Australian diet quality index project

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Acknowledgments

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Abbreviations

AIHW	Australian Institute of Health and Welfare
Aust-HEI	Australian healthy eating index
CATI	computer assisted telephone interview
DQI	diet quality index
FFQ	food frequency questionnaire
HEI	healthy eating index
NHMRC	National Health and Medical Research Council
NNS	National Nutrition Survey
RDA	recommended dietary allowance (USA)
RDI	recommended dietary intake (Australia)
RFS	recommended foods score
SDQ	short dietary questions
SEIFA	Socio-economic index for areas

Summary

A diet quality index (DQI) provides a summary measure of overall diet quality. It represents a collection of scores applied to selected dietary components deemed to be representative of a healthy diet. Internationally, measures of overall diet quality have been associated with chronic disease risk and health outcomes.

This paper presents preliminary work in developing an Australian DQI, named the Australian Healthy Eating Index (Aust-HEI). The Aust-HEI is based on previously published DQIs and adapted for use with nutrition data from a food frequency questionnaire and short dietary questions. This preliminary work utilises data from the 1995 National Nutrition Survey (NNS) food frequency questionnaire (FFQ) and short dietary questions (SDQ). The Aust-HEI focuses on usual consumption of food and dietary behaviours, and consists of seven variables representing three dietary aspects—dietary variety, fruit and vegetable consumption, and fat (particularly saturated fat) consumption. These three elements have all been shown to relate to chronic disease risk, and are weighted equally in the Aust-HEI.

Application of the Aust-HEI would enable the derivation of a single measure for healthy dietary behaviours (particularly in relation to chronic disease risk) from a survey incorporating a limited nutrition component. While this would not take the place of collecting detailed nutrition data, it would enhance presentation and interpretation of data collected in more general surveys.

As there are no Australian longitudinal data with which to assess chronic disease outcomes in relation to the Aust-HEI scores, this preliminary work was developed to have construct validity (i.e. in the derivation of each score and its relation to the overall score) and was assessed for internal consistency. As a measure of healthy dietary behaviours, the Aust-HEI demonstrates internal consistency and construct validity. Individuals scoring low on any one component tend to score low overall, which implies that the overall DQI score provides a balanced representation of all three elements. It also suggests that the derivation of each component score is logical.

To follow on from this preliminary work, validation of the Aust-HEI using longitudinal data on morbidity or mortality outcomes is recommended. Existing data sources, such as the Australian longitudinal study on women's health, should be investigated as a possible source of such data. In addition, for future survey analysis to utilise the Aust-HEI most effectively, the model proposed here should be refined in conjunction with the development of a new FFQ that better reflects current food choices.

It appears that use of the Aust-HEI to derive a comprehensive measure for dietary behaviour would add value to chronic disease risk factor monitoring, as it is a relatively robust and internally consistent summary measure of healthy dietary behaviours. By using both a FFQ and SDQ, the Aust-HEI provides an indication of a range of dietary choices and behaviours, by addressing dietary variety, fruit and vegetable consumption, and saturated fat consumption.

1 Introduction

1.1 The diet quality index project

The aim of this project is to derive an Australian diet quality index (DQI), here referred to as the Australian healthy eating index (Aust-HEI), that could be used as a measure of total diet quality. This index would allow the calculation of a single measure for diet from a survey with a limited nutrition component, although it would not take the place of the collection of regular comprehensive nutrition data. The Aust-HEI particularly focuses on healthy dietary choices and behaviours relevant to chronic disease (dietary variety, fruit and vegetable consumption, and fat consumption), and is based on data from a food frequency questionnaire (FFQ) and short dietary questions (SDQ).

This paper provides an overview of relevant literature and studies relating to DQIs, an outline of a possible Aust-HEI based on existing Australian data and relevant to Australian dietary advice, assessment of the internal consistency of this index and its correlation to other variables, and a discussion of the potential applicability of this index in Australia.

The most recent national dietary intake data for Australians are from the 1995 National Nutrition Survey (NNS), and it has previously been suggested that it would be appropriate to use the 1995 NNS FFQ (which also includes SDQ) to look at indices of health status and food patterns (Baghurst et al. 2000; Coles-Rutishauser 2000). However, the FFQ used in the 1995 NNS cannot be used to quantify intake of foods, and thus nutrient intakes, as it did not collect information on serving sizes (unlike the 24-hour recall component). As a result, the Aust-HEI does not encompass measures regarding sufficiency of nutrient intakes.

One of the potential applications of this DQI model is use with data collected via a computer assisted telephone interviewing (CATI) - survey. Such surveys usually include SDQ, and could be supplemented by a mail-out FFQ. The Aust-HEI would provide a concise way to present such data, which incorporates key dietary components important in chronic disease prevention.

1.2 Diet quality indexes

A DQI is designed to provide a summary measure of overall diet quality. It represents a collection of scores applied to selected dietary components (considered to be representative of healthy eating) to make up a total DQI score. The advantage of this approach is that it takes into account dietary synergy—the relevance of the whole diet to health, not just specific foods, food groups or nutrients (Patterson et al. 1994; Kant et al. 2000; Hu 2002; Jacobs & Steffen 2003).

DQIs measure population food intake against an objective 'good diet', such as that advocated by national dietary guidelines. This is an important area of difference from other dietary pattern analyses, such as factor analysis, because it provides an 'a priori' analysis (it is determined in advance what a 'healthy' or 'good' diet is). In contrast, factor analysis bases dietary patterns on what people have chosen to consume, dividing a population into 'healthy' and 'unhealthy' patterns (Schulze et al. 2003).

1.3 Diet quality and chronic disease

Internationally, measures of overall diet quality have been associated with chronic disease risk and health outcomes (Kant et al. 2000, Jacques & Tucker 2001). Recently, McCullough et al. (2002) found that high scores on the Alternate Healthy Eating Index (see Section 2.1 for detail) were associated with significant reductions in chronic disease risk. Similarly, Kant et al. (2000) found that higher Recommended Food Scores were associated with a decreased risk of mortality in women. There is also some Australian evidence of a link between dietary variety and dietary patterns and the incidence of cardiovascular disease and cancer, respectively (Kune et al. 1987; Wahlqvist et al. 1989).

The components of the Aust-HEI—dietary variety, fruit and vegetable consumption, and saturated fat consumption—have all been seen to be related to chronic disease. Dietary variety has been linked to a range of chronic diseases (Wahlqvist et al. 1989; NHMRC 2003), fruit and vegetable consumption is associated with heart disease, stroke and some cancers (Lock et al. 2005), and consumption of saturated fat is associated with increased plasma low-density lipoprotein (LDL) cholesterol levels, which is the 'bad' cholesterol linked to heart and vascular disease (AIHW 2004).

The Aust-HEI also reflects the recommendations of the *Dietary guidelines for Australian adults* (NHMRC 2003, see Box 1). Although it is primarily based on the literature (discussed below), most of which has come from the United States of America (USA), DQIs developed in the USA have been modified for use in other countries. For example, Dubois (2000) developed a modified DQI for Canada, using Canadian dietary recommendations.

Box 1: Dietary guidelines for Australian adults

Enjoy a wide variety of nutritious foods

- *Eat plenty of vegetables, legumes and fruits*
- *Eat plenty of cereals (including breads, rice, pasta and noodles), preferably wholegrain*
- *Include lean meat, fish, poultry and/or alternatives*
- *Include milks, yoghurts, cheeses and/or alternatives: reduced fat varieties should be chosen, where possible*
- *Drink plenty of water*

and take care to:

- *Limit saturated fat and moderate total fat intake*
- *Choose foods low in salt*
- *Limit your alcohol intake if you choose to drink*
- *Consume only moderate amounts of sugars and foods containing added sugars*

Prevent weight gain: be physically active and eat according to your energy needs

Care for your food: prepare and store it safely

Encourage and support breastfeeding

Source: NHMRC 2003.

2 Developing the Aust-HEI

2.1 Background

There is a wide range of DQIs represented in the literature, which vary in composition from reasonably basic measures relating to variety or whether 'recommended' foods are consumed, to complex indices requiring substantial analysis of the components of composite foods. This section summarises some of the key DQIs from the literature review that was conducted.

The FFQ-SDQ-based DQI developed for this project was based on the literature, however (unlike many previous DQIs) it does not utilise 24-hour recall data.

Newby et al. (2003) developed the diet quality index—revised (DQI-R) to include additional aspects of diet quality such as variety and moderation. It uses a scoring system similar to the original DQI (Patterson et al. (1994); the DQI had eight categories with scores ranging from 0–10). The original DQI categories were total fat, saturated fat, cholesterol, fruit and vegetables, grains and legumes, protein, sodium, and calcium. The changes with the DQI-R are based on the US dietary guidelines, and include the addition of dietary moderation and diversity as two new components, the division of fruit and vegetables into two separate components, the simplification of the grains and legumes category to only grains, the removal of sodium, and the replacing of protein with iron. The total fat, saturated fat and cholesterol components were categorically scored as 0, 5 or 10, and the remaining components were scored as continuous variables from 0–10, proportional to the recommended range of intake.

McCullough et al. (2002) found that the alternate healthy eating index (AHEI) predicted chronic disease risk better than the HEI or RFS (see below). A FFQ was used which had specified serving sizes for foods, and thus nutrient intakes could be computed. The nine components were servings per day of vegetables, fruit, nuts and soy, and alcohol, ratio of white to red meat, cereal fibre (g/day), trans fat (% energy), the ratio of polyunsaturated to saturated fat, and duration of multivitamin use. Each component received a score out of 10, except for multivitamin use, which was scored at either 2.5 (for non-use) or 7.5 (for use).

Kant et al. (2000) included foods in the recommended foods score (RFS) based on food types emphasised in the dietary guidelines, and found that this correlated with mortality. The components of the score were chosen from an FFQ '…because current dietary guidelines emphasize consumption of fruits, vegetables, whole grains, lean meats or meat alternates, and low-fat dairy, we decided that all questionnaire items corresponding to these groups would contribute to the score'.

The scoring was based on the sum of recommended foods consumed at least weekly. They thus had a list that served more as a marker of healthy food choices rather than a comprehensive summary of all foods that might be considered 'healthy' in all the groups.

Kennedy et al. (1995) developed the healthy eating index (HEI) as a measure of overall diet quality. The HEI is based on: the recommended servings consumed from five food groups (grains, vegetables, fruits, milk and meat); recommended consumption of fat, saturated fat, cholesterol and sodium; and a measure of dietary variety. The HEI was derived from a FFQ that incorporated serving sizes. The HEI was assessed for relevance using the degree to

which it correlated with other measures of diet quality, namely the recommended dietary allowances (RDAs) for energy and key nutrients.

Wahlqvist et al. (1989) devised an Australian dietary variety score from an index based on broad food groups (foods were grouped according to their biological source—animal, plant etc.). Subjects kept 7-day food records, using food models to estimate quantities and types of food consumed. Between 13% and 19% of the variance in arterial wall indices (a measure of macrovascular disease) was explained by food variety.

2.2 Methodology

2.2.1 Overview

The Aust-HEI is designed to provide a measure of total diet quality based on food choice and whether 'recommended' foods are being chosen—in this case, relevant to the *Dietary guidelines for Australian adults* (NHMRC 2003) and the *Australian guide to healthy eating* (Smith et al. 1998). For this preliminary development work, we assumed a similar link to health, morbidity and mortality as seen in the literature. The analysis was conducted on the 1995 NNS data, held by the AIHW. For more detail on the NNS, see McLennan & Podger (1998).

The components are measures of variety and healthy choice (from the FFQ), fruit and vegetable consumption (from the SDQ), and behaviours and consumption patterns associated with fat intakes (type of milk usually consumed and whether meat is usually trimmed of fat, from the SDQ; consumption of low nutrient 'junk' foods high in saturated fat, from the FFQ). The Aust-HEI was developed to have construct validity, which refers to the make-up of each component being feasible and relevant to the aspect of diet it is supposed to reflect (e.g. adhering to any relevant recommendations).

The Aust-HEI was assessed for internal consistency, primarily the contribution of variables to the complete index. It was also correlated with other measures of nutrient intake, in the same way other DQIs have been validated (Kennedy et al. 1995), although use of this as a method of validation was severely limited by the substantial methodological differences between the FFQ and SDQ data, and the 24-hour recall data (see Rutishauser 2000 for more detail). Longitudinal morbidity and mortality outcomes have also been used to validate DQIs (e.g. Wahlqvist et al. 1989; Kant et al. 2000; Newby et al. 2003,). However, it was not possible to correlate the Aust-HEI with mortality because of the lack of person identifiers in the 1995 NNS Confidentialised unit record file (CURF).

2.2.2 Analysis

The Aust-HEI was developed using data for adults aged 19 years and over, with pregnant and lactating women excluded because of differences in requirements. The data were weighted using the 1995 NNS FFQ population weight, as recommended in the data documentation (see McLennan & Podger 1998 for further detail). The elements of the DQI—variety and food choice, fruit and vegetable consumption, and saturated fat consumption—were all given equal weighting (20 of the total score of 60).

It should be noted that for this Aust-HEI model to be applied in the future, the components based on the FFQ (in particular) will require development work. An updated FFQ would

need to be designed that reflects new foods available, and the Aust-HEI components adjusted accordingly.

2.2.3 DQI components

The components of the DQI are listed below, with the criteria for scoring detailed in Table 1. Please see Section 2.1 for more detail on DQIs from the literature reviewed.

The **variety score** is based on the dietary variety score of Wahlqvist et al. (1989) and the dietary diversity score of Newby et al. (2003) which both divided foods into food groups and assessed diversity within these. The items in the FFQ were divided into five food groups (based on the *Australian guide to health eating* (Smith et al. 1998), see Table A1). A score was given based on how many of these foods were consumed at least once per week, as in the healthy choice score. The score for each of the five food groups was adjusted to be out of 2, with the overall score being the sum of these scores (out of 10). Where a food appeared more than once on the FFQ (within the same food group) in a different form, these items were grouped (e.g. milk on breakfast cereal, milk as a drink, milk in hot beverages, flavoured milk).

The '**healthy choice**' score is based on the recommended foods score of Kant et al. (2000). It was derived from the FFQ, based on whether people report consuming foods nominated as 'healthy choices' once per week or more, as in the Kant et al. study. However, these foods differ somewhat from those in that study, due to the foods that were included in the 1995 NNS FFQ (see Table A1).

The **fruit score** and **vegetable score** are based on the short questions 'how many serves of fruit (vegetables) do you usually eat each day?' Fruit and vegetable consumption are given prominence because of the association between consumption and disease risk (e.g. Lock et al. 2005). These were scored discretely, with a score of 10 given for two or more serves of fruit and for four or more serves of vegetables and a score of 0 given for those who reported that they do not eat fruit/vegetables. Intermediate scores were given, with those consuming one serve or less of fruit scoring 5, and those consuming one serve or less of vegetables and two or three serves of vegetables scoring 3 and 6, respectively.

The **milk score** is based on the question 'what type of milk do you usually consume?' This question has been shown to be a useful proxy for intake of fat and saturated fat (Rutishauser et al. 2001). A score of 5 was given for those who reported usually consuming skim or fat-reduced milk, 2.5 for those usually consuming a combination of skim or fat-reduced and whole milk, and 0 for those usually consuming whole milk. It should be noted that this question is limited in that it provides no option for those who rarely or never consume milk, or opportunity for detail on milk alternatives usually consumed.

The **meat score** is based on the question 'how often is the meat you eat trimmed of fat, either before or after cooking?', as another indicator of fat intake. This question was included as an indication of whether people were actively choosing to lower their fat/saturated fat intakes. A score of 5 was given for those who usually trim fat (and also to those who reported that they don't eat meat, in order to not disadvantage such people), 2.5 was given for those who sometimes trim the fat from meat, and 0 for those who rarely or never trim the fat.

The **saturated fat (junk food) score** was developed as a corollary to the meat and milk scores (which related to healthy behaviours in relation to fat intake) and was modelled on the healthy choice score. It was based on those foods high in fat (particularly saturated fat) for which consumption once per week or more was reported. This score was weighted so that

foods consumed two to three times per week and five times per week or more contributed more towards the score.

To develop the measure of variety, foods from the FFQ were subdivided into the five food groups referred to in the *Australian guide to healthy eating* (Smith et al. 1998). For the healthy choice component of the Aust-HEI, 'healthy choice' foods were identified from within these food groups (see Table A1).

Table 1: Summary of DQI components

Component	Criterion for maximum score	Minimum score	Maximum score	Data source
Measure of variety	Total number of foods from each food group usually eaten at least once per week	0 (none)	10	FFQ
Measure of 'healthy choices'	All 'healthy choice' foods usually eaten at least once per week	0 (none)	10	FFQ
Fruit consumption	Two or more serves per day	0 (none)	10	SDQ
Vegetable consumption	Four or more serves per day	0 (none)	10	SDQ
Low-fat milk chosen	Low-fat or skim milk	0 (no)	5	SDQ
Trim fat off meat	Usually (or do not eat meat)	0 (no)	5	SDQ
Consumption of high saturated fat, low nutrient density foods	Total number of foods eaten once per week or more	0	10 (none)	FFQ
TOTAL		**0**	**60**	

FFQ = food frequency questionnaire; SDQ = short dietary questions.

Note: See Table A1 for relevant variables from the 1995 National Nutrition Survey.

3 Results

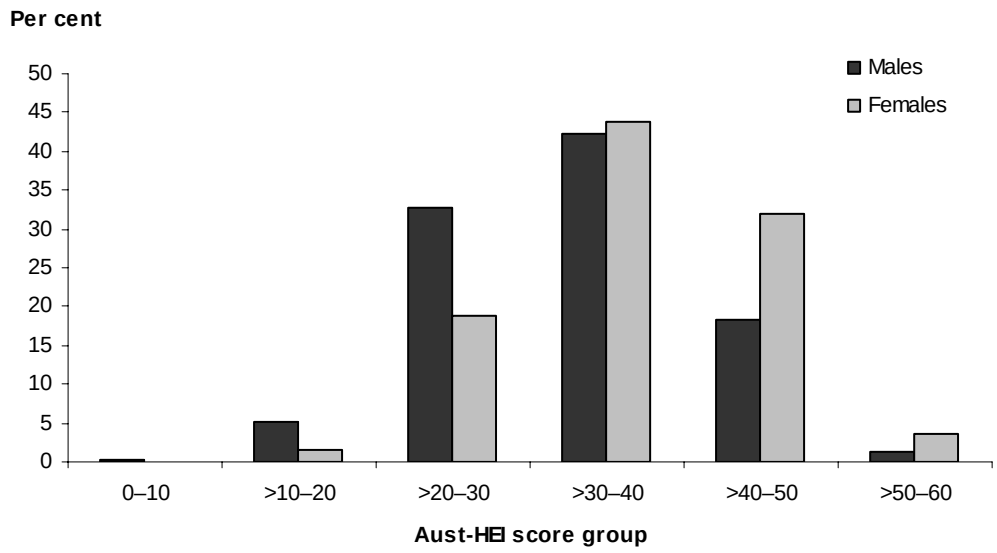
3.1 Australian Healthy Eating Index scores

The average score for the Aust-HEI was 35 out of 60 (59%) (Table 2). Females had a consistently higher average score than males for all components, and a higher proportion of females achieved Aust-HEI scores above 40 (Figure 1).

Table 2: Mean and median scores for Aust-HEI and components

Variable	Males (n = 3559)		Females (n = 4019)		Persons (n = 7578)	
	Mean	Median	Mean	Median	Mean	Median
Aust-HEI score	32.8	32.6	36.8	36.9	34.7	34.8
Healthy choice score	4.3	4.4	4.8	4.9	4.6	4.6
Variety score	5.4	5.5	5.8	5.9	5.6	5.7
Fruit score	7.1	5.0	7.7	10.0	7.4	10.0
Vegetable score	5.7	6.0	6.2	6.0	6.0	6.0
Milk score (out of 5)	2.0	0.0	2.7	5.0	2.3	0.0
Meat score (out of 5)	4.0	5.0	4.4	5.0	4.2	5.0
Saturated fat (junk food) score	4.3	4.4	5.2	5.6	4.7	5.0

Source: AIHW analysis of the 1995 NNS.



Source: AIHW analysis of the 1995 NNS.

Figure 1: Australian Healthy Eating Index (Aust-HEI) scores by sex

3.2 Components

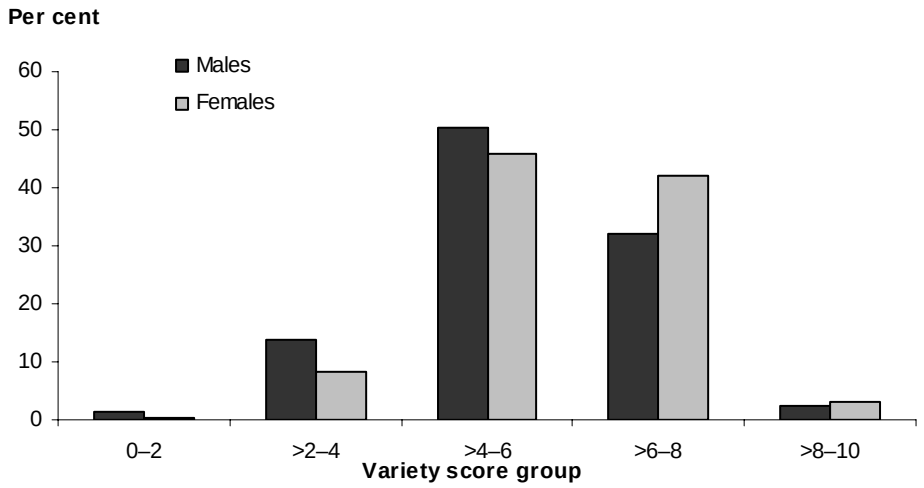
The scores for the Aust-HEI components generally reflect the spread and composition of the overall Aust-HEI score, with a higher proportion of females scoring higher. The Aust-HEI also shows internal consistency, with persons scoring low on an individual component also tending to score low on the Aust-HEI overall (see Figures 2–15).

For assessing internal consistency, the data have been presented using bar charts rather than a scatter plot to facilitate visual interpretation of the underlying associations. In interpreting the graphs, it should be noted that few people achieved low scores in the Aust-HEI—in particular, there was only one woman with an overall score of 0–10.

Variety score

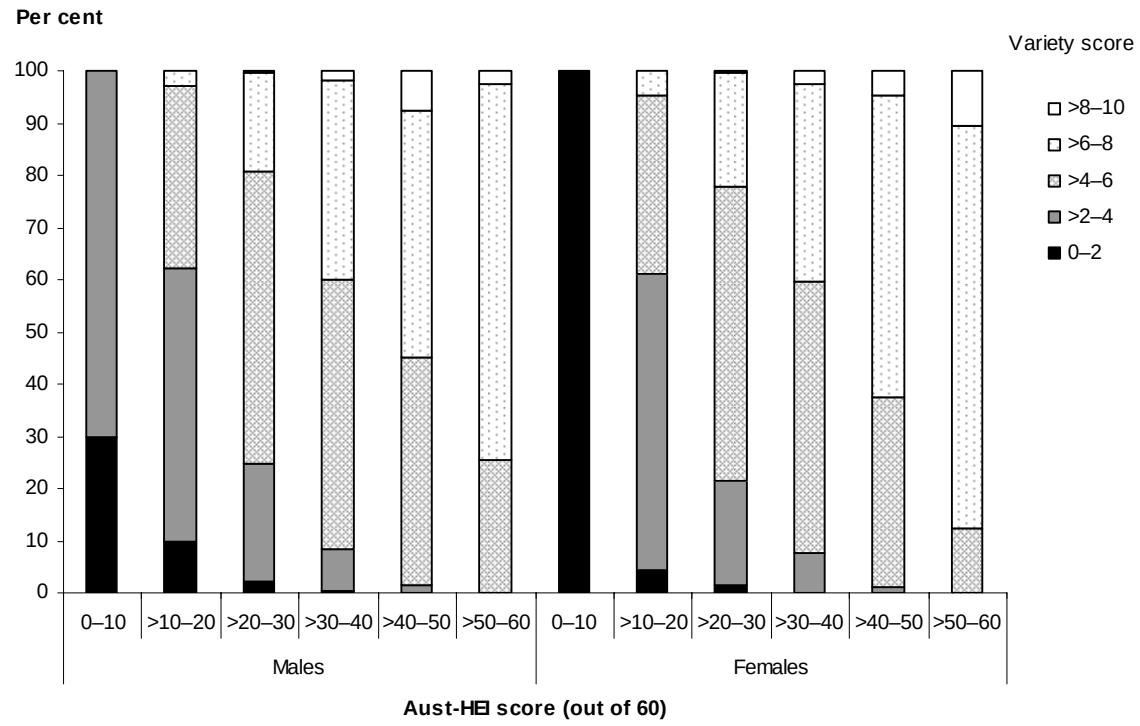
The mean variety score was 5.6 out of 10, with a median score of 5.7 (Table 2). The majority of individuals scored between 4 and 8 for the variety score, with very few scoring in the 0–2 range (Figure 2). The variety score indicates the number of different foods that people report consuming (see Section 2.2.3 for further detail).

Figure 3 shows that among people who scored very highly (>50–60) on the overall Aust-HEI, 5% of males and 10% of females achieved a variety score of >8–10, 65% of males and 80% of females achieved a variety score of >6–8, and around 30% of males and 10% of females achieved a variety score of >4–6.



Source: AIHW analysis of the 1995 NNS.

Figure 2: Variety score by sex

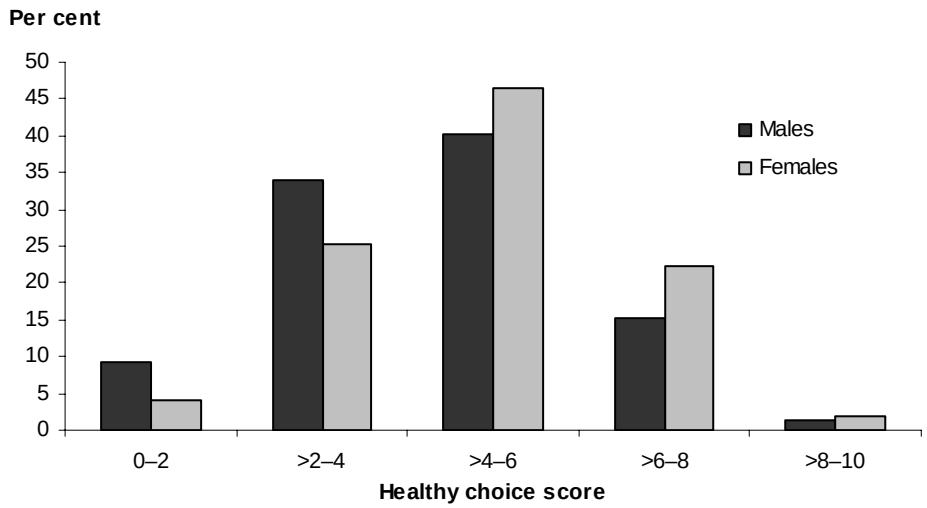


Source: AIHW analysis of the 1995 NNS.

Figure 3: Variety score by Aust-HEI score

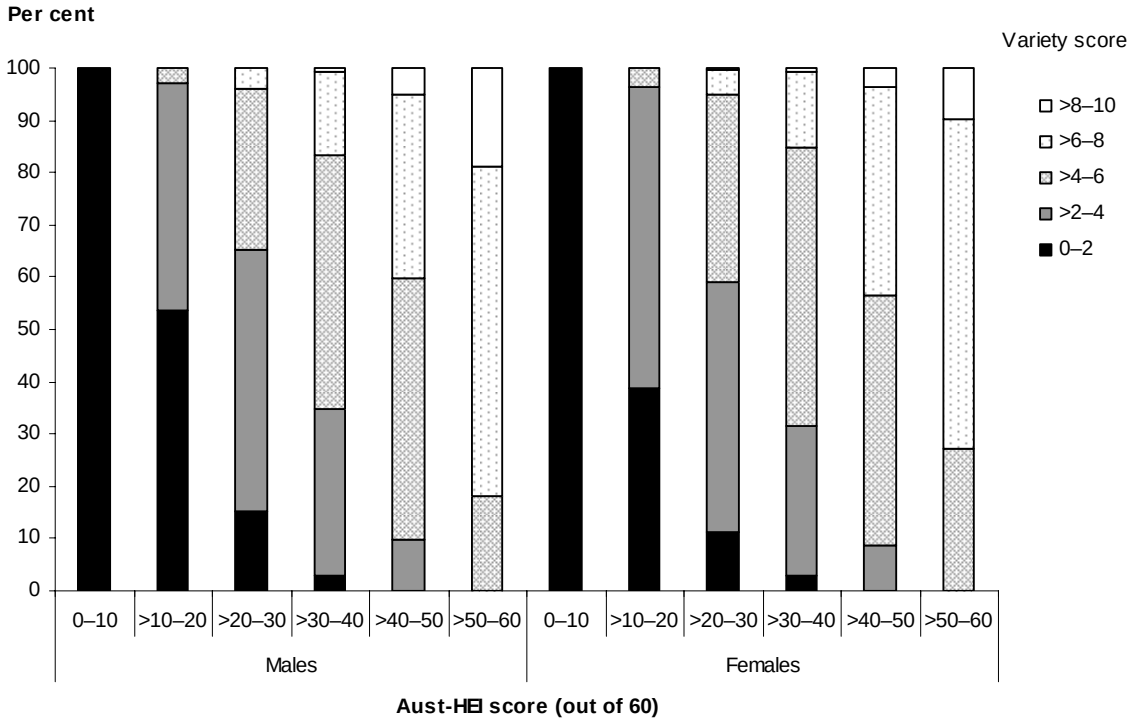
Healthy choice score

The mean and median for the healthy choice score were 4.6 out of 10 (Table 2). Very few individuals scored highly in the healthy choice score (>8) (Figure 4), although the majority of those who did also scored very highly in the overall Aust-HEI (Figure 5).



Source: AIHW analysis of the 1995 NNS.

Figure 4: Healthy choice score by sex

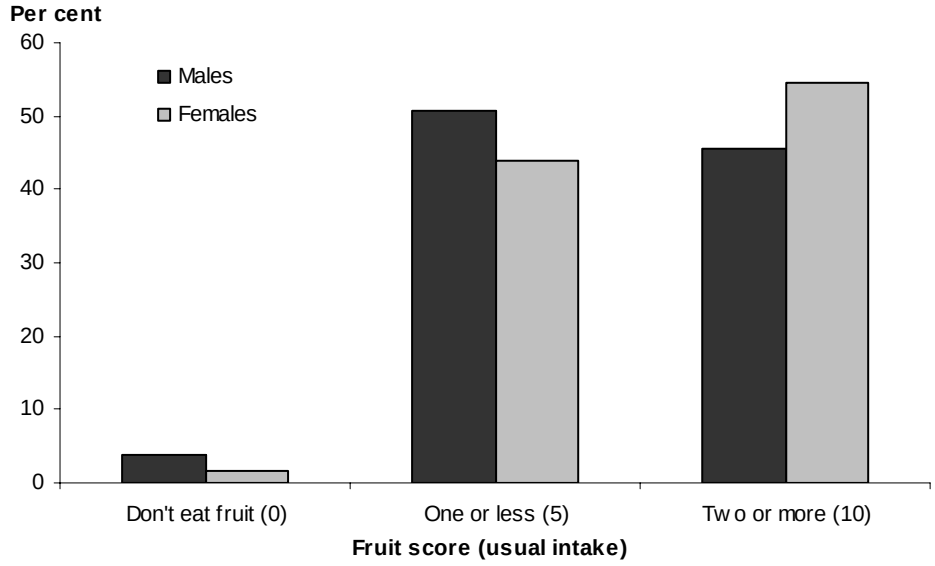


Source: AIHW analysis of the 1995 NNS.

Figure 5: Healthy choice score by Aust-HEI score

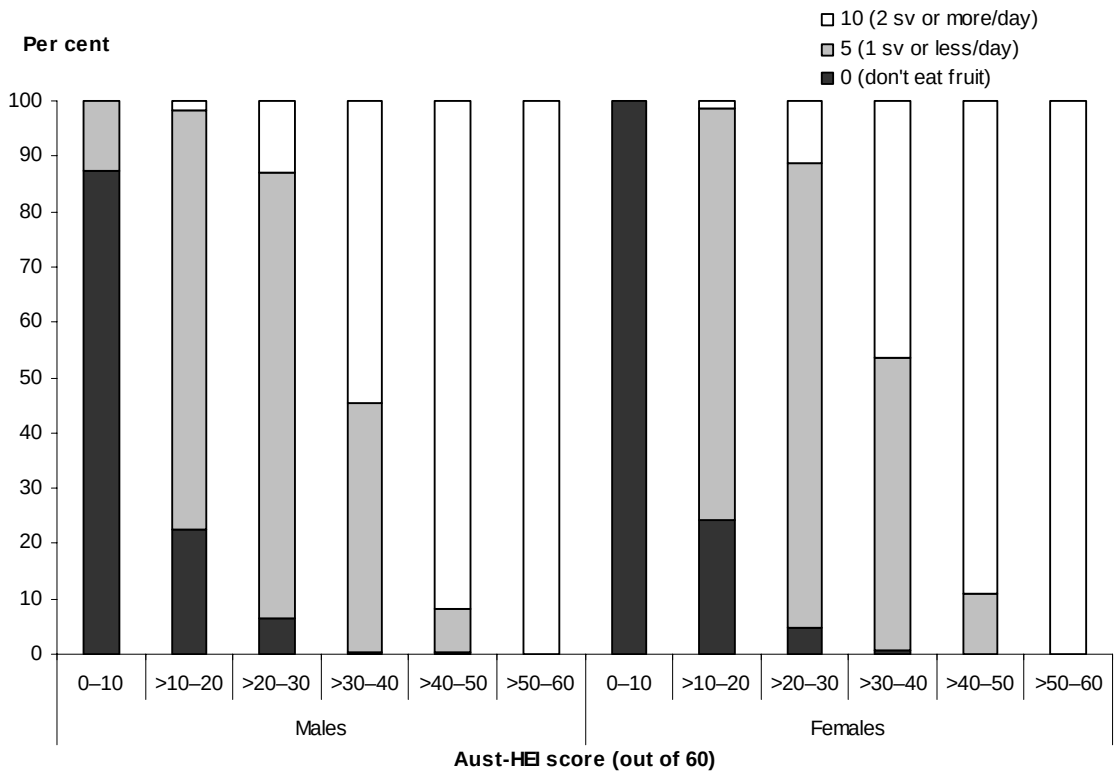
Fruit score

The mean fruit score was 7.4 out of 10, with a median score of 10 (Table 2), which represents two or more serves of fruit per day. While the mean fruit scores were similar for males and females (7.1 compared to 7.7) the median score was lower for males (5, which equates to one serve or less per day). Very few individuals reported that they do not eat fruit (Figure 6). All persons who scored in the highest Aust-HEI bracket reported eating the recommended two or more serves of fruit per day (Figure 7).



Source: AIHW analysis of the 1995 NNS.

Figure 6: Fruit score by sex

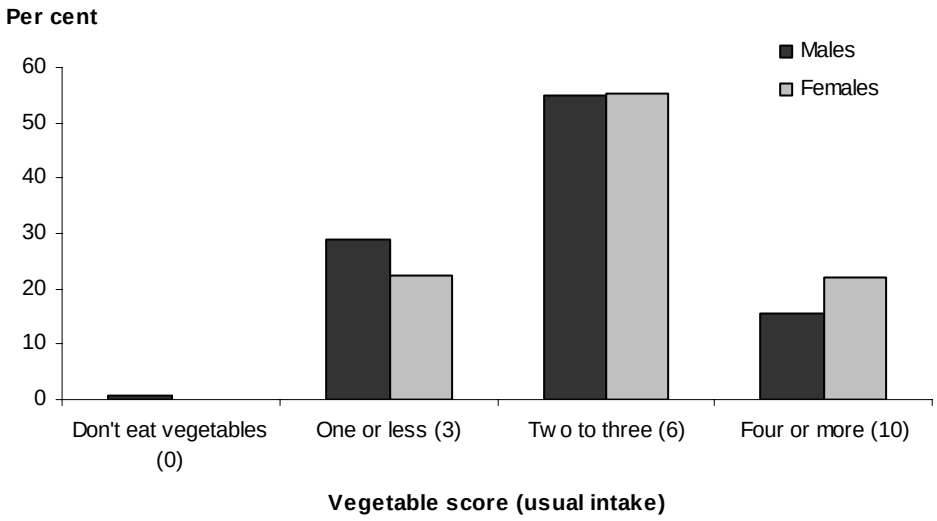


Source: AIHW analysis of the 1995 NNS.

Figure 7: Fruit score by Aust-HEI score

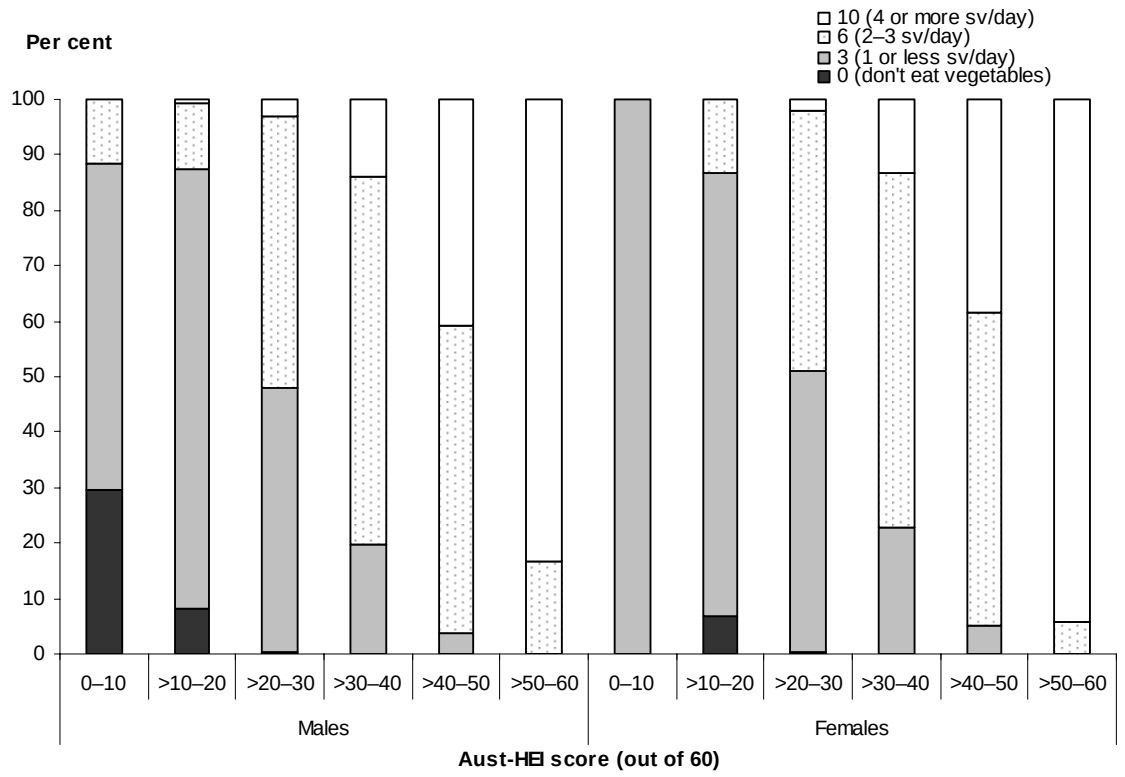
Vegetable score

The mean and median for the vegetable score were 6 out of 10 (Table 2), which represents two to three serves of vegetables per day. Very few people reported that they do not eat vegetables (Figure 8), however more than 25% of males with an Aust-HEI score of 0–10 reported not eating vegetables (Figure 9).



Source: AIHW analysis of the 1995 NNS.

Figure 8: Vegetable score by sex

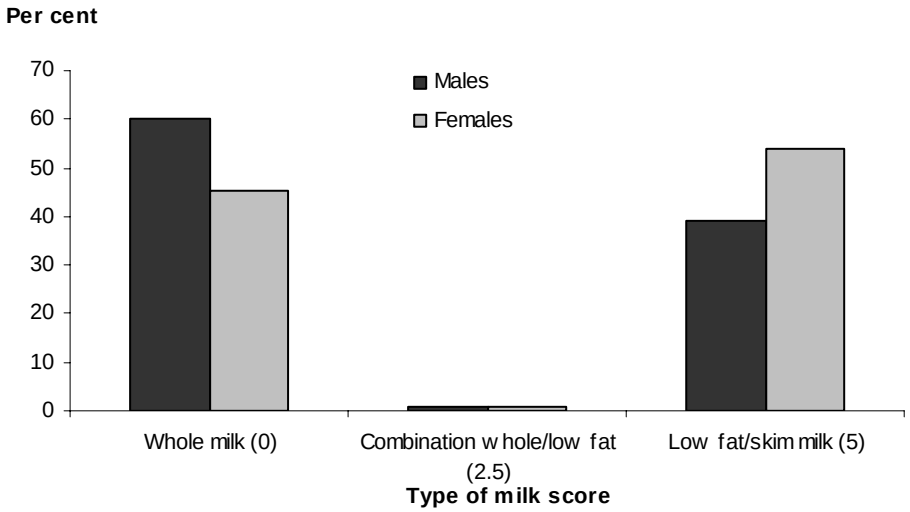


Source: AIHW analysis of the 1995 NNS.

Figure 9: Vegetable score by Aust-HEI score

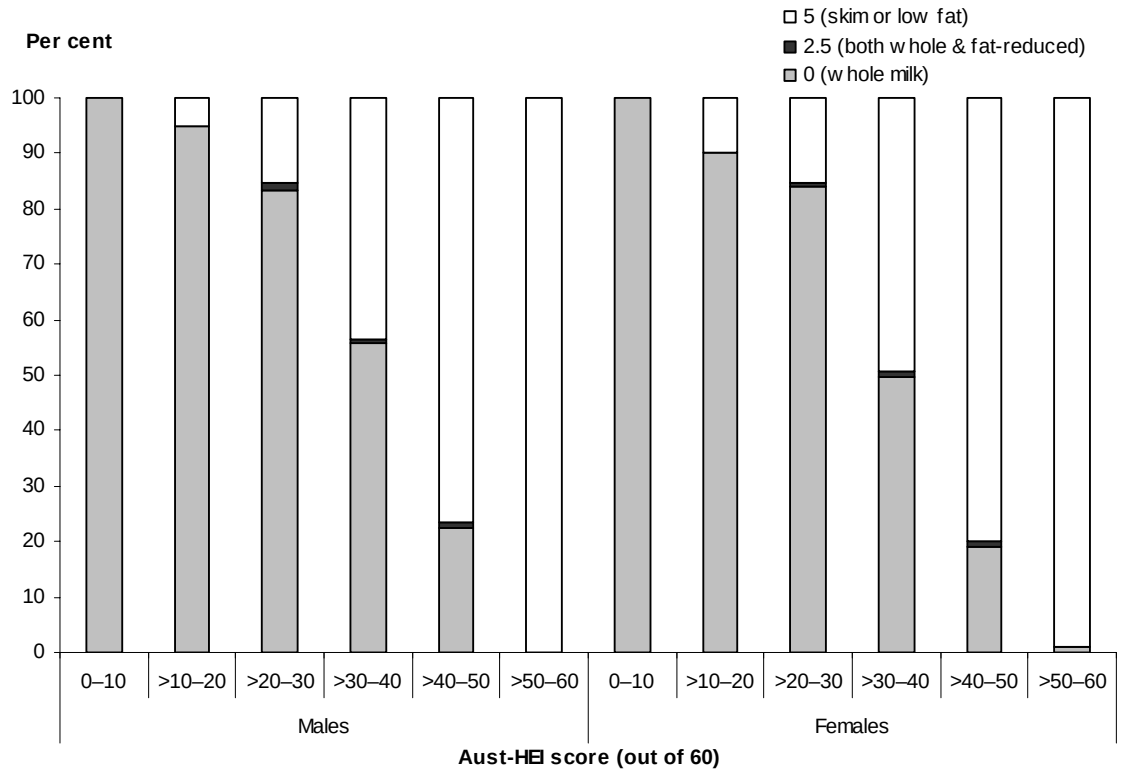
Milk score

The mean milk score was 2.3 out of 5, with a median score of 0 (whole milk) (Table 2), and spread for the milk score was quite different to the other scores, with most respondents polarised and very few consuming a combination of whole and low fat/skim milk (score of 5) (Figure 10). This reflects the structure of the question in the NNS, which is not conducive to reporting consumption of both types of milk (see McLennan & Podger 1998 for further detail). Individuals' milk score reflected their Aust-HEI score, with almost all those scoring low (<30) consuming whole milk, while nearly all those with a high Aust-HEI score (>40) reported consuming low fat or skim milk (Figure 11). All those scoring 5 for the milk score also scored between 20 and 50 for the Aust-HEI.



Source: AIHW analysis of the 1995 NNS.

Figure 10: Type of milk usually consumed score by sex

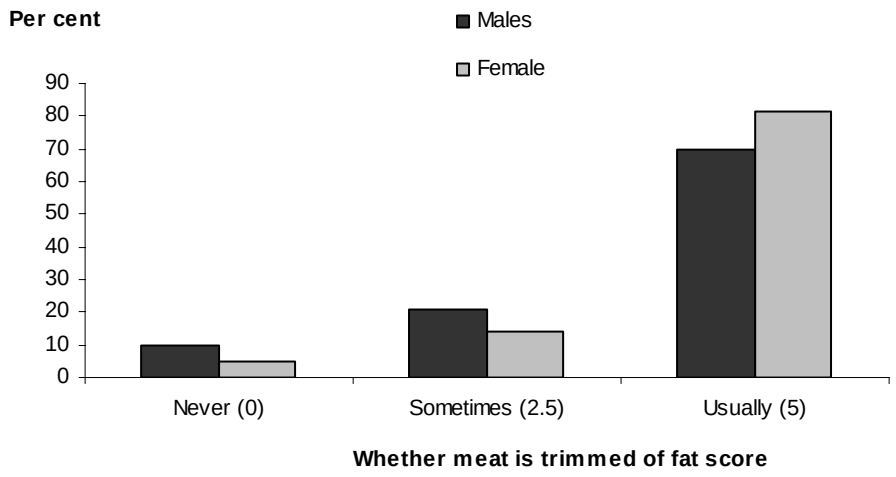


Source: AIHW analysis of the 1995 NNS.

Figure 11: Type of milk usually consumed score by Aust-HEI score

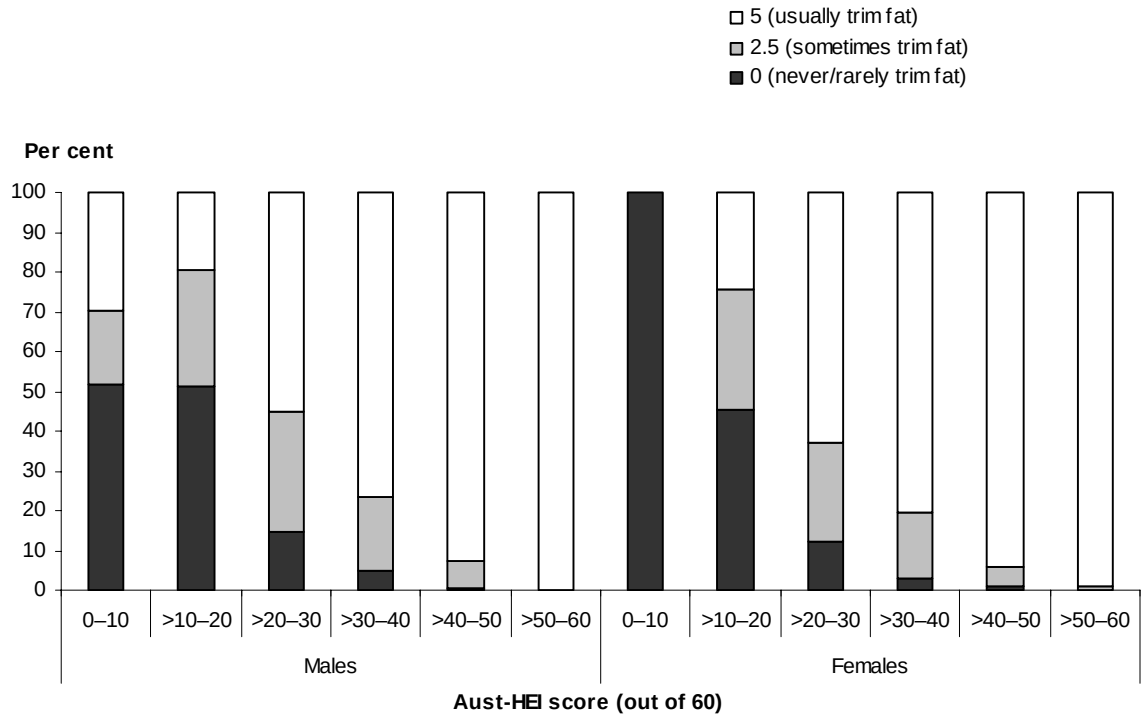
Meat score

The mean meat score was 4.2 out of 5, with a median score of 5 (meat is usually trimmed of fat) (Table 2). Although relatively few people did not consume meat that had been trimmed of fat (Figure 12), these individuals comprised 75% of females and 50% of males who received a low Aust-HEI score (0–20) (Figure 13).



Source: AIHW analysis of the 1995 NNS.

Figure 12: Whether meat is trimmed of fat score by sex

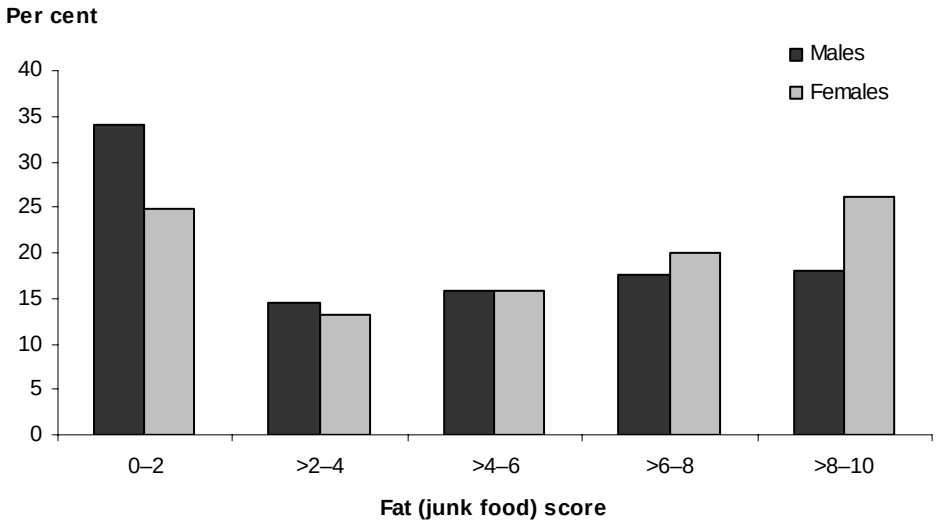


Source: AIHW analysis of the 1995 NNS.

Figure 13: Whether meat is trimmed of fat score by Aust-HEI score

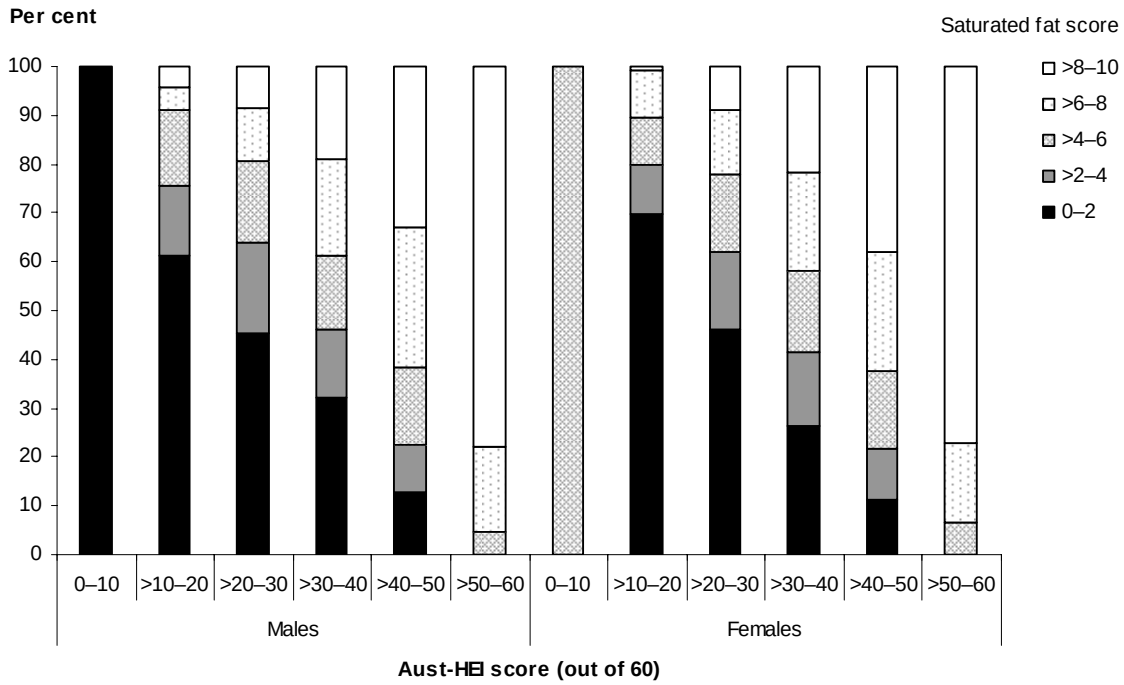
Saturated fat (junk food) score

The mean saturated fat score was 4.7 out of 10, with a median score of 5 (Table 2). This score is 'reversed', where a high score indicates less reported consumption of 'junk food' than a low score. The spread of the saturated fat score shows a fairly flat distribution of scores over the range (Figure 14). Among persons scoring highly in the overall DQI, the majority also scored highly in the saturated fat score (Figure 15). However, this score does show an exception to the norm, with the one female respondent who scored 0–10 in the overall DQI scoring relatively well on the fat score (4–6). This could be the result of consuming a very restricted range (and possibly volume) of food overall, which would result in low scores for the variety, healthy choice, fruit and vegetable scores, but a high score for the junk food score (which is based on the number of different types and frequency of consumption of 'junk foods' high in fat, particularly saturated fat).



Source: AIHW analysis of the 1995 NNS.

Figure 14: Saturated fat (junk food) score by sex



Source: AIHW analysis of the 1995 NNS.

Figure 15: Saturated fat (junk food) by Aust-HEI score

3.3 Correlations

The Aust-HEI score was assessed for correlation with other variables from the 1995 NNS, using the Pearson correlation coefficient.

The correlation between Aust-HEI score and measures of fat (and saturated fat) intake as a proportion of energy intake from the NNS 24-hour recall showed a moderately negative significant relationship, which implies that as the percentage of energy intake from fat increases, the Aust-HEI score decreases (Table 3). Intakes of fibre, fruit and fruit and vegetables (although not vegetables alone) showed a positive correlation with the Aust-HEI score.

These moderate correlations (in the direction expected) with data from the 24-hour recall suggest that the Aust-HEI reflects, to some extent, healthy eating behaviours as measured by a different methodology. Reasons for the correlation not being stronger may relate to the different aims of the survey techniques, with the FFQ aiming to elucidate usual intakes over time and the 24-hour recall aiming to assess detailed population intakes at a point in time.

Table 3: Correlation between Aust-HEI score and 1995 NNS 24-hour recall nutrition variables

Variable	Correlation coefficient	P value
Per cent energy from saturated fat	–0.26	<0.0001
Per cent energy from fat	–0.22	<0.0001
Fibre intake	0.18	<0.0001
Fruit intake	0.30	<0.0001
Vegetable intake	0.10	<0.0001
Fruit & vegetable intake	0.26	<0.0001

Source: AIHW analysis of the 1995 NNS.

The Aust-HEI also showed a weak but significant correlation between the Aust-HEI score and age, as well as with the socio-economic index for areas (SEIFA) index of disadvantage (Table 4). The correlation with age suggests that older respondents are somewhat more likely to score highly. The weak correlation with SEIFA suggests that persons residing in disadvantaged areas are not much more likely to score poorly on the Aust-HEI than those in areas of low disadvantage.

Table 4: Correlation between Aust-HEI score and 1995 NNS demographic variables

Variable	Correlation coefficient	P value
Age	0.17	<0.0001
SEIFA index (disadvantage)	0.08	<0.0001

Source: AIHW analysis of the 1995 NNS.

There was no correlation between the Aust-HEI score and the health-related variables for blood pressure and self-reported health status (Table 5). However, this is likely due to the fact that blood pressure is very well controlled in Australia through medication, and that self-reported health status may not be related to chronic disease status. There was a weak positive correlation between the Aust-HEI score and physical activity levels and whether breakfast was usually consumed (Table 5).

Table 5: Correlation between Aust-HEI score and 1995 NNS health-related variables

Variable	Correlation coefficient	P value
Diastolic blood pressure	–0.02	0.066
Self-reported health status (1 = excellent, 5 = poor)	–0.05	<0.0001
Physical activity level	0.12	<0.0001
Whether breakfast usually eaten	0.14	<0.0001

Source: AIHW analysis of the 1995 NNS.

Discussion

The elements of the Aust-HEI—dietary variety, fruit and vegetable intake, and saturated fat intake—have all been linked to chronic disease and by incorporating these three aspects of diet, the Aust-HEI provides a more comprehensive indication of dietary behaviour than any single measure. Currently, the main proxy for dietary behaviour in relation to chronic disease risk is usual consumption of fruit and vegetables. While this is certainly an important factor, it is hoped that developing a measure with broader scope would provide a more accurate indication of total diet. This measure of diet quality would not take the place of collecting regular detailed national nutrition data but could be used to augment the analysis of more general health surveys such as CATI surveys or the National Health Survey.

As a measure of healthy food behaviours, the Aust-HEI exhibits construct validity and is internally consistent. Individuals scoring low on any one component tend to score low overall, which implies that the overall DQI score provides a balanced representation of all three elements. This also suggests that the derivation of each component score is logical.

However, the validity of the Aust-HEI as a predictor of chronic disease risk could not be assessed with the data available. In previous studies, this sort of validity has been assessed using longitudinal morbidity and mortality data (e.g. Kant et al. 2000), or through clinical assessment (e.g. Wahlqvist et al. 1989). In order to provide some indication of the usefulness of the Aust-HEI, it was correlated with measures of fat, fibre and fruit intake from the 24-hour recall, which reflect some of the key recommendations of the NHMRC's dietary guidelines (for example, eat plenty of vegetables, legumes and fruits, eat plenty of cereals… preferably wholegrain, limit saturated fat and moderate total fat intake) (NHMRC 2003). These showed moderate correlation with the Aust-HEI, as would be expected.

The next phase in the development of the Aust-HEI should be validation using longitudinal data, such as data from the Australian longitudinal study on women's health (Women's Health Australia), which included a food frequency questionnaire and short dietary questions in the 2003 'Third survey for younger women' and the 2001 'Third survey for mid-age women'. While this preliminary work provides a considered basis from which to conduct further validation of the Aust-HEI, the components would need to be adapted for use with different data. For example, the foods in the FFQ in the women's health survey are different to those in the 1995 NNS and thus the foods contributing to the variety score, the healthy choice score, and the fat (junk food) score would need to be revised.

Similarly, in order to collect new data to be used with the Aust-HEI, a new FFQ would need to be developed that incorporates current foods. This development could also be informed by the aims of the Aust-HEI. For example, inclusion in the new FFQ of the range of healthier options that are now available, such as 'low fat', 'salt reduced' and other modifications available for some foods. The new FFQ, if it is to be used as a supplement to an existing health survey, may not need to incorporate SDQ (as did the 1995 NNS FFQ), as these are now a common component of Australian health surveys (e.g. National Health Surveys, CATI surveys).

Further development and refinement of the Aust-HEI in conjunction with the development of the new FFQ would also strengthen the index as a measure of healthy choices. In particular, inclusion of more specifically 'healthy' and 'unhealthy' choices in the new FFQ would feed into the design of the healthy choice component of the Aust-HEI (for example, whether the meat consumed is lean), improving the accuracy of this component of the index.

Currently, this component is limited in many cases by a lack of distinction between foods that represent healthy choices and those that represent high-fat, -salt, or -sugar choices.

It appears that use of the Aust-HEI to derive a comprehensive measure for dietary behaviour would add value to chronic disease risk factor monitoring, as it is a relatively robust and internally consistent summary measure of healthy dietary behaviours. While there are some data quality issues, these could mostly be resolved through the development of a new FFQ and the revision of some of the Aust-HEI components in line with this. By using both a FFQ and SDQ, the Aust-HEI provides an indication of a range of dietary choices and behaviours relevant to chronic disease, incorporating dietary variety, fruit and vegetable consumption, and saturated fat consumption.

Appendix 1: Foods in NNS FFQ

Table A1: Foods in 1995 NNS FFQ, by food group

	Food group				
	Cereals	**Vegetables**	**Fruit**	**Dairy**	**Meat**
FFQ foods in this category[#]	Breads, muffins Biscuits, muesli, porridge, breakfast cereal, rice, pasta	Vegetable or tomato juices, sandwich with vegetables, side salad, vegetable stir-fry, vegetable casserole, pumpkin, sweet potato, peas, green beans, spinach, broccoli, cauliflower, brussels sprouts, carrots, zucchini, capsicum, sweet corn, mushroom, tomato, lettuce, celery, onion, soybeans, baked beans, lentils	Fruit juice, apple, orange, banana, peach, mango, pineapple, grapes, melon	Milk, flavoured milk, milk on breakfast cereals, milk in hot beverages, cream, icecream, yoghurt, cottage cheese, cheddar cheese	Mince meat, steak, lamb chops, pork chops, bacon, ham, poultry, roast poultry, sausage, luncheon meats & salami, mixed beef/ pork/ lamb or poultry dishes, liver, offal, canned fish, baked/grilled fish, fried fish, seafood Alternatives: egg, peanut butter, nuts, soybeans, baked beans, lentils
Foods contributing to scoring (i.e. indicative of 'healthy choices')	Wholemeal bread, muesli, porridge, rice, pasta	Vegetable or tomato juices, sandwich with vegetables, side salad, vegetable stir-fry, vegetable casserole, pumpkin, sweet potato, peas, green beans, spinach, broccoli, cauliflower, brussels sprouts, carrots, zucchini, capsicum, sweet corn, mushroom, tomato, lettuce, celery, onion, soybeans, baked beans, lentils	Fruit juice, apple, orange, banana, peach, mango, pineapple, grapes, melon		Canned fish, baked/grilled fish, seafood (lentils etc included in vegetable group)

Other FFQ foods/variables: Cakes etc., sweet pies or sweet pastries, puddings or desserts, sweet biscuits, chocolate, other confectionery, savoury pies, pizza, hot chips, hamburgers, dressings, potato, corn chips etc., jam etc., Vegemite, fruit drink, cordial, soft drink, tea, coffee, soy beverage, beer, wine, sherry, spirits, water. Supplements: multivitamin with iron, multivitamin, vitamin A, vitamin B, vitamin C, vitamin E, betacarotene, calcium, folate, iron, zinc

Glossary

food frequency questionnaire a non-quantified, closed-ended questionnaire used in the 1995 National Nutrition Survey, designed to assess usual patterns (over the previous 12 months) of food intake of individuals aged 12 years and over for comparison with public health nutrition recommendations and estimate the frequency of consumption of foods providing specific protective nutrients, such as vitamins A, C and E and calcium

recommended dietary allowance the recommendations for nutrient consumption for the United States of America

recommended dietary intake the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group

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