]

However, Paper three revealed significant methodological diversity among the studies describing the clustering of SNAP health risk behaviours. This diversity included: a) which SNAP and other risk factors were examined- for example, not all papers examined all four SNAP risk factors, and some papers included additional risks (such as body weight, stress, drink driving and unsafe sex), which are likely to have

impacted on the resulting clusters; b) the measures used to assess risk factors and how risk status was defined; and c) the statistical approach taken to the analysis of clustering. Such inconsistencies in methodology made it difficult to meet the main aim of Paper three, which was to identify which of the SNAP risk factors have a propensity to co-occur. Future work examining clustering of health risks would benefit from a broad consensus on the measurement and definition of risk for SNAP factors, as well as expert guidance as to the most appropriate statistical approach for cluster analysis.

Finding 5: Little data are available about the clustering of SNAP health risks for disadvantaged and indigenous groups (Paper three)

The way that common health risks cluster among disadvantaged groups may differ from those who are more advantaged, due to differing social and cultural influences on behaviours and variations in the underlying prevalence of health risks.[34,35] Less than 10% of the 56 studies included in Paper three (a total of five studies) reported on SNAP health risk clustering among disadvantaged samples,[36-39] with one of these including a comparison between more and less disadvantaged groups.[39] A consistent pattern of clustering of health risks for disadvantaged samples was not evident. For example, identified clusters included ‘better’ and ‘worse’ clusters among Indigenous Australians based on smoking, heavy drinking and poor diet, with physical inactivity not included in either cluster;[37] while Bryant et al., 2013 identified ‘smoking and alcohol’ and ‘physical inactivity and poor nutrition’ clusters among disadvantaged social and community welfare clients.[36] Reijneveld et al., 2012 compared health risk patterns among Dutch born residents and immigrants living in the Netherlands, the

later of whom are considered to be relatively socially disadvantaged.[39] Dutch born residents were characterised by three clusters based on health-enhancing behaviours, alcohol, and 'rule-breaking behaviours' (such as aggression, drug use and delinquency). In contrast, immigrants showed two clusters, one based on alcohol and the other on rule-breaking behaviours, which also included smoking.[39] Of note there was an absence of clustering of health-enhancing behaviours among immigrants.[39] When looking more closely at the 'better' cluster for Indigenous Australians reported by Burke et al., 2007, for men this included approximately 20% current smokers, 25% heavy drinkers and 30% who did not exercise at least once a week (as compared to 100%, 49% and 46% respectively in the 'worse' cluster); For women, these rates were zero, 2% and 46% in the better cluster compared to 100%, 37% and 26% respectively, in the worse cluster.[37] It is therefore possible that socially disadvantaged groups, and males in particular, are less likely to be characterised by a 'healthy' or 'risk-free' cluster (although this suggestion is based on a very small sample of studies).

Further research exploring the clustering of common health risks among disadvantaged populations would help to confirm this suggestion. Such work will need to adopt those principles outlined above, including agreement about definitions of risk status and the most appropriate statistical approach to cluster analysis. Latent Class Analysis (LCA) is a statistical approach which has been used in a number of recent studies exploring the clustering of health risk behaviours in prevention research,[40-42] and could considered in future clustering research. LCA examines the interrelationships among risk factors and has several advantages over traditional approaches, including that assumptions of linear relationships, normal distributions,

or homogeneity are not required, and that probabilities estimated directly from the model are used to determine the clusters.[41]

Finding 6: The ACCHS client group can be characterised by one of three clusters of health risk behaviours (Paper four)

Paper four aimed to address the gap in the literature related to the clustering of key health risks for Aboriginal Australians. Among 377 people attending an ACCHS, 80% of whom were of Aboriginal and/or Torres Strait Islander origin, LCA identified three clusters. Cluster 1 ('low fruit and vegetable intake/lower risk') made up 51% of the sample and consisted of older men and women (predominantly over 55 years) whose main risk behaviours related to an inadequate consumption of fruit and vegetables, and being overweight. Cluster 2 ('risk-taking'; 22%) included younger (under 55 years), unemployed males with a high prevalence of smoking, risky alcohol, and illicit drug use. Cluster 3 ('inactive, overweight, depressed'; 28%) was characterised by younger to mid-aged women (predominantly 35-54 years) who were overweight, physically underactive, and who had a high probability of being depressed. This cluster was the most likely to have experienced emotional or physical violence. No cluster was characterised by an absence of all risk factors.

In line with previous non-indigenous specific findings, alcohol and smoking were found to cluster[29,31] (along with drug use) in the 'risk-taking cluster'. Our results contrast with those reported for an Indigenous sample by Burke et al., 2007, although Burke et al., 2007 did not include drug use, weight or depression, and also used different indicators of diet.[37] It is not clear whether the health risk clusters reported in

Paper four apply broadly to other Aboriginal communities, or are more specific to the type of sample described- namely communities from major towns,[43] in inner regional locations,[44] of New South Wales (NSW). Patterns of health risk prevalence among Indigenous Australians tend to vary according to remoteness, and any differences in underlying prevalence may impact on the specific make-up of health risk clusters[45] across locations. For example, the prevalence of overweight or obesity is highest among Indigenous Australians from inner regional areas, and lowest in very remote areas; smoking rates are highest in very remote areas, and lowest in major cities; and psychological distress is highest in outer regional areas and major cities, and lower in very remote areas.[46] Although most of these differences are relatively small (e.g. < 10%), further clustering research with samples of Aboriginal people from larger metropolitan or urban areas, and from more remote locations, is needed to in order to explore whether the clustering results of Paper four also apply in such locations.

Finding 7: Clustering 'is here to stay' and primary care needs to be able to provide appropriate preventive care and support

More generally, the results of Papers three and four confirm that clustering of health risks is a consistent phenomenon, and that social disadvantage is associated with riskier health behaviour patterns. Disadvantage may even be characterised by the absence of a 'healthy' or 'risk-free' cluster. These findings have important implications for the way that preventive care is delivered. Recognition of the clustering of health risks calls for a shift in primary care, away from focussing on single health risks in isolation,[47,48] towards the targeting of 'lifestyles' or holistic patterns of behaviours.[49] Given that most people present with multiple risk

behaviours, an integrated approach to multiple risks represents more holistic and patient-centred practice.[50] This is of particular relevance to services providing care for disadvantaged and indigenous groups, such as ACCHSs, where it is possible that few in the population will show a 'healthy' or risk-free profile.

In Australia, primary care operates on a short-consultation, fee-for-service system, which focuses on individual consultations rather than the overall care provided to a patient. This system tends to result in fragmented care and is generally not well suited to addressing chronic illness,[51] or the kind of care needed to support lifestyle change across multiple health behaviours.[50] Australia's public health system, known as Medicare, provides government funding for a range of healthcare services offered by GPs. There are a number of Medicare items designed to specifically support GPs to provide preventive care.[52] However, these items are generally not adequate for providing complex or ongoing assistance. For example, GPs can claim reimbursement for a health assessment for an adult aged 40-49 years once only per person (until they reach age 75 years), or once every three years for patients with a high risk of developing type 2 diabetes;[52] a health assessment for an Aboriginal and Torres Strait Islander person can be claimed annually.[53] A more holistic primary care model which allows for ongoing care is needed if individuals are to be supported to achieve multiple health behaviour changes.

Glasgow et al., 2004 hypothesise that preventive care practices should be offered over time, in a coordinated and progressive way.[54] The 'inverse care law' describes a mismatch between the availability of medical care in deprived areas and the needs of

the population served.[55] The increased burden of ill health and multimorbidity seen among poor communities places a high demand on primary care services, often resulting in less time per consultation and higher levels of GP stress.[56] Although ACCHSs generally have higher levels of clinical staffing per client than non-ACCHSs,[57] clients present with significantly more health problems per consultation than mainstream general practice patients.[25] Therefore, ACCHSs are likely to require significant support in order to provide more holistic, continuous and ongoing care, and improve patient health outcomes. For example, a recent qualitative study reported on the development of a primary care-based complex intervention to address multimorbidity in areas of high deprivation in Scotland.[58] Participants in the study reported that longer consultations, relational continuity (being able to see the same healthcare provider each time), and a holistic approach to care, were highly valued.[58] When tested, longer consultation times and continuity of care (system-level change), GP training and support in patient health assessment and planning (provider-level change), and the use of patient self-management support materials (patient-level change), were successful in improving the well-being and quality of life of intervention patients.[59]

Finding 8: Interventions targeting three different clusters of health risks are likely to benefit ACCHS clients (Paper four)

Assuming that future research confirms broadly similar clustering results to those reported in Paper four, ACCHSs patients may benefit from the development of primary care interventions addressing three distinct clusters of risk factors. The first should target risk-taking behaviours including smoking, alcohol use and drug use, and

would need to be tailored towards engaging younger and more disadvantaged men. The second, focused on mid-aged women (35-54 years), should aim to increase physical activity and reduce weight, while providing social and emotional support for issues including depression and exposure to violence. The third should focus on improving diet and weight for ACCHS clients aged mainly 55 years and over.

The social determinants of health framework aims to draw attention to, and ultimately tackle, the wider or upstream factors which impact on health.[60] The results of Paper four highlight the potential contribution of a number of such factors on the manifestation of different clusters of risky health behaviours. Unemployment and lower education were significantly associated with the 'risk-taking' cluster (cluster 2); while exposure to violence was significantly associated with the 'inactive, overweight and depressed' cluster (cluster 3). These indicators of living and working conditions are, in turn, impacted by more upstream factors not assessed in the survey. For example, racism impacts on employment and education opportunities, and has been associated with maladaptive responses such as smoking, alcohol and other drug use [5,61]. Alcohol and drug use can in turn lead to, or exacerbate, violence.[62] Racism can also impact on health by undermining self-esteem and self-worth, leading to stress and mental ill health.[61]

The loss of culture experienced by Indigenous Australians has also directly contributed to feelings of depression, through collective hopelessness and helplessness.[63] Intervention approaches which focus on rebuilding culture may therefore hold promise for improving Indigenous well-being and health.[63-65] While

addressing issues around culture, employment, and education will help to improve health at an individual level, addressing structural inequities and collective power is also needed to improve the health of Indigenous societies.[66] Health interventions at the primary care level, which focus on addressing interrelated health risk behaviours, therefore need to be complemented by efforts to address the broader social and cultural determinants of Indigenous health.

While the results of Paper four illustrate the need for multiple health behaviour change (MHBC) interventions at the primary care level, these remain largely untested among Aboriginal communities. The design of MHBC interventions for Aboriginal communities needs to be sensitive to the social disadvantage experienced by such communities. MHBC approaches are potentially associated with a high burden of treatment.[67,68] This may particularly impact on Aboriginal Australians, who tend to experience higher levels of stress and distress,[69,70] and often have lower levels of education and health literacy,[71] compared to other Australians. Therefore, Paper five aimed to explore a range of consumer perspectives on key aspects of MHBC approaches for ACCHS clients.

Finding 9: A long-term case management approach is needed to support ACCHS clients to address their health risk behaviours (Paper five)

Paper five examined priorities for behaviour change, readiness to change, and preferences for types of support among participants attending an ACCHS. Among the 211 participants, there was a high degree of readiness to change smoking and body weight, as assessed by the ‘stage of change’ model.[72] Although stage of change

models have been subject to some criticism,[73] there is general agreement that intention to change is an important influence on behaviour, and that behaviour change is unlikely in the absence of intention.[74,75] Over two-thirds of current smokers indicated that they wanted to quit or cut down (either already trying or within the next six months), and just over half of overweight or obese participants indicated wanting to lose weight. In contrast, few at-risk participants were contemplating increasing their fruit and vegetable intake, physical activity, or reducing their alcohol consumption, despite these being among the most frequently occurring risks.

Virtually all participants (94%) had multiple health risks, however 15% of participants reported not wanting to make any changes to their health, and 51% indicated that there was only one health change that they wanted to make. The remaining 34% reported wanting to make two or more changes for their health. Of these, just over half (56%) would be willing to make simultaneous ('all at once'; 24%) or over-lapping health changes ('once I started to get somewhere with one change I would start on the next'; 32%), and the remaining 44% reported only wanting to make one change at a time. It would be useful for future work to explore whether the preferences and priorities for health behaviour change differ according to patient's health risk cluster membership. A 'one size fits all' approach is unlikely to be successful given the wide variability in ACCHSs client preferences. These findings suggest that ACCHSs will need to take a more individualized, long-term, case management approach in order to address clusters of health risks in a holistic way. Indeed, patients from deprived areas in Scotland, with multiple health conditions, reported that a holistic approach allowed care-planning to take into account the

complexity of their individual circumstances and problems.[58] Adopting a long-term approach would involve giving individuals multiple opportunities for change over time, which would capitalize on interrelationships between stage of change and self-efficacy. For example, King et al., 1996 found that those who were further along the stages of change for exercise had higher self-efficacy for smoking cessation, and vice versa.[76] Therefore MHBC is likely to occur sequentially over time if multiple opportunities are offered, with those achieving changes in one behaviour more likely to be motivated to change an additional behaviour or behaviours.[76]

Social cognition models suggest that health behaviour is determined largely by beliefs and attitudes towards behaviours- including perceptions of susceptibility and severity of harm, consequences of behaviour change, and self-efficacy or ability to change a health behaviour.[77,78] When asked about which health change they would find the most difficult to make (this data was not reported in Paper five but is included in Appendix 7.2), the two most difficult changes were smoking and losing weight, while less than one in five at-risk participants chose cutting down on alcohol, getting more exercise, or eating more fruit and vegetables as the most difficult. It therefore appears that the harm and potential benefits of change associated with smoking and being overweight are widely appreciated, while for behaviours related to low fruit and vegetable intake, physical inactivity and alcohol, they are less so. Individualised, long-term case management for ACCHSs clients might thus require a different focus depending on the risk factor. For behaviours including diet, physical inactivity and risky alcohol, a focus on intention to change (for example, through raising awareness about the current guidelines and associated risks) might be needed; while for weight

loss and smoking, focusing on self-efficacy and strategies for achieving change is likely to be appropriate.

Finding 10: Support services for health behaviour change need to be tailored to suit ACCHS clients (Paper five)

The most popular types of support for participants indicating that there was at least one health change they wanted to make were help from a doctor or Health Worker, going to a support group, and seeing a specialist, which were each selected by approximately half of participants (Paper five). In contrast, less than a fifth of participants selected telephone, electronic (internet or smart phone) or written forms of assistance. These findings have significant implications for ACCHSs. The types of support preferred by participants were generally the most costly and time intensive options to deliver (e.g. face-to-face services including GP, specialists and support groups). If electronic support services (e.g. via internet or smart phone) were to be offered, additional efforts would be needed to ensure acceptability, effectiveness, access and uptake of such services.

If ACCHSs were to provide long-term support including multiple opportunities for change as discussed above, a stepped care approach could be utilised in order to maximize intervention effectiveness and efficiency at a minimal cost.[79,80] Stepped care generally involves offering the least intensive and costly interventions first, with more intensive and expensive interventions offered to those who do not benefit from the simpler intervention approach.[80,81] The treatment or intervention is 'stepped up' if a successful outcome is not achieved. Therefore, brief GP advice, supplemented with

written or recorded self-help materials might be provided as the 'first line' intervention for health behaviour change, followed by providing a support group, telephone/online support or a smart phone app, and stepping up to ongoing face-to-face support delivered by a GP or other specialist.

A substantial proportion of the sample indicated that they would like health behaviour change support services to include family members or friends, in particular those non-clinical services such as support groups and self-help materials. Although the evidence supporting the inclusion of family members or other support persons is limited, family-based interventions have been shown to improve outcomes for alcohol use in indigenous communities.[82] In non-Indigenous settings, there is also support for family or social network interventions in improving chronic illness[83] and substance misuse.[84] Given that the social environment is recognised as a key influence for Aboriginal people on behaviours such as smoking[85] and physical activity,[86] it is possible that offering individuals the choice of having family or other support persons also participate in health behaviour change support services will be beneficial.

Finding 11: Individual choice is needed about which health risks to address and in what order (Paper five)

Addressing multiple behaviours may have the benefit of multiple exposures to the principles and practice of behaviour change, or may suffer from the increased treatment burden of trying to change several behaviours at once.[87] Paper five found that, despite having multiple risks, the majority of participants only wanted to make one health change, and of those who wanted to make more than one change, less than

a quarter would choose to make more than one change at a time. Nigg et al., 2002 suggest that there may be an order of behaviours that individuals feel able to cope with trying to change.[87] Glasgow et al., 2004 also hypothesise that patients who are allowed to choose the health behaviour(s) to focus on will be more successful than those who are not. Therefore a flexible and choice-based approach to MHBC for Indigenous Australians is needed, in which individuals can select the health behaviour (or behaviours) they wish to tackle first. This should be part of a holistic and ongoing care plan which also aims to address an individual's other health risks.

Choice could be accommodated within the long-term, case management approach involving stepped care outlined above. There is some evidence that people are more likely to achieve behaviour change when they actively participate in the choice of change to be made.[88] Allowing choice in the health change or changes to be made therefore may result in greater success in achieving at least one change, which may in turn increase motivation and confidence to address additional behaviours.[89] This might also be seen for those only wanting to address one health behaviour: successful change in this behaviour may provide an opportunity to discuss other changes needed to improve health and reinforce self-confidence to undertake an additional change or changes. A stepped care approach would attempt to achieve the best behaviour change outcomes at the minimum cost.

Together the results of Papers four and five suggest that while three distinct clusters of health risks need to be addressed among ACCHS clients, primary care services will need to work with individuals on a long-term, flexible, ongoing basis. Preventive care

approaches will need to be tailored in terms of choosing an initial target behaviour/s, the timing of starting on subsequent health changes, and the types and format of support offered to support behavioural change. Significant resources will be needed to support ACCHSs to provide more holistic, continuous and person-centred preventive care.

Summary of the main study implications

Overall, the results of the series of studies presented here indicate that:

- Within the primary care setting for Aboriginal Australians, there needs to be a focus on addressing multiple rather than single health risk behaviours.
- Electronic 'while you wait' health risk screening and point-of-care feedback has the potential for incorporation into routine care, and could contribute towards systematic and consistent assessment of the health risk status of individual patients and assist with monitoring health risk status over time.
- Point-of-care feedback could provide the basis for discussion between the healthcare provider and patient about priorities, preferences, and barriers to MHBC, and for developing a long-term health behaviour plan.
- This plan needs to take account of established links between risk behaviours such as smoking, alcohol and drug use, and the potential impact of factors such as depression and exposure to violence on risk behaviours.
- The health risks associated with poor diet, excess alcohol and physical inactivity may need to be emphasised to encourage willingness to improve these behaviours, while individual strategies to enable smoking cessation and weight loss need to be explored.

- A stepped care approach, in which the simpler and less costly types of support are offered first, and stepped up if a successful outcome is not achieved, would help to meet the identified preferences for types of behaviour change support for ACCHS clients in an efficient way.
- Providers could offer brief advice and self-help materials, followed by access to a facilitated support group, telephone or online support, and progressing to face-to-face GP or specialist appointments as needed.
- Long-term case management of multiple health risks, perhaps delivered by an Aboriginal Health Worker or other care coordinator, would allow monitoring of individual progress and outcomes over time, tailoring of intervention approaches as needed, and provide for multiple opportunities for change over time.
- Allowing this choice and time for successful change in one target behaviour may increase confidence and self-efficacy for making changes in other health risks where motivation is lower.[90]
- Although the ACCHS sector is better positioned to provide ongoing and individualised care, traditional general practice is generally ill equipped to deal with the complex challenges in behaviour change for Aboriginal health.[91]
- Changes in primary care systems for Indigenous Australians are needed in order to provide relational continuity and more holistic, long-term care.
- Complex and multifaceted change at the system, provider and patient level will be needed to assist ACCHSs to provide more holistic, continuous preventive care
- In addition to action within primary care, comprehensive social action is also required in order to address the broader social determinants of health for

> Indigenous Australians, such as education, employment and racism. Although improved health care services are an essential part of the solution, they are not, on their own, sufficient.[92]

Following a discussion of key study limitations, some future directions for research into reducing modifiable health risks for Indigenous Australians are described below.

Limitations

While these studies have a number of strengths, such as being among the first to examine the clustering of key health risks among ACCHS clients and client preferences for support for health behaviour change, it is important to consider some of the study limitations, given that they potentially impact on the reliability and generalisability of the results. The key limitations relate to: a) the representativeness of the participating health services and patient sample; b) survey response rates; c) use of self-report measures of health risks; and d) issues related to the cut-offs used to define risk.

Representativeness of the health services and sample

Recruitment of a representative sample is needed to maximise the validity and generalisability of the data obtained.[93] Four ACHHS were approached about participating in the study, two of which consented. The services approached were a convenience sample based on previous relationships with the research group and involvement with the group on a concurrent research project. Consenting services therefore likely represent organisations with an active interest in research and/or in

improving outcomes for their clients. Negotiation of approval for the study was led by the Principle Supervisor (A/Prof Christine Paul) with assistance from the PhD candidate, and services were engaged through multiple discussions with staff over time and several field visits. Some difficulties in gaining approval resulted from ACCHS staffing changes which occurred during this period. Staff and clients from site 1 were involved in pilot testing and refining the study recruitment approach and study materials during a field visit prior to study commencement. Staff from site 2 also provided feedback on the study materials.

The two ACCHSs who participated in the research were slightly larger in terms of client numbers than the national average.[57] However they were typical in terms of staff/services offered including Aboriginal Health Workers, allied health workers, and transport services being provided to patients.[57] The two services were located in inner regional areas of NSW.[44] In comparison, approximately 35% of Aboriginal Australians live in major cities, 22% in outer regional, and 20% in remote and very remote areas,[57] and are not therefore represented in the current sample. Remote communities may have additional literacy or technology barriers which could influence the acceptability of the electronic approach to health risk screening and feedback reported in Papers one and two. Different social and environmental factors associated with living in more urban or more remote areas could influence health behaviours and the clustering of these, as reported in Paper four. Preferences and priorities for behaviour change (Paper five) may also vary according to community location and context. Therefore, care is needed in generalising the results to Aboriginal communities across NSW or Australia.

The overall study sample was relatively small (total n = 404), comprised of 188 participants from site 1 and 216 from site 2. This represents just over 10% of all active adult patients attending the two services (those who have made at least 3 visits in the last 2 years), and approximately 0.3% of the adult Aboriginal population of NSW.[94] Power calculations indicated that a sample size of 200 would enable the prevalence of major outcomes (for example, acceptability measures, health risk factors, and preferences for support), to be calculated with a precision level of +/-7% and 95% confidence intervals (Papers one, four and five); and would also provide 90% power for the detection of a mean increase of one in the number of health risk topics discussed with the GP, according to the type of feedback received (Paper two). There is limited guidance regarding required sample sizes for LCA, although a recent review found that the median sample size among published studies was 377.[95]

In this thesis, paper one was based only on data from site 1, and Paper five on data from site 2. This was due to substitution of the survey acceptability measures (Paper one) with measures of health behaviour change priorities and preferences (Paper five), in order to keep the survey length to a minimum. Papers two and four were based on combined data from both sites. However, the required sample size was not achieved for Paper two, as discussed in the limitations section of this paper. Data collection continued at each site until either the desired sample size was achieved, or until data collection became inefficient due to a very small number of new patients attending the service (i.e. patients who had not already been invited to participate in the study at a previous visit).

Response rate and selection bias

The overall study consent rate (69%) also potentially affects the validity and generalisability of the results. Almost 30% of those approached declined to participate, and approximately 5% of patients were considered too unwell to be invited. Individuals with better and/or more interest in health may have been more willing to participate in the series of studies, and the screening survey may have missed patients with more significant health risks or multimorbidity. If so, the results present a more positive picture of the health status and willingness to engage in health behaviour change than is the case for all ACCHS clients. However, the sample was representative of patients who attended the services during the recruitment period (when compared to medical service records of active patients) in terms of age and gender, with no significant differences between those who consented and those refused to participate. Non-Aboriginal patients were more likely than Aboriginal patients to consent to participate. While this needs to be considered in interpreting the study results, it is likely that the study sample represents the client base which would be most willing to engage in preventive healthcare initiatives that might be offered by ACCHSs.

Accuracy and validity of data obtained from participants

The main limitation related to study measures was reliance on self-reported health risk behaviours. The exception was Body Mass Index (BMI), which was based on the measured height and weight of participants rather than self-report. A description of the measures used to assess risk status, including the source of each measure and details about reliability and validity is given in Table d.2. Measures or tools which

have been validated specifically for use with Aboriginal people were selected wherever possible (and highlighted in ***bold*** in the Table). However, where such tools were not available, measures with established validity and reliability, and/or those used in large, national surveys were utilised. Pictures were used to demonstrate serving sizes for fruit and vegetables and standard drink sizes, and to illustrate clinical tests. This was aimed at overcoming literacy barriers and improving response accuracy.[96,97]

All self-report measures are subject to recall and social desirability biases.[98-100] Recall of the time elapsed since a screening test is also likely to be affected by telescoping, where events are recalled as having occurred more recently than in reality.[101] As a result, the prevalence rates reported in Papers three-five may somewhat underrepresent the true prevalence of risk for this population. However, in many cases self-report is the only efficient and feasible means of obtaining health behaviour information.[99,102,103] Therefore, the results of the thesis studies are subject to similar limitations that affect the majority of research into health risk behaviours.

Validation of measures- that is, a comparison of their performance against an accepted gold standard measure- was outside the scope of this study. However, in relation to alcohol consumption, additional Paper six provides a comparison of the performance of the retrospective seven-day diary and two questions based on the third question from the AUDIT-C,[104] modified to reflect current Australian alcohol guidelines for short-term and long-term risk. The appropriateness of standardised measures of alcohol intake for Aboriginal Australians is a particular methodological

concern, given that patterns of alcohol use tend to differ from those seen in the non-Aboriginal population.[105] Although retrospective diaries are generally considered to be more reliable than other measures,[106,107] they may not capture episodic patterns of drinking well.

In additional Paper six (see Appendix 6), 188 participants completed a seven-day retrospective diary for alcohol intake, followed by the questions based on the modified third AUDIT-C question (AUDIT-3m). The two measures identified similar proportions of potentially at-risk drinkers among the sample. The seven-day diary missed approximately one-third of drinkers (drinkers who did not consume any alcohol in the week before the survey) and therefore did not adequately capture variability in alcohol consumption. There were also some inconsistencies in participant responses to the two AUDIT-3m questions. Paper six therefore provides some recommendations for future measures of alcohol intake among Aboriginal communities, including asking about specific drinking occasions (such as “the last few times you had a drink” or “the last few times you drank a lot”), and allowing participants to respond to quantity of alcohol questions in non-standard drink sizes.

Table d.2: Summary of the source and reliability and validity of self-report measures of health risk behaviours used in the studies

Health risk factor and source of measure	**Validity and reliability data**
Smoking: NSW Population Health Survey[108]	Self-reported smoking status has demonstrated good agreement with biochemical measures of smoking among ***Aboriginal communities***;[109-111]
Alcohol use: Seven-day retrospective diary[102] AUDIT-3m: Third question from the AUDIT-C[104] modified to reflect NHMRC guidelines to reduce short-term and long-term alcohol related risk[112]	Seven-day Diary: Retrospective diaries are generally considered to be more reliable and can improve accuracy by providing a recall prompt and estimating actual rather than usual alcohol consumption;[106,107] ***Not specifically validated for use with Aboriginal people*** AUDIT-3m: The third AUDIT-C question (AUDIT-3) has shown good sensitivity and specificity for the detection of unhealthy alcohol use and risky consumption;[113,114] ***Not specifically validated for use with Aboriginal people****;*
Physical activity: Single item[115]	Single question showed good sensitivity (77%) and specificity (81%) compared to a longer assessment tool among a sample of women in general practice;[115] ***Not specifically validated for use with Aboriginal people****;*
Fruit and vegetable intake:	Measures of daily fruit and vegetable intake are correlated with biochemical measures such as blood levels of serum carotenoids and red-cell folate,[116] but tend to over-

NSW Population Health Survey[108]	estimate the number of serves when compared to 24-recall;[117] ***Not specifically validated for use with Aboriginal people****;*
Depression: Modified version of the PHQ-9[118,119]	80% sensitivity and 71% specificity against clinical interview in diagnosing major depression among ***Aboriginal*** patients with heart disease;[120]
Illicit drug use: Simple self-report question	Reasonable levels of agreement against the consensus of health workers ***among some Aboriginal communities***;[121,122]
Screening: Simple self-report questions	Likely that adequate screening is overestimated by self-report compared to clinical test data;[101,123] Among an ***Aboriginal sample***, sensitivity for screening tests for diabetes, cholesterol and cervical cancer screening was good (94%, 83%, 90% respectively) but specificity was low (28%, 30%, 45%), indicating that a significant proportion of individuals who had not been screened according to pathology records reported having had appropriate screening;[124]

Dichotomisation of health risk status

The tailored health risk feedback, and latent class analysis, relied on the specification of cut-offs to define risk status. Based on Australian guidelines (current at the time of survey development), these cut-offs resulted in a large proportion of the sample being classified as 'at- risk'. For example, 84% of the sample were classified as having a poor diet (consuming less than five serves of vegetables and/or less than two serves of fruit daily), 69% as overweight or obese, and 52% as physically inactive. Thresholds used to define high risk may influence the degree of clustering found.[45] Therefore, the clustering of health risks presented in Paper four may have differed if different cut-offs had been used, for example by classifying obese but not overweight participants, or as those consuming none or few, rather than seven or less, daily serves of fruit and vegetables, as at-risk. However, the cut-offs endorsed in the Australian guidelines are based where possible on evidence of risk. For example, a BMI of $\geq 25 kg/m^2$ (overweight) is associated with an increased risk of cardiovascular disease, hypertension and type 2 diabetes, compared to a BMI of $< 25 kg/m^2$.[125] Therefore, an alternative classification of risk was possible, but the use of different cut-offs would not have been based on the available evidence.

A suggested future intervention to improve key health risk behaviours among Aboriginal Australians

Changes in the prevalence of key risk factors including smoking, nutrition, alcohol, physical activity and being overweight or obese ('SNAPO' health risks) have the potential to significantly reduce the disease burden for Aboriginal Australians.[7] Primary care interventions aimed at reducing the prevalence of these key risk

behaviours are therefore needed, if the health of Aboriginal Australians is to be improved. Given evidence of significant clustering of health risks among this population, holistic change across multiple risks is needed in order to prevent or manage chronic disease.[47] MHBC has been described as 'the future of preventive medicine',[126] but there is little work exploring the effectiveness of MHBC interventions for Aboriginal Australians.

A 2011 review[127] identified five intervention studies which addressed multiple SNAP health risks factors among Australian Aboriginal communities. The majority of studies were aimed at improving nutrition and physical activity, and involved community-wide interventions with multiple components, such as self-monitoring, healthy cooking classes, family walking groups, changes to availability of foods in local stores, and feedback to communities and health services.[128-130] Although outcomes were somewhat mixed, a key element of success was community control and ownership over the project.[129-131] Unfortunately, these studies, together with much of the intervention work done in Aboriginal health settings, used non-randomised experimental designs,[5,127] which limits the quality of the evidence which can be drawn from their findings.[127]

Therefore, building on the findings of the studies that make up this thesis, and the existing literature, a methodologically rigorous, multi-component, community-based intervention to reduce multiple SNAPO health risk behaviours among Aboriginal communities is proposed. As well as combining individual, family and community-based strategies to address SNAPO risk behaviours,[127] the intervention will aim to

address some of the broader living and working conditions which impact on health, as recognised by the social determinants of health model. It should be noted that the evidence supporting the effectiveness of community level interventions for improving health behaviours, such as smoking,[132,133] fruit and vegetable intake,[132] and physical activity,[134] is generally limited or inconsistent. However, the intervention proposed below differs from much of this previous work by being community defined and driven.

Community consultation process to identify priorities and solutions addressing SNAPO risk factors

Intervention strategies that are consultative, empowering, and community-based are more likely to be effective because they are tailored to the community and provide a sense of community ownership and empowerment.[135] Given this, the starting point for developing the proposed multi-component intervention is a community consultation process with each participating community, in order to identify community-specific strategies and priorities for addressing SNAPO health risk behaviours. This process would utilise principles of community-based participatory research, including drawing on community knowledge and experience, community control over decisions, and involving communities equitably as partners in the research.[136]

Participatory research is based on the principle that communities know their situation and needs best, and are therefore best placed to design solutions.[137] Through a series of interactive community consultation meetings, community members would be asked to identify key strategies that they believe would effectively support change across

SNAPO health risk behaviours for their community. Members of the research team would present communities with the background and rationale for the project, and a summary of available information and evidence, such as the cluster analysis results of Paper four, patient preferences and priorities from Paper five, previous successful intervention strategies, and any other results or evidence as appropriate. Community members could be asked to consider the likely clustering and interconnection of particular health risks, and identified preferences for support, and to think about strategies that target individuals, families, the wider community, and upstream social and living conditions. Communities would then be asked to reach a consensus about several key priority strategies which will be implemented and evaluated in the community. The focus of the project will be on reducing SNAPO health risks, but additional priorities (for example, mental health, or substance use issues) might be identified by communities, and could also be incorporated into the intervention.

It is proposed that the community consultation process would be led and facilitated by the local ACCHSs. ACCHSs are recognised as strategic sites for community engagement and development,[91,138] and advocate for community-initiated and community-led solutions to social and economic problems.[139] Engaging the involvement and support of community elders and leaders would be crucial for the success of the project.[140] In addition to the researchers, ACCHS and community members, the consultation process would also aim to include other relevant stakeholders, such as health experts, non-government organisations, and local and state government service representatives where possible. The role of these collaborators would be to provide guidance regarding the content and delivery of the

strategies suggested by the community, and on issues related to implementation, outcome measurement and evaluation. An advisory committee comprising several researchers, ACCHS representatives, and members of the community, would be formed to oversee and guide implementation of the project, and ensure that the community has control over decisions made about the research. The project would also include training opportunities to build capacity among community members to be involved in delivering and evaluating the intervention.

Possible components of the community-level intervention

The specific components of the intervention would be driven by the results of the consultation process described above. As suggested by the findings of Papers one, two and five, individual-level strategies might include electronic screening for SNAPO risk factors of people attending ACCHSs, and the provision of feedback about risk status to patients and healthcare staff. Individuals with multiple health risks might be offered case management including development of a long-term behaviour change/care plan, with choice about selecting an initial target behaviour or behaviours for change. Aboriginal Health Workers might act as care coordinators, taking responsibility for contacting patients, providing ongoing support and monitoring progress, and coordinating stepped care. Stepped care could be used to maximize efficiency, starting for example with simple feedback and GP brief advice, provision of self-help materials, followed by attending a support group or receiving telephone support, and stepping up to more specialist care such as consultations with a dietitian, exercise physiologist or psychologist. Examples of other individual level strategies (drawn from previous studies) might include local walking or exercise groups which

are open to families and friends, nutrition and cooking classes offered in community, work place and school settings, and ‘store tours’ to help participants identify healthier food choices.[129]

Strategies which target social or community-level influences on health (also drawn from previous studies) might include: promotion and use of cultural activities including traditional ceremonies,[63] hunting trips[129] or collection of traditional foods;[141,142] establishment of sporting teams and competitions;[5,129] provision of free or low cost recreational facilities;[143] provision of free or subsidized fruit and vegetable boxes;[144] strategies to limit fast food availability and/or label healthier options;[131] and enforcement of non-smoking policies.[129] Strategies at the wider social and living conditions level, which would require broad stakeholder support, might include initiatives to improve employment rates, education levels or housing conditions.[5,145]

Tailoring of intervention strategies to individual communities

Communities would identify their own priorities and strategies during the consultation process. This poses a challenge in terms of evaluation of the intervention, given that different strategies will be implemented across communities. As a consequence, the evaluation process will need to assess the ‘function’ rather than the ‘form’ of the intervention. The form that the components of the intervention take will vary according to community priorities, while the function of the components (i.e. to reduce the prevalence of SNAPO risk behaviours) will be consistent across communities.[146] Therefore, the overall design and approach of the intervention, including community consultation, and identification and implementation of key

strategies, rather than the specific content or components of the intervention, will be evaluated.[146,147]

Design of the multi-component community-based intervention

While the randomised controlled trial (RCT) is considered the 'gold standard' design for evaluation of intervention effects, RCTs are typically not well suited to community-level interventions.[148,149] A cluster-RCT is one option for assessing the impact of community wide interventions, in which whole communities are the unit of allocation and are randomised to receive different interventions.[150] However, cluster-RCTs typically require a large number of clusters in order to achieve adequate statistical power, making recruitment or implementation difficult or infeasible.[149,151] An additional issue is the random allocation of some communities to the control condition. The provision of assistance for some vulnerable communities (i.e. those allocated to the intervention group), but not others, can be seen as unfair or unethical.[149]

Alternative study designs which maintain methodological rigor but overcome some of these limitations include stepped wedge or multiple baseline study designs. These study designs involve implementation in a sequential or phased approach. They are randomised designs because the order in which sites receive the intervention is randomised.[149] The intervention is initially implemented in one or a cluster of communities, with the other communities acting as controls. By the end of the study, all clusters have received the intervention.[149] Evaluation involves collection of

outcome data at one or more points in time prior to and post implementation of the intervention in each community.[148,149]

Outcomes of the proposed community-based intervention will include changes in the prevalence of SNAPO health risk behaviours. The sampling strategy for assessing these outcomes also needs consideration. Longitudinal cohort samples are likely to be affected by high dropout rates, resulting in limited representativeness, while cross-sectional samples may have large sampling errors and include new residents who have not been exposed to the intervention.[152] Therefore a combination of both longitudinal cohort and cross-sectional sampling strategies might be most appropriate for the proposed study. Process measures, which assess implementation and receipt of the intervention components, and qualitative data which explores how the intervention components affect those involved, can also contribute valuable data about the success (or lack thereof) of intervention components,[147] and would therefore be included in evaluation of the proposed project.

Merzel et al., 2003 suggest that projects of only 2-3 years duration are unlikely to demonstrate an impact on health behaviour outcomes.[152] The proposed community consultation process needs to allow sufficient time for negotiation and feedback of ideas, and the long-term case management approach proposed reinforces the need for a long-term perspective. Therefore the proposed community-based intervention is likely to require a timeframe of five or more years for implementation and evaluation. Therefore a number of National Health and Medical Research Council funding schemes, such as Partnership Projects, Program Grants and Centres of Research

Excellence, might be appropriate as they allow for projects of up to five years duration. Successful delivery of the intervention would rely on an ongoing partnership between the community, researchers, ACCHS and other stakeholders (such as non-government and government organisations). Therefore a comprehensive and long-term funding commitment to the project and participating communities would be required, in particular for the implementation of those intervention strategies aimed at improving education, housing and employment.

Conclusion

The health of Australia's Aboriginal people will continue to suffer unless changes in the prevalence of multiple lifestyle risk factors, and the social and environmental conditions which contribute to these, are addressed. The findings of this thesis suggest a number of approaches to health behaviour change which are feasible and acceptable to the Aboriginal community who access health care through ACCHSs. These include the use of electronic screening for health risks and the provision of point-of-care feedback. The results also suggest that intervention approaches should target multiple, specific combinations of risk behaviours, and provide some insights, based on an exploration of consumer preferences, to inform the design of such approaches. Incorporating several of these components, a multi-component intervention aimed at reducing multiple SNAPO health risk behaviours is proposed. Using a methodologically rigorous design, the intervention would provide much needed evidence about the effectiveness of a community-based and community-tailored strategy for reducing multiple health risk behaviours among Australian Aboriginal communities.

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APPENDIX 1: PAPER ONE- Statement of Contribution from Co-authors

Citation: Noble, N. E., Paul, C. L., Carey, M. L., Sanson-Fisher, R. W., Blunden, S. V., Stewart, J. M., & Conigrave, K. M. (2014). A cross-sectional survey assessing the acceptability and feasibility of self-report electronic data collection about health risks from patients attending an Aboriginal Community Controlled Health Service. *BMC Medical Informatics and Decision Making*, 14(1), 34.

Paper 1: Co-author statement of the candidate's contribution to joint publications

By signing below I confirm that Natasha Noble contributed development of the study materials, conduct of data collection, data analysis and interpretation, and drafting of the manuscript, to the paper/publication entitled "A cross-sectional survey assessing the acceptability and feasibility of self-report electronic data collection about health risks from patients attending an Aboriginal Community Controlled Health Service"; *BMC Medical Informatics and Decision Making*; 2014, 14(1), 34.

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APPENDIX 2: PAPER TWO- Statement of Contribution from Co-authors

Citation: Noble, N., Paul, C., Carey, M., Blunden, S., & Turner, N. (2015). A randomised trial assessing the acceptability and effectiveness of providing generic versus tailored feedback about health risks for a high need primary care sample. *BMC Family Practice*, *16*(1), 95.

Paper 2: Co-author statement of the candidate's contribution to joint publications

By signing below I confirm that Natasha Noble contributed development of the study materials, conduct of data collection, data analysis and interpretation, and drafting of the manuscript, to the paper/publication entitled "A randomised trial assessing the acceptability and effectiveness of providing generic versus tailored feedback about health risks for a high need primary care sample"; 2015; *BMC Family Practice*, 16(1), 95.

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APPENDIX 3: PAPER THREE- Statement of Contribution from Co-authors

Citation: Noble, N., Paul, C., Turon, H., & Oldmeadow, C. (2015). Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors. *Preventive Medicine*, 81, 16-41.

Paper 3: Co-author statement of the candidate's contribution to joint publications

By signing below I confirm that Natasha Noble contributed development of the study idea, searching of the literature, data extraction from included studies, and drafting of the manuscript, to the paper/publication entitled "Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors"; 2014; *Preventive Medicine*, 81, 16-41.

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APPENDIX 4: PAPER FOUR- Statement of Contribution from Co-authors

Citation: Noble, N. E., Paul, C. L., Turner, N., Blunden, S. V., Oldmeadow, C., & Turon, H. (2015). A cross-sectional survey and latent class analysis of the prevalence and clustering of health risk factors among people attending an Aboriginal Community Controlled Health Service. *BMC Public Health*, 15(1), 666.

Paper 4: Co-author statement of the candidate's contribution to joint publications

By signing below I confirm that Natasha Noble contributed development of the study materials, conduct of data collection, some data analysis and interpretation, and drafting of the manuscript, to the paper/publication entitled "A cross-sectional survey and latent class analysis of the prevalence and clustering of health risk factors among people attending an Aboriginal Community Controlled Health Service"; *BMC Public Health*, 15(1), 666.

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Paper 4: Co-author statement of the candidate's contribution to joint publications

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APPENDIX 5: PAPER FIVE- Statement of Contribution from Co-authors

Citation: Noble, N., Paul, C., Sanson-Fisher, R., Turon, H., Turner, N., & Conigrave, K. (2016). Ready, set, go: a cross-sectional survey to understand priorities and preferences for multiple health behaviour change in a highly disadvantaged group. *BMC Health Services Research*, 16(1), 488.

Paper 5: Co-author statement of the candidate's contribution to joint publications

By signing below I confirm that Natasha Noble contributed development of the study materials, conduct of data collection, data analysis and interpretation, and drafting of the manuscript, to the paper/publication entitled "Ready, set, go: a cross-sectional survey to understand priorities and preferences for multiple health behaviour change in a highly disadvantaged group"; 2016; *BMC Health Services Research,* 16(1), 488.

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Paper 5: Co-author statement of the candidate's contribution to joint publications

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APPENDIX 6: PAPER SIX

Citation: Noble, N., Paul, C., Conigrave, K., Lee, K., Blunden, S., Turon, H., Carey, M., & McElduff, P. (2015). Does a retrospective seven-day alcohol diary reflect usual alcohol intake for a predominantly disadvantaged Australian Aboriginal population*? Substance Use & Misuse*, 50(3), 308-319.

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Appendix 6.2: Statement of Contribution from Co-authors

Paper 6: Co-author statement of the candidate's contribution to joint publications

By signing below I confirm that Natasha Noble contributed development of the study materials, conduct of data collection, data analysis and interpretation, and drafting of the manuscript, to the paper/publication entitled "Does a retrospective seven-day alcohol diary reflect usual alcohol intake for a predominantly disadvantaged Australian Aboriginal population?"; 2015; *Substance Use and Misuse;* 50:3, 308-319.

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APPENDIX 7: ADDITIONAL STUDY DATA NOT REPORTED IN PUBLISHED PAPERS

Appendix 7.1: Comparison of the health risk and socioeconomic status of Aboriginal and non-Aboriginal patients attending an ACCHSs

The health risk and sociodemographics of the study participants included in Paper four, by Indigenous status, are presented in Tables A1 and A2 below. Note that only participants with complete health risk and sociodemographic data were included (i.e. participants with missing data were excluded). Chi-square analysis was used to explore an significant differences in the prevalence of health risk factors, and in key sociodemographic characteristics, between Aboriginal and non-Aboriginal study participants.

In relation to the health risk status of Aboriginal and non-Aboriginal study participants, there were significant differences for body weight and underscreening. Aboriginal participants were more likely than non-Aboriginal participants to be classified as overweight or obese, and not to be screened in line with recommended timeframes.

In relation to sociodemographic characteristics, there were significant differences in age and type of housing for Aboriginal and non-Aboriginal participants. Aboriginal participants in the study were less likely to be in the older age group (60yrs+), and were also less likely to own or be paying off their homes, compared to non-Aboriginal participants.

Table A1: Health risk status of study participants by Indigenous status

	Aboriginal participants (n=302) n (%)	**Non-Aboriginal participants (n=75) n (%)**
BMI		
Underweight/normal	86 (29%)	31 (41%)*
Overweight/obese	216 (72%)	44 (59%)
Smoking status		
Non-smoker	172 (57%)	43 (57%)
Current smoker	130 (43%)	32 (43%)
Fruit & vegetable intake		
Adequate	54 (18%)	7 (9%)
inadequate	248 (82%)	68 (91%)
Alcohol consumption		
Not risky	234 (78%)	55 (73%)
Risky	68 (23%)	20 (27%)
Physical activity		
Adequate	140 (46%)	40 (53%)
Inadequate	162 (54%)	35 (47%)
Depression		
PHQ9 Score <10	194 (64%)	51 (68%)
PHQ9 Score ≥10	108 (36%)	24 (32%)
Drug use		
No	240 (79%)	59 (79%)
Yes	62 (21%)	16 (21%)
Screening status		
Up to date	138 (46%)	45 (60%)*
Underscreened[a]	164 (54%)	30 (40%)

[a]Underscreened included any participant who was not screened in line with the recommended timeframes based on their age, gender and Indigenous status, for the following: blood pressure, cholesterol, blood sugar or HbA1c for those with diabetes, cervical, breast and colorectal cancer
* $p<.05$; ** $p<.01$

Table A2: Sociodemographic characteristics of study participants by Indigenous status

	Aboriginal participants (n=302) n (%)	**Non-Aboriginal participants (n=75) n (%)**
Age		
18-39yrs	130 (41%)	28 (34%)**
40-59yrs	140 (44%)	29 (35%)
60yrs+	51 (16%)	26 (31%)
Gender		
Male	118 (37%)	38 (46%)
Female	203 (63%)	45 (54%)
Employment		
Employed	105 (32%)	28 (34%)
Unemployed	216 (67%)	55 (66%)
Education		
Year 10 or below	201 (63%)	46 (55%)
Yr 12 or TAFE	69 (22%)	25 (30%)
University or other	50 (16%)	12 (15%)
Type of housing		
Housing Commission	181 (57%)	27 (33%)**
Private rental	108 (34%)	27 (33%)
Own/ paying off	30 (9%)	28 (34%)
Exposure to violence		
No	253 (82%)	56 (71%)
Yes	57 (18%)	22 (28%)

* $p<.05$; ** $p< .01$

Appendix 7.2: Health risk changes rated as most difficult to change

This data was collected as part of Paper five but not included in the published paper. Participants were asked to select one health change, out of those included in the survey, that would be the most difficult for them to make. As a proportion of those who were classified as at risk for each health risk, the three most difficult changes were: stopping or cutting down on smoking (66% of current smokers), losing weight (32% of overweight/obese participants), and drinking less alcohol (18% of those drinking above current guidelines). Less than 15% of at risk participants chose getting more exercise, eating more fruit and vegetables, stopping or cutting down on drug use, or finding ways to feel less depressed as the most difficult changes.

Table A3: Health risks rated by at-risk participants as being the most difficult to change

Health risk change	**Number of participants as proportion of those at risk selecting change as the most difficult**
Losing weight	49/153 (32%)
Stop or cut down on smoking	59/90 (60%)
Drink less alcohol	7/38 (18%)
Get more exercise	15/102 (15%)
Eat more fruit and vegetables	10/173 (6%)
Stop or cut down on drug use	5/33 (15%)
Find ways to feel less sad or depressed	6/69 (9%)

APPENDIX 8: STUDY MATERIALS

Appendix 8.1: University of Newcastle and AHMRC Human Research Ethics Committee Approval Sites 1 and 2 (*Papers one, two, four and five*)

University of Newcastle Ethics Approval Site 1

HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Notification of Expedited Approval

To Chief Investigator or Project Supervisor: **Associate Professor Christine Paul**
Cc Co-investigators / Research Students: **Ms Natasha Noble**
Laureate Professor Robert Sanson-Fisher Doctor Mariko Carey
Re Protocol: **Acceptability, feasibility and effectiveness of providing feedback to Aboriginal Community Controlled Health Service patients and their GPs about patients' risks alcohol, tobacco and drug use**
Date: **19-Aug-2011**
Reference No: **H-2011-0153**
Date of Initial Approval: **12-Aug-2011**

Thank you for your **Response to Conditional Approval** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Chair/Deputy Chair.

I am pleased to advise that the decision on your submission is **Approved** effective **12-Aug-2011**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request. Your approval number is **H-2011-0153**.

If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants You may then proceed with the research.

Conditions of Approval This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:
In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University's HREC.

- ***Monitoring of Progress***

Other than above, the University is obliged to monitor the progress of research projects involving human participants to ensure that they are conducted according to the protocol as approved by the HREC. A progress report is required on an annual basis. Continuation of your HREC approval for this project is conditional upon receipt, and satisfactory assessment, of annual progress reports. You will be advised when a report is due.

- ***Reporting of Adverse Events***

It is the responsibility of the person **first named on this Approval Advice** to report adverse events. Adverse events, however minor, must be recorded by the investigator as observed by the investigator or as volunteered by a participant in the research. Full details are to be documented, whether or not the investigator, or his/her deputies, consider the event to be related to the research substance or procedure. Serious or unforeseen adverse events that occur during the research or within six (6) months of completion of the research, must be reported by the person first named on the Approval Advice to the (HREC) by way of the Adverse Event Report form within 72 hours of the occurrence of the event or the investigator receiving advice of the event.
Serious adverse events are defined as:
- Causing death, life threatening or serious disability. Causing or prolonging hospitalisation.
- Overdoses, cancers, congenital abnormalities, tissue damage, whether or not they are judged to be caused by the investigational agent or procedure.
- Causing psycho-social and/or financial harm. This covers everything from perceived invasion of privacy, breach of confidentiality, or the diminution of social reputation, to the creation of psychological fears and trauma.
- Any other event which might affect the continued ethical acceptability of the project.

Reports of adverse events must include:
- Participant's study identification number; date of birth;
- date of entry into the study; treatment arm (if applicable); date of event;
- details of event;
- the investigator's opinion as to whether the event is related to the research procedures; and action taken in response to the event.

Adverse events which do not fall within the definition of serious or unexpected, including those reported from other sites involved in the research, are to be reported in detail at the time of the annual progress report to the HREC.

- ***Variations to approved protocol***

If you wish to change, or deviate from, the approved protocol, you will need to submit an *Application for Variation to Approved Human Research*. Variations may include, but are not limited to, changes or additions to investigators, study design, study population, number of participants, methods of recruitment, or participant information/consent documentation. **Variations must be approved by the (HREC) before they are implemented** except when Registering an approval of a variation from an external HREC which has been designated the lead HREC, in which case you may proceed as soon as you receive an acknowledgement of your Registration.

Linkage of ethics approval to a new Grant

HREC approvals cannot be assigned to a new grant or award (ie those that were not identified on the application for ethics approval) without confirmation of the approval from the Human Research Ethics Officer on behalf of the HREC.
Best wishes for a successful project. Professor Alison Ferguson
Chair, Human Research Ethics Committee

For communications and enquiries:
Human Research Ethics Administration

Research Services Research Integrity Unit HA148, Hunter Building The University of Newcastle Callaghan NSW 2308
T +61 2 492 18999
F +61 2 492 17164
Human-Ethics@newcastle.edu.au

Linked University of Newcastle administered funding:

Funding body	Funding project title	First named investigator	Grant Ref
NSW Department of Health/Drug and Alcohol Council Research Grants Program(**)	Acceptability and feasibility of providing feedback to ACCHO patients and their GPs about patients' risky alcohol, tobacco and drug use	Carey Mariko,Leanne	G1100306

Aboriginal Health & Medical Research Council

of New **South** Wales

AH&MRC ETIDCS COMMITTEE

11 October 2011

Associate Professor Christine Paul
School of Medicine & Public Health
University of Newcastle
Callaghan NSW 2308

Dear Associate Professor Paul,

Acceptability, feasibility and effectiveness of providing feedback to ACCHS patients and their GPs about patients' risky alcohol, tobacco and drug use - (806/11)

The Aboriginal Health and Medical Research Council (AH&MRC) Ethics Committee has considered your application received on 26 July 2011 for ethics approval for the above project. Your emails of 19 August, 26 August and 27 September 2011 containing additional information are considered to form part of the application.

The Committee agreed to approve the application, subject to the Standard Conditions and Special Condition/s of Approval below:

Standard Conditions of Approval (where applicable to the project)

L The approval is for a period from 12 October 2011 until 31 October 2012, with extension subject to providing a report on the research by 31 October 2012.
2. All research participants are to be provided with a relevant Participant Information Statement and Consent Form in the format provided with your application.
3. Copies of all signed consent forms must be retained and made available to the Ethics Committee on request. A request will only be made if there is a dispute or complaint in relation to a participant.
4. Any changes to the staffing, methodology, timeframe, or any other aspect of the research relevant to continued ethical acceptability of the project must have the prior written approval of the Ethics Committee.
5. The AH&MRC Ethics Committee must be immediately notified in writing of any serious or unexpected adverse effects on participants.
6. The research must comply with:
   - the *AH&MRC Guidelines for Research in Aboriginal Health – Key Principles*
   - *National Statement on Ethical Conduct in Research Involving Humans* (April 2007)
   - the *NSW Aboriginal Health Information Guidelines.*

7. The final draft report from the research, and any publication or presentation prior to that report where new data or findings are presented, must be provided to the AH&MRC Ethics Committee to be reviewed for compliance with ethical and cultural criteria prior to:
   - any submission for publication; and/or
   - any dissemination of the report.
8. A copy of the final published version of any publication is to be provided to the AH&MRC Ethics Committee.

Special Condition/s

9. NIL.

Please acknowledge receipt of this letter and your acceptance of the above conditions within fourteen (14 days).

We would also appreciate your agreement that the AH&MRC may, on request, obtain access to the data obtained from the research in order to assist the future development of policy and programs in Aboriginal health.

On behalf of the AH&MRC Ethics Committee,

Yours sincerely

Val Keed
Chairperson
AH&MRC Ethics Committee

University of Newcastle Ethics Approval Site 2

HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Associate Professor Christine Paul**
Cc Co-investigators / Research Students:	**Ms Nicole Turner Doctor Heidi Turon Ms Natasha Noble Laureate Professor Robert Sanson-Fisher Doctor Mariko Carey**
Re Protocol:	**Acceptability, feasibility and effectiveness of providing feedback to Aboriginal Community Controlled Health Service patients and their GPs about patients' risks alcohol, tobacco and drug use**
Date:	**28-Mar-2013**
Reference No:	**H-2011-0153**

Thank you for your **Variation** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to a variation to the above protocol.

Variation to:

1. Add an additional data collection site - Durri Aboriginal Corporation Medical Service.

2. Add a short 'preference/ priorities for addressing health risk factors' module to the health risk survey, and other minor changes to the health risk survey and exit survey.

3. Add a prompt for GPs about health changes their patient would like advice about and/or are willing to try and change, to the personalised feedback component of the study.

4. Make minor changes to the exit survey and other study materials to reflect the above changes.

5. Add Heidi Turon and Nicole Turner to the research team.

- Letter of Support from Durri Aboriginal Corporation Medical Service
- Patient Health Risk Survey (v4, dated 15/03/2013)
- GP Prompt (v1, dated 15/03/2013)
- Revised Exit Survey (v3, dated 15/03/2013)
- Personalised Patient Feedback (v4, dated 15/03/2013)
- Generic Patient Feedback (v3, dated 15/03/2013)
- Revised Study Flyer (v2, dated 15/03/2013)
- Revised Patient Information Statement (v3, dated 15/03/2013)

Your submission was considered under **Expedited** review by the Chair/Deputy Chair.

I am pleased to advise that the decision on your submission is **Approved** effective **26-Mar-2013**.

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request.

Professor Allyson Holbrook
Chair, Human Research Ethics Committee

For communications and enquiries:
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The University of Newcastle Callaghan NSW 2308
T +61 2 492 18999
F +61 2 492 17164
Human-Ethics@newcastle.edu.au

RIMS website - https://RIMS.newcastle.edu.au/login.asp

Linked University of Newcastle administered funding:

Funding body	Funding project title	First named	Grant Ref
NSW Ministry of Health/Drug and Alcohol Council	Acceptability and feasibility of providing feedback to ACCHO patients and their GPs about	Carey Mariko,	G1100306

Aboriginal Health and Medical Research Council Ethics Approval Site 2

Aboriginal Health & Medical Research Council
of New South Wales

AH&MRC ETHICS COMMITTEE

16 April 2013

Professor Christine Paul
Priority Research Behaviour for
Health Behaviour HMRI Building
University of
Newcastle
CALLAGHAN
NSW 2308

Dear A/Professor Paul,

Acceptability, feasibility and effectiveness of providing feedback to ACCHS patients and their GPs about patients' risky alcohol, tobacco and drug use. (806/11)

I refer to your letter dated 15th March 2013 requesting approval for amendments to the above project which has previously been approved by the Aboriginal Health and Medical Research Council (AH&MRC) Ethics Committee.

The amendments requested relate to:

1) data collection from an additional site (Durri Aboriginal Corporation Medical Service);
2) addition of a short 'preference/ priorities for addressing health risk factors' module to the health risk survey, and other minor changes to the health risk survey and exit survey;
3) addition of a prompt for GPs about health changes their patient would like advice about and/or are willing to try and change, to the personalised feedback component of the study;
4) addition of two investigators to the project; and
5) other minor changes to the study materials to reflect the above changes.

The Committee has agreed to approve the amendments.

The conditions of approval contained in the original approval letter will

continue to apply. On behalf of the AH&MRC Ethics Committee,

Yours sincerely

Val Keed Chairperson
AH&MRC Ethics Committee

Funded by NSW Health Department

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web: www.ahmrc.org.au

Appendix 8.2: Study Flyer and Participant Information Statement Site 1 (*Paper one, two and four)*

Study Flyer Site 1

<INSERT MEDICAL SERVICE NAME>

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Health Risk Study

Would you like to take part?

What would you be asked to do?

You will be asked to do a health survey on a touch screen computer while you wait for your appointment. The survey asks about health risks like smoking, diet and exercise.

The survey is very easy to do.

A Research Assistant will help you do the survey if you want.

How long does it take?

It takes about 15-20 minutes.

If you are called to your appointment you can quit the survey and go to see your doctor.

Why are we doing the study?

Your answers will help the <INSERT MEDICAL SERVICE> see what services their patients need the most. We also want to see how patients feel about answering health questions on the computer, and whether giving patients a printed checklist about their health is helpful.

If you would like to take part, or have any questions, please tell reception or the Research Assistant.

Body weight

Smoking

Exercise

Diet

Participant Information Statement Site 1

Information Statement for the Research Project:
Prevalence of Health Risk Factors and the Value of Feedback for Patients of Aboriginal Community Controlled Health Services
Document Version 2; dated 29/07/2011

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

You are invited to participate in the above research project. The project is being conducted as part of Natasha Noble's studies at the University of Newcastle. The project and the student are supervised by Dr Chris Paul and L/Professor Rob Sanson-Fisher; and Dr Mariko Carey is also involved in the study. The research has been approved by the head of this health service - Mr Steve Blunden. Part of the study is being funded by the NSW Health Drug and Alcohol Research Grants Program 2011/12.

Why is the research being done?
We want to see what patients of Aboriginal Community Controlled Health Services think of answering questions about their health using a touchscreen computer survey. We hope to give this information to the medical service so it can see what services patients need the most. We will also test whether giving patients and their doctors a printed sheet about patient's main health risks is useful to them. The doctors at the medical service have been told about the study.

Who can participate in the research?
You can participate in the study if you are attending the medical service for a doctor's appointment, are aged 18 years or older, and are able to give informed consent.

What choice do you have?
It is up to you to decide if you participate. Only people who agree will be given the survey. You do not have to participate. Everyone will still have their doctor's appointment as usual. If you do participate, you can stop at any time without giving a reason.

What will you be asked to do?
If you do participate, the researcher will measure your height and your weight. You will also be asked to complete a survey on the computer, while you wait for your appointment. The survey asks about things like smoking, drinking, using drugs, exercise, eating fruit and vegetables, and tests like a blood test for diabetes. There are also questions about age, education, housing, exposure to violence and what you think of the computer survey. **If there are any questions in the survey that you don't want to answer, you can skip these questions. You can skip the height and weight measurement if you want.**

After the survey, some patients will get two copies of a print out about their main health risks. There is a copy for the doctor if you want to give it to them. Everyone else will get some simple take-home information about health care. After your appointment today, we will ask you to do another very quick survey on the computer. This survey will ask you whether you and your doctor talked about anything in the survey. We will also ask you whether you thought the printed sheet was useful or not.

How much time will it take?
The first computer survey should take about 20 minutes to complete. If you need to go to your appointment before the survey is finished, that is OK. You can stop the survey whenever you want. The quick survey after your appointment should only take a couple of minutes.

***What are the risks and benefits of participating*?**
We are not sure that you will benefit from taking part in this research. We hope it might help you to talk about your health with the doctor. By taking part in the study, you will help identify the main health risks for patients at this service, which may help to improve care in the future.

There are no direct risks to you from taking part in the study. If you find any of the questions distressing, please mention it to the researcher, or talk to your doctor or the medical staff.

How will your privacy be protected?
All of the information that the researchers keep will be anonymous. The researchers will not record your name. Once you have finished the survey, no one can link your answers to you. If you are one of the patients given a printed sheet, it will contain health suggestions based on your survey answers. You can show these to your doctor if you want to. The researchers will not be able to link your answers to your name. They will only give grouped information to this medical service.

How will the information collected be used?
The information will be used to decide whether the computer survey and the printed sheet is a good way to help patients talk about their health with the doctor. The results of the study will be reported in journals and conference papers, and will form part of Natasha Noble's PhD studies.

***What do you need to do to participate*?**
Please read this Information Statement and make sure you understand it before you agree to participate. You can ask the researcher if you have any questions.

If you would like to participate, please tell the researcher. She will show you how to complete the computer survey. Doing the survey means you have agreed to participate in the study.

Further information
If you would like further information please contact Natasha Noble on (02) 49138337 or email Natasha.Noble@newcastle.edu.au; or Dr Chris Paul on (02) 49138472 or email Chris.Paul@newcastle.edu.au

If doing the survey makes you upset or you have questions or worries about your health, please talk to the medical staff or to your GP. The staff can tell you about support services which you might want to use.

Thank you for considering this invitation.

Dr Chris Paul
Senior Research Academic
The University of Newcastle
Level 2 David Maddison Building
Callaghan NSW 2308
Ph: (02) 49138472
Fax: (02) 49138779

L/Prof Rob Sanson-Fisher
Professor of Health Behaviour
The University of Newcastle

Natasha Noble
PhD Candidate
University of Newcastle

Complaints about this research
This project has been approved by the University's Human Research Ethics Committee, Approval No. H-2011-0153 and the Aboriginal Health & Medical Research Council of NSW (Ref No. 806/11).
Should you have concerns about your rights as a participant in this research, or you have a complaint about

the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au; or the Aboriginal Health and Medical Research Council Ethics Committee, Aboriginal Health & Medical Research Council of NSW, PO Box 1565, Strawberry Hills, NSW 2012, telephone (02) 92124777, email ethics@ahmrc.org.au

Appendix 8.3: Study Flyer and Participant Information Statement Site 2 (*Paper two, four and five)*

Study Flyer Site 2

Health Risk Survey

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Would you like to take part?

What would you be asked to do?

You will be asked to do a health survey on a touch screen computer while you wait for your appointment. The survey asks about health risks like smoking, diet and exercise. It also asks about any health changes you want to make.

The survey is very easy to do.

A Research Assistant will help you do the survey if you want.

How long does it take?

It takes about 20-25 minutes.

If you are called to your appointment you can quit the survey and go to see your doctor.

Why are we doing the study?

Your answers will help the Medical Service see what services their patients need the most. We also want to see whether giving patients a checklist about their health is helpful, and what kind of help patients would use to get better health.

No names are recorded in the survey.

Body weight

Smoking

Exercise

Diet

Participant Information Statement Site 2

Information Statement for the Research Project:
Prevalence of Health Risk Factors and the Value of Feedback for Patients of Aboriginal Community Controlled Health Services

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

You are invited to participate in the above research project. The project is being conducted as part of Natasha Noble's studies at the University of Newcastle. The project and student are supervised by A/Prof Chris Paul and Dr Heidi Turon; L/Prof Rob Sanson-Fisher and Dr Mariko Carey are also involved in the study. The research has been approved by the Board of Directors of the Durri Aboriginal Corporation Medical Service. Part of the study is being funded by the NSW Ministry of Health. The doctors at the medical service have been told about the study.

Why is the research being done?
We want to see what the main health problems for patients of Aboriginal Medical Health Services are. We will give this information to the medical service so it can see what services patients need the most. We also want to test whether giving patients a printed sheet about their main health risks is useful to them. Finally, we want to see what health problems patients are ready to change and what kind of help would be best for them in making these changes.

Who can participate in the research?
You can participate in the study if you are attending the medical service for a doctor's appointment, are aged 18 years or older, and are able to give informed consent.

What choice do you have?
It is up to you if you want to participate. You do not have to take part in the study. Everyone will still have their doctor's appointment as usual. If you do participate, you can stop at any time without giving a reason.

What will you be asked to do?
If you agree, the researcher will measure your height and your weight. You will be asked to complete a survey on the computer while you wait for your appointment. The survey asks about things like smoking, drinking, using drugs, exercise, eating fruit and vegetables, and tests like a blood test for diabetes. There are also questions about your age, education, housing, and income. The last questions are about whether there are any health changes you are willing to make and what kind of help you would like. **If there are any questions in the survey that you don't want to answer, you can skip these questions.** After doing the survey, everyone will be offered some simple take-home information about improving health. After your appointment, we will ask you to do another very quick survey on the computer. This survey will ask you whether you and your doctor talked about anything in the survey. We will also ask you whether you thought the printed information was useful or not.

How much time will it take?
The main computer survey should take about 20-25 minutes to complete. If you need to go to your appointment before the survey is finished, that is OK. You can stop the survey whenever you want. The quick survey after your appointment should only take a couple of minutes.

***What are the risks and benefits of participating*?**
We are not sure that you will benefit from taking part in this research. We hope it might help you to talk about your health with the doctor. By taking part in the study, you will help identify the main health risks for patients at this service, which may help to improve care in the future.

There are no direct risks to you from taking part in the study. If you find any of the questions distressing, please mention it to the researcher, or talk to your doctor or the medical staff.

How will your privacy be protected?
All of the information that the researchers keep is anonymous. The researchers will not record your name. Once you have finished the survey, no one can link your answers to you. The printed report about your health also has no names on it. The researchers will only give group information to this medical service, there is no information about you personally.

How will the information collected be used?
The information will be used to see what the most important health risks are for patients of Aboriginal Medical Services, whether the survey is a good way to help patients talk about their health with their doctor, and what kinds of help patients would like to help improve their health. These results will be given to the Medical Service to help them understand what their patients want and need. The results of the study will also be reported in journals and conference papers, and will form part of Natasha Noble's PhD studies.

***What do you need to do to participate*?**
Please read this Information Statement and make sure you understand it before you agree to participate. You can ask the researcher if you have any questions.
If you would like to participate, please tell the researcher. She will show you how to complete the computer survey. Doing the survey means you have agreed to participate in the study.

Further information
If you would like further information please contact Natasha Noble on (02) 40420652 or email Natasha.Noble@newcastle.edu.au; or A/Prof Chris Paul on (02) 40420693 or email Chris.Paul@newcastle.edu.au

If doing the survey makes you upset or you have questions or worries about your health, please talk to the medical staff or to your GP. The staff can tell you about support services which you might want to use.

Thank you for considering this invitation.

A/Prof Chris Paul
Senior Research Academic
School of Medicine and Public Health
The University of Newcastle
Callaghan NSW 2308
Ph: (02) 40420693
Fax: (02) 40420044

Natasha Noble
PhD Candidate
The University of Newcastle
Callaghan NSW 2308
Ph: (02) 40420652
Fax: (02) 40420044

Complaints about this research
This project has been approved by the University's Human Research Ethics Committee, Approval No. H-2011-0153 and the Aboriginal Health & Medical Research Council of NSW (Ref No. 806/11). Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au; or the Aboriginal Health and Medical Research Council Ethics Committee, Aboriginal Health & Medical Research Council of NSW, PO Box 1565, Strawberry Hills, NSW 2012, telephone (02) 92124777, email ethics@ahmrc.org.au

Appendix 8.4: Health Risk Survey Questions (*Papers one, two, four and five)*

Note: This is a text version of the survey which was presented and completed on a touchscreen laptop computer. The electronic survey included images and pictures to illustrate the questions and response options where possible.

(1 Question Name = Day of the week)
Day of the week:
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday

(2 Question Name = Participant ID)
Insert Participant ID:

(3 Question Name = Info Screen)

(4 Question Name = Gender)
Please touch your answer, then touch NEXT
Section 1: About You and Your Health

Are you:
- Male
- Female

(5 Question Name = Age)
Please touch your answer, then touch NEXT
What is your age?
- 18- 24 years
- 25- 29 years
- 30- 34 years
- 35- 39 years
- 40- 44 years
- 45- 49 years
- 50- 54 years
- 55- 59 years
- 60- 64 years
- 65- 69 years
- More than 70 years

(6 Question Name = Weight kgs)
Please touch the numbers on the number pad, then touch NEXT.
What is your weight (kg)?

(7 Question Name = Height cm)
Please touch the numbers on the number pad, then touch NEXT
What is your height (cm)?

(8 Question Name = Indigenous status)
Please touch your answer, then touch NEXT
Are you of Aboriginal or Torres Strait Islander origin?
- Yes, Aboriginal
- Yes, Torres Strait Islander
- Yes, both Aboriginal and Torres Strait Islander
- No

(9 Question Name = Diagnosed Conditions)
Please touch the boxes for each condition you have, then touch NEXT
Have you ever been told by a doctor or health worker that you have any of these conditions?

(10 Question Name = Diabetes type)
Please touch your answer, then touch NEXT
What type of diabetes were you told you have?

TYPE 1	(usually starts in childhood, needs daily insulin injections)
TYPE 2	(usually starts in adulthood, may not need insulin injections)
GESTATIONAL diabetes	(occurs during pregnancy)
Not sure	

(11 Question Name = Cancer type Men)
Please touch your answer, then touch NEXT
What type of cancer were you told you have?
Colorectal or bowel cancer
Prostate cancer
Other type of cancer

(12 Question Name = Cancer type Women)
Please touch your answer, then touch NEXT
What type of cancer were you told you have?
Breast cancer
Cervical cancer
Colorectal or bowel cancer
Other type of cancer

(13 Question Name = Self Report BMI(1))
Please touch your answer, then touch NEXT
How would you describe your weight?
Underweight
Normal weight
Overweight
Very overweight or Obese

(14 Question Name = Smoking)
Please touch your answer, then touch NEXT
Which of the following best describes your smoking?
I smoke daily
I smoke occasionally (e.g. when I have a drink)
I don't smoke now but I used to
I have tried it, but have never smoked more than a total of 100 cigarettes
I have never smoked

(15 Question Name = Exercise)
Please touch your answer, then touch NEXT
Do you usually do at least half an hour of moderate or vigorous exercise on most days (5 or more days) of the week?
Yes
No
Sometimes
Not sure

(16 Question Name = Fruit)
Please touch your answer, then touch NEXT
How many serves of fruit do you usually eat each day?
None
1
2 or more

(17 Question Name = Veg)
Please touch your answer, then touch NEXT
How many serves of vegetables (and salad) do you usually eat each day?
None
1
2
3
4
5 or more

(18 Question Name = Alcohol)

Please touch your answer, then touch NEXT
Do you drink alcohol?
- Yes
- No
- I don't drink now but I used to

(19 Question Name = Alcohol 4SDs)
Please touch your answer, then touch NEXT
How often do you have MORE THAN 4 standard drinks on one occasion?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

(20 Question Name = Alcohol 2SDs)
Please touch your answer, then touch NEXT
How often do you have MORE THAN 2 standard drinks in one day?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

(21 Question Name = Alcohol in past week)
Please touch your answer, then touch NEXT
In the last WEEK, did you have any drinks containing alcohol?
- Yes
- No

(22 Question Name = Alcohol Diary Yest)
Please try to estimate how many standard drinks you had using the pictures.
These questions are about your drinking in the last week.

How many standard drinks did you have YESTERDAY?
- none
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more

(23 Question Name = Alcohol Diary TAILORED TO DAY OF WEEK)
Please try to estimate how many standard drinks you had using the pictures.
How many standard drinks did you have on <e.g. THURSDAY>?
- none
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more

(24 Question Name = Alcohol Diary WED)
Please try to estimate how many standard drinks you had using the pictures.
How many standard drinks did you have on <e.g. WEDNESDAY>?
- none
- 1

2
3
4
5
6
7
8
9
10 or more

(25 Question Name = Alcohol Diary TUES)
Please try to estimate how many standard drinks you had using the pictures.
How many standard drinks did you have on <e.g. TUESDAY>?
none
1
2
3
4
5
6
7
8
9
10 or more

(26 Question Name = Alcohol Diary MON)
Please try to estimate how many standard drinks you had using the pictures.
How many standard drinks did you have on <e.g. MONDAY>?
none
1
2
3
4
5
6
7
8
9
10 or more

(27 Question Name = Alcohol Diary SUN)
Please try to estimate how many standard drinks you had using the pictures.
How many standard drinks did you have on <e.g. SUNDAY>?
none
1
2
3
4
5
6
7
8
9
10 or more

(28 Question Name = Alcohol Diary SAT)
Please try to estimate how many standard drinks you had using the pictures.
How many standard drinks did you have on <e.g. SATURDAY>?
none
1
2
3
4
5
6
7
8

9
10 or more

(34 Question Name = Diary same as usual)
Please touch your answer, then touch NEXT
Is this about the same amount of alcohol you would usually drink in a week?
Yes
No, this is MORE than I usually drink
No, this is LESS than I usually drink

(35 Question Name = Illicit drugs)
Please remember your answers are anonymous. You can also skip this question.
When was the last time you used any illegal or illicit drugs?
In the last month (the last 4 weeks)
More than 1 month ago but in the last year
More than 1 year ago (including many years ago)
Never
I prefer not to answer

(36 Question Name = Illicit drugs2)
Your answers are anonymous. You can skip this question if you want.
How often do you usually use illicit or illegal drugs?
Every day
5-6 days a week
3-4 days week
1-2 days a week
Several times a month
About once a month
Less than once a month

(37 Question Name = Depression PHQ2)
These next questions are about your feelings and emotions.
Over the last 2 weeks, how often have you been bothered by the following problems?
Not enjoying things like you used to
Feeling down, sad, depressed or hopeless
never
a little
a lot
all the time

(38 Question Name = Depression PHQ9a)
Over the past 2 weeks, how often have you been bothered by any of the following problems?
Trouble falling asleep or staying awake, or sleeping too much
Feeling tired or having little energy
Eating more or less than you used to
Feeling bad about yourself. Feeling shamed or that you have let yourself or others down
never
a little
a lot
all the time

(39 Question Name = Depression PHQ9b)
Over the past 2 weeks, how often have you been bothered by any of the following problems?
Trouble paying attention to what is going on around you
Moving or speaking so slowly that others could have noticed. Or the opposite- being so nervous or restless that you have been moving around a lot more than usual
Thoughts that you would be better off dead or of harming yourself in some way
Feeling angry
never
a little
a lot
all the time

NOTE: BLOOD PRESSURE QUESTIONS 40-43 WERE TAILORED ACCORDING TO PARTICIPANTS' INDIGENOUS STATUS, RISK STATUS (e.g. history of diabetes, high BP, CVD etc) AND AGE

(40 Question Name = Blood pressure 6m Indig)
Please touch your answer, then touch NEXT
When did you last have your blood pressure checked?
- Never
- In the last 6 months (since XX MONTH/YEAR)
- More than 6 months ago (before XX MONTH/YEAR)
- Can't remember

(41 Question Name = Blood pressure 6m non-Indig)
Please touch your answer, then touch NEXT
When did you last have your blood pressure checked?
- Never
- Within the last 6 months (since XX MONTH/YEAR)
- More than 6 months ago (before XX MONTH/YEAR)
- Can't remember

(42 Question Name = Blood pressure 12 months)
Please touch your answer, then touch NEXT
When did you last have your blood pressure checked?
- Never
- In the last year (since XX MONTH/YEAR)
- More than 1 year ago (before XX MONTH/YEAR)
- Can't remember

(43 Question Name = Blood pressure 2 yrs)
Please touch your answer, then touch NEXT
When did you last have your blood pressure checked?
- Never
- In the last 2 years (since XX MONTH/YEAR)
- More than 2 years ago (before XX MONTH/YEAR)
- Can't remember

NOTE: BLOOD CHOLESTEROL QUESTIONS 44-47 WERE TAILORED ACCORDING TO PARTICIPANTS' INDIGENOUS STATUS, RISK STATUS (e.g. history of diabetes, high BP, CVD, smoking status etc) AND AGE

(44 Question Name = Blood cholesterol 12m Indig)
Please touch your answer, then touch NEXT
When did you last have your blood cholesterol checked?
- Never
- In the last year (since XX MONTH/YEAR)
- More than 1 year ago (before XX MONTH/YEAR)
- Can't remember

(45 Question Name = Blood cholesterol 12m non-Indig)
Please touch your answer, then touch NEXT
When did you last have your blood cholesterol checked?
- Never
- In the last year (since XX MONTH/YEAR)
- More than 1 year ago (before XX MONTH/YEAR)
- Can't remember

(46 Question Name = Blood cholesterol 2 yr)
Please touch your answer, then touch NEXT
When did you last have your blood cholesterol checked?
- Never
- In the last 2 years (since XX MONTH/YEAR)
- More than 2 years ago (before XX MONTH/YEAR)
- Can't remember

(47 Question Name = Blood cholesterol 5 yrs)
Please touch your answer, then touch NEXT
When did you last have your blood cholesterol checked?
- Never
- In the last 5 years (since mid XX YEAR)
- More than 5 years ago (before mid XX Year)
- Can't remember

NOTE: BLOOD SUGAR QUESTIONS 48 AND 49 WERE TAILORED ACCORDING TO PARTICIPANTS' INDIGENOUS STATUS, RISK STATUS (e.g. diabetes status, CVD) AND AGE

(48 Question Name = Blood sugar 2 yrs)
Please touch your answer, then touch NEXT
When did you last have your blood sugar level checked?
- Never
- In the last 2 years (since XX MONTH/YEAR)
- More than 2 years ago (before XX MONTH/YEAR)
- Can't remember

(49 Question Name = Blood sugar 3 yrs)
Please touch your answer, then touch NEXT
When did you last have your blood sugar level checked?
- Never
- In the last 3 years (since XX MONTH/YEAR)
- More than 3 years ago (before XX MONTH/YEAR)
- Can't remember

NOTE: ONLY PARTICIPANTS WITH SELF-REPORTED DIABETES WERE ASKED TO ANSWER QUESTION 50

(50 Question Name = HbA1c test)
Please touch your answer, then touch NEXT
When did you last have a blood sugar (an HbA1c) test?
- Never
- In the last 6 months (since XX MONTH/YEAR)
- More than 6 months ago (before XX MONTH/YEAR)
- Can't remember

NOTE: ONLY WOMEN WERE ASKED TO ANSWER QUESTIONS 51-54
ONLY THOSE AGED 50-69YRS WITH NO HISTORY OF BREAST CANCER WERE ASKED TO ANSWER QUESTION 51
ONLY THOSE AGED 18-69YRS WITH NO HISTORY OF CERVICAL CANCER WERE ASKED TO ANSWER QUESTION 54

(51 Question Name = Mammogram)
Please touch your answer, then touch NEXT
When did you last have a test for breast cancer (a mammogram)?
- Never
- In the last 2 years (since XX MONTH/YEAR)
- More than 2 years ago (before XX MONTH/YEAR)
- Can't remember

(52 Question Name = Hysterectomy)
Please touch your answer, then touch NEXT
Have you had a total or partial hysterectomy?
- Yes
- No

(53 Question Name = Pregnancy)
Are you pregnant?
- Yes
- No
- Not sure

NOTE: ONLY THOSE AGED 18-69YRS WITH NO HISTORY OF CERVICAL CANCER WERE ASKED TO ANSWER QUESTION 54

(54 Question Name = Pap test)
Please touch your answer, then touch NEXT
When did you last have a test for cervical cancer (a Pap smear test)?

Never
In the last 2 years (since XX MONTH/YEAR)
More than 2 years ago (before XX MONTH/YEAR)
Can't remember

NOTE: ONLY PARTICIPANTS AGED 50YRS+ WITH NO HISTORY OF BOWEL CANCER WERE ASKED TO ANSWER QUESTIONS 55=57

(55 Question Name = FOBT)
Please touch your answer, then touch NEXT
When did you last have a test for bowel cancer (a Faecal Occult Blood Test)?
Never
In the last 2 years (since XX MONTH/YEAR)
More than 2 years ago (before XX MONTH/YEAR)
Can't remember

(56 Question Name = Colonoscopy)
Please touch your answer, then touch NEXT
Have you had a colonoscopy in the last 5 years (since mid XX YEAR)?
Yes
No
Can't remember

(57 Question Name = Colonoscopy symptom)
Please touch your answer, then touch NEXT
Did you have your last colonoscopy because you had a symptom of bowel cancer?
Yes
No

(58 Question Name = Health Assess)
When did you last have a Health Assessment?
Never
In the last year (since XX MONTH/YEAR)
More than 1 year ago (before XX MONTH/YEAR)
Can't remember

(59 Question Name = Previous advice1)
Please touch all that apply
Has a doctor ever talked to you or given you advice about any of these things?
weight
smoking
exercise
diet
alcohol
drugs
depression
None of these

(60 Question Name = Previous advice2)
Please touch all that apply
Has a doctor ever talked to you or given you advice about any of these things?
Blood pressure
Blood cholesterol
Diabetes
Tests for cancer
None of these

(61 Question Name = Marital status)
Section 2: About You

What is your marital status?
Single
Married or living with a partner (defacto)
Divorced or separated
Widowed
Other

(62 Question Name = Education)
What is the highest level of education you have completed?
- Primary school
- Some high school (year 9 or below)
- Year 10 (at school or TAFE)
- Year 12 (at school or TAFE)
- TAFE course
- University or other tertiary qualification
- Other

(63 Question Name = Income source)
What is your main source of income?
- Centrelink (e.g. Newstart, Disability pension or Abstudy)
- Part-time or casual employment
- Full time employment
- Supported by a partner or other family member
- Self employed
- Other

(64 Question Name = Payday)
Was payday in the last 7 days?
- Yes
- No
- Not sure

(65 Question Name = Practice visits)
About how many times in the past 12 months have you come to this practice to see a doctor or Health Worker?
- None
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more

(66 Question Name = Housing)
Which best describes the type of housing where you live?
- Privately rented
- Rented from the government (Housing Commission)
- Community Housing
- Owned or being paid off
- Boarding
- Housing provided by work
- Staying with family
- Other

(67 Question Name = No. Adults)
How many OTHER adults (18yrs +) usually live in the same house as you?
- None
- 1
- 2
- 3
- 4
- 5 or more

(68 Question Name = No. Children)
How many children (under 18 yrs) usually live in the same house as you?
- None
- 1
- 2
- 3
- 4

5 or more

(69 Question Name = No. Bedrooms)
How many bedrooms are there in your house?
None
1
2
3
4
5 or more

(70 Question Name = Physical force)
In the last 12 months, did anyone, including people you know, use physical force or violence against you?
Yes
No

(71 Question Name = Emotional)
In the last 12 months, did anyone, including people you know, use emotional violence against you e.g. insult you, swear or scream at you, or threaten to hurt you?
Never
Sometimes
Often

NOTE: THE FOLLOWING SURVEY ACCEPTABILITY QUESTIONS 78-80 WERE ONLY ANSWERED BY PARTICIPANTS FROM SITE 1

(78 Question Name = Survey acceptability 1)
Section 3: About the Survey
These questions are about what you thought of the survey.

When doing the survey:
The instructions were easy to follow
The touchscreen was easy to use
I had enough privacy
The questions were easy to understand
I felt comfortable answering all the questions
Yes
No
Not sure

(79 Question Name = How often willing to complete)
How often would you be willing to complete a survey like this (with different questions) when you come to see your doctor?
Only once
Sometimes
Most of the time
Every time

(80 Question Name = Results to GP)
For future surveys, would you be happy for your doctor to see a copy of your survey answers?
Yes
No
Not sure

NOTE: THE FOLLOWING QUESTIONS 72-97 ABOUT MAKING HEALTH CHANGES WERE ONLY ANSWERED BY PARTICIPANTS FROM SITE 2

(72 Question Name = Want GP advice)
Please choose as many as you want
SECTION 3: HEALTH CHANGES
Would you like advice from your doctor about:
weight
smoking

exercise
diet
alcohol
drugs
depression
None of these

(73 Question Name = Want GP advice2)
Please choose as many as you want
Would you like advice from your doctor about:
Blood pressure
Blood cholesterol
Diabetes
Tests for cancer
None of these

(74 Question Name = Hardest change)
Please choose ONE option
Which of these health changes would be the HARDEST for you to make?
Lose weight
Stop or cut down smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Find ways to feel less sad or depressed
Not sure/ None of these

(75 Question Name = Changes want to make)
Please choose as many as you want
If you could get help, are there any of these changes you would like to make?
lose weight
stop or cut down smoking
drink less alcohol
get more exercise
eat more fruit and veg
stop or cut down drug use
Find ways to feel less sad or depressed
None of these

(76 Question Name = When change Weight)
When do you think you will try to lose weight?
I'm already trying to lose weight
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(77 Question Name = When change Smoking)
When do you think you will try to stop or cut down smoking?
I'm already trying to stop/cut down smoking
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(78 Question Name = When change Alcohol)
When do you think you will start to try to drink less alcohol?
I'm already trying to drink less alcohol
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(79 Question Name = When change Exercise)
When do you think you will start to try to get more exercise?
I'm already trying to do more exercise
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(80 Question Name = When change Fruit and veg)
When do you think you will start to try to eat more fruit and veg?
I'm already trying to eat more fruit and veg
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(81 Question Name = When change Drugs)
When do you think you will try to stop or cut down drug use?
I'm already trying to stop or cut down on drug use
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(82 Question Name = When change Depression)
When would you like help to change feelings of sadness or depression?
I'm already getting help
In the next month
In the next 2-6 months
Sometime, but not in the next 6 months

(83 Question Name = Approach)
Please choose one
If you could get help (eg from your doctor or a health worker), what would be the best way for you to make these changes?
I would finish making one change before I started on the next one
Once I started to get somewhere with one change, I would start on the next one
I would try to make some or all of these changes at once

(84 Question Name = Approach Same)
Please choose as many as you want
Which changes would you try to make at the same time?
Lose weight
Stop or cut down smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feelings of depression or sadness

(85 Question Name = Assistance AMS)
Please choose as many as you want
Would you use any of these services to help you make this health change or these health changes?
Advice and help from my doctor or Health Worker, who checks how I'm going
My doctor or Health Worker arranging for me to see a specialist (like a dietician/ exercise coach/ counsellor)
I arrange to see a specialist myself (like a dietician, counsellor/ exercise coach)
None of these

(86 Question Name = GP AHW Assistance for)
Please choose as many as you want
Which health changes would you use advice and help from your doctor or Health Worker for?
Lose weight
Stop or cut down smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feeling less sad or depressed

(87 Question Name = GP AHW arrange to see specialist)
Please choose as many as you want
Which health changes would want your doctor or Health Worker to refer you to a specialist for? (eg a dietician/ exercise coach/ counsellor)
Lose weight
Stop or cut down on smoking
Drink less alcohol

Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feeling less sad or depressed

(88 Question Name = Arrange see specialist self)
Please choose as many as you want
Which health changes would you arrange to see a specialist for? (eg dietician/ exercise coach/ counsellor)
Lose weight
Stop or cut down on smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feeling less sad or depressed

(89 Question Name = Self or More AMS)
Please choose one
Would you want this help to be:
Just for me
For me and ONE support person (like my partner, a parent or sibling, or a close friend)
For me and other members of my family or my friends
Not sure

(90 Question Name = Assistance Other)
Please choose as many as you want
Would you use any of these services to help you make this health change or these health changes?
Go to face-to-face support group meetings with others also trying to change
Use a computer to get emails or on-line advice and support
Call a telephone service for advice and support
Take home books or DVDs with information and advice
Use a phone app and text messages for advice and support
None of these

(91 Question Name = Support gp help for)
Please choose as many as you want
Which health changes would you go to a face to face support group for?
Lose weight
Stop or cut down smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feeling less sad or depressed

(92 Question Name = Phone support for)
Please choose as many as you want
Which health changes would you use a telephone support service for?
Lose weight
Stop or cut down on smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feeling less sad or depressed

(93 Question Name = Computer help for)
Please choose as many as you want
Which health changes would you use a computer to get emails and online advice and support for?
Lose weight
Stop or cut down smoking
Drink less alcohol
Get more exercise
Eat more fruit and veg
Stop or cut down on drug use
Work on feeling less sad or depressed

(94 Question Name = Book or DVD help for)
Please choose as many as you want
Which health changes would you use take home books or DVDs for?
- Lose weight
- Stop or cut down on smoking
- Drink less alcohol
- Get more exercise
- Eat more fruit and veg
- Stop or cut down on drug use
- Work on feeling less sad or depressed

(95 Question Name = Phone app help for)
Please choose as many as you want
Which health changes would you use a phone app and text messages for?
- Lose weight
- Stop or cut down smoking
- Drink less alcohol
- Get more exercise
- Eat more fruit and veg
- Stop or cut down on drug use
- Work on feeling less sad or depressed

(96 Question Name = Self or More Other)
Please choose one
Would you want this help to be:
- Just for me
- For me and ONE support person (like my partner, a parent or sibling, or a close friend)
- For me and other members of my family or my friends
- Not sure

(97 Question Name = One thing)
Please choose one
If you could choose ONE thing that would improve your life the most, what would you choose?
- Being healthier
- My family being healthier
- Having better relationships with my family or friends
- Better housing
- Having a job or a better job
- A better education or being able to study
- Stop violence at home
- Stop violence and crime in my community
- Stop racism or discrimination
- Not sure
- None of these

(98 Question Name = Finish screen)

Appendix 8.5: Exit Survey Questions (*Paper two)*

Note: This is a text version of the survey. The touchscreen exit survey completed by participants included images or pictures to illustrate the questions where possible.
The exit survey was completed by participants after their GP appointment

(1 Question Name = Info Screen)

(2 Question Name = Participant ID)
Enter participant ID: <FROM ID SLIP GIVEN TO PARTICIPANTS WHEN COMPLETING THE HEALTH RISK SURVEY>

(3 Question Name = Talk about topics)
Touch all that apply, then touch NEXT
Did you and your doctor or health worker talk about any of these health topics in your appointment today?
- Weight
- Smoking
- Alcohol
- Diet
- Exercise
- Drugs
- None of these topics
- I prefer not to say

(4 Question Name = Talk about topics2)
Touch all that apply, then touch next
Did you and your doctor or health worker talk about any of these health topics in your appointment today?
- Depression
- BP
- Cholesterol
- Diabetes
- Cancer
- None of these topics
- I prefer not to say

(5 Question Name = Did checklist help)
Touch all that apply, then touch NEXT
Did the checklist we gave you help you to talk about any of those topics?
- Yes- I gave the checklist to the doctor
- Yes- the checklist gave me some ideas about what to ask the doctor
- No- I didn't use the checklist
- Not sure

(6 Question Name = Action)
Touch all that apply, then touch NEXT
Thinking ONLY about the health topics on the checklist (pictured), did your doctor or health worker do any of these things today?
- Helped me plan changes to my lifestyle
- Gave me information (e.g. website or pamphlets)
- Gave me a test
- None of these things

(7 Question Name = Action(2))
Touch all that apply, then touch NEXT
Again thinking ONLY about the health topics on the checklist (pictured), did your doctor or health worker do any of these things today?
- Booked a test for me or gave me a referral for a test
- Organised a follow up appointment for me
- Prescribed a medication for me
- Something else
- My doctor or health worker didn't do anything else

(8 Question Name = Checklist feedback)
This last question is about the checklist that we gave you.

I think that the checklist:

Was easy to understand
Was relevant to me
Will help me improve my health
Yes
No
Not sure

(9 Question Name = Finish screen)

Appendix 8.6: Generic and Tailored Health Risk Feedback Sheets (*Paper two)*

Generic Feedback Sheet:

Healthy Guidelines Checklist

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

These are some of the screening tests recommended for people at average risk:

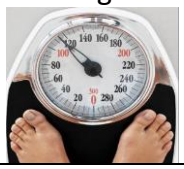
Which test?	Who should have the test?	How often?
Breast cancer check (Mammogram)	All women aged from 50-69 yrs	Every 2 years
Cervical cancer check (Pap smear test)	All women aged 18 yrs and older	Every 2 years
Bowel cancer check (Faecal Occult Blood Test)	Anyone aged 50-75 yrs	Every 2 years
Blood pressure check	Indigenous people with diabetes, high blood pressure or kidney disease	Every 6 months
	Indigenous people, and non-Indigenous people aged 50 yrs or older	Every year
	Non-Indigenous people	Every 2 years
Blood cholesterol test	All Indigenous people	Every year
	Non-Indigenous people aged 45 yrs and older	Every 5 years
Diabetes check (Fasting blood sugar test)	All Indigenous people aged 35 yrs and older	Every 2 years
Blood sugar test (HbA1c test)	All people with diabetes	Every 6 months

Some people who have more risks might need to have the tests more often.

PLEASE TALK TO YOUR DOCTOR OR HEALTH WORKER ABOUT WHAT TESTS YOU MIGHT NEED.

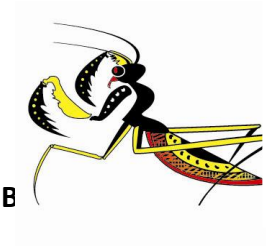
TALK TO YOUR DOCTOR OR HEALTH WORKER BEFORE YOU MAKE ANY BIG CHANGES TO YOUR LIFESTYLE

Some of these may apply to you:

Weight 	Keeping a healthy weight is important. Ask your doctor or health worker whether you need to lose weight.
Depression	If you feel sad or depressed a lot, talk to your doctor or health worker.
Smoking	If you are a smoker, quitting smoking will improve your health. Talk to your doctor or health worker about ways to quit.
Alcohol	National guidelines recommend: Only two standard drinks per day to avoid diseases like cancer. Talk to your doctor or health worker about ways to limit alcohol.
Drug Use	If you are concerned about your drug use, talk to your doctor or health worker.
Fruit and Vegetables	National guidelines recommend that healthy adults eat: 2 serves of fruit each day 5 serves of vegetables each day (2 ½ cups of cooked vegies or 5 cups of salad)
Exercise	National guidelines recommend that healthy adults: Do at least 30 minutes of moderate exercise most days.

Your GP or Health Worker may be able to give you advice or tell you about other people or programs to help you improve your health.

Example Tailored Feedback Sheet:



FOR YOU:
Your Health Checklist

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

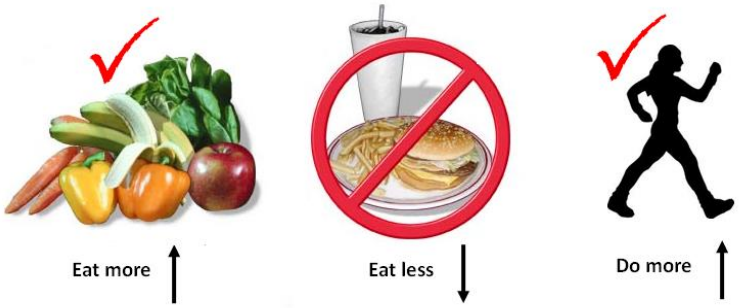
B CTING YOUR HEALTH.

NB: This advice was tailored and presented according to the risk status of each participant

You might want to talk to your doctor or health worker about:

Health Issue	What Can I Do?
Smoking	• Stopping smoking for good will help your health. • If you want to quit, talk to your doctor. • Medicines can help you stop. Ask your doctor, health worker or pharmacist. Nicotine patches Nicotine gum • Your smoking can affect others. Avoid smoking indoors, in the car or near children. ✓ Feel fitter and have more energy for your family ✓Save money on cigarettes $$$
Eating enough Fruit and Vegetables **You have <Q16> serves of fruit & <Q17> of vegetables a day**	• Eat 2 or more pieces of fruit per day. • Eat at least 5 serves of vegetables a day. 2 serves ✓ 5 serves (2½ cups of veg or 5 cups of salad) ✓ • Have some fruit like an apple or orange as a snack. • Add some vegetables or a salad to your meal. ✓Help prevent heart disease, stroke and some cancers
Not enough exercise	• Do 30 minutes of exercise every day. • This can be 3 x 10min sessions.

Health Issue	What Can I Do?
	 • Try going for a walk with friends or the kids or walking to the shop instead of driving. ✓Have more energy for your family ✓Help to lose weight
Your alcohol use **You <sometimes drink more than 4 drinks on one occasion> or <often drink more than 2 drinks every day>**	• Have no more than 4 drinks in one session. • Try to have 2 or less drinks a day. • Try drinks with less alcohol, like light beer. Drink water in between alcohol drinks. ✓ Better for your brain and your liver ✓ Less risk of hurting yourself or others
Depression **Your score = <INSERT>** You might have <mild/mod/severe> depression	• If you feel sad, depressed or hopeless a lot, talk to your doctor, health worker or a friend. • Ask to see a counsellor. • Call Lifeline on 13 11 14. • Beyond Blue can also help. Call 1300 224636.
Your drug use 	• Get help to avoid using drugs. • Ask to see the Drug and Alcohol Health Worker.

Health Issue	What Can I Do?
	• Try other support services: ✓Counselling Online (anytime 7 days per week): www.counsellingonline.org.au/en/ ✓Cannabis information & helpline (11am-8pm Mon-Fri): Call 1800 30 40 50.
Your weight **Your weight = <Q6>** **A healthy weight for you = <(Q7/100)^2 x 25>**	• Eat plenty of fruit and vegetables. Eat less fatty, fried or sugary foods.  • Do more exercise like going for a walk, or doing a sport. • Call the 'Get Healthy Information and Coaching Service' (Mon- Fri 8am – 8pm) on 1300 806 258. ✓Be healthier for your family ✓Less risk of getting diabetes

Your doctor or health worker may be able to give you advice or tell you about other people or programs to help you improve your health.

TALK TO YOUR DOCTOR OR HEALTH WORKER BEFORE MAKING ANY BIG CHANGES.

SOME TESTS YOU MIGHT NEED:

Ask your doctor of health worker if you need any of these tests

1. Breast cancer test (a mammogram)
2. Cervical cancer test (a pap smear test)
3. Bowel cancer test (a Faecal Occult Blood Test)
4. Blood pressure check
5. Blood cholesterol test
6. Blood test for diabetes (a fasting blood sugar test)
7. Blood sugar test (HbA1c test to measure your blood sugars over the last month)

Example GP prompt sheet:

Note: This GP prompt sheet was only provided to participants at site 2. The relevant column (advice only, help in the next month, help in a few months' time) was ticked according to participants' survey responses.

THIS SECTION IS FOR YOUR DOCTOR.
[Your doctor can give you advice or help you start to make these health changes]

I WOULD LIKE ADVICE OR HELP FOR:	ADVICE ONLY	HELP IN THE NEXT MONTH	HELP IN A FEW MONTHS
Losing weight	☐	☐	☐
Quitting or cutting down smoking	☐	☐	☐
Drinking less alcohol	☐	☐	☐
Getting more exercise	☐	☐	☐
Eating more fruit and veg	☐	☐	☐
Stopping or cutting down on drug use	☐	☐	☐
Depression or feelings of sadness	☐	☐	☐