

## ORIGINAL ARTICLE

# Weight gained in two years by a population of mid-aged women: how much is too much?

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**Objective:** To establish the prevalence of weight change in mid-aged women over a 2-year period, and to assess the relationship between weight change and physical and mental well-being (SF36) in order to begin debate about the need for quantified standards of weight gain.

**Design:** Prospective study of weight change and well-being over a 2-year period among mid-aged women participating in a large national survey.

**Subjects:** Seven thousand two hundred and seventy women without surgical menopause aged between 45 and 50 years (termed mid-aged), enrolled in the Australian Longitudinal Study on Women's Health.

**Measurements:** Weight change (self-reported weight at two time points) and physical and mental well-being (SF-36) explored using linear regression, while adjusting for potential confounders.

**Results:** Only half the women maintained their weight within 2.25 kg, and one-third gained more than this amount in a 2-year period. While weight gain ( $\geq 2.25$  kg) was negatively associated with physical well-being, both weight loss and weight gain were associated with poorer mental well-being.

**Conclusion:** This is the first prospective study using a large, population-based cohort to demonstrate that small changes in weight are associated with changes in well-being in mid-aged Australian women. It provides further evidence of the need for public health messages to specify the actual amount that constitutes weight gain, but further research is needed to establish these standards for the entire population.

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## Introduction

The epidemic of obesity and its associated health risks are of worldwide concern.<sup>1</sup> However, while the increasing prevalence of obesity has been established in several countries worldwide, and populations are continually advised to 'maintain weight' or 'prevent weight gain', there has been little quantitative research on which to base definitions of weight maintenance or weight gain. Agreed definitions of these terms are needed to assess the prevalence of weight gainers in populations, and to provide the public with clear messages for self-monitoring of weight.

Only two authorities have attempted to make quantified recommendations on weight gain. In 1995, the World Health Organisation (WHO) recommended that people with a body mass index (BMI) between 25.0 and 30.0 kg/m<sup>2</sup> should measure weight annually and those who gain more than 5 kg during a 2-year period should 'halt weight gain'.<sup>2</sup> In 1996, the Scottish Intercollegiate Guidelines Network (SIGN) recommended that those with a BMI of 18.5–25.0 kg/m<sup>2</sup> should aim for adult weight gain of <5 kg; and those with a BMI in the overweight or obese range, and who have successfully lost weight, should aim for weight maintenance (defined as a regain of <3 kg at 2 years after the initial weight loss).<sup>3</sup> Neither the WHO nor the SIGN specified the rationale for the 5 kg weight gain cutoff.

Some researchers have attempted prospective quantification of the health effects of weight gain. The observational study, 'Relationships of Energy, Nutrition and Obesity to Cardiovascular Disease Risk' (known as the RENO Study) examined the health risks of natural weight change prospectively over periods of 1–4 years in 205 men (105 normal

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weight and 100 obese) and 180 women (92 normal weight and 88 obese).<sup>4</sup> A weight gain of five pounds (approximately 2.25 kg) or more over 4 years resulted in significantly higher body fat, waist-to-hip ratio, total cholesterol and blood pressure in weight gainers, compared with those who lost or maintained their weight within five pounds.

Larger cohort studies have relied on self-report measures of well-being, such as the Medical Outcomes Study Short Form survey (MOS SF-36).<sup>5</sup> Cross-sectional studies have demonstrated a clear relationship between physical well-being scores on the SF-36 and BMI.<sup>6–8</sup> The Nurses Health Study assessed this relationship longitudinally in more than 45 000 women (46–71 years) who completed the SF-36 at baseline (1992) and again after 4 years (1996).<sup>9</sup> Researchers found that weight gains of as little as 2.25 kg were associated with worsening health status. The more weight gained, the more dramatic the reduction in functioning, especially for the SF-36 subscales of physical function, vitality and bodily pain, for all categories of initial BMI.

Although the Nurses Health Study provides evidence of the detrimental effects of gaining 2.25 kg in a 4-year period in women who are nurses, it is not known whether changes over a shorter period, or in a population sample, are associated with adverse health effects. The Women's Health Australia cohort provided the opportunity to investigate weight gain and well being in a large national random sample of women. The aims of this study were therefore: (1) to establish the prevalence of weight gainers over a 2-year period in a cohort of mid-aged women; and (2) to assess the relationships between changes in weight and in physical and mental well-being (SF-36).

## Methods

### *WHA study overview*

The Australian Longitudinal Study on Women's Health, now known as Women's Health Australia (WHA), is a prospective study that commenced in 1996. The overall aim of the study is to examine health and health determinants during significant stages of physical, psychological and social change in women's lives.<sup>10</sup> The WHA study instruments are self-complete mailed surveys containing items on health status and factors affecting health. Ethics clearance for the WHA study was obtained from the Human Research Ethics Committee of the University of Newcastle.

### *Participants*

The WHA project involves three cohorts of women (young, mid-age and older) who were randomly selected from the Medicare database of the Health Insurance Commission of Australia, with stratification to ensure over-sampling of women living in rural and remote areas.<sup>11</sup> The mid-aged cohort was selected for this study, since this is a recognised

stage of weight gain in Australian women.<sup>12</sup> The mid-aged cohort includes 14 100 women who were 45–50 years old at the baseline survey (survey one, S1) in 1996 (response rate 54%).<sup>11</sup> Demographic characteristics show that the mid-age cohort is largely representative of Australian women in this age group, but with slight overrepresentation of women with higher education and in paid employment than their population counterparts.<sup>11</sup> The first follow-up survey (referred to as survey two, S2) was completed by 92% ( $N = 12\,328$ ) of the initial cohort in 1998.<sup>13</sup> Non-respondents tended to be divorced or separated, and to have slightly lower levels of education than the women in the continuing cohort.

All women who did not report hysterectomy with or without bilateral oophorectomy (surgical menopause) at either survey were included in this analysis. Women with implausibly high weight change values between S1 and S2 (a change of more than 30 kg in 2 years) ( $n = 12$ ) were excluded.

### *Measures*

Body mass index (BMI) was derived from the weight and height variables by the equation: weight (kg) divided by the square of height (m). Body mass index was used as a continuous or categorical variable depending on the analysis. Body mass index scores were assigned to one of four categories according to the recommendations of the World Health Organisation as 'underweight' ( $\text{BMI} < 18.5 \text{ kg/m}^2$ ), 'acceptable' ( $18.5 \leq \text{BMI} < 25.0 \text{ kg/m}^2$ ), 'overweight' ( $25 \leq \text{BMI} < 30.0 \text{ kg/m}^2$ ) and 'obese' ( $\text{BMI} \geq 30.0 \text{ kg/m}^2$ ).<sup>1</sup>

Changes in self-reported weight and in BMI between S1 (1996) and S2 (1998) were calculated. Patterns of weight change were assessed by classifying women into one of five categories based on weight change between S1 and S2. The categories were:

1. lost 2.25 kg or more (weight losers);
2. lost up to 2.25 kg (maintainers 1);
3. no change or gained  $< 2.25$  kg (maintainers 2);
4. gained  $\geq 2.25$  kg and  $< 4.5$  kg (weight gainers 1);
5. gained 4.5 kg or more (weight gainers 2).

These categories were created on the basis of evidence that a weight gain of 2.25 kg has a clinically significant effect on some health measures.<sup>4,9</sup>

The area of residence at S1 was coded according to the Rural, Remote and Metropolitan Areas (RRMA) classification.<sup>14</sup> The seven categories used in the RRMA classification are combined into three categories in the WHA study: urban (capital city and other metropolitan) rural (large rural centres, small rural centres and other areas within the rural zone) and remote (remote centres and other areas within the remote zone).

The physical and mental health component summary scores from the Short-Form of the Medical Outcomes Study (SF-36) were used to assess physical and mental well-being.<sup>5</sup>

The SF-36 is a 36 item, self-administered measure of physical and emotional health, developed and validated in the United States<sup>5,15</sup> but with physical (PCS) and mental (MCS) health component summary scores computed and standardised using data from the entire mid-aged WHA cohort.<sup>16</sup> The standardised PCS and MCS scores have a mean of 50 and standard deviation of 10.

Women were grouped into one of three categories of smoking at S1: current smoker (occasionally or regularly), ex-smoker or never smoked. Other S1 categorical variables included alcohol intake (never/rarely, moderate, high) physical activity category (low, moderate, high, very high), and menopause status (pre-menopausal, peri-menopausal, post-menopausal, HRT-taking).

### Data analyses

Data analyses were conducted using SPSS version 10. Demographic and health characteristics of women for whom weight change data were missing, and women who provided weight data at both surveys were compared using cross-tabulation and  $\chi^2$  tests for categorical variables, and unpaired Student's *t*-tests for continuous variables. The estimation of the prevalence of weight gainers relied on descriptive statistics. Paired Student's *t*-tests were used to compare weight and BMI of the cohort at S1 with the same variables at S2. For the analysis of weight change and functional health status, two regression models were developed: one with SF-36 PCS at S2 as the outcome and another with SF-36 MCS at S2 as the outcome. In both models, weight change (with five categories) was the main explanatory variable. The models were adjusted for the potential confounders of the relationship between weight change and well-being, including age, BMI, smoking and PCS/MCS at S1. Area of residence at S1 was included in the models to adjust for the sampling scheme and the reference category was 'gained 4.5 kg or more in weight'. *Post hoc* comparisons using least significant differences were conducted to explore the significance of differences in paired means.

## Results

### Participant characteristics

Of the 9207 women in the mid-age cohort who had not had surgical menopause, 8338 provided plausible height and weight data at both S1 and S2. Demographic and health characteristics of these 8338 women, and of the 869 who did not report weight data, are compared in Table 1. In general, weight and BMI were slightly lower, and alcohol intake, physical activity, self-rated general health and SF-36 summary scores were slightly higher at S1 in the women included in the analyses, than in those for whom weight data was missing (see Table 1).

**Table 1** Survey one characteristics for women with weight missing at either time point (missing weight change group) compared with women without missing data (weight change data group)

	Missing weight change data (n = 869)	Weight change data <sup>a</sup> (n = 8338)	Difference
<i>Area of residence (%)</i>			<i>P</i> = 0.224 <sup>b</sup>
Urban	34.5	37.2	
Rural	59.8	56.6	
Remote	5.7	6.2	
<i>Highest qualification (%)</i>			<i>P</i> = 0.273 <sup>b</sup>
No post school qualification	64.0	63.2	
Trade/Apprentice	2.8	3.5	
Certificate/Diploma	16.3	16.7	
University Degree	17.0	16.7	
<i>Marital status (%)</i>			<i>P</i> = 0.661 <sup>b</sup>
Married/Defacto	81.8	83.6	
Separated/Divorced	12.2	11.0	
Widowed	2.0	2.0	
Single	4.0	3.4	
<i>Self-rated general health (%)</i>			<i>P</i> < 0.0001 <sup>b</sup>
Excellent	12.1	15.3	
Very good	33.6	39.2	
Good	43.9	37.0	
Fair	8.9	7.4	
Poor	1.4	1.1	
<i>Smoking (%)</i>			<i>P</i> = 0.675 <sup>b</sup>
Never smoked	56.5	54.6	
Ex-smoker	27.8	29.3	
Smoker	15.7	16.2	
<i>Alcohol (%)</i>			<i>P</i> = 0.014 <sup>b</sup>
Never/rarely	49.0	43.5	
Moderate	44.9	49.9	
High	6.1	6.6	
<i>Physical activity (%)</i>			<i>P</i> < 0.0001 <sup>b</sup>
None	32.9	26.0	
Low	30.6	30.9	
Moderate	23.5	26.2	
High	13.0	16.9	
<i>Menopause status (%)</i>			<i>P</i> = 0.128 <sup>b</sup>
HRT	10.3	12.2	
Post-menopausal	8.4	7.1	
Peri-menopausal	27.8	25.5	
Pre-menopausal	53.5	55.2	
<i>SF-36 summary score, Mean (s.d.)</i>			
Physical	50.0 (10.0)	51.4 (8.9)	<i>P</i> < 0.0001 <sup>c</sup>
Mental	50.2 (9.7)	51.0 (9.4)	<i>P</i> = 0.029 <sup>c</sup>
<i>Anthropometry, Mean (s.d.)</i>			
Weight (kg)	69.9 (14.2)	67.8 (13.7)	<i>P</i> = 0.002 <sup>c</sup>
Height (cm)	162.7 (6.9)	163.2 (6.7)	<i>P</i> = 0.060 <sup>c</sup>
BMI (kg/m <sup>2</sup> )	26.3 (5.3)	25.5 (2.0)	<i>P</i> < 0.0001 <sup>c</sup>
Age (years), Mean (s.d.)	47.7 (1.5)	47.7 (1.5)	<i>P</i> = 0.059 <sup>c</sup>

<sup>a</sup>Women with implausibly high weight change values (*n* = 12) were excluded.  
<sup>b</sup>One-way ANOVA. <sup>c</sup>Unpaired Student's *t*-tests.

*Body mass index and prevalence of weight gainers*

Mean (standard deviation) weight of the 8338 women in the cohort at S1 was 67.8 (13.7) kg and at S2 was 68.9 (14.2) kg; with a mean increase of 1.04 (4.7) kg ( $P < 0.0001$ ) over the 2-year period. Corresponding BMI data were 25.5 (5.0) and 25.9 (5.1) kg m<sup>2</sup>; an increase of 0.44 ( $P < 0.0001$ ) ( $N = 8338$ ). There was a notable upward shift in BMI category between surveys, with 27.6% of women overweight and 16.0% obese at S1, compared with 30.3 and 18.1% respectively at S2. The distribution of the five weight change categories is shown in Table 2.

One-third of the cohort gained 2.25 kg or more in just 2 years.

*Functional health status according to weight change category*

Mean PCS and MCS scores (unadjusted, and after adjustment for age, area of residence, BMI, smoking, menopause status and PCS/MCS at S1) for each of the five weight change categories are shown in Table 3. Complete data were available for 7270 women. Results of the regression analyses are also shown in this table.

The explanatory variables accounted for a significant part of the variance in PCS scores ( $F_{14,7270} = 16.064$ ,  $P < 0.0001$ ). Weight change category was significantly related to physical

health status at S2 ( $P < 0.0001$ ) after adjusting for other variables. Physical health scores were highest in those who lost the most weight, then decreased as women gained more weight. These results were independent of BMI at S1. *Post hoc* comparisons showed that there was a statistically significant difference in the mean physical health scores at S2 between those who gained the most weight and each of the other categories (see Table 3a). Weight change category was significantly related to mental well-being at S2 ( $P = 0.001$ ). The explanatory variables accounted for a significant part of the variance in MCS scores ( $F_{14,7270} = 4.552$ ,  $P = 0.001$ ). Adjusted mean MCS scores were poorest in the group that lost 2.25 kg or more, followed by those that gained 4.5 kg or more. *Post hoc* comparisons showed that the only statistically significant difference in the mean MCS scores at S2 was between those who gained the most weight and those who lost the most weight (see Table 3b).

**Discussion**

This study was the first to prospectively monitor change in functional health status in relation to 2-year weight change in a large population-based group of mid-aged Australian women. Those women who lost 2.25 kg or more over a 2-year period reported the best physical well-being, and the women who gained the most weight had the worst physical well-being (although it should be noted that the difference between mean scores was only just over two points which may not be clinically significant).<sup>17</sup>

The fact that there was no clear relationship between weight change and mental well-being reflects the complex relationship between weight change and psychological stress or anxiety. The women who lost the most weight, while

**Table 2** Two-year weight change category for 8338 mid-aged women

Classification	Weight change category	%
Weight losers	Lost 2.25 kg or more	16.4
Maintainers 1	Lost up to 2.25 kg	24.5
Maintainers 2	No change or gained <2.25 kg	25.7
Weight gainers 1	Gained $\geq 2.25$ kg and <4.5 kg	15.8
Weight gainers 2	Gained $\geq 4.5$ kg	17.6

**Table 3** Mean (s.d.) (a) physical (PCS) and (b) mental (MCS) health component summary score of the SF-36 at S2 for 7270 women according to weight change category

(a) Weight change category	n	Mean PCS score at S2 (unadjusted)	Mean PCS score at S2 (adjusted) <sup>a</sup>	Standard error of adjusted mean	95% CI	Parameter estimates (B)
Lost 2.25 kg or more	1198	50.1	50.9 <sup>b</sup>	0.251	50.4–51.3	2.118
Lost <2.25 kg	1783	51.4	50.6 <sup>b</sup>	0.219	50.1–51.0	1.838
No change or gained <2.25 kg	1866	51.2	50.1 <sup>b</sup>	0.216	49.6–50.5	1.328
Gained $\geq 2.25$ and <4.5 kg	1154	50.8	50.0 <sup>b</sup>	0.253	49.5–50.5	1.292
Gained 4.5 kg or more	1269	48.5	48.7	0.240	48.3–49.2	0
(b) Weight change category	n	Mean MCS score at S2 (unadjusted)	Mean MCS score at S2 (adjusted) <sup>c</sup>	Standard error of adjusted mean	95% CI	Parameter estimates (B)
Lost 2.25 kg or more	1198	50.3	50.4 <sup>b</sup>	0.282	49.9–51.0	-0.785
Lost <2.25 kg	1783	51.6	51.4	0.246	50.9–51.9	0.209
No change or gained <2.25 kg	1866	51.8	51.7	0.242	51.2–52.2	0.466
Gained $\geq 2.25$ and <4.5 kg	1154	51.5	51.6	0.285	51.0–52.2	0.383
Gained 4.5 kg or more	1269	50.6	51.2	0.271	50.7–51.7	0.0

<sup>a</sup>Adjusted for age, BMI, menopause status, smoking, area of residence and PCS at S1. <sup>b</sup>Significantly different from the reference category (gained 4.5 kg or more) on *post hoc* comparisons. <sup>c</sup>Adjusted for age, BMI, menopause status, smoking, area of residence and MCS at S1.

having the best physical well-being, had the poorest mental well-being. However, it is not known whether this weight loss was intentional or not. Weight maintenance was associated with optimal mental well-being. The Nurses Health Study similarly found that weight change was more clearly associated with physical than mental well-being.<sup>9</sup>

The SF-36 scores for this mid-aged WHA cohort were slightly higher than the age standardised population norms from the 1995 Australian Health Survey,<sup>18</sup> possibly due to the exclusion of the large proportion of women who reported having a hysterectomy ( $N = 3298$ ). The women who had a hysterectomy had lower mean PCS [(47.1 (11.3)] and MCS [49.2 (10.6)] scores at S1.

The large numbers and the longitudinal design were strengths of this study. However, use of self-reported weight and height is a study limitation, given that validation studies show that women tend to under-report their weight, particularly if they are obese.<sup>19,20</sup> Despite this acknowledged tendency, validation studies show the amount of bias appears to be fairly consistent,<sup>21,22</sup> which suggests weight might be consistently under-reported across time.

This cohort of mid-aged women experienced a mean increase in weight of 1 kg over 2 years, providing prospective evidence of population weight gain at this life stage. Those who gained 2.25 kg or more over 2 years had poorer physical well-being, suggesting that 2.25 kg could serve as a reasonable cutoff for the definition of medium-term or 2-year weight change. Standardisation of the definition of weight gain would allow comparisons with key studies in the literature and facilitate clarity in public health messages. Five-pounds is a convenient measure in the United States where the unit of body weight is the imperial pound. Since the metric equivalent of 2.27 kg would not register on bathroom scales that measure in 1-kg increments, the metric message to the public could be simplified to 2 kg. If mid-aged women who gain 2 kg were encouraged to take measures to reduce or stabilise weight, they could prevent more significant weight gain, thereby engaging in prevention rather than treatment. Further research should investigate the relationship between weight-change and well-being in men in order to set appropriate recommendations for the whole population.

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