

The Australian Recommended Food Score did not predict weight gain in middle-aged Australian women during six years of follow-up

Abstract:

Objective: To evaluate the relationship between diet quality score, as measured by the Australian Recommended Food Score (ARFS) and six-year weight gain in middle-aged Australian women.

Methods: Participants were a sub-sample of women from the Australian Longitudinal Study on Women's Health (ALSWH) who were followed up from 2001 to 2007 ($n = 7,155$, aged 48 to 56 years). The ARFS was derived from responses to a sub-set of questions from a food frequency questionnaire, with possible scores ranging from 0 to 74 (maximum). Absolute weight gain was calculated from the difference in self-reported weight between 2001 and 2007. Linear regression was used to test the relationship between diet score and weight change.

Results: On average, women gained weight during follow-up (1.6 ± 6.2 kg) and had a mean baseline ARFS of 32.6 (SD 8.7) which was not optimal. There was no association between ARFS and weight change during follow-up ($\beta = 0.016$; $p = 0.08$) in the fully adjusted model that included total energy intake, education, area of residence, baseline weight, physical activity, smoking and menopause status.

Conclusions: Weight gain and low ARFS were common. However, diet quality as measured by the ARFS did not predict six-year weight gain.

Implications: This lack of association may be due to limitations related to ARFS, or may be a false negative finding. Further research is warranted to evaluate the impact of promoting optimal diet quality on weight gain prospectively.

Key words: diet score, weight gain, The Australian Recommended Food Score, middle-aged women.

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Internationally, the prevalence of overweight and obesity has increased rapidly,¹ with the World Health Organization estimating that obesity affected at least 500 million adults worldwide in 2008, with an additional 1.5 billion adults considered overweight.² In Australia in 2004–05,³ 54% of adults were considered overweight or obese and this combined percentage increased to 61.4% in 2007–08.⁴

Middle-aged women are at particular risk of weight gain due to the menopausal transition and at this life stage are likely to gain greater amounts of weight than men of the same age.⁵ A previous study examining weight gain in the middle-aged cohort of the Australian Longitudinal Study on Women's Health (ALSWH) found that more than 33% of the women gained 2.25 kg or more over two years.⁶ Those who gained 2.25 kg or more had a significantly higher proportion of body fat, and higher total cholesterol and blood pressure, compared with those who gained less than 2.25 kg or lost weight over four years during the menopausal transition.⁶

The causes of weight gain are multifactorial and complex. However, diet is one major modifiable risk factor. Human and animal studies demonstrate that food habits, food quality and total food quantity predict future weight gain.⁷ A systematic review of the relationship between diet quality and prospective weight gain in adults found only a limited number of studies.⁸ These studies had varying methodologies in regard to the method or tool used to assess diet quality, how body weight change was evaluated, and also in the approach to statistical analyses. In addition, the conclusions varied, with some studies ($n = 4$) reporting a positive correlation between weight change and diet quality and other studies finding no relationship ($n = 3$).⁸

Measuring diet quality, in terms of how closely eating patterns and nutrient intakes align with National Dietary Guidelines, has recently become a focus within public health nutrition research. The importance of optimising diet quality has been acknowledged in the 2013 revised Dietary Guidelines for Australians.⁹ In addition, a review of the

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relationship between diet quality (as assessed using various dietary indices or tools) and health outcomes demonstrated that these tools are able to quantify the risk of some health outcomes, including biomarkers of disease and risk of CVD, some cancers and total mortality.¹⁰ Given that weight gain could be an early indicator of risk for adverse health outcomes, its relationship with diet quality requires examination. However, as higher diet quality has been reported as being associated with higher energy intake, evidence is needed as to whether optimising dietary quality, in line with national dietary recommendations, does not lead to weight gain over time.

The Australian Recommended Food Score (ARFS) has been developed and validated previously as a measure of overall diet quality in the middle-aged cohort from the ALSWH and shown to align with National Dietary Guidelines for Australian adults.¹¹ Higher ARFS scores were associated with a greater variety of nutrient-dense core foods and better intakes of key nutrients.¹¹ However, the ARFS has not previously been used to examine the relationship with prospective weight change in middle-aged women.

Therefore, the aim of this study was to examine the relationship between diet quality score, as measured by the Australian Recommended Food Score (ARFS), and six-year weight gain in women in the middle-aged cohort of ALSWH.

Methods

Study population

The ALSWH is a prospective cohort study of a nationally representative sample of Australian women. It was established in 1996 with more than 40,000 women divided into three cohorts based on the age of women at baseline: young (18–22 years), $n=14,779$; middle-aged (45–49 years), $n=14,099$; and older women (70–74 years), $n=12,939$. The purpose of the ALSWH is to examine the health status and a range of social, psychological and environmental factors affecting health and well-being over time. Participants were randomly selected from National Health Insurance database and have been shown to be broadly representative of the Australian population for women in the same age groups.¹² This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human participants were approved by the Human Ethics committees of both the University of Newcastle and the University of Queensland. Written informed consent was obtained from all participants.

Participants

The current study was conducted in the middle-aged cohort. The follow-up time was from 2001 to 2007. The current analyses were conducted in a sub-sample of women who were disease free by excluding those who self-reported any of the following conditions at either baseline or follow-up: type 2 diabetes; impaired glucose tolerance; heart disease (including heart attack and angina); stroke; or any type of cancer, with the exception of skin cancer. Of the 11,226 middle-aged women recruited at baseline, 959 were excluded (diabetes $n=320$; impaired glucose tolerance $n=69$; heart disease

and stroke $n=218$; cancer $n=352$) leaving 10,267 women who were eligible for the analyses. The response rate at follow-up was a total of 10,638 women, with 1,538 women excluded (diabetes $n=705$; impaired glucose tolerance $n=154$; heart disease and stroke $n=361$; cancer $n=318$). The total number of women who were eligible for this study at follow up was 9,100. The total number of observations included in the analysis after excluding ineligible persons and those with missing ARFS or weight change data is $n=7,115$ (Figure 1).

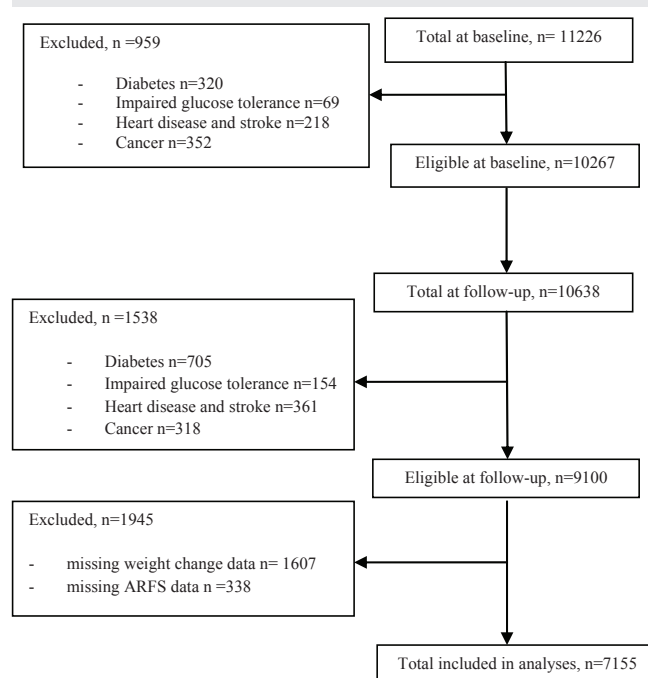
Dietary intake

Dietary intake was assessed using the Dietary Questionnaire for Epidemiological Studies Version 2 (DQES v2) FFQ developed by the Cancer Council of Victoria.¹³ This quantitative FFQ, with a total of 74 food items and 6 alcoholic beverages, is completed via self-report and asks about intake over the previous 12 months using frequency options that range from 'never' up to 'three or more per day'. The FFQ has been validated in Australian women previously¹⁴ and the nutrient output is derived using the NUTTAB95 Australian Nutrient Database,¹⁵ the Australian Government food composition database using software developed by the Cancer Council of Victoria.

Australia Recommended Food Score (ARFS)

The diet quality score was assessed using the ARFS, which was adapted from the Recommended Food Score (RFS)¹⁶ and previously validated for use in the middle-aged cohort of ALSWH (described in detail elsewhere).¹¹ The ARFS calculation is based on regular consumption of FFQ items that align with the recommendations in the National Dietary Guidelines and the Australian Guide to Healthy Eating.^{11,17} The ARFS scoring method is reported in detail

Figure 1: Flow chart of participant's selection for the analysis.



elsewhere.¹¹ Briefly, it is made up of seven sub-scales and has a score range from 0–74. The sub-scale scores are calculated from the following food groups with one point awarded for each item reported as being consumed at least once a week. The total score within each sub-scale is: vegetables – 22 points (including potato cooked without fat); fruit – 14 points; protein foods – 14 points; grains – 14 points; dairy – seven points; fats – one point and alcoholic beverages – two points.¹¹ The maximum ARFS score is 74, reflecting the healthiest or most optimal diet quality score. We previously reported that among the middle-aged ALSWH cohort, those in the highest quintile of ARFS had better self-reported health status, higher intakes of key nutrients, and lower intakes of total fat and saturated fat, compared to those in the lowest ARFS quintile.¹¹

Body weight

The six-year weight change (kg) was calculated by subtracting weight in 2007 from baseline weight in 2001. Weight was self-reported, and this method has been previously validated in a study of 159 women with a mean BMI of $26.70 \pm 5.18 \text{ kg/m}^2$.¹⁸

Co-variables

Physical activity

Given that physical activity (PA) is an important confounder of body weight,¹⁹ PA was measured using minutes of metabolic equivalents of task (MET. mins) based on self-reported walking and moderate and strenuous physical activity as follows: $(3 \times \text{minutes walking}) + (4 \times \text{minutes of moderate activity}) + (7.5 \times \text{minutes of vigorous activity})$, with PA used as continuous variable in the models. For descriptive analyses, PA was classified into four groups based on weekly energy expenditure as follows: nil/sedentary (0 to <40 MET.min/week); low (40 to <600 MET.min/week); moderate (600 to <1,200 MET.min/week) or high ($\geq 1,200$ MET.min/week).

Education

Level of education was categorised into six groups based on highest qualification obtained as follows: no formal qualifications, school certificate, higher school certificate, trade/apprenticeship, university degree or higher university degree.

Smoking habits

Given that smoking status can affect weight change,¹⁹ women were categorised into three groups according to smoking status as follows: current smoker, ex-smoker or never smoked. Current smoker was defined as usually smoking more than 10 cigarettes per a day.

Menopausal Status

Menopausal status has previously been shown within the ALSWH to be a strong predictor of weight gain.²⁰ Hence it was included as a confounder and categorised based on self-report as follows: 1) surgical menopause if uterus, ovaries or both removed; 2) hormone replacement therapy (HRT) user; 3) oral contraceptive (OCP) user; 4) pre-menopause if they had menstruated in the last three months and reported no change in menstrual frequency in

the last 12 months; 5) peri-menopause if they reported changes in menstrual frequency or 3–11 months of amenorrhea; or 6) post-menopause if they reported amenorrhea for 12 consecutive months or more.

Total energy intake

Total energy intake (TEI) was derived from the FFQ data as megajoules per day using NUTTAB95 as described above. A sub-analysis was performed to assess the relationship between those who had valid data on TEI and weight gain over time. TEI misreporters were identified using the ratio of reported energy intake to BMR, and applying the Goldberg cut-offs²¹ as previously reported in this cohort.¹¹

Area of residence

Based on postcode, an area of residence variable was created with three categories of urban, rural and remote.

Statistical analysis

The weight gain and ARFS data was assessed for normality and found to be normally distributed. Thus, means and standard deviations were used to describe the data. Three main linear regression models were used to test the relationship between diet quality score as measured by ARFS, and absolute weight gain during the period from 2001 to 2007, as follows: 1) a crude model which examined diet score and weight gain, where ARFS was the independent variable and weight gain the dependent variable; 2) a partially adjusted model including ARFS as the independent variable and weight gain as dependent variable with adjustment for the main confounders (education, area of residence, weight in kg at baseline, physical activity, smoking status and menopause); and 3) a fully adjusted model similar to model 2, but with the addition of TEI. This model was employed to separately examine to what degree the FFQ derived TEI explained the relationship between ARFS and weight change. This is because our interest is in the potential application of ARFS alone in practice, where TEI would not be known. In addition, the previous ARFS validation study¹¹ demonstrated that in both the full samples and the sub-sample least likely to have misreported energy intake, that the relationship between higher ARFS and more optimal macro- and micronutrient intakes was similar. While there was a weak correlation between energy intake and ARFS in the full sample, this disappeared when examined in the valid reporter sub-sample. In addition, when nutrient intakes were expressed per 1,000 calories, the positive associations between ARFS and nutrient intakes largely remained.¹¹

The same three linear regression models were also applied to identify any relationship between ARFS subscales and weight gain, with both as continuous variables. No adjustments were made for multiple hypothesis testing. All statistical analyses were performed using the statistical program STATA (version 11.1 for windows, 2009, StataCorp LP, USA).²²

Results

A comparison between those participants classed as misreported, based on TEI (n=5,561) and those participants classed as non-misreporters (n=2,154) found no difference between the groups. Therefore, all participants (n=7,715) were included in the presented analyses.

Descriptive analyses

Table 1 summarises the characteristics of the women in the cohort (n=7,155). The mean ARFS was 32.6 (\pm 8.7) and the majority of participants reported no (17%) or low physical activity (37%), while the remainder reported moderate (21%) and high (25%) levels of physical activity. The majority of participants (55%) had never smoked, while 14% identified as current smokers. More than 50% of participants lived in a rural area, but the original recruitment method

for ALSWH oversampled rural and remote women to achieve adequate samples. Almost half the participants had completed a secondary education (31%), while 14% had attained a university undergraduate or postgraduate degree.

Further analyses were done to compare those with and without missing FFQ data, with no differences found in weight change over time (data not shown). In addition, we compared ARFS in those who had data on weight change (n=7,155) and those who did not (n=1,607), and found that there was no significant difference in the score.

Longitudinal analysis

Table 2 reports six-year weight gain by quintiles of the ARFS. The first quintile reflects the lowest ARFS and the last quintile reflects the highest ARFS. Weight increased non-significantly within all

Table 1: Demographic characteristics of participants from the middle-aged cohort of the Australian Longitudinal Study on Women's Health (n=7,155).

Variable		Descriptive Statistics					
		Baseline			Follow-up		
		Mean	SD	Range	Mean	SD	Range
ARFS		32.6	8.7	6–61	-	-	-
Age (years)		52.4	1.4	48.0–56.0	58.4	1.4	54–62
Weight (kg)		70.1	14.2	36–150	71.5	14.4	37–155
BMI		26.3	5.1	13–62	26.9	5.2	15–58
Weight difference		1.6	6.2	-40 to 38	-	-	-
Energy Intake (kJ)		6,648.7	2,515.2	1,251.4–54,779.8	-	-	-
		%			%		
Physical	Nil	17			15		
Activity	Low	37			26		
	Moderate	21			23		
	High	25			36		
Smoking Status	Non-smoker	55			62		
	Ex-smoker	31			28		
	Smoker	14			10		
Area of residence	Urban	38			39		
	Rural	57			56		
	Remote	5			5		
Menopause Status	Surgical menopause	27			31		
	HRT use	19			7		
	OCP use	9			0.1		
	Premenopause	19			0.2		
	Perimenopause	25			2.2		
	Postmenopause	10			60		
Education	No formal	18			-		
	School certificate	32			-		
	Higher school certificate	17			-		
	Trade/apprentice	30			-		
	Certificate/diploma	16			-		
	University degree	9			-		
	Higher degree	5			-		

ARFS, Australian Recommended Food Score; BMI, body mass index; SD, standard deviation; –No available data

Table 2: Mean six-year absolute weight and BMI change across quintiles of diet quality score as measured by the ARFS in women from the middle-aged cohort of the Australian Longitudinal Study on Women's Health (n=7,155).

	Australian Recommended Food Score (ARFS)				
	1st quintile (21 ± 4) (n= 1,446)	2nd quintile (29 ± 2) (n=1,638)	3rd quintile (34 ± 1) (n=1,334)	4th quintile (38 ± 1) (n=1,321)	5th quintile (45 ± 4) (n=1,416)
Weight (kg)	1.7	1.7	1.3	1.6	1.7
SDb	6.5	6.5	6.2	5.7	5.9
BMI	0.6	0.6	0.5	0.6	0.6
SDb	2.4	2.5	2.3	2.2	2.2

BMI, body mass index; SD, standard deviation

quintiles, with no significant difference in weight gain between ARFS quintiles ($p=0.53$).

Table 3 reports the results of the linear regression analyses examining the relationship between ARFS and six-year weight gain. There was no statistically significant relationship between ARFS and weight gain in any of the three models ($p>0.05$). There were no significant associations between any ARFS subscales and weight gain (Table 3).

Discussion

This study investigated the relationship between diet quality, as measured using the Australian Recommended Food Score, and weight gain in a healthy sample of middle-aged Australian women and found no significant association between ARFS and six-year weight gain. This suggests that a dietary pattern that focuses on usual consumption of a greater variety of foods and that aligns with national guidelines is not associated with greater weight gain in this group of women.

However, the finding in the current study are consistent with results of a study conducted by Kimokoti, et al. in 15,151 adults from the Framingham Off Spring and Spouse Study (FOS) which used the Framingham Nutritional Risk Score to measure diet quality, and found no relationship with weight gain over 16 years of follow up.¹⁹ In another study by Sanchez-Villegas, et al. of 6,319 adults from the Seguimiento University of Navarra (SUN) Cohort, there was no significant relationship between the Mediterranean Diet Scores (MDS) and weight gain over two years.²³ A recent study by Lassale et al.²⁴ in 3,151 adults evaluated the relationship between six different diet quality indices, all reflecting adherence to national healthy dietary recommendations, and 13-year weight change. There was no relationship between any of the diet quality scores and weight change in women. In contrast, two other studies have found that higher diet quality was associated with lower weight gain over time in both men and women, compared to weight gain in those with the lowest diet quality.^{25,26} In these two studies the indices used to evaluate dietary intake were the Diet Quality Index²⁵ and the MDS, respectively.²⁶

It was reported previously that a higher ARFS was an indicator of more favourable nutrient intake profiles in this population, including higher fibre, beta-carotene, folate, thiamine, niacin, riboflavin,

vitamin C, vitamin E, calcium and iron.¹¹ Higher ARFS scores were also consistent with more optimal macronutrient profiles in terms of higher percentage energy intakes from carbohydrate, protein and monounsaturated fat and a lower percentage energy from total fat and saturated fat.¹¹

The mean ARFS in this population was not high, indicating that diet quality could be improved. Women on average consumed a

Table 3: Longitudinal predictors of six-year weight change in women from the middle-aged cohort of the Australian Longitudinal Study on Women's Health (n=7,155).

Predictor	Model	Coefficient	(95% C.I.)	p-value
ARFS	1 ^a	-0.000	(-0.017, 0.016)	0.981
	2 ^b	0.009	(-0.008, 0.026)	0.315
	3 ^c	0.011	(-0.007, 0.028)	0.236
Vegetable sub-scale	1 ^a	0.013	(-0.020, 0.047)	0.424
	2 ^b	0.022	(-0.012, 0.056)	0.195
	3 ^c	0.025	(-0.010, 0.059)	0.159
Fruit sub-scale	1 ^a	-0.023	(-0.068, 0.022)	0.312
	2 ^b	0.007	(-0.040, 0.059)	0.780
	3 ^c	0.009	(-0.038, 0.056)	0.709
Protein sub-scale	1 ^a	0.064	(-0.010, 0.137)	0.090
	2 ^b	0.068	(0.006, 0.143)	0.073
	3 ^c	0.076	(0.0004, 0.152)	0.051
Grain sub-scale	1 ^a	-0.086	(-0.165, -0.007)	0.034*
	2 ^b	-0.056	(-0.137, 0.025)	0.173
	3 ^c	-0.052	(-0.137, 0.025)	0.230
Dairy sub-scale	1 ^a	0.058	(-0.084, 0.200)	0.425
	2 ^b	0.066	(-0.078, 0.210)	0.370
	3 ^c	0.063	(-0.081, 0.208)	0.389
Fat sub-scale	1 ^a	0.032	(-0.269, 0.334)	0.834
	2 ^b	0.126	(-0.179, 0.432)	0.419
	3 ^c	0.121	(-0.186, 0.428)	0.440
Alcohol sub-scale	1 ^a	-0.156	(-0.386, 0.074)	0.183
	2 ^b	-0.055	(-0.289, 0.179)	0.648
	3 ^c	-0.053	(-0.287, 0.181)	0.659

* Statistically significant results ($p<0.05$)

a Unadjusted model

b Adjusted for education, area of residence, baseline weight (kg), physical activity, smoking status, menopause.

c Adjusted for the same confounders in model two, plus total energy intake

relatively low variety of nutrient dense foods within each ARFS subscale, potentially placing them at increased risk of diet-related chronic disease, including CVD and some cancers.¹⁰

The diet quality indices used in previous studies have been constructed differently with varying sub-scales used, including regular consumption of differing but specific food items; and/or inclusion of sub-scales reflecting specific nutrient intakes such as saturated or total fat; and assignment of differing weightings to sub-scales – making direct comparisons difficult. In addition, previous studies^{23,26} assessed the relationship with weight change in adults in general and then adjusted for gender, while other studies examined the relationship between diet quality and weight change separately for men and women.^{19,24,25} However, the current study supports the majority of the previous literature which indicates that dietary patterns that are in line with national dietary guidelines are not associated with prospective weight gain in middle-aged women.

Strengths and limitations of the study

Previous studies have investigated the relationship between a range of diet quality indices and weight gain in adults. The strength of the current study is that it is the first to examine this relationship using the ARFS. While it has been shown to predict nutrient intakes and health outcomes previously,¹¹ this longitudinal analysis was conducted on a large number of middle-aged healthy women from the nationally representative ALSWH with follow-up for six years.

However the limitations must be acknowledged, and include that ALSWH data is self-reported, including body weight. Women were excluded from the analysis if they had self-reported specific disease states. This may have introduced bias, as some women may have had a disease they were not aware of at assessment, and subsequently improved their diet and reduced weight over the follow-up period. In addition, the ARFS does not capture food portion size, which is an important factor impacting on TEI and the association between dietary intake and weight change over time. However, the current study was not examining the relationship between portion size and weight gain. There was a large number of participants with missing weight and/or FFQ data, although there was no difference between those who misreported TEI and those who did not, or between those with missing weight or ARFS data.

The present study is limited by the fact that weight is self-reported. However, the impact may have been moderated because it was self-reported on both occasions. Although a previous study¹⁸ showed that women in the middle-age cohort tended to under-report their weight and height, the difference between self-reported and objectively measured weight and height was not clinically important, and the authors concluded that self-reported and objectively measured weight and height were in good agreement. The degree of misreporting cannot be verified in the current study and results should be interpreted with caution. Further, future studies examining accuracy of self-reporting of weight over time are needed.

No adjustments were made for multiple statistical testing.

Conclusion and implications

While women in the middle-aged cohort gained weight over a six-year period, their total ARFS as an indicator of overall diet quality did not predict weight gain. This means that consuming a dietary pattern that aligns with national dietary guidelines does not lead to weight gain in this population. This may indicate that women can safely be advised to follow the national dietary guidelines without risk of weight gain. However, further research is needed to confirm this.

The current analysis found that ARFS was not related to weight gain in this group of middle-aged women. It is possible that there is no association, or the lack of relationship may be a false negative and a true association does exist. These results may have arisen due to limitations specific to the ARFS as a measure of diet quality, such that the elements of diet responsible for weight gain were not captured; or due to the limited number of foods in the original FFQ the ARFS was derived from.

It is possible that population-wide changes in eating habits that were also not detected in the current analysis are contributing to weight gain, particularly as the FFQ in the current study was first developed in the 1980s. It would be useful to explore the relationship between weight change and the ARFS across other time frames, and in other age and population groups, including males. Furthermore, research is required to explore the relationship between the ARFS and risk of developing lifestyle-related chronic conditions, including cardiovascular disease and type 2 diabetes.

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Supporting Information

Additional supporting information may be found in the online version of this article.

Supplementary Table 1: The scoring method for the Australian Recommended Food Score (ARFS).

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