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DEVELOPMENT OF A CHRONIC DISEASE RISK FACTOR INDEX AND IDENTIFYING POPULATION SUBGROUPS AT RISK USING NEW SOUTH WALES ADULT HEALTH SURVEY 2002 DATA

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Recent chronic disease prevention frameworks at both the national and state level in Australia have emphasised a transition from vertical, single-issue public health efforts to a more coordinated approach that targets clustered risk factors for chronic disease.[1,2] An integrated approach to reducing modifiable risk factors requires the development of suitable performance measures that can be used to monitor the progress and effectiveness of combined efforts as well as to identify trends in the risk of population subgroups to assess progress in addressing health inequalities.

NSW Health recently proposed the concept of a 'Dashboard of Indicators' to monitor health system performance and prevention activities. This study describes different methods of calculating an indicator of chronic disease risk using health behaviour measures from the NSW Adult Health Survey 2002, and explores the use of a summary indicator for identifying subgroups within the population at high risk of developing chronic disease.

BACKGROUND

An important role of surveillance is to describe the population prevalence and clustering of risk factors for chronic disease.[3-9] Risk factor clustering has been described for obese populations[10] and for those with coronary artery disease.[11] Other studies have used cohort data on multiple risk factors to predict mortality[12-14] or specific disease outcomes.[11, 13-15]

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The methods for assessing risk factor clustering vary widely across studies. Most researchers have simply summed the number of risk behaviours or conditions for each person[4, 6, 7, 9, 10, 13-16], while others have looked at *a priori* defined combinations of specific risk factors[5, 11, 12] or which risk factors are more likely to co-exist or 'cluster'.[6-8] Murtagh and colleagues also calculated a numerical risk score which considered the magnitude of the dose-response relationship in the scoring system.[8] Kim and colleagues created a 'lifestyle index' that also weighted different risk factors according to their contribution to different disease outcomes in China and the United States.[17] This paper extends previous work by developing and comparing indexes that include a weighting of risk factors by their contribution to the burden of disease in Australia, which is methodologically more rigorous than previous summary indices.

The chronic diseases included in the *NSW Chronic Disease Prevention Strategy* 2003–2007 are cardiovascular diseases, cancers, asthma and chronic lung disease, non-insulin-dependent (Type II) diabetes, obesity, injuries from falls, and poor emotional and psychological well-being.[2] The primary risk factors agreed upon in the strategy as potentially contributing to chronic disease risk include smoking, poor nutrition (lack of fruit and vegetables), hazardous alcohol use, physical inactivity, and psychosocial risk factors such as stress. This study describes the development of summary indices for clusters of chronic disease risk factors in the NSW population, based on risk behaviours reported in the NSW Adult Health Survey 2002.

METHODS

This analysis used data from all adults (aged 16 years and over) who participated in the NSW Adult Health Survey 2002. Cases were excluded where the participant had not responded to survey items to assess each of the risk behaviours and demographic variables.

The model of chronic disease risk outlined in the *Chronic Disease Prevention Strategy 2003–2007*[2] formed the basis of the analysis, with slight modifications for theoretical and measurement-related reasons. Psychological health was excluded from this analysis for two reasons: firstly

TABLE 1

RISK FACTOR SCORE ASSIGNMENT TO THREE CHRONIC DISEASE RISK FACTOR INDEXES

	Definitions of risk and attributable weight			
	Index 1	**Index 2**		**Index 3**
	Dichotomous categories currently used for NSW Health reporting (un-weighted) (Range = 0–5)	Dichotomous categories weighted for different contributions to the score proportionate to their contribution to total DALYs[a] (Range for males = 0–2.47) (Range for females = 0–3.08)[b]		Unweighted multiple categories developed according to linear risk associated with differing levels of the risk factor (Range = 0–3.8)
		Males	**Females**	
Smoking	Smoker = 1 Non–smoker = 0	Smoker = 1 Non-smoker = 0	Smoker = 1 Non-smoker = 0	Smoke daily = 1 Smoke occasionally = 0.8 Ex-smoker = 0.5 Never smoked = 0
Lack of fruit & vegetables	Inadequate = 1 Adequate = 0	Inadequate = 0.25 Adequate = 0	Inadequate = 0.35 Adequate = 0	Tertiles for total serves per day Low = 0.4 Moderate = 0.2 High = 0
Alcohol[c]	Any risk drinking = 1 No risk drinking = 0	Any risk = 0.35 No risk = 0	Any risk = 0 No risk = 0	Non-drinker/low risk = 0 Hazardous = 0.3 Harmful = 0.4
Physical inactivity	Inadequate PA[d] = 1 Adequate PA = 0	Inadequate = 0.5 Adequate = 0	Inadequate = 1.1 Adequate = 0	Sedentary = 1 Inadequate = 0.4 Adequate = 0.1 High = 0
Overweight and obesity	Not o'weight/ obese = 0 O'weight or obese = 1	Not o'weight/ obese = 0 O'weight/ obese = 0.37	Not o'weight/ obese = 0 O'weight/ obese = 0.63	Underweight/ healthy weight = 0 O'weight = 0.3 Obese = 1

[a] Disability-adjusted life years

[b] Since the attributable burden of disease associated with each risk factor differs for men and women, the score for the presence of each risk factor and the resulting index (Index 2) are gender-specific.

[c] For alcohol, the total attributable risk used to calculate Index 2 and Index 3 was based on the sum of the contribution of alcohol harm and alcohol benefit (negative risk).

[d] Physical activity

because it has not been applied as a risk factor in other studies and secondly because the K-10 measure of psychological distress in the survey comprises a chronic disease outcome. Overweight and obesity (based on body mass index calculated from self-reported height and weight) was included as a risk factor rather than a disease outcome, since this is consistent with current risk factors defined in the Burden of Disease and Injury in Australia study.[18] Risk factors included in the analysis are outlined in Table 1. The definitions used to categorise exposure to each risk factor were consistent with national reporting norms[18] and are explained and justified elsewhere.[19]

Three methods for defining the primary risk factors to construct a chronic disease risk factor index were explored (see Table 1):

1. Utilising dichotomous categories currently used for reporting by the ongoing NSW Population Health Survey as a basis for scoring each risk factor, assigning a score of one for exposure to the risk factor and a score of zero for no exposure. Scores were summed across risk factors to calculate Index 1, which represents the total number of risk factors. This method assumes the equal influence of each risk factor in developing chronic disease.
2. Dichotomous scoring for each risk factor weighted proportionate to its contribution to the total burden of disease (measured in disability-adjusted life years, or DALYs)[18] relative to the contribution of smoking (set at a score of one). Risk factors were weighted relative to smoking because tobacco contributes most to the overall burden of disease.[18] Weighted scores were then summed across risk factors to calculate Index 2. This method attempts to account for the differential contribution of risk factors to chronic disease outcomes and is thus more sensitive to differences in risk factors that have higher contributions to the burden of disease (such as smoking in men and physical inactivity among women).
3. To account for dose response relationships between primary risk factors and chronic diseases, the total risk for each risk factor was divided across levels of exposure to the risk factor. This was distributed according to the estimated relative risk of chronic disease for each level of exposure to the risk factor, based on current epidemiological evidence. The sum of 'weighted' scores across risk factors was used to derive the index (see Table 1). This method attempts to account for linear associations between risk factor exposure and chronic disease, and is thus more sensitive to the cumulative effect of exposure to multiple risk factors at lower levels. The justification for the relative weighting of categories for each risk factor is reported elsewhere.[19]

In order to identify population sub-groups at increased risk and compare findings using the different indices, differences in mean risk factor index levels across the three risk indices were described by gender, age group, and ethnicity (as described by the variables 'country of birth' and 'language spoken at home'). Differences were also examined by socioeconomic status using measures of highest level of education and quintile of socioeconomic

TABLE 2

PROPORTION OF ADULTS IN NEW SOUTH WALES AGED 16 YEARS AND OVER WITH A HIGH INDEX 2 ACROSS LEVELS OF SOCIODEMOGRAPHIC CHARACTERISTICS, AND ESTIMATED ODDS RATIOS (OR) WITH AND WITHOUT ADJUSTMENT FOR OTHER SOCIODEMOGRAPHIC VARIABLES

	Men					Women				
	% (high risk)	OR	95% CI	Adjusted OR[a]	95% CI	% (high risk)	OR	95% CI	Adjusted OR[a]	95% CI
Socioeconomic disadvantage										
Least disadvantaged	19.9	1.0		1.0		19.3	1.0		1.0	
Second least disadvantaged	23.8	1.3	0.9–1.7	1.2	0.9–1.6	23.7	1.3	1.0–1.7	1.2	0.9–1.6
Mid disadvantage	26.6	1.5	1.1–1.9[b]	1.4	1.0–1.8	27.8	1.6	1.3–2.1[b]	1.5	1.2–1.9[b]
Second most disadvantaged	28.9	1.6	1.3–2.1[b]	1.5	1.3–2.0[b]	31.6	1.9	1.5–2.5[b]	1.8	1.4–2.2[b]
Most disadvantaged	32.5	1.9.	1.5–2.5[b]	1.8	1.4–2.4[b]	33.3	2.1	1.6–2.6[b]	1.8	1.4–2.3[b]
Language spoken at home										
English speaking	28.4	1.0		1.0		29.6	1.0		1.0	
Non-English speaking	24.0	0.8	0.6–1.0	0.8	0.6–1.0	27.1	0.9	0.7–1.1	1.0	0.8–1.3
Educational Attainment										
Tertiary educated	19.3	1.0		1.0		19.9	1.0		1.0	
No tertiary education	30.3	1.8	1.5–2.2[c]	1.7	1.5–2.1[c]	31.5	1.9	1.6–2.1[c]	1.6	1.4–1.9[c]

CI = confidence interval

[a] Adjusted for age and other sociodemographic characteristics presented in the table.

[b] Significantly different from those in the least disadvantaged quintile.

[c] Significantly different from those with a tertiary degree.

Source: NSW Adult Health Survey 2002

disadvantage, based on the SEIFA (socioeconomic index for areas) index of relative socioeconomic disadvantage.[20] Independent sample two-tailed t-tests and one-way analysis of variance was used to examine differences across demographic groups for each index.

Further analysis was conducted using Index 2, because this score used risk categories aligned with the current reporting categories from the ongoing NSW Population Health Survey while accounting for the differential contribution of each risk factor to overall chronic disease risk. Index 2 was categorised as 'high' (vs 'other') based on the highest quartile of scores (ie upper 25 per cent) in the distribution for men and women separately. Logistic regression analysis assessed the likelihood of having a 'high' Index 2 score based on sociodemographic variables. The models for each index were gender specific, and were calculated both with and without adjustment for other sociodemographic variables. All statistical analysis was conducted using SPSS 13.0.

RESULTS

Of the total sample aged 16 years or over, 92.8 per cent (N = 11,710) responded to all items necessary for calculation of the indices and were included.

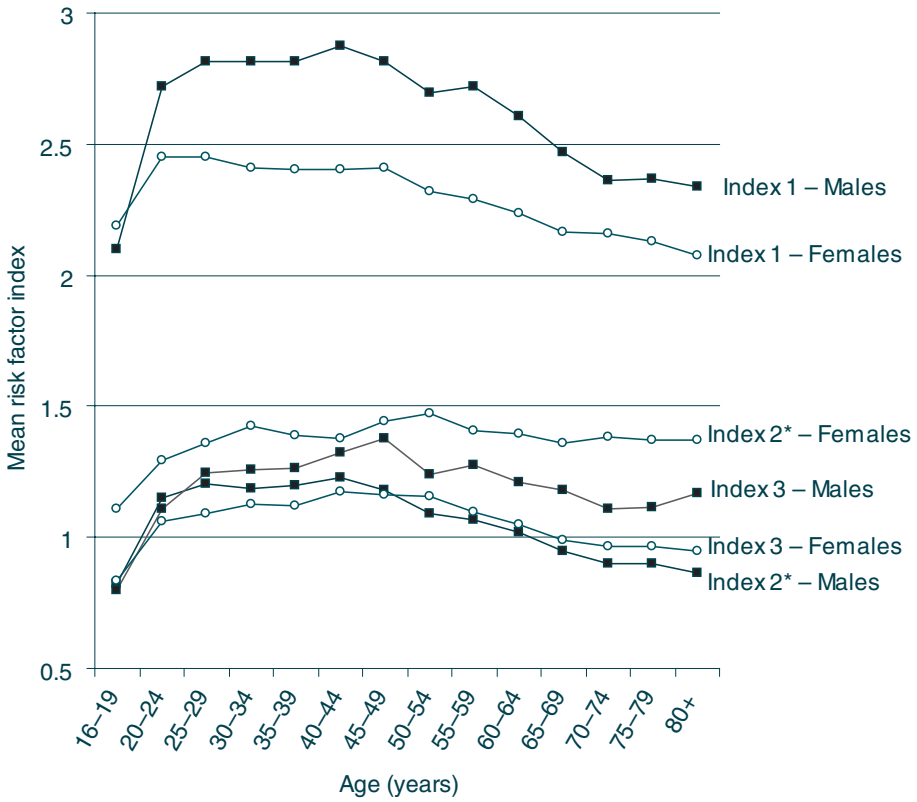
The mean index was significantly higher among men than women for both Index 1 ($p<0.001$), and Index 3 ($p<0.001$). Index 2 was not compared between men and women since score construction was gender-specific. Mean indices across all three scoring protocols were significantly different by age groups for men and women ($p<0.001$; see Figure 1). Differences between men and women in the pattern of mean Index 3 in older age groups suggest that there is a steady decline in risk with age among women that is not evident among men.

Mean index across all three indices increased significantly with increasing socioeconomic disadvantage for both men and women ($p<0.001$; see Figure 2). Similar patterns across levels of education were found for both men and women using each index, and those who had completed a tertiary degree had significantly lower risk across all indices for both men and women ($p<0.001$).

The majority of the people sampled were Australian born (80.2 per cent), and had a slightly higher mean Index 1 ($p<0.001$) and mean Index 3 ($p<0.001$) compared with

FIGURE 1

MEAN RISK FACTOR INDICES BY AGE FOR NEW SOUTH WALES ADULTS AGED 16 YEARS AND OVER IN 2002



*The score construction for Index 2 was gender specific, so the results for males and females cannot be compared.

Source: NSW Adult Health Survey, 2002

those born elsewhere (Mean (Index 1) = 2.31 and Mean (Index 3) = 1.06). When separated by gender, the mean of all indices was higher among those born in Australia than those born elsewhere ($p<0.001$).

The majority of the sample spoke English at home (92.8 per cent), and had significantly higher mean Index 1 ($p<0.001$) and Index 3 score ($p<0.05$) compared to those who spoke a language other than English. Among men, higher mean scores were evident among English-speaking respondents for all indices ($p<0.01$). English-speaking women had a significantly higher mean Index 1 ($p<0.01$) and Index 3 ($p<0.001$) compared to those who spoke a language other than English at home, but there was no significant difference in mean Index 2 scores.

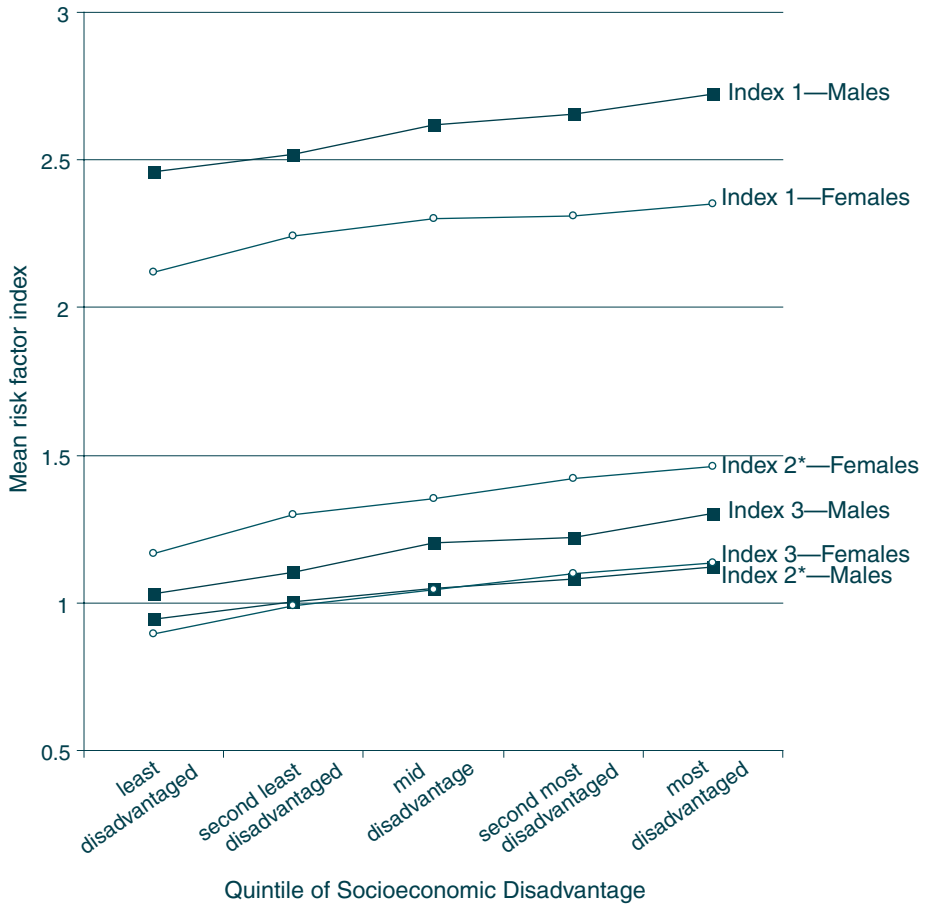
Both men and women in the three highest quintiles of socioeconomic disadvantage were more likely to be at high risk using Index 2 than those in the least disadvantaged quintile (see Table 2). Not having a tertiary degree significantly increased the likelihood of being at high risk for both men and women after adjusting for age, language spoken at home, and socioeconomic disadvantage.

DISCUSSION

The results demonstrate the calculation and use of chronic disease risk factor indices in population surveys. These different scoring protocols generally find similar at-risk population sub-groups. Consistent findings suggest that mean risk scores and the odds of a high risk score decrease with socioeconomic advantage and education among both men and women. Speaking a language other than English at home and being born outside Australia were significantly associated with lower risk, with the exception of Index 2 among women. Since Index 2 is more heavily weighted for physical inactivity because of its substantial contribution to ill health among women, lack of difference based on language may be explained by a high prevalence of physical inactivity among non-English speaking women in Australia.[21]

FIGURE 2

MEAN RISK FACTOR INDICES BY QUINTILE OF SOCIOECONOMIC DISADVANTAGE FOR NEW SOUTH WALES ADULTS AGED 16 YEARS AND OVER



*The score construction for Index 2 was gender specific, so the results for males and females cannot be compared.

Source: NSW Adult Health Study, 2002

Comparison of risk across age groups suggests that those aged 16–19 years have significantly lower summary risk scores compared with those in all other age groups. However, this may be partly attributable to misreporting of certain risk behaviours that are legislatively discouraged for those at the lower end of this age group (such as tobacco and alcohol use). Risk behaviours appear to steadily decrease with age among those 50 years and older. The observed decline in risk factors with age may be confounded by a survival effect, whereby those people who survive into older age have lower summary risk than those who do not. There is a steep decrease in number of risk factors among men from age 60, which is not evident among women. This may be attributable to the earlier onset of heart disease in men.[21]

Patterns of risk according to age group also revealed some interesting differences between an index based on crude number of risk factors compared to that which accounts for differing levels of exposure to each risk factor. Most notably, the decline with increasing age was steeper for Index 1 than for Index 3. Since the scoring of Index 3 accounts for lower levels of exposure to risk behaviours, this suggests that older groups may be engaging in risk behaviours at lower levels of exposure that are not accounted for when risk is categorised dichotomously in Index 1.

Development of these chronic disease risk factor indices was limited by the questions asked in the NSW Adult Health Survey 2002. For some of the variables, these categories do not allow sensitivity analyses using alternative categories across each risk factor. Other studies with continuous measures available have developed more sensitive dose-response weighted scoring systems. More sensitive measures of these risk behaviours and appropriate weighting of each level of exposure are likely to result in less misclassification for risk of the outcome. Nonetheless, the work here, based on the Australian Burden of Disease study [18], allows a comparison with other work done at the national level. It has also helped to identify population sub groups experiencing multiple risk factors and should inform the development of a standard index for ongoing analysis of chronic disease risks within the context of surveillance data in Australia.

CONCLUSIONS

The methods used to calculate different risk factor indices resulted in the identification of very similar high-risk population sub-groups. The findings of this study reinforce the known socioeconomic gradients in chronic disease risk as being related to economic and educational disadvantage rather than ethnicity[16], and observed trends were similar to gradients observed for single risk factors (such as tobacco, alcohol and obesity).

Index 2 uses dichotomous categories of exposure weighted proportionate to each risk factor's contribution to the total burden of disease. This method of calculating a summary measure of chronic disease risk is recommended if policymakers wish to use a summary index for ongoing surveillance; the reason for this is that it uses categories currently defined for NSW Health reporting and it is aligned with the Australian Burden of Disease approaches. [18]

A chronic disease risk factor index can be used in performance assessment for integrated public health campaigns that target multiple risk factors and attempt to address health inequities through targeting at-risk population subgroups. Before its application, the validity of the index should be tested for its ability to predict chronic disease health outcomes and for its sensitivity in detecting meaningful reductions in risk exposure.

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REFERENCES

1. National Public Health Partnership. *Preventing chronic disease: A strategic framework. (Background paper).* Melbourne; National Public Health Partnership, 2001.
2. NSW Department of Health. *NSW Chronic Disease Prevention Strategy 2003–2007.* Sydney: NSW Health, 2003.
3. Berrigan D, Dodd K, Troiano RP, Krebs-Smith SM, Barbash RB. Patterns of health behavior in U.S. adults. *Prev Med* 2003; 36: 615–23.
4. Wu DM, Pai L, Chu NF, Sung PK, Lee MS, Tsai JT, et al. Prevalence and clustering of cardiovascular risk factors among healthy adults in a Chinese population: the MJ Health Screening Center Study in Taiwan. *Int J Obes* 2001; 25: 1189–95.
5. Jackson RT, Al-Mousa Z, Al-Raqua M, Prakash P, Muhanna AN. Multiple coronary risk factors in healthy older Kuwaiti males. *Eur J Clin Nutr* 2002; 56: 709–14.
6. Schuit AJ, van Loon AJM, Tijhuis M, Ocke MC. Clustering of lifestyle risk factors in a general adult population. *Prev Med* 2002; 35: 219–24.
7. Twisk JWR, Kemper HCG, van Mechelen W, Post GB. Clustering of risk factors for coronary heart disease: the longitudinal relationship with lifestyle. *Ann Epidemiol* 2001; 11: 157–65.
8. Murtagh KH, Borde-Perry WC, Campbell KL, Gidding SS, Falkner B. Obesity, smoking, and multiple cardiovascular risk factors in young adult African Americans. *Ethn Dis* 2002; 12: 331–5.
9. New Zealand Ministry of Health. *Taking the pulse: the 1996/97 New Zealand Health Survey.* Wellington: New Zealand Ministry of Health, 1999.
10. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA* 1999; 282(16): 1523.
11. Mansur AP, Gomes EPSG, Avakian SD, Favarato D, Cesar LAM, Aldrighi JM, et al. Clustering of traditional risk factors and precocity of coronary disease in women. *Int J Cardiol* 2001; 81: 205-209.
12. Chang M, Hahn RA, tetchy SM, Hutwagner LC. Multiple risk factors and population attributable risk for ischemic heart disease mortality in the United States, 1971–1992. *J*