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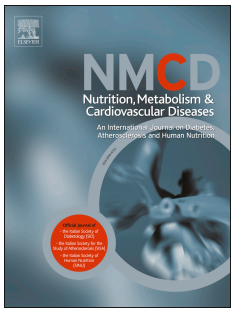

Improving diet quality over nine-years is associated with less weight gain in mid-age Australian women: A cohort study

Haya M. Aljadani, Amanda Patterson, David Sibbritt, Rachael M. Taylor, Clare E. Collins

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TITLE PAGE

Title

Improving diet quality over nine-years is associated with less weight gain in mid-age Australian women: A cohort study

Authors

Haya M. Aljadani, Amanda Patterson, David Sibbritt, Rachael M. Taylor and Clare E. Collins

Affiliations

Faculty of Nutrition and Health Science, King Abdul-Aziz University, Jeddah, MK 80200, Saudi Arabia (HMA)
Priority Research Centre in Physical Activity and Nutrition, University of Newcastle, Newcastle, NSW 2308, Australia (AP, RMT, CEC)
School of Health Sciences, University of Newcastle, Newcastle, NSW 2308, Australia (AP, RMT, CEC)
Faculty of Health, University of Technology Sydney, Sydney, NSW 2007, Australia (DS)

Corresponding Author

Clare E. Collins

Nutrition and Dietetics, Priority Research Centre in Physical Activity and Nutrition,

The University of Newcastle, Level 3 ATC Building, Callaghan Drive, Callaghan, NSW 2308, Australia. Tel.: +61 2 49215646 Fax: +61 2 49217053

E-mail: clare.collins@newcastle.edu.au

Short Title

Diet quality in relation to weight change in mid-age women

Abstract

Background and Aims: Most studies measure baseline diet quality exclusively and hence the impact of longitudinal changes in dietary intake in relation to weight change is not considered. Therefore, this study aimed to examine whether change in diet quality over nine-years was associated with weight change over the same period in mid-age Australian women.

Methods and Results: Healthy mid-age (45-49 years) women from the Australian Longitudinal study on Women's Health (ALSWH) were eligible a valid total energy intake (TEI) was reported at baseline (n=2,381), determined using Goldberg cut-offs. Diet quality was measured by the Australian Recommended Food Score (ARFS) using data derived from a validated food frequency questionnaire. Multiple linear regressions were used to evaluate relationships between change in diet quality and weight in mid-age women (n=1,999). Women in the highest tertile of ARFS change improved diet quality [mean ±SD] [7±4 points], while those in the lowest [-9 ±5 points] and middle [-1±2 points] tertiles had worse diet quality at follow-up. Overall, mean weight gain was 2.3±7.2kg over nine years. Those in the highest tertile of ARFS change gained significantly less weight , compared to the lowest tertile; β = -1.2 kg [95% CI: -2.31, -0.11; p=0.03] after adjustment for changes in confounders and baseline weight, baseline ARFS, and total energy intake.

Conclusions: Improving diet quality could be an important strategy for promoting modest weight loss and *potentially contribute to* preventing weight gain in mid-age women, which is important for metabolic health.

Keywords: Diet quality, weight gain, mid-age women, longitudinal, cohort

Introduction

Globally the prevalence of obesity has approximately tripled between 1975 and 2016 [1]. This presents a major public health issue, given obesity is linked to an increased risk of all-cause morbidity and mortality [2, 3]. In 2016, the World Health Organization (WHO) estimated that amongst adults (≥aged 18 years), 55% of females and 50% of males were overweight or obese, highlighting a slightly higher prevalence among females relative to males [1]. In western countries, mid-age (45-54 years) women are at high risk of weight gain [4, 5]. The 2017-2018 Australian National Health Survey, reported that the prevalence of overweight and obesity in women increased from 60% at ages 45-54 years to 65% at ages 55-64 years [6].Weight gain in mid-age women is associated with changes in dietary intake including increased energy intake [7, 8] and alcohol consumption [9, 10] as well as a reduction in physical activity [11, 12] and change in smoking status [8, 10]. Apart from behavioural factors, weight gain during this lifestage may be partially attributed to the menopausal transition, with declining estrogen (estradiol) concentration associated with an increase in abdominal fat deposition [13]. Obesity in postmenopausal women is associated with a higher risk for all-cause mortality and both coronary heart disease and breast cancer mortality [14-17].

A substantial body of evidence has shown that moderate weight loss (i.e. 5-10% of initial body weight) lowers the risk of cardiovascular disease [18, 19]. Therefore, aiming to prevent weight gain during the menopausal transition is an important strategy for reducing the burden of chronic disease as well as risk of morbidity and mortality among mid-age women. Diet is a key modifiable determinant of overweight and obesity and therefore an area likely to be important to target for mid-age weight management. Mid-age women are known to attempt to lose weight or try to prevent weight gain, but currently few women achieve weight management success [20]. Therefore, developing effective dietary recommendations to guide weight management efforts for this population group at high risk of weight gain is needed.

Considerable research has examined the relationship between the intake of single nutrients or food items and weight status [21, 22]. However, evaluations should consider an individuals' whole diet, and not be limited to individual foods or isolated nutrients. It is likely, whole diets and dietary patterns may have cumulative effects on weight status compared with single nutrients or food items [23, 24]. Evidence based on dietary patterns can be more easily translated into messages that inform dietary interventions and dietetic practice [25, 26]. Diet quality indexes or scores can be used as a measure of overall dietary intake and alignment of

eating patterns with dietary guidelines, while also predicting the risk of morbidity and mortality [27, 28]. However, a systematic review (*n*=16 studies) indicated that few studies (25%) have measured diet quality across multiple time-points and examined the association between longitudinal changes in diet quality in regard to weight change over time [29] .

Therefore, the current study aimed to evaluate change in diet quality, as measured by the validated Australian Recommended Food Score (ARFS) [33, 34] and weight change in mid-age women over nine-years of follow-up, among those who were free of disease and had reported valid total energy intakes (TEIs) at baseline. This evaluation is important in regard to informing dietary recommendations for the prevention of overweight and obesity in mid-age women.

Methods

Population

The current study analysed data from mid-age women participating in the Australian Longitudinal Study on Women's Health (ALSWH) at two points in time, 2001 and 2010 [35-37]. The ALSWH was established in 1996 and recruited over 40,000 women in three cohorts, based on age: young women (18-22 years), mid-aged women (45-49 years) and older women (70-74 years). The overall aim of the ALSWH was to examine the social, psychological and physical predictors of mental health, well-being and health outcomes of women over time. The National Health Insurance database (Medicare) was used as a sampling frame to recruit women as it is the most up-to-date and complete dataset for women and permanent residents in Australia. Participants were randomly selected from the Medicare database. The study was approved by the University of Newcastle and the University of Queensland Human Research Ethics committees.

Participants

Analyses were restricted to data obtained from the mid-age cohort (*n*=1,999) who completed questionnaires in 2001 and 2010. Women were excluded if they reported any of the following chronic conditions at baseline: type 2 diabetes, impaired glucose tolerance, heart disease, stroke or breast, cervical or bowel cancer. A valid TEI was identified using Schofield equations to calculate Basal Metabolic Rate (BMR) for each participant, based on age

(years), self-reported weight (kilograms), with a Physical Activity Level (PAL) of 1.55 applied to calculate individual Estimated Energy Requirements (EER). EERs were compared with individual TEIs derived from the food frequency questionnaires (FFQs) and Goldberg cut-offs (<0.76 and >1.24) for under and over-reporters were applied to identify those with valid TEIs [38]. The TEI (KJ/day) and nutrient intakes were quantified from the Australian nutrient composition database using the Nutrient Data Table (NUTTAB) [39].

Dietary assessment

Dietary intake was assessed in both Survey 3 (2001) and Survey 6 (2010) of the ALSWH using the Dietary Questionnaire for Epidemiological Studies Version 2 (DQESv2), an FFQ developed by the Cancer Council of Victoria [40] which has previously been validated in Australian women [41]. The DQESv2 required the women to report their consumption of 74 food items and six-alcoholic beverages over the previous 12 months using a 10-point frequency scale which ranges from never to 3 or more times per day. Photographs were used to represent different serving sizes for vegetables, potatoes and meat casserole dishes, enabling a portion factor to be calculated that accounted for serving size variability.

Diet quality

The ARFS was used to calculate an overall diet quality score. Validation studies have indicated that higher ARFS scores are associated with more optimal nutrient intakes and better self-rated health in mid-age women [33, 34]. The ARFS was based on the US Recommended Food Score [42] and contains a total of 74 items arranged into seven sub-scales, with scores ranging from zero up to 74 points. Each item scores one point if the participant meets 100% of the specific food group serves recommendation, and zero if otherwise. Higher scores reflect dietary patterns more closely aligned with the Australian Guide to Healthy Eating recommendations [43]. The seven sub-scales have various point allocations and additional points are allocated for optimal types or amounts within the sub-scales. These include: Vegetables (21 items + 1 point for ≥4 serves daily = 22 points); Fruit (13 items + 1 point for ≥2 serves daily = 14 points); Protein Foods (14 points), including animal protein (8 animal protein items, 1 point ≤ 2 eggs weekly; 7 items scored 1 point for 1–4 serves/week of beef, lamb, pork, poultry, fish/seafood (3 items); + 6 plant protein items each item scored 1 point for ≥1 serve weekly = 14 points); Grains (13 items + 1 point for ≥4 serves per day = 14 points); Dairy (5 items + 1 point for using skim or reduced fat milk + 1 point for >500ml milk per day = 7 points); Fats (1 point for using poly or monounsaturated

margarine = 1 point); Alcoholic Beverages (1 point for beer/wine/spirits up to 4 days per week + 1 point for 2 or less drinks each occasion = 2 points) [34]. Zero points are awarded when alcohol is not consumed due to the U-shaped association between alcohol intake and health status [34]. To evaluate nine year change in ARFS, follow-up scores were subtracted from baseline ARFS.

Weight

Weight (kilograms) was self-reported and weight change was calculated by subtracting weight in 2001 from weight in 2010.

Potential confounders

The highest levels of education attained by the women were categorised into school certificate (≤11 years schooling), higher school certificate (12-13 years schooling), trade/apprenticeship, undergraduate university degree and post-graduate degree. The location of residence of the women were categorised using the Australian Bureau of Statistics definitions: urban (with 100,000 or more people), rural (with 200 to999 people) and remote (<200 people). The change in area of residence were categorised into: women who lived in urban areas in 2001 and 2010, those who lived in rural areas in 2001 and 2010, those who lived in an urban area in 2001 and moved to a rural area by 2010, those who lived in a rural area in 2001 and moved to an urban area by 2010. The changes in smoking status were categorised into: women who reported that they never smoked in 2001 and 2010, those who reported smoking only in 2010, those who reported they were current smokers in 2001 and 2010, and those who were smokers in 2001 and quit smoking by 2010. The changes in menopause status were categorised into: women who were pre-menopausal or were using oral contraceptive (OCP) in 2001 to being peri-menopausal in 2010, those who were pre-menopausal in 2001 to being post-menopausal (or surgical menopause) in 2010, women who were peri-menopausal in 2001 and remained peri-menopausal or had begun hormone replacement therapy (HRT) in 2010, women who were peri-menopausal in 2001 and became post-menopausal in 2010, and those women who were post-menopausal at baseline.

Physical activity

Participants self-reported walking, moderate and strenuous physical activity (PA) frequency which was used to derive a PA score in metabolic equivalents (METs) per minute (MET.mins) [44]. Total MET minutes were calculated and categorised into four groups: nil/sedentary (0 to <40 MET.min/week), low (40 to <600 MET.min/week), moderate (600 to <1200 MET.min/week) and high (≥1200 MET.min/week) [45]. The change in physical activity from 2001 to 2010 was calculated as MET.min at follow-up subtracted from the MET.min at baseline.

Statistical analyses

All analyses were conducted using STATA 11 (College Station, TX: StataCorp LP 2011). All changes in data were checked for normality and found to be normally distributed. Analysis of variance (ANOVA) was used to compare means of the continuous variables across tertiles of ARFS change. Multivariate linear regressions were used to examine whether change in the ARFS, classified as tertiles, impacted on weight change from 2001 to 2010. The models included change in ARFS (grouped as tertiles), as the independent variable and weight change (in kilograms) as the dependent variable. The lowest tertile of change in ARFS was the reference group in the regression models. Two separate linear regressions were applied: a crude and a fully adjusted model, the latter of which was adjusted for changes in confounder variables or for baseline results (i.e. changes in education, smoking status, area of residence, menopause status, baseline weight, baseline ARFS, and baseline TEI).

Results

Of the 10,267 women in the mid-age cohort in 2001, 5,989 met the inclusion criteria and had ARFS and weight data at both 2001 and 2010 (Figure 1). Of these, 2,381 women were deemed to have a valid TEI at baseline and 1,999 women had complete weight and dietary data.

No significant differences were found between women with a valid TEI (n=2,381) and an invalid TEI (n=3,608) at baseline in terms of age, education, menopause status, area of residence and smoking status variables. However, there were significant differences between the samples in terms of baseline prevalence of healthy weight (BMI 18.5 to 24.9kg/m^2) or obesity (BMI: ≥30), $p<0.01$. For women with an invalid TEI, baseline prevalence of healthy weight was 34% compared with 50% amongst those with a valid TEI, while baseline obesity

prevalence among women with a valid TEI 16% versus was 23% among those with an invalid TEI.

After the nine year follow-up, women on average were heavier [mean(standard deviation(SD)] [2.3 (7.2) kg] and demonstrated a small decline in diet quality of 2(8) ARFS points (Table 1). There was an 11% increase in the prevalence of obesity, with no significant changes in PA reported during the nine-year follow-up.

ARFS change was -9.0(5.0) [range values (-4 to -31) and median = -8] for the lowest (worse diet quality) tertile, -1.0(2.0) [range values (2 to -3) and median was -1.] for the middle tertile and +7.0(4.0) [range values (22 to 3), and median was 6 scores] for the highest tertile (greatest improvement in diet quality), p=<0.01 (Table 2). Weight change was [+2.6(6.8)], [+2.2(7.5)] and [+1.5(7.4)] for those in the lowest, middle and highest tertiles of change in ARFS score, p=0.04 (Table 2).

Table 3 reports the change in ARFS sub-scale scores across tertiles of nine-year change in ARFS scores. Across the tertiles of all sub-scale change scores, there were significant differences detected between 2001 and 2010, p-values <0.001. The greatest increase in sub-scale scores were reported for vegetables [3(3) points], fruit [2(3) points] and protein [2(2) points] for women in the highest tertile of ARFS change. For women in the lowest tertile of change in ARFS, the greatest decreases in sub-scale scores were reported for vegetables [-5(4 points)], fruit [-2(3points)] and grains [-2(2 points)].

In the fully adjusted models, women in the highest tertile (greatest improvement in diet quality) of ARFS change, gained significantly less weight compared with women in the lowest tertile (worse diet quality) over nine-years of follow-up; β: -1.2 [95% CI: -2.31, -0.11], (p= 0.03) (Table 4).

Discussion

The current analysis indicates that improvements in diet quality are associated with less weight gain among mid-age Australian women over a nine-year period. Those with the greatest improvement in diet quality (i.e. highest tertile of ARFS change), gained less weight (i.e. -1.2kg over nine years) compared to women whose diet quality worsened (i.e. lowest tertile of ARFS change) over nine-years of follow-up. Although the magnitude of weight gain

was small in the current study, population attributable fractions (PAFs) derived from a cohort of Swedish adults (*n*=33,184) indicated that 22-42% cases of newly diagnosed diabetes could be prevented by population wide weight maintenance (±1.0 kg/m^2) or moderate weight loss (−1.0 to −2.0 kg/m^2) [47]. Furthermore, evidence indicates that for each kilogram of weight gain the risk of developing diabetes increases by 5-9% over the proceeding 10 to 20 years [48, 49]. While weight gain following weight loss termed weight cycling, is also associated with an increased risk of developing diabetes [50, 51]. The Kangbuk Samsung Health study (*n*=4,818) reported that adults who were overweight at baseline who experience high weight cycling (≥1.83 kg) over two years had a significantly greater risk of developing diabetes compared to those with normal weight at baseline and a lower degree of weight cycling (<1.18 kg) over four years (odds ratio 2.27; 95% CI 1.12-4.57) [50]. These studies highlight the importance of preventing weight gain and of sustaining weight loss for promotion of long-term health.

Overall women reported a mean weight gain of 2.3(7.2) kg and a reduction in diet quality scores of -2(8) points during this time. We previously [54] identified that baseline diet quality was not associated with weight gain or loss over six years of follow-up among 7,155 mid-age ALSWH women (48 to 56 years). This current analysis examined the relationship between change in ARFS and weight gain over a longer follow-up period (nine-years). This highlights the importance of evaluating the relationship between change in diet quality and patterns of weight gain, and further that diet quality is not static over time for mid-age women. In contrast to the current findings, Arabshahi et al., [55] found no relationship between change in diet quality, measured by the Dietary Guidelines Index (DGI), and weight change in Australian women aged 25 to 75 years over 15 years of follow-up. These conflicting findings could be due to differences in the characteristics of the study sample, measurement of diet quality, study design or differences in the adjustment for confounders.

Studies worldwide have also reported an inverse association between change in diet quality and BMI change [56], weight change [57, 58] or risk of obesity [59]. In the Framingham Offspring cohort, women aged 49-56 years (*n*=1847) with higher mean diet quality scores, as measured by the DQI at two time-points, gained significantly less weight at 3.3 (17.4) lb, compared with those with lower mean diet quality scores 8.0 (13.0) lb over eight years of follow-up [57]. Similarly, in the Spanish prospective cohort (SUN project), adults (*n*=6319) in the highest quartile of diet quality at baseline, which aligned with a Mediterranean Diet Pattern (MDP), had significantly less weight gain compared with those in the lower quartile of diet quality at baseline (p=0.016) [58]. Boggs et al., [59] reported that African American women *(n*=12,271*)*

with a healthy weight at baseline (BMI 18.5 to 24.9kg/m^2) reported improved diet quality scores, measured using the Alternative Healthy Eating Index (AHEI), and had a lower risk of becoming obese BMI ≥30 kg/m^2) over six years. Interestingly, Fung et al., [31] reported that the relationship between improved diet quality and lower weight gain was stronger for younger women (aged <55 years) compared with older women (≥55 years) over four year follow-up ($p<0.0001$). These age-related differences in weight change could potentially be confounded by weight gain risk related to the menopause transition [60].

Women undergoing the menopausal transition are at an elevated risk of weight gain [60] and are not meeting the national dietary guidelines [61]. The current study found that mid-age Australian women have poor diet quality, with a mean baseline ARFS of 35 out 74 (47%). Even women in the highest tertile of change in ARFS score, who reported modest improvements in ARFS score, still gained weight over time, which is supported by other Australian studies [55, 61-65]. Azadbakht et al., [66] reported that less weight gain over four years in young Iranian women aged ≥ 18 years (*n*=120,877*)* in association with a higher consumption of vegetables, wholegrains, fruits, nuts and yoghurt ($p\leq0.005$). Many of these foods are relatively low in energy and high in fibre, providing greater satiety [67]. Therefore, it is not surprising that higher consumption of these foods contributes to less weight gain. However, ARFS only captures intake of the healthy foods from nutrient-dense core food groups (i.e. vegetables, grains, fruit, dairy and alternatives and meat and alternatives), but does not evaluate portion size, estimate energy intake or the consumption of energy-dense nutrient poor foods. The relationship between ARFS and weight is based on the previous finding that greater consumption of the core, nutrient-dense foods displaces energy-dense and nutrient-poor foods [34] and therefore impacts overall energy intake. Despite this, the ARFS sub-scale analysis in the current study showed that women who gained the least amount of weight, consumed a greater variety of vegetables, fruit and lean protein over time. These study findings suggest that mid-age women need specific advice and guidance from health professionals in regards to adopting healthy eating behaviours to promote better diet quality, including the consumption of a variety of healthy nutrient-dense foods, for the prevention of prospective weight gain.

This was a robust analysis of a prospective cohort study in a representative sample of mid-age Australian women. However, there are some important limitations that need to be acknowledged. Dietary intake, weight, socio-demographic and lifestyle information were self-reported therefore, misreporting can not be excluded and could be related to other

factors, including socioeconomic status, BMI, perceived weight status and level of physical activity [68-70]. However, the DQESv2 has been previously validated in Australian women [41], and self-reported weight in the ALSWH cohort shows good agreement with objective measurements [71]. Furthermore, the study analyses only included women with a valid TEI to minimise mis-reporting bias. The determination of TEI based on the evaluation using the food list in the DQESv2 and may have not captured all energy–dense, nutrient-poor foods although, this is the case for most epidemiological studies that utilise FFQs. A strength of the current analysis is that the ARFS has been validated and adapted for use in Australian populations [33, 34]. In addition, the longitudinal study design permitted assessment for change in diet quality, while adjusting for change in confounders such as smoking, PA and menopausal status.

Conclusion

Women, who improved their dietary quality, by increasing the consumption of a variety of nutrient-dense, core-foods, gained the least weight over nine-years, while those with the greatest reductions in diet quality gained the most weight. The current study provides some support that improving diet quality in women during mid-life that is associated with very modest weight reduction. Evaluation of whether promoting higher diet quality as a strategy for preventing weight gain and reducing long-term susceptibility to chronic disease is warranted..

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Competing Interests

There are no conflicts of interest to declare.

Authorship

Contribution of each author; AP, DS, CEC conceptualised the research project; all authors were involved in the design of the research; HMA conducted the research; HMA conducted the analysis and HMA, RMT drafted the manuscript; all authors edited and provided feedback and approved the final manuscript. The content in this manuscript is the original work of all authors involved. The manuscript is not under consideration nor published elsewhere in the same or in a similar form. All authors have read and approved the manuscript.

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Table 1: Characteristics and anthropometric measurement for mid-age women (*n*=1999) with valid total energy intake (TEI)

Variable	**Baseline Mean**	**Baseline SD**	**Follow-up Mean**	**Follow-up SD**
ARFS at baseline	35.0	9.0	32.0	8.0
Change in ARFS over nine-years	n/a	n/a	-2.0	8.0
Weight (kg)	68.5	13.7	72.7	15.7
Change in weight over nine-years (kg)	n/a	n/a	2.3	7.2
Participant Characteristics				
TEI (KJ/d)	8956.5	1414.0	n/a	n/a
Age (years)	52.5	1.5	61.5	1.5

PA (Met. minutes)	1012.9	1414.2	1220.3	1539.2
Change PA (exstat)	n/a	n/a	239.9	1678.6
Participant Characteristics	**Baseline Percentage**		**Follow-up Percentage**	
Underweight (BMI: <18.5) (%)	2.1		2.0	
Healthy weight (BMI: ≥18.5 to <24.9)(%)	50.0		37.0	
Overweight (BMI: ≥24.9 to <29.9) (%)	31.0		34.0	
Obese (BMI: ≥30) (%)	16.0		27.0	
Smoking Status (Non-smoker/ex-smoker/smoker)	57/30/13		62/29/9	
[1]Area of Residence (Urban/rural/remote)	35/60/5		38/57/4	
Education (No formal/school certificate/trade and apprentice/university degree and higher)	18/32/17/23		15/24/19/41	
Marital status (Married/defacto/separated/divorced/widowed/ single)	77/6/3/8/3/3		70/6/4/11/6/3	
Menopause status (Surgical menopause/ HRT use/OCP use/Pre-menopausal/Peri-menopausal/Post-menopausal)	27/20/9/19/24/1		37/4/0/0/59	

SD, Standard deviation. ARFS, Australian Recommended Food Score. n/a, Not applicable. BMI, Body Mass Index. TEI, Total energy intake. KJ, Kilojoules. PA, Physical activity. Met. minutes, Metabolic equivalents per minute. Exstat, physical activity summary score [(72)]. HRT, Hormone replacement therapy. OCP, Oral contraceptive pill.

[1]Urban (100, 00 or more people), rural (200-999 people), remote (<200 people).

Table 2: Social-demographic variables of mid-age women (*n*=1999) at baseline and follow-up by tertile of changes of the Australian Recommended Food Score (ARFS)

	Baseline (2001)							Follow-up (2010)						
Variable	**Tertile 1 (*n*=778; 39%)**		**Tertile 2 (*n*=557; 28%)**		**Tertile 3 (*n*=664; 33%)**		***p-value ANOVA***	**Tertile 1 (*n*=778; 39%)**		**Tertile 2 (*n*=557; 28%)**		**Tertile 3 (*n*=664; 33%)**		***p-value ANOVA***
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	
ARFS	39.0	7.0	35.0	8.0	30.0	8.0	*<0.01	30.0	7.0	34	8	37.0	8.0	*<0.01
Change in ARFS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-9.0	5.0	-1.0	2.0	7.0	4.0	*<0.01
Change in weight (kg)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.6	6.8	2.2	7.5	1.5	7.4	*0.04
Weight (kg)	69.0	13.1	69.1	14.1	67.7	13.4	0.27	71.6	14.2	71.2	15.6	69.0	13.1	*0.02
Energy intake (KJ/d)	8980.3	1406.7	8,896.2	1427.2	8806.0	1381.0	0.18	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age (years)	52.4	1.5	52.5	1.5	52.5	1.5	0.61	61.4	1.5	61.5	1.5	61.5	1.5	0.53
	Tertile 1 (*n*=778; 39%)		**Tertile 2 (*n*=557; 28%)**		**Tertile 3 (*n*=664; 33%)**		***p-value ANOVA***	**Tertile 1 (*n*=778; 39%)**		**Tertile 2 (*n*=557; 28%)**		**Tertile 3 (*n*=664; 33%)**		***p-value ANOVA***
	Percentage		**Percentage**		**Percentage**			**Percentage**		**Percentage**		**Percentage**		
BMI: (Underweight/healthy/ overweight/obese) (%)	2/50/34/14		2/50/28/20		2/50/33/14		0.07	1/40/37/22		1/44/31/24		3/44/34/18		1.13
PA in METs (nil/low/moderate/ high) (%)	13/36/22/29		12/35/26/27		17/40/19/24		*<0.01	15/28/22/35		13/24/21/42		16/27/22/35		0.41
Changes in PA (METs)	n/a		n/a		n/a		n/a	150.7(1,476.1)		343.8 (1,757.4)		368.5(1,440.9)		0.07
Smoking status (never/ ex-smoker/ current) (%)	57/32/11		56/34/10		56/29/15		0.22	62/31/7		61/32/7		64/28/8		0.64
Residence (urban/ rural/ remote); proportion (%)	36/52/5		34/61/5		34/62/4		0.90	37/59/4		35/60/5		36/61/3		0.90
Highest education (nil/ school certificate/ trade/ university degree) (%)	28/36/18/18		17/38/18/18		17/34/19/33		*<0.01	10/41/21/28		11/44/25/20		17/48/16/19		*<0.01

ANOVA, Analysis of variance. SD, Standard deviation. ARFS, Australian Recommended Food Score. n/a, Not applicable. KJ, Kilojoules. BMI, Body Mass Index. PA, Physical activity. METs, Metabolic equivalents per minute.

[1]Urban (100, 00 or more people), rural (200-999 people), remote (<200 people).

*Statistically significant (p<0.05)

602 **Table 3: Change in the ARFS subscales (2001-2010) in mid-age women by tertiles**

	Changes of the ARFS tertiles (*n*=1999)						
Variable	**Tertile 1 (*n*=778; 39%)**		**Tertile 2 (*n*=557; 28%)**		**Tertile 3 (*n*=664; 33%)**		**p-value *(ANOVA)***
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
ARFS (baseline)	39.0	7.0	35.0	8.0	30.0	8.0	<0.001*
Vegetables	-5.0	4.0	-1.0	3.0	3.0	3.0	<0.001*
Fruit	-2.0	3.0	-0.04	2.0	2.0	3.0	<0.001*
Dairy	0.02	1.0	0.2	1.0	0.5	1.0	<0.001*
Grains	-2.0	2.0	-0.5	2.0	0.5	2.0	<0.001*
Protein	-0.1	2.0	1.0	2.0	2.0	2.0	<0.001*
Fat	-0.10	1.0	-0.07	0.5	0.03	1.0	<0.001*
Alcohol	-0.10	1.0	-0.07	0.5	0.03	1.0	<0.001*

603 ARFS, Australian Recommended Food Score. ANOVA, Analysis of variance. SD, Standard deviation.
604 *Statistically significant ($p<0.05$)

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Table 4: Multiple linear regression models to predict nine-year weight change in mid-age women (*n*= 1999)

Predictor: Diet Quality Index	**Model**	**Tertile (Comparator Tertile 1)**	**[1]ΔWeight (kg) *β* co-efficient**	**[1]ΔWeight (kg) 95% Confidence Interval**	**p-value**
Change in ARFS (2001-2010)	*[1]Crude*	2	-0.41	-1.32, 0.49	0.37
		3	-1.06	-2.01, -0.10	*0.03
	[1]Fully adjusted	2	-0.33	-1.28, -0.62	0.49
		3	-1.2	-2.31, -0.11	*0.03

ARFS, Australian Recommended Food Score.

[1]Crude model: the dependent variable is nine- year weight change in kg and independent variable the nine-year change in ARFS score in tertiles. Fully adjusted model: same as the crude model plus adjustment for changes in confounder variables (including education and smoking status, area of residence, menopause status) and baseline weight, baseline ARFS, and total energy intake. The lowest tertile of the ARFS was the reference group in the models.

*Statistically significant ($p<0.05$)

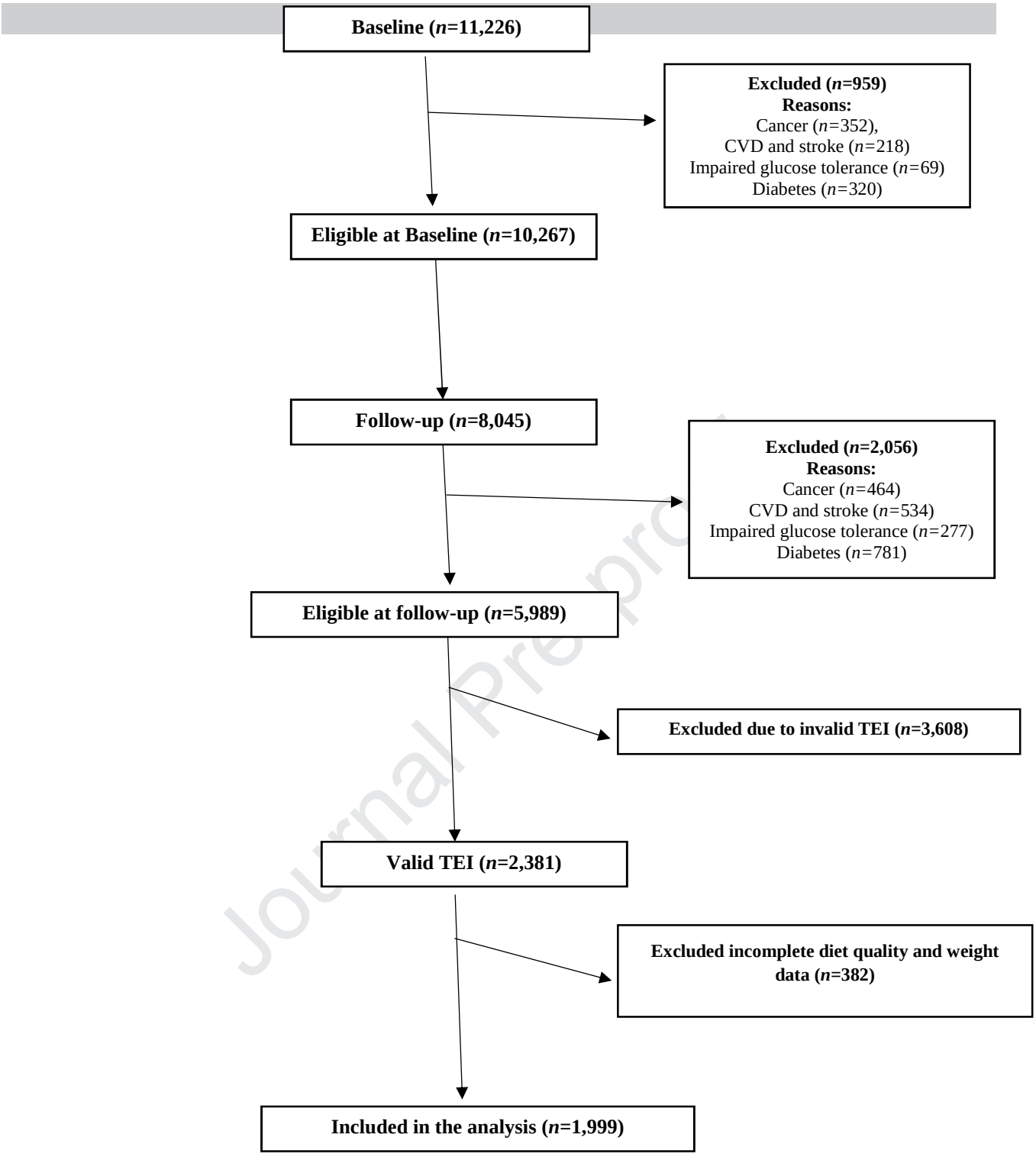

Figure 1. Flow of participants in the Australian Longitudinal Study on Women's Health (ALSWH).

CVD, cardiovascular disease TEI, total energy intake.

Highlights

- In western countries mid-age (45-54 years) women are at a higher risk of weight gain
- Factors that may contribute to weight gain in mid-age women include hormonal changes associated with menopause transition and changes in eating and exercising behaviours
- Improvements in diet quality are associated with less weight gain in mid-age Australian women over a nine year period
- Interventions that improve diet quality may be an effective strategy for preventing weight gain in mid-age women