

# **Women's Weight - Findings from the Australian Longitudinal Study on Women's Health**

## Table of contents

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<b>1.</b>	<b>EXECUTIVE SUMMARY.....</b>	<b>1</b>
1.1.	AIMS OF THIS REPORT.....	1
1.2.	SUMMARY OF MAJOR FINDINGS.....	2
1.2.1.	<i>Trends in women's weight, height and body mass index.....</i>	<i>2</i>
1.2.2.	<i>Predictors of weight change.....</i>	<i>3</i>
1.2.3.	<i>Weight, weight change, and health and wellbeing.....</i>	<i>4</i>
1.2.4.	<i>Weight, weight change, and health care usage.....</i>	<i>5</i>
1.3.	DISCUSSION.....	5
<b>2.</b>	<b>WOMEN'S WEIGHT CHANGE.....</b>	<b>7</b>
2.1.	KEY FINDINGS.....	7
2.2.	INTRODUCTION.....	7
2.3.	WEIGHT, HEIGHT AND BMI IN 1996.....	7
2.4.	CHANGES IN WEIGHT, HEIGHT AND BMI BETWEEN SURVEYS 1 SURVEY 4.....	8
2.4.1.	<i>Changes in weight.....</i>	<i>8</i>
2.4.2.	<i>Changes in height.....</i>	<i>9</i>
2.4.3.	<i>Changes in BMI.....</i>	<i>9</i>
2.5.	CHANGES IN BMI CATEGORIES OVER TIME.....	11
2.6.	WOMEN'S COMMENTS.....	12
2.6.1.	<i>Increased weight among Younger women.....</i>	<i>12</i>
2.6.2.	<i>Increased physical activities among Mid-aged women.....</i>	<i>13</i>
2.7.	DISCUSSION.....	14
2.8.	REFERENCES.....	15
<b>3.</b>	<b>PREDICTORS OF WEIGHT CHANGE.....</b>	<b>16</b>
3.1.	KEY FINDINGS.....	16
3.2.	PHYSICAL ACTIVITY.....	18
3.3.	TIME SPENT SITTING.....	23
3.3.1.	<i>Changing sitting time and weight gain.....</i>	<i>25</i>
3.4.	ENERGY INTAKE AND DIET.....	26
3.4.1.	<i>Women's comments.....</i>	<i>29</i>
3.5.	PREGNANCY.....	30
3.5.1.	<i>Women's comments.....</i>	<i>31</i>
3.6.	SMOKING.....	32
3.6.1.	<i>Women's comments.....</i>	<i>34</i>
3.7.	HYSTERECTOMY.....	34
3.8.	AREA OF RESIDENCE.....	35
3.9.	EDUCATIONAL LEVEL.....	37
3.10.	DISCUSSION.....	39
3.11.	REFERENCES.....	39
<b>4.</b>	<b>WEIGHT CHANGE, HEALTH AND WELL-BEING.....</b>	<b>41</b>
4.1.	KEY FINDINGS.....	41
4.2.	INTRODUCTION.....	41
4.3.	PHYSICAL AND MENTAL HEALTH BY BMI CATEGORIES FOR THE YOUNGER, MID-AGED AND OLDER COHORTS.....	42
4.4.	CHANGES IN PHYSICAL AND MENTAL HEALTH OVER TIME FOR WOMEN GROUPED ACCORDING TO THEIR BMI AT SURVEY 1.....	42
4.5.	WEIGHT CHANGE BY PHYSICAL AND MENTAL HEALTH FOR THE YOUNGER, MID-AGED AND OLDER COHORT.....	45
4.6.	WEIGHT, WEIGHT GAIN AND CHRONIC DISEASE.....	46
4.7.	WOMEN'S COMMENTS.....	47
4.8.	DISCUSSION.....	47
4.9.	REFERENCES.....	48
<b>5.</b>	<b>WEIGHT, PHYSICAL ACTIVITY AND HEALTH CARE USAGE.....</b>	<b>49</b>
5.1.	KEY FINDINGS.....	49

5.2.	INTRODUCTION.....	50
5.2.1.	<i>Health care usage and BMI</i> .....	50
5.2.2.	<i>Total charges and BMI</i> .....	50
5.2.3.	<i>Number of GP visits by BMI</i> .....	51
5.2.4.	<i>Total Medicare claims by BMI category</i> .....	53
5.2.5.	<i>Health care costs and weight change</i> .....	54
5.2.6.	<i>Total charges, total Medicare claims and weight change</i> .....	54
5.3.	NUMBER OF GP VISITS AND WEIGHT CHANGE .....	55
5.4.	HEALTH CARE USAGE AND PHYSICAL ACTIVITY .....	56
5.4.1.	<i>Total charges, total claims and physical activity</i> .....	56
5.4.2.	<i>Number of GP visits and physical activity</i> .....	58
5.5.	CASE STUDY.....	59
5.6.	DISCUSSION .....	60
5.7.	REFERENCES .....	61
<b>6.</b>	<b>APPENDICES.....</b>	<b>62</b>
<b>APPENDIX 1:</b>	<b>PAPERS.....</b>	<b>63</b>
<b>APPENDIX 2:</b>	<b>THE AUSTRALIAN LONGITUDINAL STUDY ON WOMEN'S HEALTH..</b> <b>.....</b>	<b>64</b>
A 2.1:	PARTICIPATION AND RETENTION .....	65
A 2.2:	CASE STUDIES .....	70
<b>APPENDIX 3:</b>	<b>ABBREVIATIONS AND DEFINITIONS .....</b>	<b>71</b>
A 3.1:	AREA OF RESIDENCE (RRMA).....	71
A 3.2:	BODY MASS INDEX (BMI) .....	71
A 3.3:	MENTAL HEALTH COMPONENT SCORE (MCS) AND PHYSICAL HEALTH COMPONENT SCORE (PCS).....	71
A 3.4:	PHYSICAL ACTIVITY.....	72
A 3.5:	REFERENCES.....	72
<b>APPENDIX 4:</b>	<b>TABLES.....</b>	<b>74</b>
<b>APPENDIX 5:</b>	<b>GRAPHS.....</b>	<b>77</b>

## List of Figures

---

Figure 2-1: Average self-reported weight, height and calculated BMI with 95% confidence intervals for each cohort group (Younger, Mid-aged, Older) for Surveys 1, 2, 3 and 4 from 1996 to 2006. ....	10
Figure 2-2: Proportions of women in each of the BMI categories based on self-reported height and weight for each age cohort for Surveys 1, 2, 3 and 4 from 1996 to 2006. ....	12
Figure 3-1: Median and inter quartile ranges for physical activity (MET.mins) in each BMI category (U=underweight; H= healthy weight; V= overweight; B= obese) for Surveys 2, 3 and 4 for the Younger and Older cohort and for Surveys 3 and 4 for the Mid-aged cohort. ....	19
Figure 3-2: Physical activity categories for Younger women at Surveys 2, 3 and 4, by BMI category at Survey 2. ....	20
Figure 3-3 Physical activity categories for Mid-aged women at Surveys 2 and 3, by BMI category at Survey 3. ....	21
Figure 3-4: Physical activity categories for Older women at Surveys 2, 3 and 4, by BMI category at Survey 2. ....	21
Figure 3-5: Odds ratios and 95% confidence intervals for gaining more than 5kg (N=2046), compared with maintaining weight ( $\pm$ 2.25kg, N=3077), for Mid-aged women in each physical activity group; adjusted for menopause, hysterectomy, smoking, BMI, energy intake and sitting time. ....	22
Figure 3-6: Average weight with 95% confidence intervals by time spent sitting group at Survey 2 for the Younger cohort. ....	23
Figure 3-7: Average weight with 95% confidence intervals by time spent sitting group at Survey 3 for the Mid-aged cohort. ....	24
Figure 3-8: Average weight with 95% confidence intervals by time spent sitting group at Survey 3 for the Older cohort. ....	24
Figure 3-9: Average weight with 95% confidence intervals by changes in time spent sitting between Surveys 2 and 3 in the Younger cohort. ....	25
Figure 3-10: Average weight with 95% confidence intervals by changes in time spent sitting between Surveys 3 and 4 in the Younger cohort. ....	26
Figure 3-11: Average weight with 95% confidence intervals by changes in time spent sitting between Surveys 3 and 4 in the Mid-aged cohort. ....	26
Figure 3-12: Average weight with 95% confidence intervals by energy intake for the Younger cohort at Surveys 1, 2, 3 and 4. ....	27
Figure 3-13: Average weight with 95% confidence intervals by energy intake for the Mid-aged cohort at Surveys 1, 2, 3 and 4. ....	28
Figure 3-14: Weight change for most commonly occurring smoking patterns for the Younger cohort from 1996 to 2006. ....	33
Figure 3-15: Weight change for most commonly occurring smoking patterns for the Mid-aged cohort from 1996 to 2004. ....	34
Figure 3-16: Average BMI with 95% confidence intervals at Surveys 1, 2, 3 and 4 by hysterectomy status for the Mid-aged cohort from 1996 to 2004. ....	35

Figure 3-17: Average BMI with 95% confidence intervals by area of residence for the Younger cohort, at Surveys 1, 2, 3 and 4, from 1996 to 2006. ....	36
Figure 3-18: Average BMI with 95% confidence intervals by area of residence for the Mid-aged cohort, at Surveys 1, 2, 3 and 4, from 1996 to 2004. ....	36
Figure 3-19: Average BMI with 95% confidence intervals by area of residence for the Older cohort, at Surveys 1, 2, 3 and 4, from 1996 to 2005. ....	37
Figure 3-20: Average weight at Surveys 1, 2, 3 and 4 by education status at Survey 4 for the Younger cohort. ....	38
Figure 3-21: Average weight at Surveys 1, 2, 3 and 4 by education status at Survey 1 for the Mid-aged cohort. ....	38
Figure 3-22: Average weight at Surveys 1, 2, 3 and 4 by education status at Survey 1 for the Older cohort. ....	39
Figure 4-1: Average mental health component scores (MCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Younger cohort. ....	43
Figure 4-2: Average mental health component scores (MCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Mid-aged cohort. ....	43
Figure 4-3: Average mental health component scores (MCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Older cohort. ....	44
Figure 4-4: Average physical health component scores (PCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Younger cohort. ....	44
Figure 4-5: Average physical health component scores (PCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Mid-aged cohort. ....	45
Figure 4-6: Average physical health component scores (PCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Older cohort. ....	45
Figure 5-1: Total Charges at Surveys 2 and 3 by BMI category at Survey 1 for Younger women. ....	51
Figure 5-2: Total Charges at Surveys 2, 3 and 4 by BMI category at Survey 1 for the Mid-aged cohort. ....	51
Figure 5-3: Number of GP visits at Surveys 2 and 3 by BMI at Survey 1 for the Younger cohort. ....	52
Figure 5-4: Number of GP visits at Surveys 2, 3 and 4 by BMI at Survey 1 for the Mid-aged cohort. ....	52
Figure 5-5: Total Medicare claims by at Surveys 2 and 3 BMI at Survey 1 for the Younger cohort. ....	53
Figure 5-6: Total Medicare claims at Surveys 2, 3 and 4 by BMI at Survey 1 for the Mid-aged cohort. ....	53
Figure 5-7: Total charges at Surveys 2, 3 and 4 by weight change trajectory for the Mid-aged cohort: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	55
Figure 5-8: Total Medicare claims at Surveys 2, 3 and 4 by weight change trajectory for the Mid-aged cohort: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	55
Figure 5-9: Number of GP visits at Surveys 2, 3 and 4 by weight change trajectory for the Mid-aged cohort: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	56
Figure 5-10: Total Charges at Surveys 2 and 3 according to physical activity group at Survey 3 for the Younger cohort. ....	57

Figure 5-11: Total Charges at Surveys 2, 3 and 4 according to physical activity group at Survey 4 for the Mid-aged cohort.....	57
Figure 5-12: Total Medicare claims at Surveys 2, 3 and 4 in the 'low' physical activity group by BMI category at Survey 3 for the Mid-aged cohort.....	58
Figure 5-13: Number of GP visits at Surveys 2 and 3 according to physical activity group at Survey 3 for the Younger cohort.....	59
Figure 5-14: Number of GP visits at Surveys 2, 3 and 4 according to physical activity group at Survey 4 for the Mid-aged cohort.....	59
Figure A1: Mean mental health component scores (MCS) and 95% confidence intervals in the Younger cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.....	77
Figure A2: Mean mental health component scores (MCS) and 95% confidence intervals in the Mid-aged cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.....	77
Figure A3: Mean mental health component scores (MCS) and 95% confidence intervals in the Older cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.....	78
Figure A4: Mean physical health component scores (PCS) and 95% confidence intervals in the Younger cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.....	78
Figure A5: Mean physical health component scores (PCS) and 95% confidence intervals in the Mid-aged cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.....	79
Figure A6: Mean physical health component scores (PCS) and 95% confidence intervals in the Older cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.....	79
Figure A7: Mental health component scores (MCS) for the Younger cohort for most commonly occurring weight change patterns from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys.....	80
Figure A8: Mental health component scores (MCS) for the Mid-aged cohort for most commonly occurring weight change patterns from 1996 to 2004: S=no weight change G=weight gain L=weight loss between two consecutive surveys.....	80
Figure A9: Mental health component scores (MCS) for the Older cohort for most commonly occurring weight change patterns from 1996 to 2005: S=no weight change G=weight gain L=weight loss between two consecutive surveys.....	81
Figure A10: Physical health component score (PCS) for the Younger cohort for most commonly occurring weight change patterns from 1996	

to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	82
Figure A11: Physical health component scores (PCS) for the Mid-aged cohort for most commonly occurring weight change patterns from 1996 to 2004: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	82
Figure A12: Physical health component scores (PCS) for the Older cohort for most commonly occurring weight change patterns from 1996 to 2005: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	83
Figure A13: Relationship between BMI (in intervals of 1 kg/m <sup>2</sup> ) and percentage of Younger women reporting medical problems, surgical procedures, symptoms and GP visits at Survey 1. Data from Younger women with BMI > 30kg/m <sup>2</sup> are included in the BMI category labeled 30. ....	84
Figure A14: Relationship between BMI (in intervals of 1 kg/m <sup>2</sup> ) and percentage of Mid-aged women reporting medical problems, surgical procedures, symptoms and health care utilizations at Survey 1. ....	85
Figure A15: Total charges at Surveys 2 and 3 by most commonly occurring weight change patterns for the Younger cohort from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	86
Figure A16: Total number of Medicare claims at Surveys 2 and 3 by most commonly occurring weight change patterns for the Younger cohort from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	86
Figure A17: Number of GP visits at Surveys 2 and 3 by most commonly occurring weight change patterns for the Younger cohort from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys. ....	87
Figure A18: Total number of Medicare claims at Surveys 2 and 3 by physical activity group at Survey 3 for the Younger cohort. ....	87
Figure A19: Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'no activity' group at Survey 3. ....	88
Figure A20: Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'low activity' group at Survey 3. ....	88
Figure A21: Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'moderate activity' group at Survey 3. ....	89
Figure A22: Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'high activity' group at Survey 3. ....	89
Figure A23: Total number of Medicare claims at Surveys 2, 3 and 4 by physical activity group at Survey 4 for the Mid-aged cohort. ....	90

## List of Tables

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Table 1-1: Schedule of Surveys for the Australia Longitudinal Study on Women's Health. ....	1
Table 2-1: Mean and 95% confidence intervals for weight, height and BMI for the Younger, Mid-aged and Older cohort in 1996. ....	8
Table A1: Participation and retention of Younger women. ....	65
Table A2: Participation and retention of Mid-aged women. ....	66
Table A3: Participation and retention of Older women. ....	67
Table A4: Completion of surveys by Younger women (n=14247). ....	68
Table A5: Completion of Surveys by Mid-aged women (n=13716). ....	68
Table A6: Completion of Surveys by Older women (n=12432). ....	69
Table A7: Number of women in each BMI category at Surveys 1, 2, 3 and 4 for the Younger, Mid-aged and Older cohort. ....	74
Table A8: Number of women in each physical activity (PA) category at Surveys 2, 3 and 4 by BMI category at Survey 2 for the Younger cohort. ....	74
Table A9: Number of women in each physical activity (PA) group at Surveys 3 and 4 by BMI category at Survey 3 for the Mid-aged cohort. ....	75
Table A10: Number of women in each physical activity (PA) group at Surveys 2, 3 and 4 by BMI category at Survey 2 for the Older cohort. ....	75



# 1. Executive summary

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## 1.1. Aims of this report

The Australian Longitudinal Study on Women's Health (ALSWH) is a longitudinal population-based survey funded by the Australian Government Department of Health and Ageing. The project began in 1996 and involves three large, nationally representative, cohorts of Australian women representing three generations:

- Younger women, aged 18 to 23 years when first recruited in 1996 (n=14247)
- Mid-aged women, aged 45 to 50 years in 1996 (n=13716)
- Older women, aged 70 to 75 years in 1996 (n=12432) (Lee et al. 2005).

The women have now been resurveyed at least three times over the past 10 years providing a large amount of data on women's lifestyles and health outcomes.

**Table 1-1: Schedule of Surveys for the Australia Longitudinal Study on Women's Health.**

	<b>Survey 1</b>	<b>Survey 2</b>	<b>Survey 3</b>	<b>Survey 4</b>	<b>Survey 5</b>	<b>Survey 6</b>	<b>Survey 7</b>
<b>Younger</b>	(1996) 18-23 yrs	(2000) 22-27 yrs	(2003) 25-30 yrs	(2006) 28-33 yrs	(2009) 31-36 yrs	(2012) 34-39 yrs	(2015) 37-42 yrs
<b>Mid-aged</b>	(1996) 45-50 yrs	(1998) 47-52 yrs	(2001) 50-55 yrs	(2004) 53-58 yrs	(2007) 56-61 yrs	(2010) 59-64 yrs	(2013) 62-67 yrs
<b>Older</b>	(1996) 70-75 yrs	(1999) 73-78 yrs	(2002) 76-81 yrs	(2005) 79-84 yrs	(2008) 82-87 yrs	(2011) 85-90 yrs	(2014) 88-93 yrs

This report has been prepared on the basis of discussions between the ALSWH research team and staff of the Department of Health and Ageing and presents findings on women's weight from four surveys of the three cohorts. The following research questions are addressed:

- What are the trends in women's weight, height and body mass index (BMI) among the three age groups of participants in the ALSWH over the first eleven years of the study?
- What factors are predictive of weight change?
- What are the effects of weight and weight change on women's health?
- What are the effects of weight and weight change on health care usage?

The report includes summaries of published and unpublished papers, as well as primary analyses. Case studies of individual women who have commented in their surveys on the topic of weight change are included to illustrate the findings of this report. All ALSWH publications relating to this report are provided as a supplement (see Appendix 1). Additional Appendices are included to provide current information about ALSWH data (i.e., the study design, attrition and retention rates) and some of the definitions and measurements used in the report.

This report uses the cut-off for BMI categories (underweight, healthy weight, overweight and obese) as defined by the WHO (see Appendix 3, Section A3.2). To classify area of residence, the Rural, Remote and Metropolitan Areas classification scheme (RRMA) was used (see Appendix 3, Section A3.1). As a measurement for mental and physical health, the two summary measures mental health component

score (MCS) and physical health component score (PCS) were used (see Appendix 3, Section A3.3).

## **1.2. Summary of major findings**

### **1.2.1. Trends in women's weight, height and body mass index**

Over the period of the study there has been an overall increase in the women's weight, particularly for women in the Younger cohort. While these women had the lowest BMI at the start of the study, they have gained an average of 6.32 kg over ten years (between Survey 1 in 1996 and Survey 4 in 2006). Mid-aged women have gained 3.43 kg in 8 years (between Survey 1 in 1996 and Survey 4 in 2004). In contrast, Older women have lost an average of 1.67 kg in nine years (between Survey 1 in 1996 and Survey 4 in 2005). These data are only provided for women in each cohort who answered questions on height and weight on all four surveys. Women were more likely to be categorised as "healthy weight" at Survey 1 than women who did not provide data for all four surveys.

#### **Changes for Younger women**

At Survey 1, Younger women had the lowest average weight and BMI. At this time, less than 1 in 10 of the Younger women were underweight, almost 7 in 10 were in the healthy weight range, and 2 in 10 were classified as overweight or obese. By Survey 4, less than 4 in 100 were classified as underweight, and almost 4 in 10 were classified as overweight or obese.

With an average weight of 62.7 kg at Survey 1, the Younger women were almost 6kg lighter than women in the Mid-aged cohort. They were also taller, and so their BMI was considerably lower than the Mid-aged cohort, with the Younger women having an average BMI of 22.8 which is well within the healthy weight range. Over subsequent surveys there have been clear increases in weight among women in the Younger cohort, and the average BMI for these women increased to 25.03 which is just into the overweight range. The proportion of women in the healthy weight range was reduced from 67.7% to 56.9%, and the proportion of women in the obese range more than doubled, from 6.0% at Survey 1 to 15.8% at Survey 4.

The rapid increase of weight in this cohort means that the BMI pattern for the Younger women aged 28-33 years of age is fast approaching the pattern seen for the Mid-aged cohort when they were 45-50 years of age. If this rate of weight gain continues, the cohort of Younger women will be substantially heavier than the Mid-aged women by the time they reach 45.

#### **Changes for Mid-aged women**

At Survey 1, Mid-aged women had the highest average weight and BMI. At Survey 1, almost 4 in 10 Mid-aged women were classified as overweight or obese. This prevalence increased to almost 6 in 10 by Survey 4. The rate of weight gain for the Mid-aged women was not as rapid as observed among the Younger cohort, but there was a steady increase in the proportions of women classified as overweight or obese

at each Survey, and a corresponding decrease in the proportions in the healthy weight range.

## **Changes for Older women**

The Older women showed an average decrease in weight over the four Surveys. However, they also showed a decrease in height (around 1.85 cm). As a consequence of these two anthropometric changes, the average BMI for the Older women did not change greatly across the first three Surveys, although there was a reduction in average BMI at Survey 4. Between Surveys 1 and 4, the main changes in BMI categories for women in the Older cohort were a slight increase in the proportion classified as obese (increasing from 12.4% to 13.4%), a reduction in the proportion classified as healthy weight (from 51.1% to 49.2%) and an increase in the proportion classified as underweight (from 2.2% to 4.3%).

### **1.2.2. Predictors of weight change**

Energy balance, the net effect of energy intake (through diet) and energy expenditure (through physical activity), is one of the major factors affecting weight and weight change among women in the cohorts. However, the prevalence of these factors varies according to sociodemographic, lifestyle and other personal factors. Findings also suggest that strategies aimed at changing eating behaviours and physical activity should be age-group specific and be related to other lifestyle factors.

#### **Energy intake and diet**

Energy intake is one of the major predictors of weight and weight change. In the Younger and Mid-aged cohorts, women with lowest energy intake had lowest weight and women with highest energy intake had highest weights throughout the study period. Among Younger women, those with greater energy intake gained more weight from Survey 1 to Survey 4 (7.4 kg), than did women with lower energy intake (5.7 kg). Diet and energy intake were not assessed among women in the Older cohort. Intakes of food and nutrients varied significantly across socio-demographic groups, with unmarried women, and women in “labouring occupations” (e.g. cleaner, factory worker, kitchen hand) having poorer nutrition intake.

#### **Physical activity**

Throughout the study period, physical activity levels have declined among Younger women, particularly among those women who were already overweight at Survey 1. In contrast, physical activity levels have increased among Mid-aged women and particularly among those who were overweight at Survey 1. Physical activity levels have declined among Older women. Compared with women in the ‘high’ physical activity group, Mid-aged women who reported doing less than recommended levels of (‘moderate’) physical activity were about 1.5 times more likely to gain weight at twice the average rate. High physical activity did not appear to carry additional advantage when compared with moderate activity.

Sitting time is used as an indicator of physical inactivity, and is strongly associated with weight. The difference in average weight of women who reported sitting less

than three hours per day and those who reported sitting for more than eight hours a day at Survey 3 was 2.61kg among Younger women, 5.36kg among Mid-aged women, and 6.64kg among Older women. Younger and Mid-aged women who increased their sitting time gained most weight and those who decreased their sitting time by more than three hours per day gained weight at the slowest rate.

### **Other personal and lifestyle factors associated with weight and weight change**

A number of other lifestyle factors were associated with weight and weight change:

- Among Younger women, weight was associated with ever having a baby at Survey 1, and changes in weight were associated with having a baby between Survey 1 and subsequent surveys. Younger women who have had children gained 2-3kg in addition to the 4kg weight gained by women who had not had children up to Survey 3.
- Younger and Mid-aged women showed greater weight gain in the period around quitting smoking than women who did not change their smoking habits during the study period.
- Mid-aged women who had a hysterectomy before 1996 had higher BMI than those who have not had a hysterectomy. However, there is no evidence that having had a hysterectomy leads to increased weight gain.

### **Sociodemographic factors associated with weight and weight change**

In the Younger and Mid-aged cohorts, women in rural areas showed higher weight gain than women in urban areas. However, in the Older cohort there was very little difference in BMI or weight according to area of residence.

In all three cohorts, women with a university degree had lowest weights and BMI throughout the study period compared to women with no formal qualifications, who had highest weights and BMI. However, there is no evidence of differences in weight change over time between women with different qualifications.

### **1.2.3. Weight, weight change, and health and wellbeing**

Composite scores for physical and mental health were obtained from the Short-Form 36 (SF-36) health profile, and were used to provide general health and wellbeing. According to these scores, women in all three cohorts experienced declining physical health over the course of the study, however, those who were underweight and women with healthy weight had better physical health than overweight and obese women at Survey 1. Weight loss between two surveys was associated with improving physical health for the Mid-aged cohort. Among the Younger women, those who gained weight between two surveys had deteriorating physical health, whereas those with stable weight did not show a significant change in their physical health.

Mental health improved over time for the Younger and Mid-aged cohorts. In all three cohorts, mental health for Survey 1 was poorest for women who were underweight. Among the Mid-aged and Older women, women in the healthy weight range had better mental health than women in the obese category. Best mental health was

reported by women in all three cohorts who had a stable weight throughout the study period. Weight loss between two surveys resulted in deteriorating mental health for the Mid-aged and Older cohort. Mid-aged women with unstable weight patterns also reported poorer mental health. Among Younger women, weight loss between surveys was not a common trajectory. Younger women who gained weight between surveys had poorest mental health in this cohort.

#### **1.2.4. Weight, weight change, and health care usage**

There are clear associations between weight and health care usage (total charges, number of Medicare claims, number of GP visits). Among Younger women, these associations are less strong than among the other age groups, and there is no difference in total charges (aggregate total cost in dollars incurred by each participant) according to BMI category. Younger women in the obese group made more Medicare claims for GP visits than Younger women in the healthy weight group. Among Mid-aged women, women in the obese group had higher total charges, higher total Medicare claims, and more GP visits at each Survey when compared to women in the healthy weight range. Women in the obese group also had more Medicare claims and more GP visits than women in the overweight group at all surveys, and had higher total charges than overweight women at Survey 4. In 2004, total charges for women in the obese group were around \$130 higher per woman (on average) than charges for women in the overweight group. Mid-aged women who maintained a stable weight across all surveys tended to have lower charges, fewer GP visits and fewer total Medicare claims.

There were also associations between physical activity and health care usage, and there was some evidence that these associations varied according to BMI category. Younger women in the 'none' physical activity group had higher total charges than women in the 'moderate' and 'high' physical activity categories. The difference in total charges between the 'none' and the 'high' physical activity groups was around \$200 per woman for 2003.

Total charges for the Mid-aged cohort were higher at all surveys for women in the 'none' physical activity group compared to women in the 'high' physical activity group. Women in this group also had more GP visits and more total Medicare claims at all surveys compared to all other physical activity groups. Mid-aged women in the 'low' physical activity group made more claims if they were obese compared to women with healthy weight.

### **1.3. Discussion**

This report emphasises the growing problem of obesity among Australian women. The longitudinal data provided by the study show the rapid increase in weight among Younger women. This problem is underestimated by simple cross-sectional comparisons. Indeed, cohort differences in weight and BMI at Survey 1 would suggest the Younger women had healthier weight profiles than the Mid-aged women. As the Younger women age, however, their weight is increasing rapidly and their weight profiles now resemble those of the Mid-aged cohort at the start of the study. Unless there is a significant reduction in the rate of weight increase in this Younger

cohort, they will have a much higher prevalence of obesity and overweight when they reach 45 years of age.

The report also demonstrates the relationship between overweight and obesity and poorer mental and physical health and higher health care costs. These conditions contribute significantly to poor health among women in Australia and there is potential for considerable cost savings, at a population level, if trends in overweight and obesity could be reversed.

An exploration of the factors contributing to overweight and obesity suggests that while energy balance is important, through attention to diet and physical activity, other contextual factors must also be taken into account.

There are also key life events that signal times when women may be more susceptible to weight gain (such as the periods following childbirth). Women's health promotion may need to emphasise the particular importance of healthy eating and adequate physical activity following these events. Quitting smoking is also another key event when women seem to gain weight, and the case studies reveal the tensions women feel about these competing health risks. Strategies are needed to help women quit smoking, and receive the benefits of this healthy change, without trading the risks of smoking for risks associated with increasing weight.

## **2. Women's weight change**

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### **2.1. Key findings**

- At Survey 1, Younger women had the lowest average weight (62.7kg) and BMI (22.8). Mid-aged women had the highest average weight (68.6kg) and BMI (25.7).
- Younger and Mid-aged women experienced weight and BMI increases over time (Younger women: 10%, Mid-aged women 5%). At Survey 1, 9 in 100 of Younger women were underweight but this proportion declined to less than 4 in 100 by Survey 4.
- At Survey 1, 2 in 10 Younger women and more than 4 in 10 Mid-aged women were classified as overweight or obese. This increased to almost 4 in 10 and 6 in 10 respectively by Survey 4.
- Between the last two surveys, the average rate of weight gain in Younger women (1.7kg) was almost double that of the Mid-aged women (0.9kg).
- Older women lost weight and became shorter over time, resulting in a relatively stable average BMI (25.0-25.5).

### **2.2. Introduction**

Women in all three cohorts have reported their height and weight in every survey since the Study began in 1996. These data give important insights into changes in weight and body mass index (BMI), which uses the cutoff for underweight, healthy weight, overweight and obese as defined by the WHO (see Appendix 3, section A 3.2 for the definition and categorization of BMI) which are associated with the onset and outcomes of many chronic health problems.

Data are presented here as means and 95% confidence intervals (CI) for the Younger (N= 5609), Mid-aged (N= 7507) and Older women (N= 6264) who have reported their height and weight at all surveys. Mid-aged and Older women who have reported their height and weight at all surveys were more likely to be categorised as 'healthy weight' at baseline than those women who did not answer these questions at all surveys and those who did not continue responding to the surveys.

### **2.3. Weight, height and BMI in 1996**

In 1996, the Younger women had the lowest average weight (62.7kg) while the Mid-aged women were heaviest (68.6kg), a difference of almost 6 kg. The average weight of the Older women was between that of the other two cohorts (65.8kg). There were also considerable differences in height; with the Younger women being tallest (165.8 cm) followed by the Mid-aged (163 cm) and Older (161.5 cm) women. Consequently, average BMI was highest in the Mid-aged women (25.7), followed by the Older (25.2) and Younger (22.8) women (Table 2-1).

**Table 2-1: Mean and 95% confidence intervals for weight, height and BMI for the Younger, Mid-aged and Older cohort in 1996.**

		<i>Mean</i>	<i>95% CI</i>
<i>Younger</i>	<i>Weight</i>	62.7	[62.4; 63.0]
	<i>Height</i>	165.8	[165.7; 166.0]
	<i>BMI</i>	22.8	[22.6; 22.9]
<i>Mid-aged</i>	<i>Weight</i>	68.6	[68.3; 68.9]
	<i>Height</i>	163.0	[162.9; 163.1]
	<i>BMI</i>	25.7	[25.6; 25.8]
<i>Older</i>	<i>Weight</i>	65.8	[65.5; 66.1]
	<i>Height</i>	161.5	[161.3; 161.6]
	<i>BMI</i>	25.2	[25.1; 25.4]

In 1996, the highest proportion of women in the healthy weight range was found in the Younger cohort (69.7%, compared with 52.5% of the Mid-aged and 51.1% of the Older women). The Younger cohort also had a much higher proportion of underweight women (9.3%, compared with only 1.5% and 2.2% of the Mid-aged and Older women respectively). In contrast, the proportion of women categorised as obese was highest in the Mid-aged cohort (17.6%), followed by the Older (12.4%) and Younger (6.0%) cohorts. More than one third of the Older cohort were overweight at Survey 1 (34.3%, compared with 28.4% of the Mid-aged women and 15.0% of the Younger women) (Table A7).

## **2.4. Changes in weight, height and BMI between Surveys 1 Survey 4**

Changes in weight, height and BMI for each cohort from 1996 to 2004 are shown in Figure 2-1.

### **2.4.1. Changes in weight**

Between the first and fourth surveys, there were clear increases in weight in the Younger and Mid-aged cohorts and a decline in the Older cohort (Figure 2-1). Average weight increased most in the Younger cohort. Over the ten year period between Surveys 1 and 4, the average weight of the Younger women increased by 6.32kg, and the rate of weight gain decreased from 588g/year between Surveys 1 and 2 to 567g/year between Surveys 3 and 4. In contrast, the average weight of the Mid-aged women increased by 3.43kg during the eight years from Survey 1 to Survey 4, and the rate of weight gain decreased from 460g/year between Surveys 1 and 2 to 303g/year between Surveys 3 and 4. Over nine years from Survey 1 to Survey 4, the average weight of the Older women decreased by 1.67kg, and between Surveys 1 and 2 they lost weight at a rate of 137g/year compared with 360g/year between Surveys 3 and 4.



### **2.4.2. Changes in height**

The average reported height of the Young and Mid-aged women did not change over the first four surveys (Figure 2-1). However, the average height of the Older women decreased by 1.85 cm over the nine years between Surveys 1 and 4.

### **2.4.3. Changes in BMI**

Changes in BMI between Surveys 1 and 4 are also shown in Figure 2-1. Between Surveys 1 and 4, the average BMI of the Younger women increased by 2.2 (from 22.8 at Survey 1), with a steady rate of increase between Surveys 3 and 4 compared with between Surveys 1 and 2. Average BMI changed more slowly in the Mid-aged cohort, increasing by 1.3 (from 25.7 at Survey 1) over the eight years between Surveys 1 and 4. In the Older women, average BMI remained largely unchanged over the first three surveys, reflecting the decreases in both weight and height in this cohort; but it declined between Surveys 3 and 4.

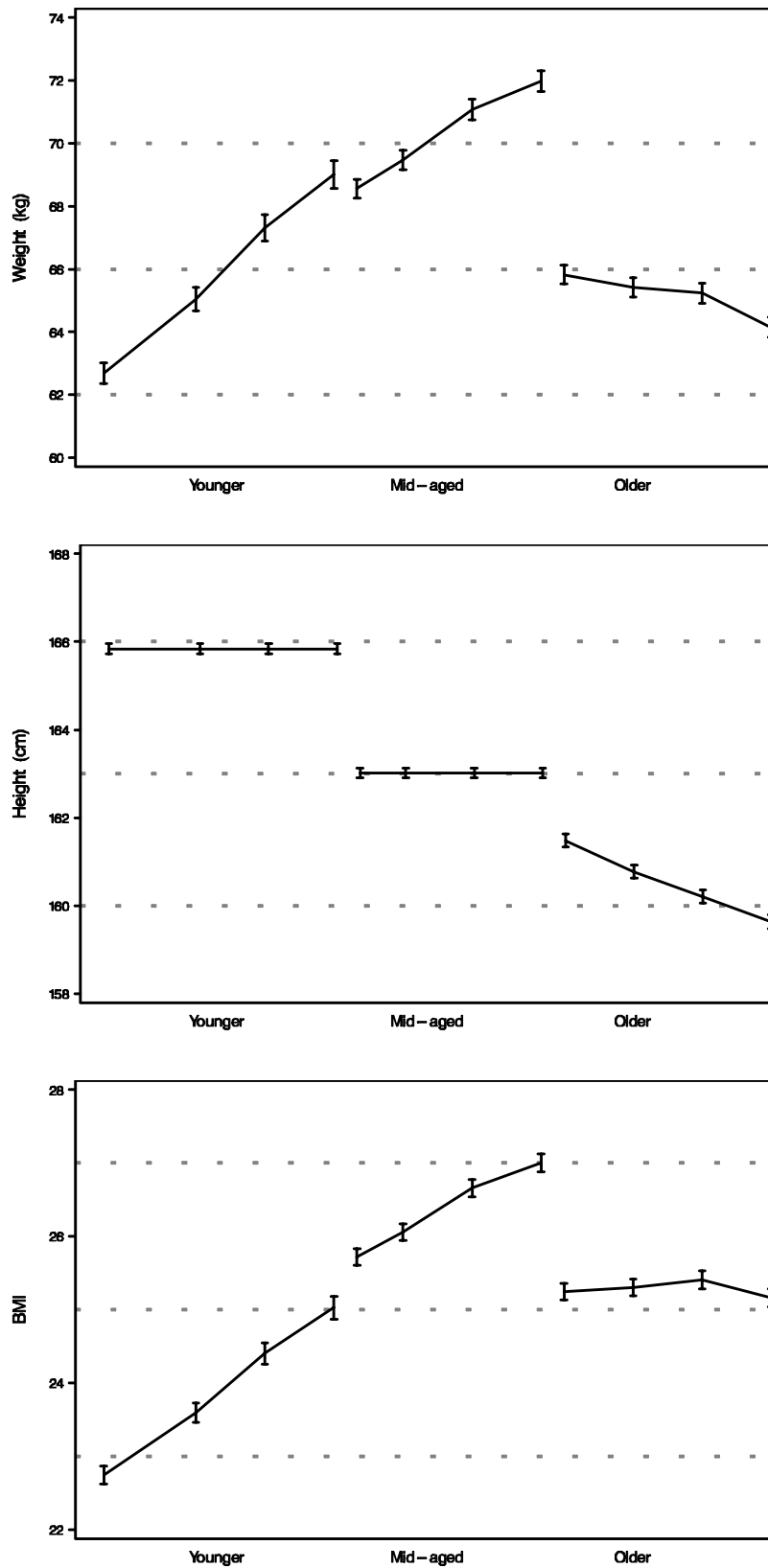


Figure 2-1: Average self-reported weight, height and calculated BMI with 95% confidence intervals for each cohort group (Younger, Mid-aged, Older) for Surveys 1, 2, 3 and 4 from 1996 to 2006.

## **2.5. Changes in BMI categories over time**

Changes in the proportions of women in each of the BMI categories since the beginning of the Study are shown in Figure 2-2.

In the Younger cohort the proportion of women in the healthy weight range decreased from 67.7% at Survey 1 to 56.9% at Survey 4. While the proportion of underweight Younger women also decreased markedly (from 9.3% to 3.9%), the proportion in the overweight category increased from 15.0% to 23.5%. In the same period, the proportion of Younger women categorised as obese more than doubled, from 6.0% at Survey 1 to 15.8 % at Survey 4. It is evident from Figure 2-2 that the pattern of BMI in the Younger women at Survey 4 (when they were 28 – 33 years old) is approaching that of the Mid-aged cohort at Survey 1 (who were 45 – 50 years old in 1996).

The changes in the distribution of BMI categories in the Mid-aged women show a slow decrease in the proportion of healthy weight women at each survey. By Survey 4, only 40.3% of this cohort was in the healthy weight range, with 33.7% overweight and 24.9% obese.

There was much less change in the distribution of BMI categories in the Older cohort. At Survey 1 just over half the Older women (51.1%) were in the healthy weight range and 12.4% were categorised as obese. By Survey 4 the proportion of healthy weight Older women had declined to 49.2% and the proportion who were obese had increased to 13.4%. The proportion of overweight Older women has remained stable throughout the first four surveys (34.3% – 33.0%) while the proportion of underweight Older women has increased from 2.2% to 4.3% (Figure 2-2, Table A7).

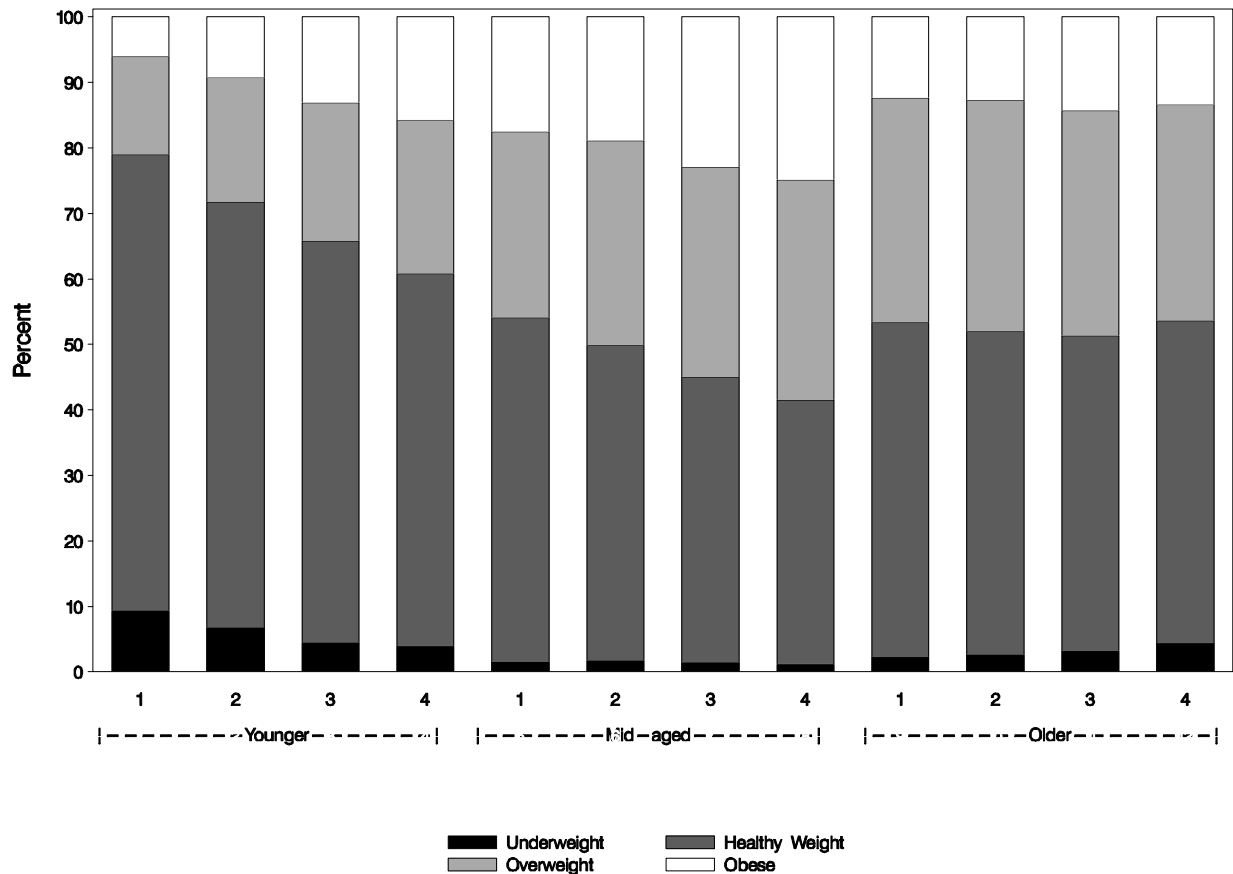


Figure 2-2: Proportions of women in each of the BMI categories based on self-reported height and weight for each age cohort for Surveys 1, 2, 3 and 4 from 1996 to 2006.

## 2.6. Women’s comments

### 2.6.1. Increased weight among Younger women

The weight gain among the Younger cohort over the four surveys is reflected in comments made by Younger participant Sally<sup>1</sup>. At Survey 1 Sally had a BMI of 23, which is within the healthy weight range. At this time her life ‘lacked routine’ and she was stressed by the need to live away from home in order to pursue study. By Survey 2 Sally had become overweight with a BMI of 28 and chose not to write any comments on the survey form.

At Survey 3 Sally had experienced significant weight gain and had a BMI of 32, indicating that over a seven year period she had moved from being a healthy weight to being obese. She wrote about being diagnosed with Polycystic Ovarian Syndrome and had moved from a ‘stressful’ job to a less rewarding but also less stressful position. Sally commented on her weight for the first time at this survey:

*Have become overweight in the last three years. I have put on about 15kgs.*

<sup>1</sup> Pseudonyms are used in the description of qualitative data.

By Survey 4 Sally had experienced more weight gain, with a BMI of 33. She again commented on her weight:

*I am overweight and very unhappy about it but I recently joined a gym for the first time ever. I am working part time in a clerical position while furthering my studies. I could earn a lot more and have a much easier financial situation but I don't want the travel and excessive hours that come with that.*

## **2.6.2. Increased physical activities among Mid-aged women**

Helen, a Mid-aged participant, made free-text comments at all four surveys and exemplifies some of the quantitative findings for the Mid-aged cohort. Helen had been steadily gaining weight across the first three surveys, but by Survey 4 she had increased her physical activity levels and consequently experienced a significant weight loss.

At Survey 1, with a BMI of 35, Helen wrote:

*I consider that the majority of my health problems are related to my obesity. I have always found it difficult to loose and keep weight off. I am on the true cycle of losing weight and then gaining more. I have been to all of the usual weight loss programs. Because of my weight I am breathless on exertion. The key to better health for me is weight loss and manageable work hours.*

At Survey 2, with a BMI of 37 Helen again wrote that her health problems were due to obesity. By Survey 3, her BMI had risen to 38 and she was using a prescribed weight loss product in an attempt to lose weight and was exercising sporadically. However, her busy lifestyle prevented her from 'exercising as much as (she) should.'

At Survey 4 Helen reported that she had started a new weight loss program 18 months beforehand. Her BMI at Survey 4 was 34, lower than it had been at any survey time point:

*18 months ago I commenced a weight loss/fitness program exercising on a treadmill morning and night (half an hour each) and in nine months lost 30 kgs in weight. I stopped medication for hypertension. I maintained the weight loss with minimal exercise for 6 months.*

Despite these positive results, Helen reported that she has gained 10 kilograms in the past six months, due to:

*...loss of motivation, increased workload/intensity, extreme tiredness associated with workload...The problem is trying to balance them all (work, family, friendships, study) I want the lot- but my age is catching up.*

This case study points to time pressure and difficulties in work-life balance as being potential barriers to sustained behavioural change and uptake of regular physical activity. Nevertheless, and as pointed out in this report, as Mid-aged women experience life changes such as children leaving home, and changes in paid work, more time might become available for women to increase their levels of physical activity.

## 2.7. Discussion

The data presented here show a trend of increasing weight in both the Younger and Mid-aged women. This trend is most marked in the Younger cohort, who gained an average of 567 g/year between Surveys 3 and 4.

An earlier analysis (Ball et al., 2002) of the factors associated with weight maintenance between Surveys 1 and 2 found that fewer than half (44%) of the Younger cohort reported their BMI at follow-up to be within 5% of their baseline BMI, while 41% had gained weight (more than 5% of baseline) and 15% had lost weight. Weight maintainers were more likely to be in managerial or professional occupations; to have never married; to be currently studying; and to not be mothers. Controlling for socio-demographic factors, weight maintainers were more likely to be in a healthy weight range at baseline; and to report that they spent less time sitting, and consumed less takeaway food, than women who gained weight. Weight gain was more marked among those who were already overweight, including women living in rural areas, though location was not independently associated with weight gain.

As more of the Younger cohort have become mothers between Surveys 2 and 4, ongoing analyses are exploring the impact of this life event on weight gain (see Section 3). The weight gain data presented here suggest that strategies for maintenance of healthy weight and prevention of further weight gain at this life stage are now urgently required, if these Younger women are to avoid the early onset of weight-related chronic health problems.

Weight gain was also notable in the Mid-aged cohort, although the decline in the rate of weight gain between Surveys 3 and 4 is encouraging. An analysis of the factors associated with weight gain between Surveys 1 and 3 found that on average the women gained almost 0.5 kg per year (average 2.42 kg [2.29-2.54] in the first five years of the Study (Brown et al., 2005)). In multivariate analyses, variables associated with energy balance (physical activity, sitting time and energy intake), as well as quitting smoking, menopause / hysterectomy, and baseline BMI category were significantly associated with weight gain, but other behavioural and demographic characteristics were not. There were independent relationships between the odds of gaining more than 5kg and lower levels of habitual physical activity; more time spent sitting; energy intake, (but only in women with BMI > 25 at baseline); menopause transition and hysterectomy.

Ongoing analyses are exploring the factors associated with increasing physical activity and decreasing rate of weight gain in the Mid-aged cohort. It is hypothesised that factors relating to the availability of time for physical activity, such as children leaving home, changes in patterns of paid work may be associated with increasing physical activity and decreasing rate of weight gain at this life stage. Other analyses are exploring the associations between weight gain and health outcomes such as high blood pressure, diabetes and back pain in this cohort.

The pattern of weight change was different in the Older cohort, with a decrease in average weight over the first nine years of the survey. Ongoing analyses are exploring the associations between weight, weight change and health outcomes in this cohort.

## **2.8. References**

Ball K, Brown W & Crawford D. Who does not gain weight? Prevalence and predictors of weight maintenance in young women. *International Journal of Obesity*, 2002 (26): 1570-1578

Brown W, Williams L, Ford J, Ball K & Dobson A. Identifying the energy gap: magnitude and determinants of 5-year weight gain in midage women. *Obesity Research*, 2005, 13(8): 1431-1441

WHO Consultation on Obesity (1999: Geneva, Switzerland) *Obesity: preventing and managing the global epidemic: report of a WHO consultation. (WHO technical report series; 894)*

## 3. Predictors of weight change

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### 3.1. Key findings

#### Physical activity (PA)

- At all surveys and in all three cohorts, there is a clear downward trend in median PA values across the healthy, overweight and obese groups. Underweight women had also having lower physical activity levels than women of healthy weight.
- Among Younger women the proportion who are adequately active declined between Surveys 3 and 4. The greatest decline was found among those who were overweight at Survey 1, where the percentage of active women declined from 59.6% at Survey 3 to 51.2% at Survey 4.
- In contrast PA levels increased over the same period among Mid-aged women. The greatest increase was found among those who were overweight at Survey 1, where the percentage of active women increased from 45.5% at Survey 3 to 55.1% at Survey 4.
- Throughout the whole study period the percentage of active women among Older women has declined, approximately 4% between Surveys 2 and 3 and 6% between Surveys 3 and 4. By Survey 4 fewer than one in five of the Older obese women were active.

#### Time spent sitting

- Younger women who reported sitting for more than 8 hours a day at Survey 4 weighed 3.40 kg more than those who reported sitting less than or equal to 3 hours per day.
- Mid-aged women who reported sitting for more than 8 hours a day at Survey 4 weighed 5.92 kg more than those who reported sitting less than or equal to 3 hours per day.
- Older women who reported sitting for more than 8 hours a day at Survey 3 weighed 5.64 kg more than those who reported sitting less than 3 hours per day.
- Each additional hour spent sitting at Survey 3 was associated with 227 grams more weight in the Younger cohort, and with 747 grams more weight in the Mid-aged cohort.
- Between Survey 2 and Survey 3 for the Younger cohort and between Survey 3 and Survey 4 for the Mid-aged cohort there is a clear pattern that women who increased their sitting time gained most weight (Younger cohort: 0.7 kg/year, Mid-aged cohort: 0.5 kg/year) and those who decreased their sitting time by more than 3 hours per day gained weight at the slowest rate (Younger cohort: 0.5 kg/year, Mid-aged cohort: 0.3 kg/year).



- Women who sit longer are heavier, or women who are heavier sit longer.

### **Energy Intake and Diet**

- In the Younger and Mid-aged cohorts, women with lowest energy intake had the lowest weight and women with the highest energy intake had the highest weights throughout the study period.
- Younger women with greater energy intake gained more weight (7.4kg) from Survey 1 to Survey 4 than women with lower energy intake (5.7kg).
- Findings suggest that strategies aimed at changing eating behaviours should be age-group specific and take account of other life style factors such as physical activity and cigarette smoking.
- Intakes of both foods and nutrients varied significantly across socio-demographic groups, with unmarried women, and women in 'labouring' occupations (e.g. cleaner, factory worker, kitchen hand) having poorer nutrition intake.

### **Pregnancy**

- Younger women who have had children during the study period gained 2-3kg in addition to the 4kg weight gain by women who had not had children by Survey 3.

### **Smoking**

- In the Younger and Mid-aged cohorts, women gained more weight in the period around the time of quitting smoking than women who did not change their smoking habits during the study period.

### **Hysterectomy**

- Mid-aged women who had a hysterectomy before 1996 had significantly higher BMI than those who have not had a hysterectomy throughout the study period. (mean BMI in 1996 for women with and without a hysterectomy: 26.6 [26.3; 26.8]; 25.3 [25.2; 25.5]).
- There is little evidence that having had a hysterectomy leads to increased weight gain (1.3units increase in BMI over the study period for women who have not had a hysterectomy and for women who had a hysterectomy before 1996).

### **Area of Residence**

- In the Younger cohort, women in rural and remote areas show more weight gain (+2.9BMI units) than women in urban areas (+2.4BMI units) throughout the study period.
- For the Younger and particularly the Mid-aged cohort show that initial BMI increased with rurality. The initial BMI for rural and remote women in the Mid-aged cohort was significantly higher than those in

other areas (urban: 25.4, large rural: 25.6, small rural: 25.8, other rural: 26.1).

- In the Older cohort there is very little difference in BMI or weight change for different areas of residence.

### **Education Level**

- In all three cohorts, women with a university degree had the lowest weights and BMI throughout the study period compared to women with no formal qualifications, who had highest weights and BMI.
- However, there is no evidence for differences in weight change over time between women with different qualifications. In the Younger cohort, women with no formal qualifications gained 3.4kg throughout the study period while women with a university degree gained 2.6kg. Corresponding values for the Mid-aged cohort are 5.7kg and 5.2kg. Older women with no formal qualifications lost 1.3kg and those with a university degree lost 1.4kg.

## **3.2. Physical activity**

Figure 3-1 shows medians and inter quartile ranges (IQR, which is the range between the third and first quartiles) of physical activity (PA) within each BMI category at each survey for all three cohorts. Physical activity is reported in MET.mins, which is a measure of energy expenditure with 600 MET.mins being equivalent to 150 minutes of moderate intensity physical activity per week. (for further details about the calculation and categorisation of physical activity levels see Appendix 3, Section A3.4)

600 MET.min: equivalent to 150 minutes of moderate intensity physical activity per week
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The large IQRs are indicative of wide variation in physical activity levels among women within the different BMI categories, but there is a clear downward trend in median values across the healthy, overweight and obese groups at all surveys and in all three cohorts (with underweight women also having lower physical activity levels than women of healthy weight).

In the Younger cohort, physical activity levels were lower in 2006 for women in every BMI category, than in the previous survey. In contrast, in the Mid-aged cohort, women in every BMI category reported more physical activity in 2004 than in 2001. (Data from the 1998 survey are not used for comparison in this cohort because the question about physical activity was asked slightly differently.) In the Older cohort, physical activity levels in women in each BMI category decreased over time at each survey from 1999 to 2005.

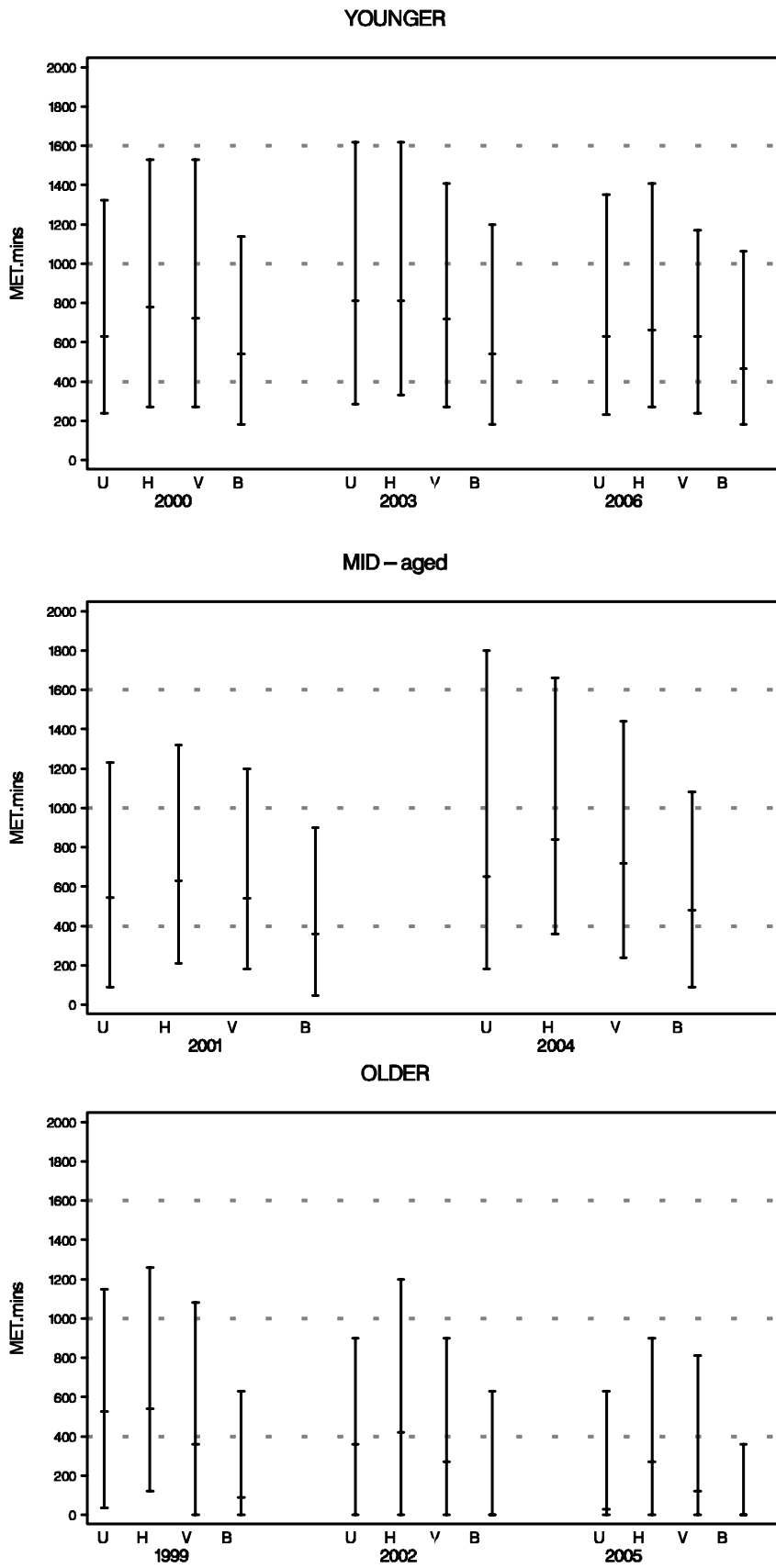


Figure 3-1: Median and inter quartile ranges for physical activity (MET.mins) in each BMI category (U=underweight; H= healthy weight; V= overweight; B= obese) for Surveys 2, 3 and 4 for the Younger and Older cohort and for Surveys 3 and 4 for the Mid-aged cohort.

Figure 3-2 to Figure 3-4 shows changes in physical activity over time based on BMI at Survey 2 for the Younger and Older cohorts, and on BMI at Survey 3 for the Mid-aged cohort. For the Younger women there was a tendency for the proportion of women categorised as 'active' (i.e., having 'moderate' or 'high' levels of physical activity sufficient to meet the guidelines for recommended levels of physical activity) to increase between Surveys 2 and 3 and to decrease between Surveys 3 and 4, with the same pattern evident in women in every BMI category (Figure 3-2, Table A8).

In contrast, in the Mid-aged cohort, the proportion of women categorised as 'active' increased between Surveys 3 and 4, by about 7% in the underweight and healthy weight women, and by 9-10% in the overweight and obese women. The proportion of 'active' women was higher in the healthy BMI category than in the overweight or obese groups at both surveys (Figure 3-3, Table A9).

'active': having 'moderate' or 'high' levels of physical activity sufficient to meet the guidelines for recommended levels of physical activity.

In the Older cohort the proportions of 'active' women were highest in the underweight and healthy BMI categories at Survey 2, and decreased with each subsequent survey in all BMI categories. By Survey 4 it was evident that fewer than one in five of the Older obese women were 'active' (Figure 3-4, Table A10).

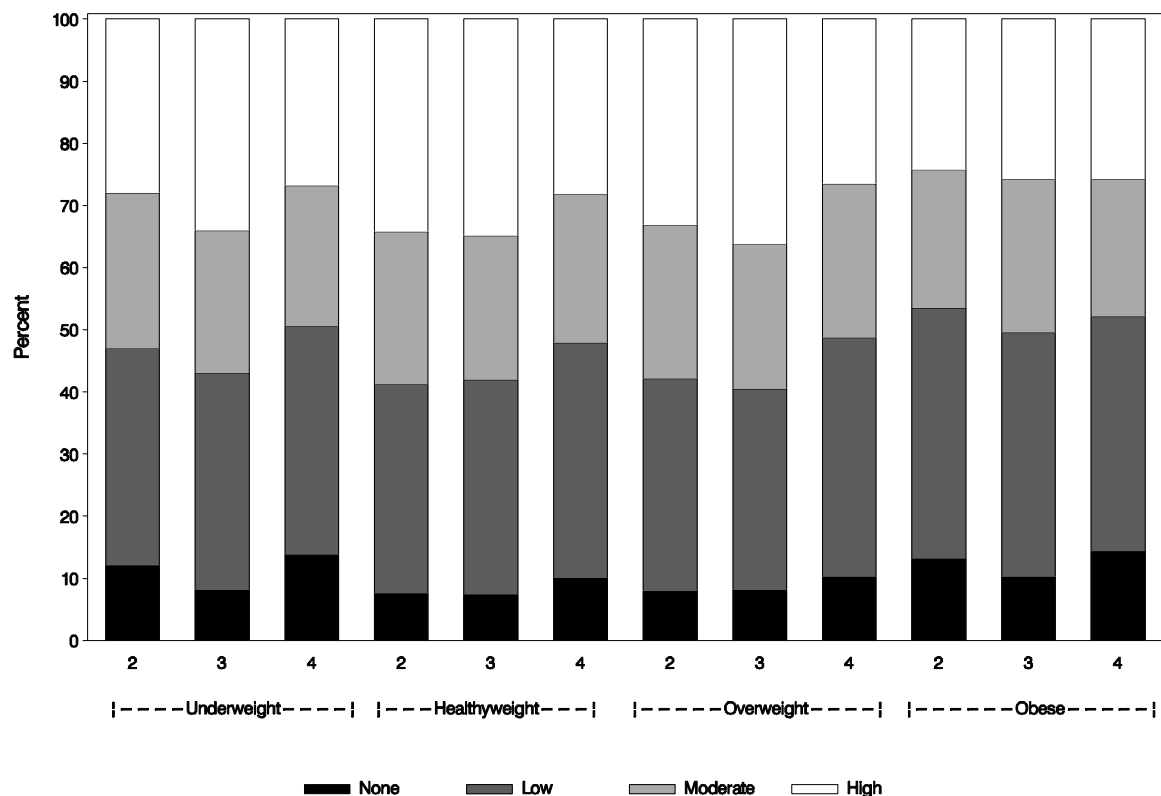


Figure 3-2: Physical activity categories for Younger women at Surveys 2, 3 and 4, by BMI category at Survey 2.

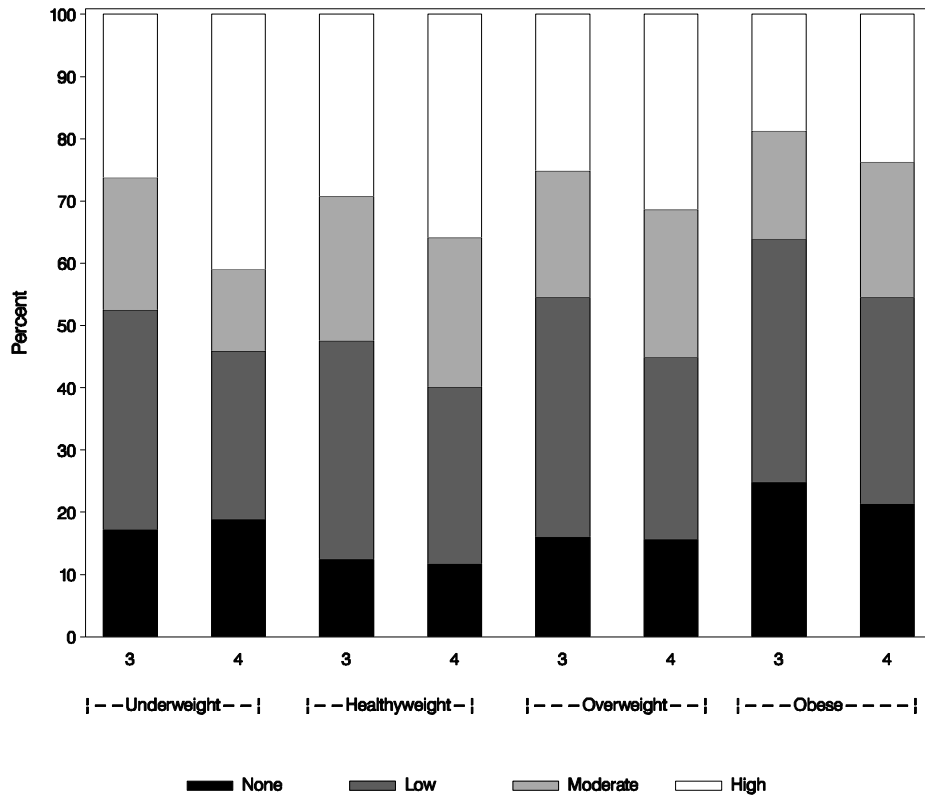


Figure 3-3 Physical activity categories for Mid-aged women at Surveys 2 and 3, by BMI category at Survey 3.

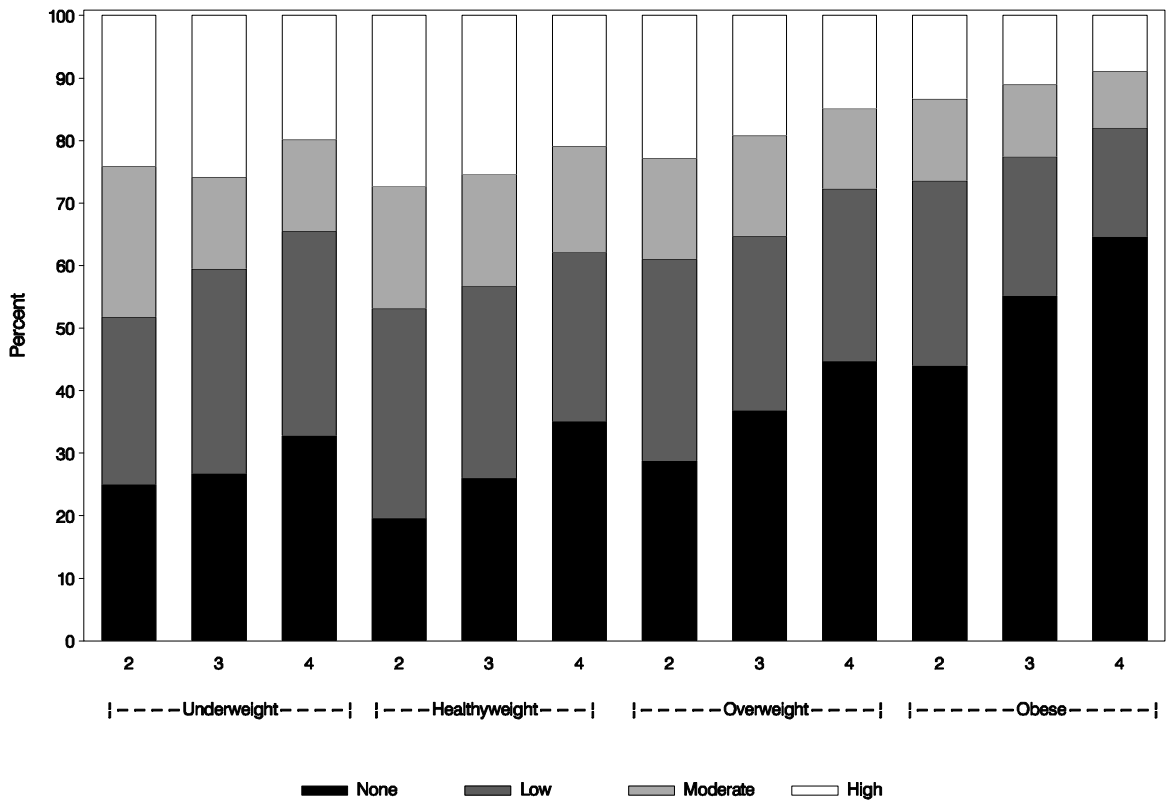


Figure 3-4: Physical activity categories for Older women at Surveys 2, 3 and 4, by BMI category at Survey 2.

The National Physical Activity Guidelines suggest that, for health benefit, all Australians should accumulate at least 30 minutes of at least moderate intensity physical activity on most, if not all, days of the week.

Figure 3-5 shows data from a paper by Brown et al (2005) depicting the relationship between total physical activity over five years (determined as the sum of the physical activity scores at Survey 1, Survey 2 and Survey 3, and categorised so that 'moderate' activity equates with meeting current guidelines) and the odds of gaining weight at twice the average rate over this period, in the Mid-aged cohort. After adjusting for all other factors associated with weight gain, the data show that women who reported doing less than recommended levels of activity were about 1.5 times more likely to gain weight at twice the average rate than women in the 'high' activity category. 'High' activity equates with about one hour per day of moderate intensity activity. Women who met the current activity guidelines ('moderate' physical activity) were not more likely to gain weight at the higher rate than the women in the 'high' activity category.

'high' activity: equates with about one hour per day of moderate intensity activity.

'moderate' activity equates to meeting the current guidelines.

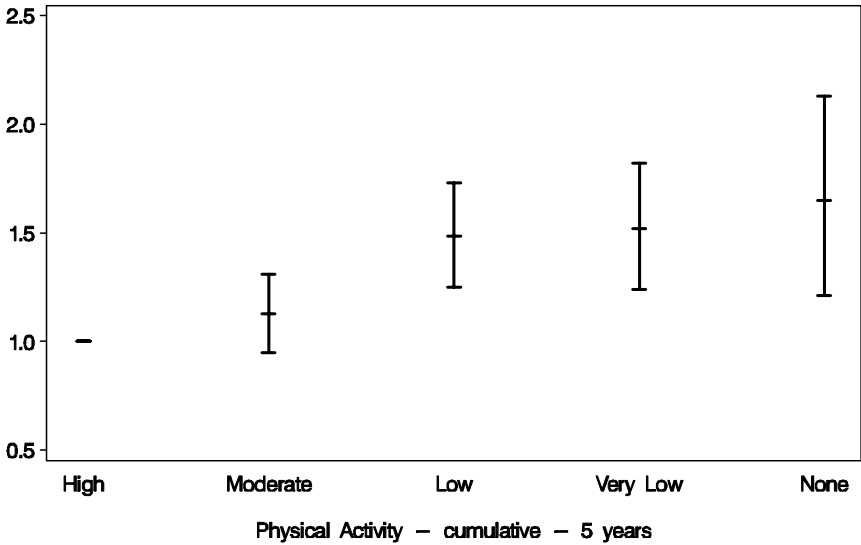


Figure 3-5: Odds ratios and 95% confidence intervals for gaining more than 5kg (N=2046), compared with maintaining weight ( $\pm 2.25$ kg, N=3077), for Mid-aged women in each physical activity group; adjusted for menopause, hysterectomy, smoking, BMI, energy intake and sitting time.

### 3.3. Time spent sitting

Indicators of physical inactivity are also known to be independently associated with weight gain (Proper et al., 2007; Mummery et al., 2005; Brown et al, 2003). Questions about sitting time have now been included in Surveys 2 to 4 for the Younger women, Surveys 3 and 4 for the Mid-aged women and Survey 3 four the Older women.

Figure 3-6 to Figure 3-8 show cross-sectional data from Survey 2 for the Younger cohort and Survey 3 for the Mid-aged and Older cohort with mean weight on the vertical axis (on the same scale for all graphs) and five categories of average time spent sitting on the horizontal axis; the categories are 0 – <= 3, 3 - <=4.5, 4.5 – <=6, 6 – <=8 and > 8 hours per day. At Survey 2 for the Younger cohort there was no difference in mean weight in relation to time spent sitting. While for the Mid-aged and Older women there was a clear positive association between weight and time spent sitting.

The difference in average weight of Younger women who reported sitting less than or equal to 3 hours per day and those who reported sitting for more than 8 hours a day at Survey 2 was only 0.19 kg (Figure 3-6); but at Survey 3 this difference was 2.61 kg; and at Survey 4 it was 3.40 kg (Figures not shown).

Corresponding data for the Mid-aged cohort at Survey 3 were 5.36 kg (Figure 3-7) and at Survey 4 5.92 kg (Figure not shown). For the Older women at Survey 3, the difference in average weight of those who reported less than or equal to 3 hrs and more than 8 hours sitting per day was 5.64 kg (Figure 3-8).

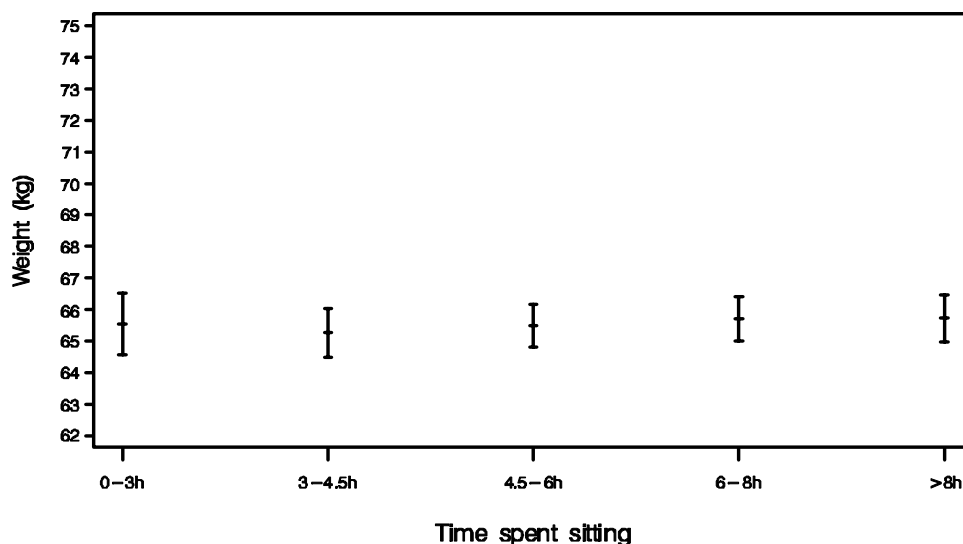
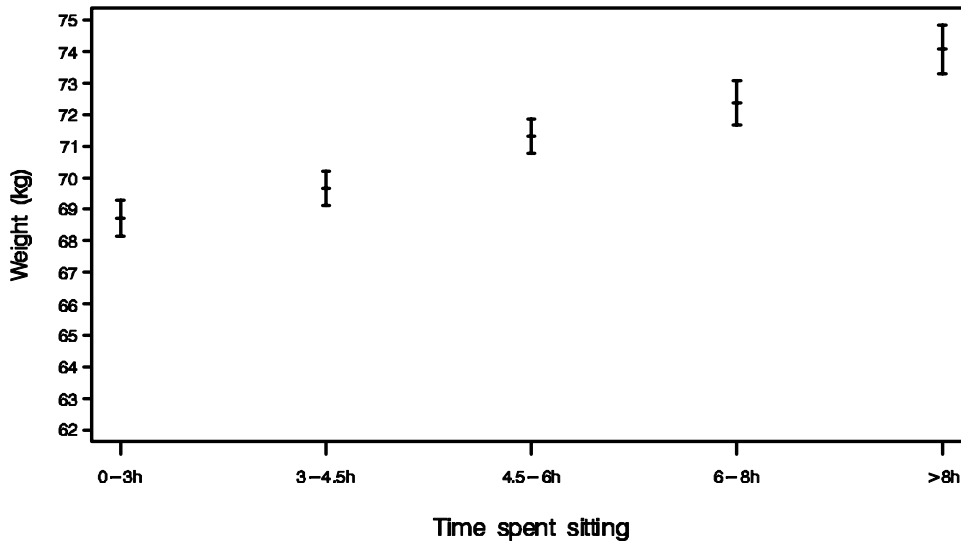
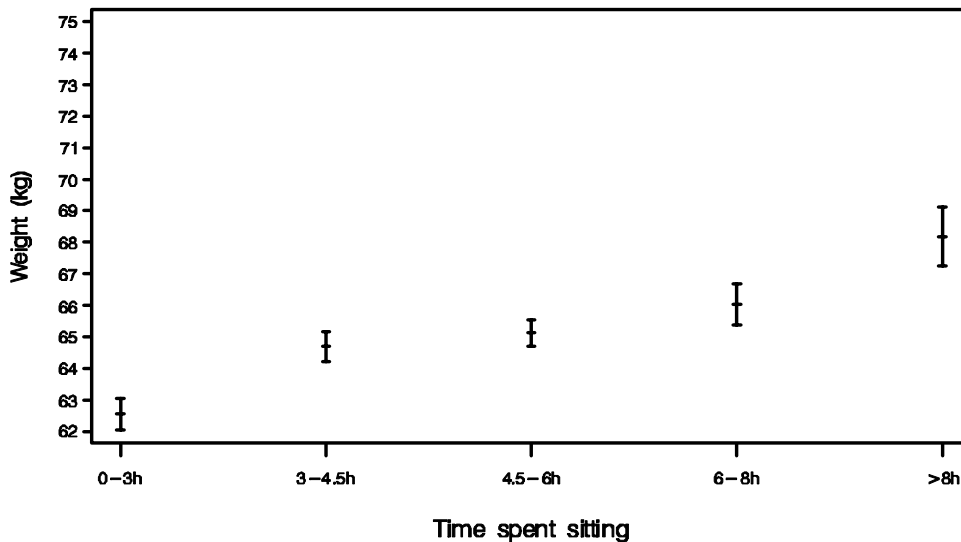


Figure 3-6: Average weight with 95% confidence intervals by time spent sitting group at Survey 2 for the Younger cohort.



**Figure 3-7: Average weight with 95% confidence intervals by time spent sitting group at Survey 3 for the Mid-aged cohort.**



**Figure 3-8: Average weight with 95% confidence intervals by time spent sitting group at Survey 3 for the Older cohort.**

Further analysis (Figures not shown) of the relationship between time spent sitting each day and weight found that:

- each additional hour spent sitting at Survey 3 was associated with 227 grams more weight in the Younger cohort.
- each additional hour spent sitting at Survey 3 was associated with 747 grams more weight in the Mid-aged cohort.

These data show that women who sit longer are heavier, or that women who are heavier sit longer. The prospective data in the following section will help to establish the direction of this relationship.



### 3.3.1. Changing sitting time and weight gain

The following graphs show changes in weight between Surveys 2 and 3 (Figure 3-9), and between Surveys 3 and 4 (Figure 3-10), for the Younger cohort, and from Survey 3 to Survey 4 in the Mid-aged cohort (Figure 3-11) in relation to their changes in sitting time which were categorised as: decrease of more than 3 hours, any change between decreasing 3 and increasing 3 hours, and increase of more than 3 hours per day. In the Older cohort the sitting time questions have only been asked in one survey, therefore no graphs of changes in sitting time and weight can be included.

The main patterns observed are:

Between Surveys 2 and 3, Younger women:

- who increased their sitting time gained most weight.
- who decreased their sitting time by more than 3 hours per day gained weight at the slowest rate.
- who did not change their sitting time by more than 3 hours initially had the lowest weight and their rate of weight gain was between those for the other two groups.

This same pattern is also apparent for the Mid-aged women between Surveys 3 and 4.

However there were almost no differences in the rates of weight gain among the Younger women between Surveys 3 and 4 indicating that other factors (including pregnancy) were probably more important determinants of weight gain during this period.

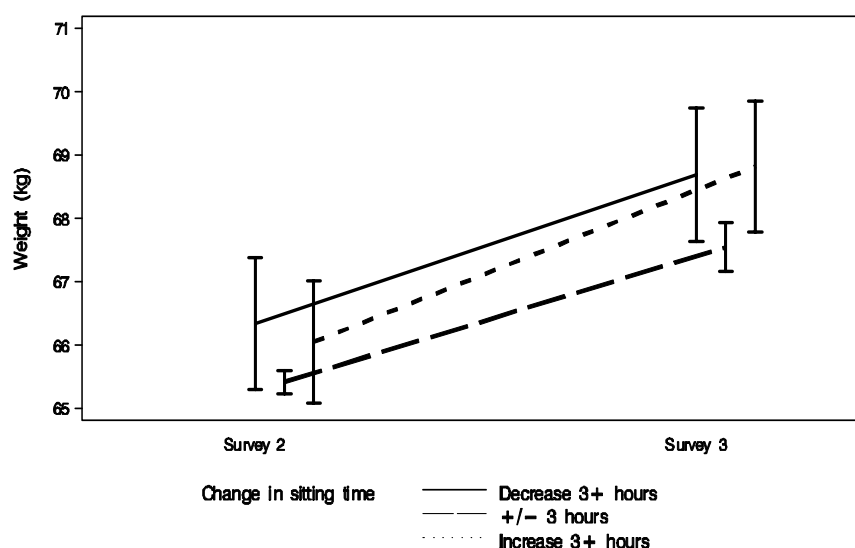


Figure 3-9: Average weight with 95% confidence intervals by changes in time spent sitting between Surveys 2 and 3 in the Younger cohort.

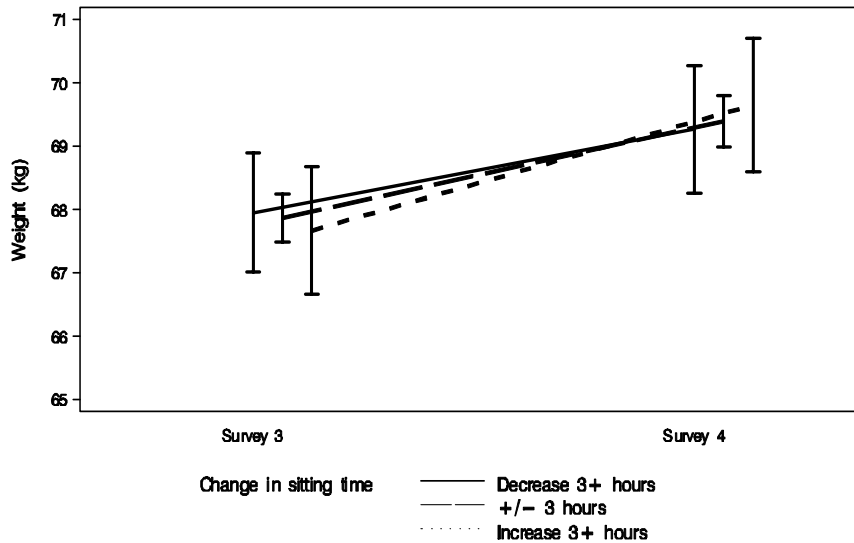


Figure 3-10: Average weight with 95% confidence intervals by changes in time spent sitting between Surveys 3 and 4 in the Younger cohort.

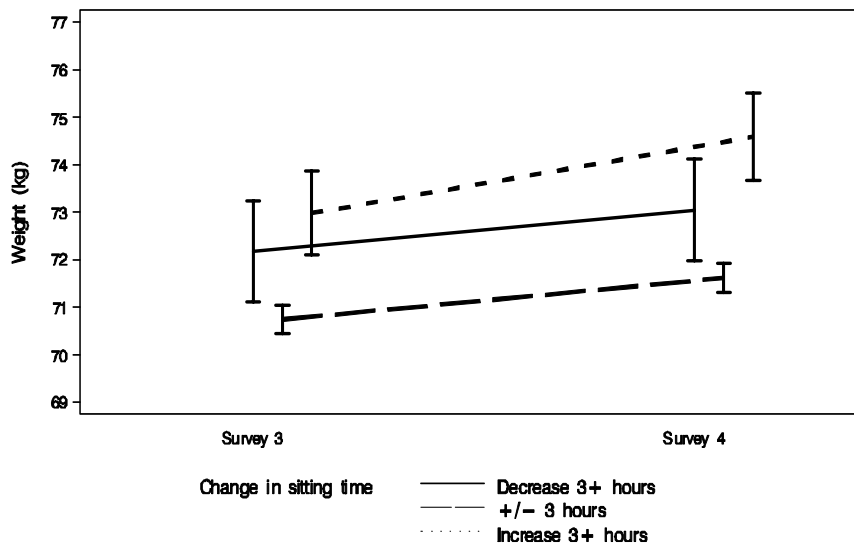


Figure 3-11: Average weight with 95% confidence intervals by changes in time spent sitting between Surveys 3 and 4 in the Mid-aged cohort.

### 3.4. Energy intake and diet

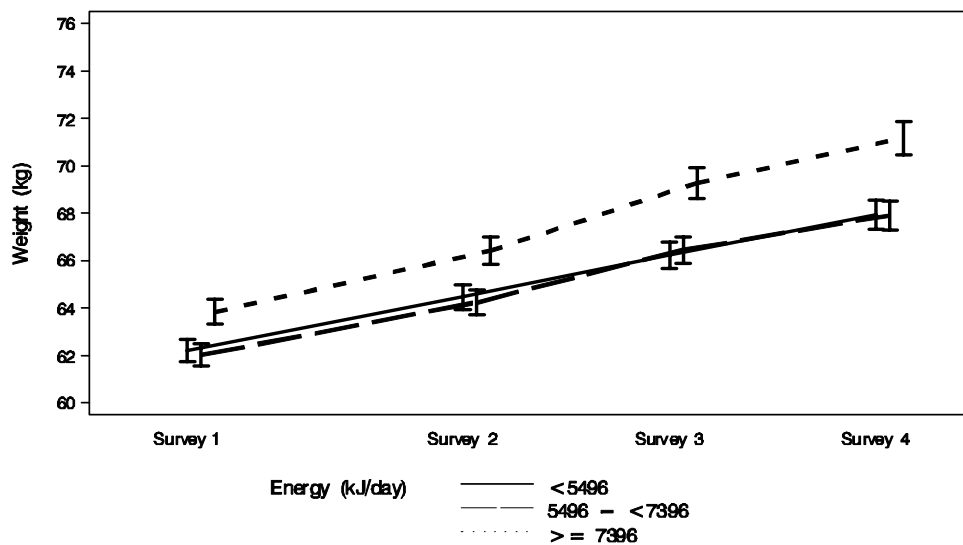
The major determinant of weight change is energy balance, the net effect of energy intake (through diet) and energy expenditure (through physical activity). Diet, and hence energy intake, has only been assessed once in the Younger and Mid-aged cohorts, using the Food Frequency Questionnaire of the Cancer Council of Victoria. The assessments were made at Survey 3 in 2001 for the Mid-aged women and at Survey 3 in 2003 for the Younger women.

To show the main effects of energy intake on weight gain we grouped the women into three groups according to their energy intake measured at Survey 3.

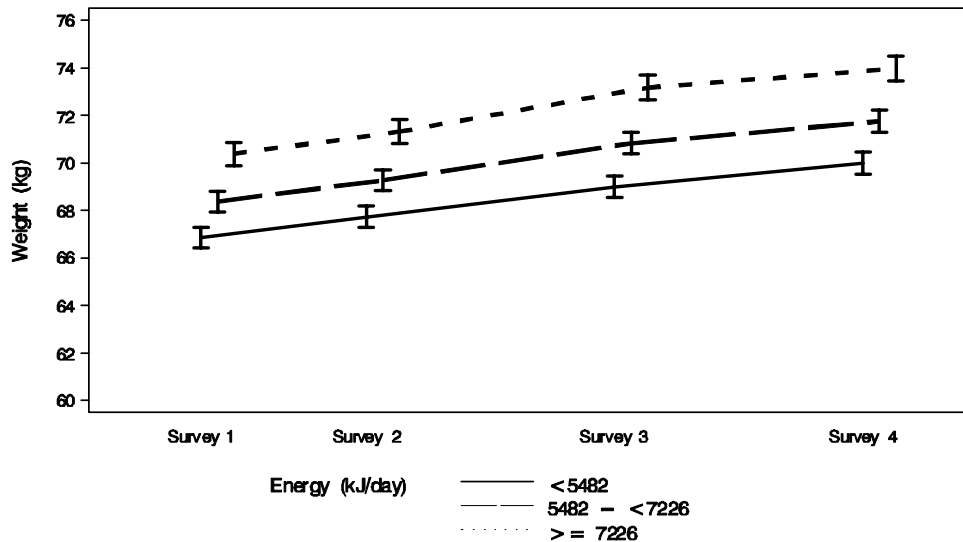
Figure 3-12 and Figure 3-13 show the mean weight over time of Younger and Mid-aged women in these groups. Women with the lowest intake had the lowest mean weight for the whole period from Survey 1 to Survey 4. Those with the highest intake weighed most at Survey 1 and at all subsequent surveys. Women in the three intermediate groups had initial mean weight in the same rank order as their energy intake.

For the Younger women, those with greater energy intake gained more weight between Surveys 1 and 4 (see Figure 3-12). In contrast, weight gain from Survey 1 to Survey 4 was fairly constant among the Mid-aged women for all categories of energy intake (see Figure 3-13).

There are some difficulties interpreting these data, because energy intake has only been measured once, but the data appear to suggest that energy intake is a better predictor of weight (for example at Survey 1) than of weight change (especially for the Mid-aged women).



**Figure 3-12: Average weight with 95% confidence intervals by energy intake for the Younger cohort at Surveys 1, 2, 3 and 4.**



**Figure 3-13: Average weight with 95% confidence intervals by energy intake for the Mid-aged cohort at Surveys 1, 2, 3 and 4.**

Brown, et al (2005) conducted an analysis of the magnitude and determinants of weight gain over the five-year period between Surveys 1 and 3 for the Mid-aged women. On average, the women gained almost 0.5 kg per year [average 2.42 kg [2.29 - 2.54] over five years]. In multivariate analyses, variables associated with energy balance (physical activity, sitting time and energy intake), as well as quitting smoking, menopause and hysterectomy, and baseline BMI category were significantly associated with weight gain, but other behavioural and demographic characteristics were not. After adjustment for all the other biological and behavioural variables, the odds of gaining weight at about twice the average rate (more than 5 kg over five years) were highest for women who quit smoking (OR = 2.94 [2.17, 3.96]). There were also independent relationships between the odds of gaining more than 5 kg and: lower levels of habitual physical activity; more time spent sitting; energy intake (but only in women with BMI > 25 at baseline); menopause transition; and hysterectomy. Average weight gain was commensurate with an energy imbalance of only about 10 kcal or 40 kJ per day, which suggests that small sustained changes in the modifiable behavioural variables could prevent further weight gain.

Some analyses of dietary composition have also been conducted. The earliest study involved data collected in a pilot study in 1995 (Dobson, et al, 1997). Younger and Mid-aged women living in urban and rural areas of New South Wales completed a very brief food frequency questionnaire. The results are listed below:

- Urban women in both age groups consumed meat less frequently than women in rural areas.
- Women in the less populated rural areas were more likely to eat green and yellow vegetables and least likely to eat dried beans. There were few other geographic differences in food habits.
- Mid-aged women consumed reduced-fat milk, fruit, vegetables, fish, biscuits and cakes significantly more frequently than Younger women.

- Smokers in both age groups consumed fresh fruit, vegetables and breakfast cereals significantly less frequently than non-smokers.
- Women with low levels of habitual physical activity consumed fresh fruit and cereals less frequently than more active women.

These results shed light on the subsequent data on weight and weight gain. Urban Mid-aged women who reported the healthiest diet have weighed less than rural women throughout the study and the Mid-aged women have gained less weight than the Younger women. These findings suggest that strategies aimed at changing eating behaviours should be age-group specific and be related to other life style factors such as physical activity and cigarette smoking.

Two major papers have been published from the dietary data from the Mid-aged women. In the first Ball and colleagues (2004) investigated the proportion of Mid-aged women meeting the national dietary recommendations. Only about one third of women complied with more than half of the 13 commonly promoted dietary guidelines. In fact only two women in the entire sample met all 13 guidelines examined. While guidelines for meat, fish, poultry, eggs, nuts, legumes and ‘extra’ foods (e.g., ice cream, chocolate, cakes, potatoes, pizza, hamburgers and wine) were met well, large percentages of women (68 - 88%) did not meet guidelines related to the consumption of breads, cereal-based foods and dairy products, and intakes of total and saturated fat and iron. Women working in lower status occupations and women living alone or with people other than a partner and/or children were at significantly increased risk of not meeting the guidelines. From these results the current national guidelines appear unachievable for many women.

The second paper, by Mishra et al (2005), examined socio-demographic inequalities in the diets of the Mid-aged women. Intakes of both foods and nutrients varied significantly across socio-demographic groups, with unmarried women, and women in ‘labouring’ occupations (e.g. cleaner, factory worker, kitchen hand) having poorer nutrition intake. As well as helping to address the dearth of current data on dietary intakes in the Australian population, these results highlighted the need for continued, targeted public health strategies aimed at improving diet of women, particularly those from more disadvantaged socio-economic backgrounds.

### **3.4.1. Women's comments**

#### **The journey from ‘I’ll die from overeating but I don’t care’ – to weight loss**

Throughout the study period, Mid-aged participant Elizabeth has been in the obese BMI category and has written about her weight at all four surveys. At Survey 1 with a BMI of 39, Elizabeth explains she is content with her size:

*I have been overweight since I had my first child. I have 5 or 6 times gone on diets and lost some weight but always ended up heavier than when I started. I was diagnosed with mature onset diabetes 2 years ago but it is very mild and I keep it well under control (gave up soft drink for the diet variety and cut down*

*on cakes, etc). I have been content with my size for some time now and feel “skinnyness” is like winning lotto – it only happens to other people.*

At Survey 2, still with a BMI of 39, weight continued to be an important issue in Elizabeth’s life, and although she had started to exercise she reiterated that she did ‘not care’ about her weight:

*I found that I didn’t feel as well when I didn’t get any exercise at all and have started feeling much better since I started playing sport again, so I will take up a bit of extra walking as well. I have always been a pretty active person, but I will not be trying actively to lose weight. I know I am overweight and have been for years but one of my mottos (rightly or wrongly) is –“I don’t smoke and I don’t drink. I’ll probably die of overeating but I don’t care!”*

At Survey 3 Elizabeth had experienced some weight loss with a BMI of 36. She still felt as if trying to lose weight would fail and that her weight did not impede her life. However, she acknowledged that her diabetes ‘would be even better if (she) lost weight.’ Elizabeth repeated her statements from Survey 2, ‘I will probably die from overeating but I don’t care.’

In 2004, eight years after completing her first survey, Elizabeth has experienced some major life changes, and has a BMI of 35, lower than at any other survey. She was living alone, had started a new job and commented, ‘I am happier than I have been for years’. Elizabeth has started actively trying to lose weight:

*So far I have lost 6 kg but it is very hard going as I have been this weight for 30 years. If I sit down I am quite stiff when I first stand up but soon loosen up after walking around a bit. I walk to work (one km each way) and play sport once a week. Diabetes is well under control.*

This case study shows that although women can be aware of the negative impact of being overweight or obese, moving to a stage where weight loss is actively undertaken can take many years and might involve other life changes. However, diet and exercise are key elements, as demonstrated by the quantitative data.

### **3.5. Pregnancy**

It is well-known that many women have difficulty regaining their pre-pregnancy weight after having a baby. In the Younger women, examination of childbearing patterns in relation to weight gain showed the following results:

- Younger women, who have not been pregnant at any time (nulliparous women), gained the least weight, approximately 4 kg between Surveys 1 and 3.
- Younger women, who had their first baby before Survey 1, were the heaviest group (by about 3 kg) at that stage. Their subsequent weight gain has been similar to nulliparous women.

- Younger women, who had babies between Surveys 1 and 2 gained most weight, during that period, which they did not subsequently lose. Their subsequent weight gain has been similar to nulliparous women.
- Younger women, who first had a baby between Surveys 2 and 3, gained most weight, approximately 4 kg during this period. By Survey 3 they were about the same weight as the other two groups of women who had had babies earlier.
- By Survey 3, Younger women who had babies between Surveys 1 and 2 were heaviest, with an average weight of approximately 71.5 kg; and nulliparous women were lightest, with an average weight of approximately 67.5 kg.
- Younger women who have had children during the study period gained 2 – 3 kg in addition to the 4 kg weight gained by women who had not had children up to Survey 3.

At this stage of the study, insufficient women had had more than one pregnancy to be able to distinguish clearly the effect of subsequent pregnancies on weight gain.

### **3.5.1. Women's comments**

#### **Soggy stomach, sagging breasts and stretch marks...**

Daniela is a member of the Younger cohort and has contributed free-text comments at three of the four surveys. At Survey 1 Daniela had just given birth and her BMI was 25, putting her at the high end of the healthy weight range. Nevertheless, Daniela noted that she had gained weight compared to before her pregnancy and was generally unhappy with her body shape:

*I still haven't lost the last of my pregnancy weight gain and the new shape i.e. soggy stomach, sagging breasts and stretch marks everywhere are hard to get used to.*

At Survey 2 Daniela did not mention her weight but had a BMI of 27, which is classified as overweight. At Survey 3, she had a BMI of 31, reflecting a steady weight gain over the study period, and echoing the results of the quantitative data that show a consistent increase in BMI among the Younger cohort. It is Survey 4 before she again comments on her weight. With a BMI of 37 Daniela has reached the obese category and has identified factors that are leading her to feel depressed, and a cyclic relationship between her weight and feelings:

*Any depression or frustration is largely centred around worrying if I am successful in parenting and how the boys will grow up. Will they be well balanced respectable people? Could I be doing things differently or better? Most of my health concerns relate to my weight and body shape. I hate being this way but it's so hard to make change, bad cycle, overweight - feel bad - eat to console self and then put on more weight.*

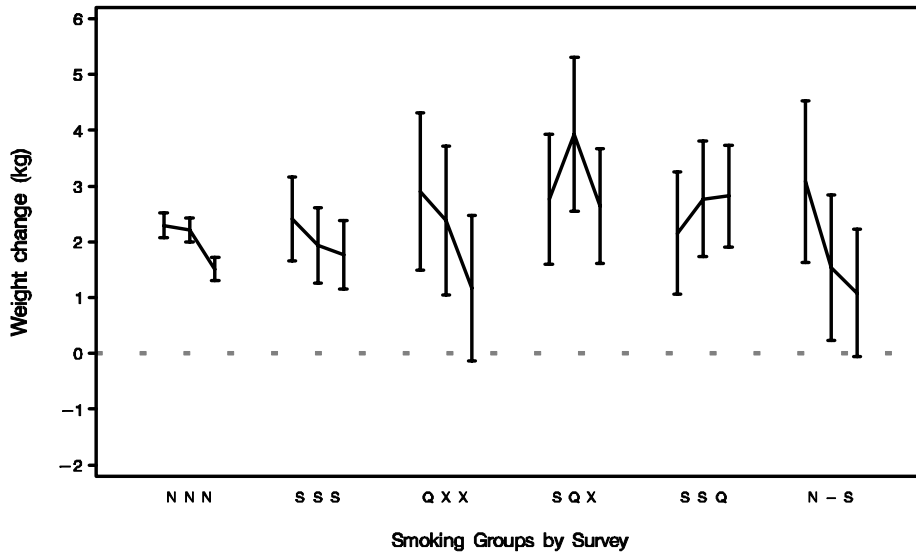
For Daniela, weight gain started with her first pregnancy and has continued over the following decade. Her experience exemplifies the quantitative findings that show an increase in weight associated with childbirth.

### 3.6. Smoking

The graphs below show weight change by smoking group. The smoking groups are the main smoking patterns found with at least 100 women included. The letters N, X and S represent change in smoking status between two surveys. N represents never smokers, S represents smoker and X represents ex (or former) smoker at both surveys. Q (quitting) represents a change in smoking status from smoker to ex (or former) smoker between two surveys. Therefore, for example SQX represents the group of women who were smoker at Surveys 1 and 2, quit smoking between Surveys 2 and 3 and stayed ex-smoker between Surveys 3 and 4. The group denoted N-S represents all those women who took up smoking during the study period between Surveys 2 and 3 (NSS) or between Surveys 3 and 4 (NNS). Weight change in kilograms is on the vertical axis with means representing mean weight change between Survey 1 and Survey 2, Survey 2 and Survey 3, and Survey 3 and Survey 4 (inclusive 95% confidence intervals). The mean weight change points are joint to make it easier to see changes over time in the same smoking group.

Figure 3-14 shows weight change by smoking group for the Younger women. Women in all groups gained about two kilograms, so that almost all the lines are above zero (which corresponds to no weight change). There was very little difference in weight change between the women had never smoked (NNN) and the smokers (SSS). There is some evidence that women who quit smoking gained weight during the same period as they quit smoking; for example, the group QXX had the highest weight gain (2.9kg) between Surveys 1 and 2, which is when they quit smoking; similarly, the group SQX had the highest weight gain (3.9kg) between Surveys 2 and 3.



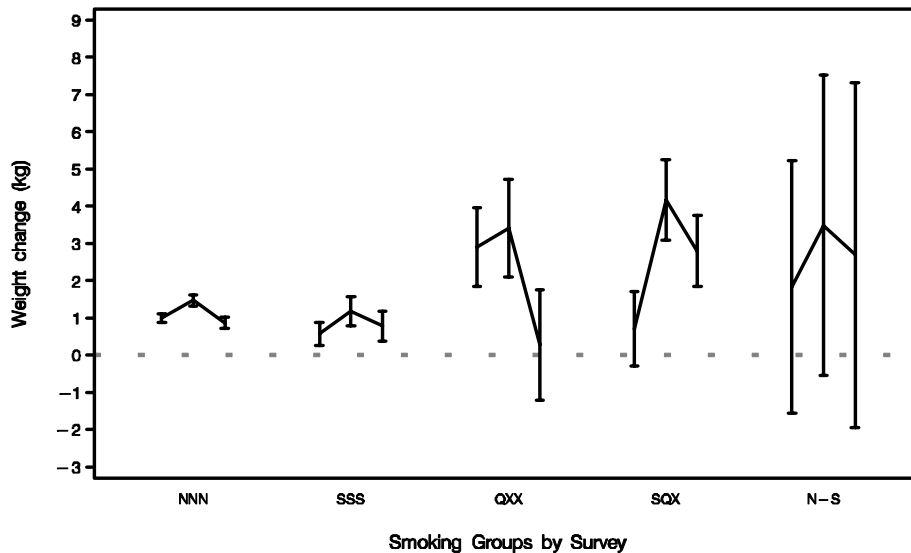


- NNN = non-smoker between Surveys 1 and 2, 2 and 3, and 3 and 4.
- SSS = smoker between Surveys 1 and 2, 2 and 3, and 3 and 4.
- QXX = quit smoking between Surveys 1 and 2, continued as an ex-smoker between surveys 2 and 3, and 3 and 4.
- SQX = smoker between Surveys 1 and 2, quit smoking between Surveys 2 and 3, an ex-smoker between Surveys 3 and 4.
- SSQ = smoker between Surveys 1 and 2, and 2 and 3, quit smoking between Surveys 3 and 4.
- N-S = non-smoker between Surveys 1 and 2, a smoker between Surveys 3 and 4. Either smoker or non-smoker between Surveys 2 and 3.

**Figure 3-14: Weight change for most commonly occurring smoking patterns for the Younger cohort from 1996 to 2006.**

Figure 3-15 shows the same graphs for the Mid-aged women. The confidence intervals for the mean weight change for the last three smoking groups are very large because of the small numbers of women who changed smoking status. Among women who were never smokers (NNN) and those who were smokers (SSS) the average weight gain was about 1 kg between each survey. Once again, weight gain was higher in the period coinciding with quitting, i.e., between Surveys 1 and 2 in the QXX group and between Surveys 2 and 3 in the SQX group.

As few of the Older women smoke, data for this group are not shown in this section of the report.



- NNN = non-smoker between Surveys 1 and 2, 2 and 3, and 3 and 4.
- SSS = smoker between Surveys 1 and 2, 2 and 3, and 3 and 4.
- QXX = quit smoking between Surveys 1 and 2, continued as an ex-smoker between surveys 2 and 3, and 3 and 4.
- SQX = smoker between Surveys 1 and 2, quit smoking between Surveys 2 and 3, an ex-smoker between Surveys 3 and 4.
- SSQ = smoker between Surveys 1 and 2, and 2 and 3, quit smoking between Surveys 3 and 4.
- N-S = non-smoker between Surveys 1 and 2, a smoker between Surveys 3 and 4. Either smoker or non-smoker between Surveys 2 and 3.

**Figure 3-15: Weight change for most commonly occurring smoking patterns for the Mid-aged cohort from 1996 to 2004.**

### 3.6.1. Women's comments

The relationship between the cessation of smoking and weight gain was commented on by Mid-aged participant Ebony. Ebony did not make any free-text comments at Survey 1, when her BMI was 21.

At Survey 2, Ebony felt that most of the answers to the survey related in some way to her stopping smoking. She attributed her weight gain and resultant feelings of discomfort with movement, lack of self esteem and a general feeling of being unfit, to ceasing smoking 6 months previously. Her BMI at this point was 26, just inside the overweight category.

By Survey 3 Ebony had started smoking again and reported losing weight, reflected in her BMI of 21. She commented:

*The loss of weight was due to resuming smoking more than diet.*

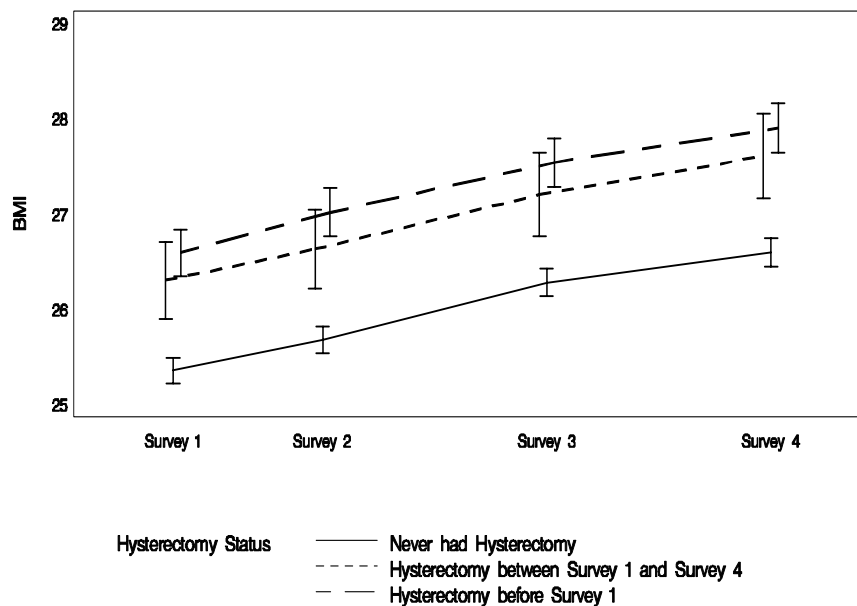
At Survey 4 Ebony again commented that her weight was directly related to whether she was smoking or not. At the time of the survey, she had a BMI of 22 and was currently smoking.

### 3.7. Hysterectomy

In some of the ALSWH analyses of weight change, having had a hysterectomy has been identified as a potential risk factor for weight gain. Changes in weight for Mid-aged women who have had and not have had a hysterectomy are illustrated in Figure

3-16. The vertical axis denotes BMI, with vertical lines denoting the means and 95% confidence intervals at each survey. The solid line represents those women who have not had a hysterectomy; the dotted line represents women who had a hysterectomy before the beginning of the study in 1996; the other dashed line represents those women who had a hysterectomy some time between Surveys 1 and 4.

Figure 3-16 shows clearly that increase in BMI is about the same for all three groups of women. It also shows that those women who had a hysterectomy before the start of the study had higher BMI at the beginning of the study than those who have not had a hysterectomy. The implication of these results is that higher BMI is a risk factor for having a hysterectomy, rather than that having had a hysterectomy leads to increased weight gain.



**Figure 3-16: Average BMI with 95% confidence intervals at Surveys 1, 2, 3 and 4 by hysterectomy status for the Mid-aged cohort from 1996 to 2004.**

### 3.8. Area of residence

The next three graphs show the average BMI at each survey for women living in urban areas, large rural centres, small rural centres and other rural areas (including remote areas). The definition of these areas is given in Appendix 3, Section A3.1. The data shown are mean BMI with 95% confidence intervals, and lines joining the means to denote changes across surveys.

Figure 3-17 and Figure 3-18 for the Younger and Mid-aged cohorts respectively show that initial BMI increased with rurality. The initial BMI for rural and remote women in the Mid-aged cohort was significantly higher than those in other areas (urban: 25.4, large rural: 25.6, small rural: 25.8, other rural: 26.1). Additionally in the Younger cohort weight gain over the four surveys was also higher among women in rural and remote areas (+2.9BMI units) than among urban women (+2.4BMI units). Figure 3-19 for the Older women shows very little difference in BMI for different areas of residence.

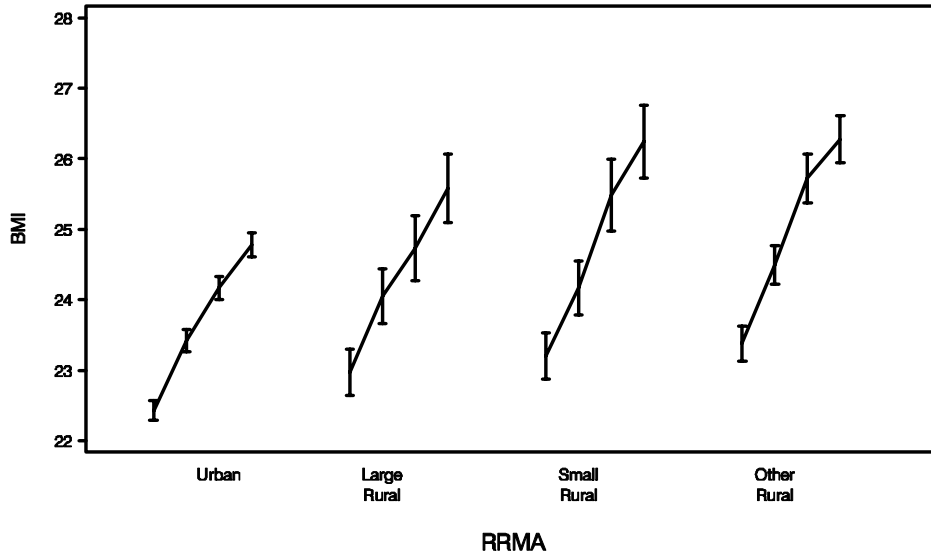


Figure 3-17: Average BMI with 95% confidence intervals by area of residence for the Younger cohort, at Surveys 1, 2, 3 and 4, from 1996 to 2006.

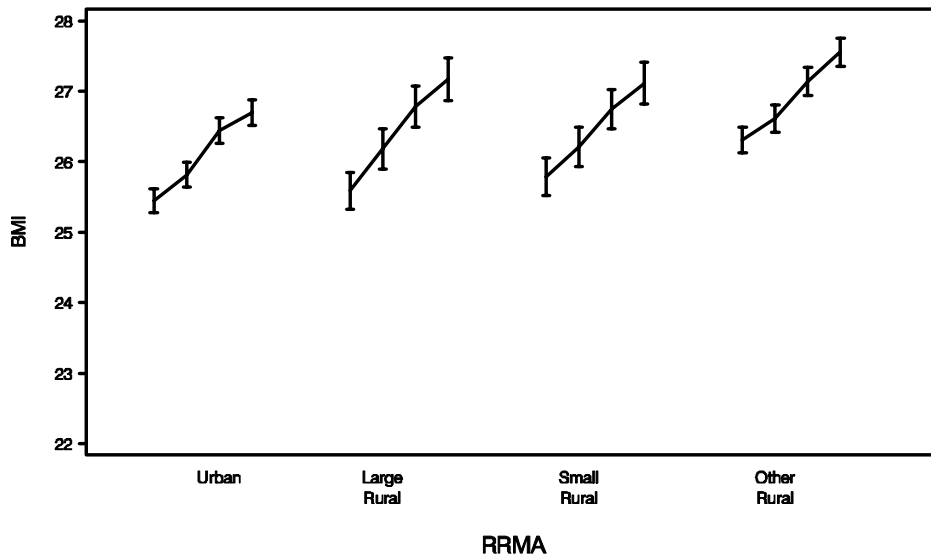
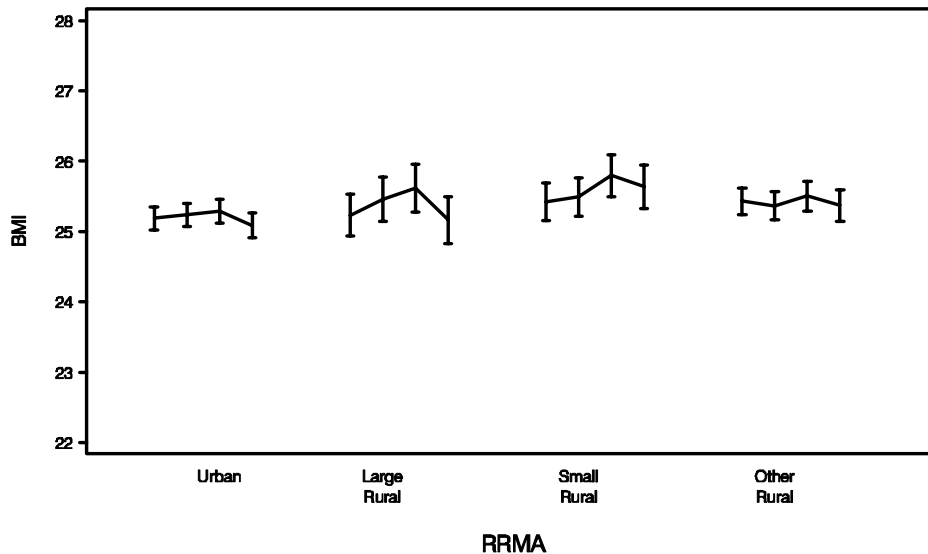


Figure 3-18: Average BMI with 95% confidence intervals by area of residence for the Mid-aged cohort, at Surveys 1, 2, 3 and 4, from 1996 to 2004.



**Figure 3-19: Average BMI with 95% confidence intervals by area of residence for the Older cohort, at Surveys 1, 2, 3 and 4, from 1996 to 2005.**

### 3.9.Educational level

For this report level of educational attainment is used as a marker of socio-economic status. Figure 3-20 to Figure 3-22 show weight changes over time for groups of women defined by levels of education. The vertical axis shows weight in kilograms and the horizontal axis shows time. Women in the Younger cohort were grouped by their level of educational attainment by Survey 4 because at earlier surveys, especially Survey 1 a large proportion was still studying full-time or part-time. Mid-aged and Older women were grouped by the level of education they reported at Survey 1, as very few have increased their level of educational attainment since then.

For the Younger cohort at Survey 1 women with no formal qualifications (shown by the open circles) had the highest weight (and also the highest BMI, not shown here), and those with university qualification (open squares), had the lowest weight (and BMI). There were no differences among the other three educational groups (school certificate only, higher school certificate only, trade/apprenticeship/certificate/diploma) who had mean weights between those of the two extreme groups. Over the 10 years between Surveys 1 and 4 mean weight increased by similar amounts for all five groups (i.e. the lines in the figure are approximately parallel) (see Figure 3-20).

The pattern for the Mid-aged women is essentially the same as for the Younger women, except those with university education have gained weight more slowly over the study period so far (see Figure 3-21).

Among the Older women, the predominant pattern is loss of weight over time, especially between Surveys 3 and 4. At Survey 1 differences in weight between the educational groups were similar to those in the Mid-aged women with a clear gradient from those with no formal qualifications (who were heaviest) to those with university level education (least weight). Over time all five groups experienced similar declines in weight (see Figure 3-22).

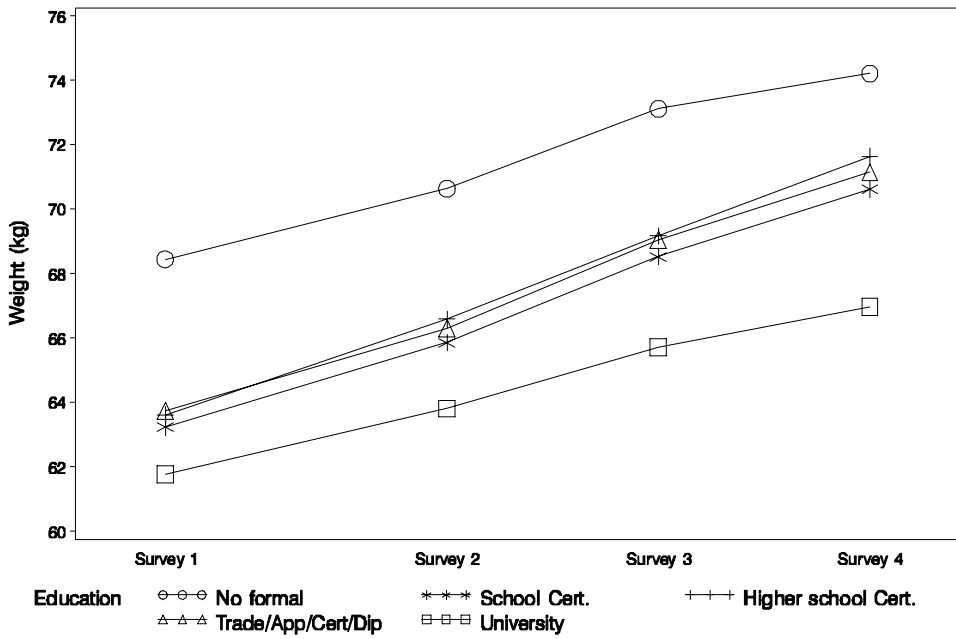


Figure 3-20: Average weight at Surveys 1, 2, 3 and 4 by education status at Survey 4 for the Younger cohort.

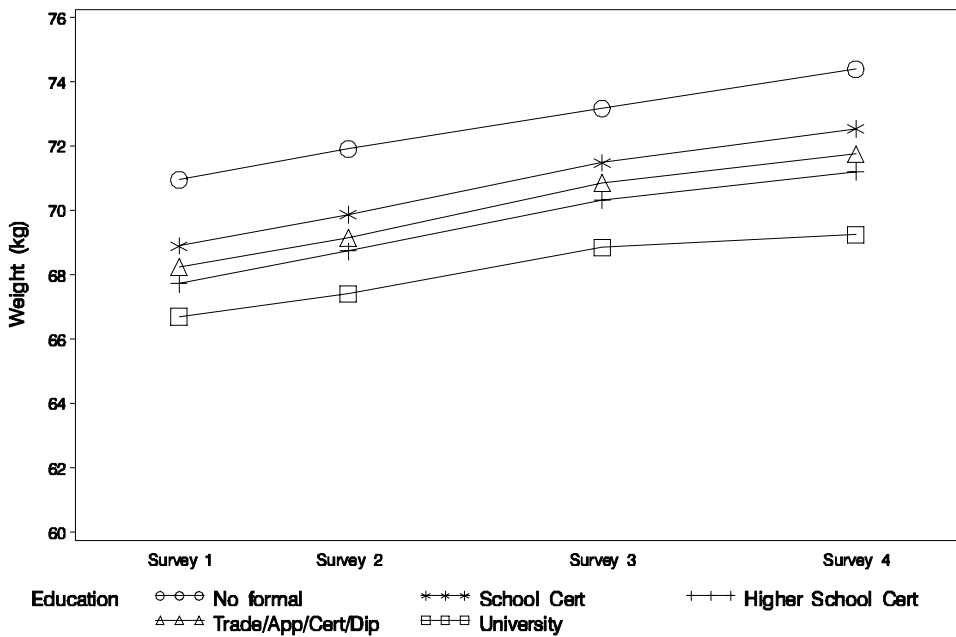


Figure 3-21: Average weight at Surveys 1, 2, 3 and 4 by education status at Survey 1 for the Mid-aged cohort.

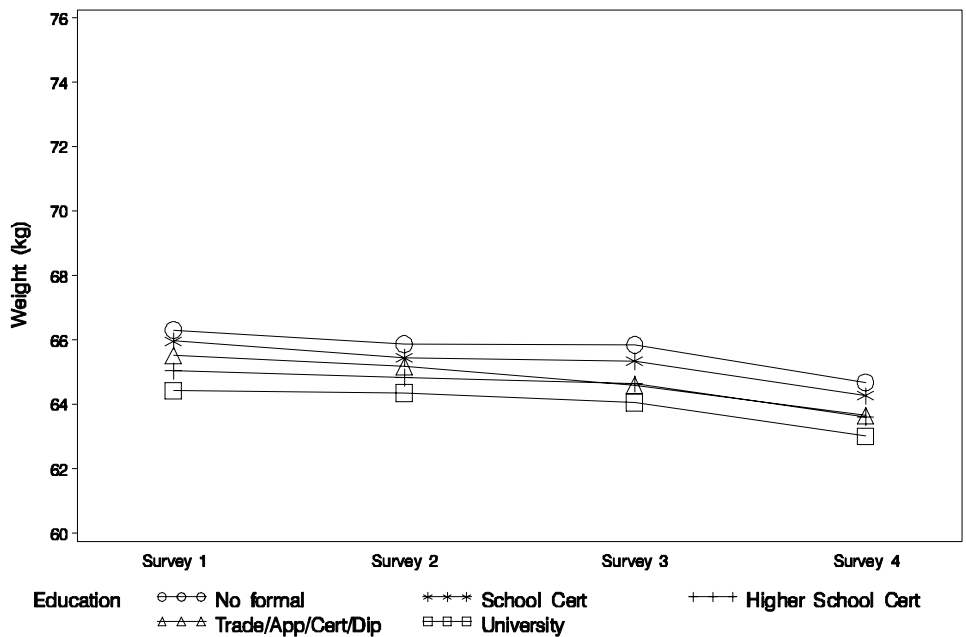


Figure 3-22: Average weight at Surveys 1, 2, 3 and 4 by education status at Survey 1 for the Older cohort.

### 3.10. Discussion

The results in this Section illustrate two important features. Firstly weight and weight gain reflect energy imbalance both in the long-term and over the 3 year periods between surveys. The estimate of 10 kcal (40 kJ) per day as the average excess of energy intake over expenditure provides a basis for considering, at a population level, how the “obesity epidemic” may best be controlled. Increased energy expenditure would involve more time devoted to physical activity to an extent that might prove difficult for many women (Costanza et al, 2007). Reduced energy intake may be more feasible. However for sustained weight loss or weight maintenance a combination of lower energy intake and increased physical activity may be optimal. The importance of time spent sitting as a contributor to energy imbalance is particularly apparent from the ALSWH results shown here.

Secondly of the other factors examined here in relation to weight gain, the most important one is pregnancy in the Younger women. This may warrant specific public health strategies to assist young mothers to regain pre-pregnancy weight.

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## **4. Weight change, health and well-being**

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### **4.1. Key findings**

- Mental health improved over time for the Younger and Mid-aged cohorts and tended to be poorer in those women who were underweight at Survey 1.
- Mental health for the Older cohort was poorest for women who were underweight at Survey 1.
- Best mental health was reported by women in all three cohorts who had a stable weight throughout the study period.
- Weight loss between two surveys resulted in deteriorating mental health for the Mid-aged and Older cohort.
- Women in all three cohorts experienced deteriorating physical health, however, those who were underweight and women with healthy weight started off with better physical health than overweight and obese women.
- Weight loss between two surveys resulted in improving physical health for the Mid-aged cohort.
- Weight gain between two surveys resulted in deteriorating physical health for the Younger cohort.

### **4.2. Introduction**

The ALSWH uses a well-known instrument SF-36 to provide general measures of health and well-being. Thirty-five of these questions are used to construct an 8-scale profile of functional health and well-being scores as well as psychometrically-based physical and mental health summary measures. The 36th item measures health transition (Ware JE, 2000). Higher scores represent better physical or mental health, lower scores represent poorer physical or mental health.

For this report two composite scores, Physical Health Component Score (PCS) and Mental Health Component Score (MCS) were used, each calculated from the 8-scale profiles measuring respectively physical and mental health (see Appendix 3, Section A3.3). The scores are standardised separately for each cohort (Mishra G, Schofield MJ, 1998). This means that the results are not comparable across cohorts so they are shown in different figures which depict trends over time and across groups defined by BMI.

The data are summarised as means and 95% confidence intervals. The scores are sensitive to small differences between groups. This characteristic, together with the large sample sizes, means that differences may be statistically significant (which can be assessed visually if the confidence intervals do not overlap) even if they are too small to be of clinical or public health importance. Typically differences of 3-4 units would be regarded as clinically important.

This sensitivity of PCS and MCS to small differences in physical and mental health makes them suitable for assessing possibly subtle effects of aspects of women's lives that may impact in often non-specific aspects of health. In this report trends in PCS and MCS are reported for women who experience stability or changes in their weight over time, for example those who lost or gained weight during the first ten years of the study compared with those whose weight remain stable.

It is important to emphasise that these data were only for women for whom data about MCS, PCS and BMI were available in all four surveys, so changes in scores over time were not due to less healthy women dropping out of the study.

### **4.3. Physical and mental health by BMI categories for the Younger, Mid-aged and Older cohorts**

For the Younger and Mid-aged women, there is a clear pattern at each survey: underweight women have poorest mental health, followed by the obese women, whereas overweight women and women with healthy weight have the best mental health (Figure A1 and Figure A2). The pattern for the Older cohort at each survey is different; underweight women have poorest mental health followed by women with healthy weight while overweight and obese women scored highest on the mental health scale (Figure A3).

In all three cohorts physical health was better for underweight women and women with healthy weight than for overweight and obese women, with obese women having poorest physical health at each survey. The differences in physical health between women who were of healthy weight, those who were overweight and those who were obese were statistically significant at all surveys except for Survey 1 and were large enough to be clinically important (Figure A4, Figure A5 and Figure A6).

### **4.4. Changes in physical and mental health over time for women grouped according to their BMI at Survey 1.**

Figure 4-1 to Figure 4-6 show changes in mean MCS and PCS over the study period for women grouped according to their BMI at Survey 1. In the Younger cohort (Figure 4-1) mental health improved overall, after a slight drop at Survey 2 and the pattern was similar for all BMI categories. Mental health also improved in the Mid-aged cohort, with lower scores for women who were underweight at Survey 1 (Figure 4-2). Among the Older cohort mental health showed evidence of deterioration, especially at Survey 4, but heavier women remained better mental health than women who were underweight at Survey 1 (Figure 4-3).

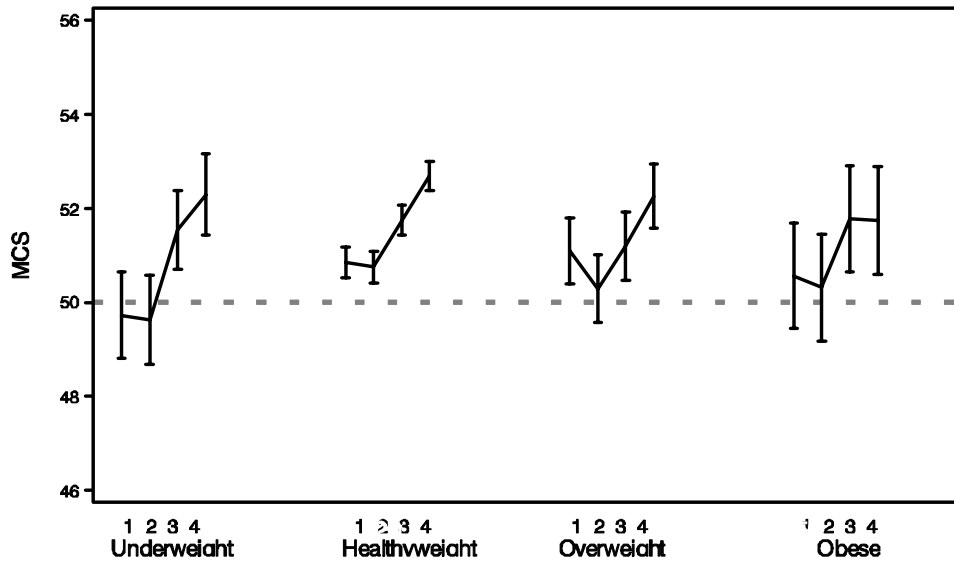


Figure 4-1: Average mental health component scores (MCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Younger cohort.

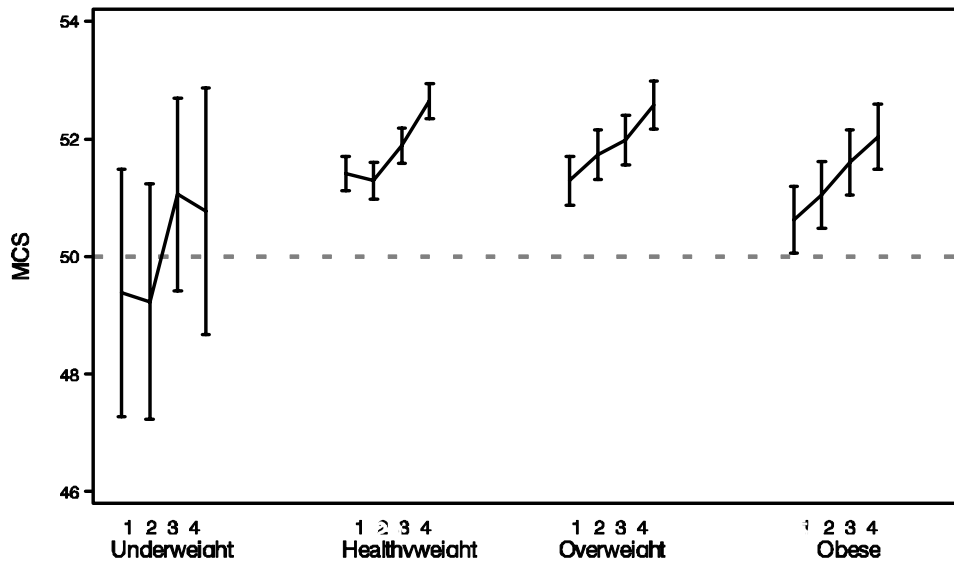
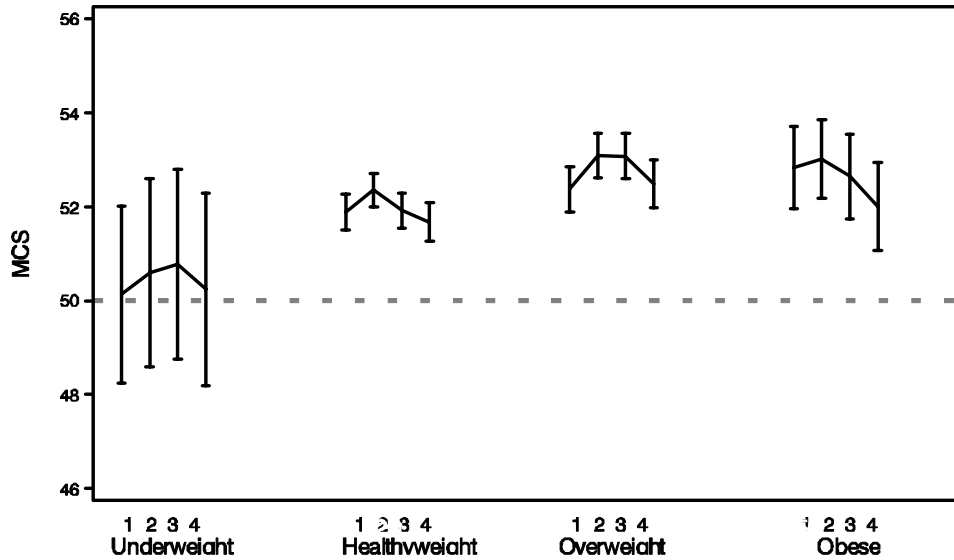
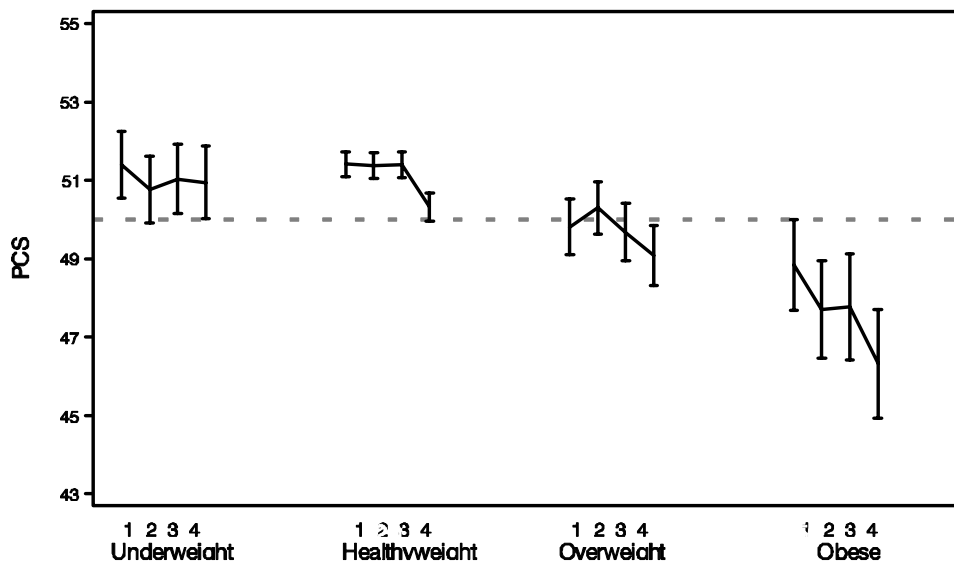


Figure 4-2: Average mental health component scores (MCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Mid-aged cohort.



**Figure 4-3: Average mental health component scores (MCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Older cohort.**

Physical health showed very different results to mental health. In each cohort physical health at Survey 1 is lower in the overweight and obese group than in the healthy group (Mean PCS for the healthy, overweight and obese group in the Younger cohort: 51.4, 49.8, 48.8; the Mid-aged cohort: 52.3, 50.5, 47.3; the Older cohort: 53.7, 51.0, 45.8). Overall, physical health deteriorated in each cohort within each BMI category, except for underweight women in the Younger cohort where physical health remained stable throughout the study period and Younger women with healthy weight whose physical health remained stable for the first three surveys (Figure 4-4 to Figure 4-6).



**Figure 4-4: Average physical health component scores (PCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Younger cohort.**

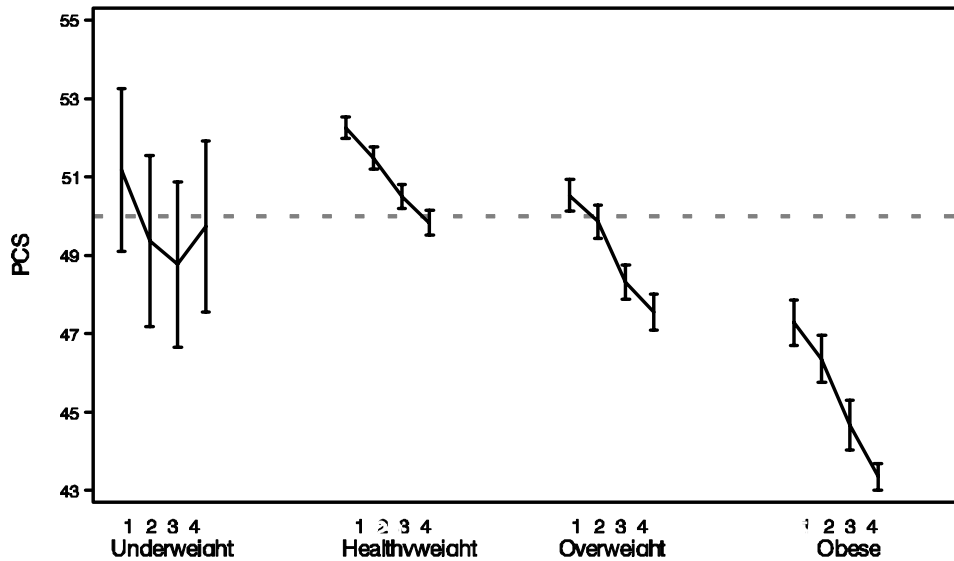


Figure 4-5: Average physical health component scores (PCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Mid-aged cohort.

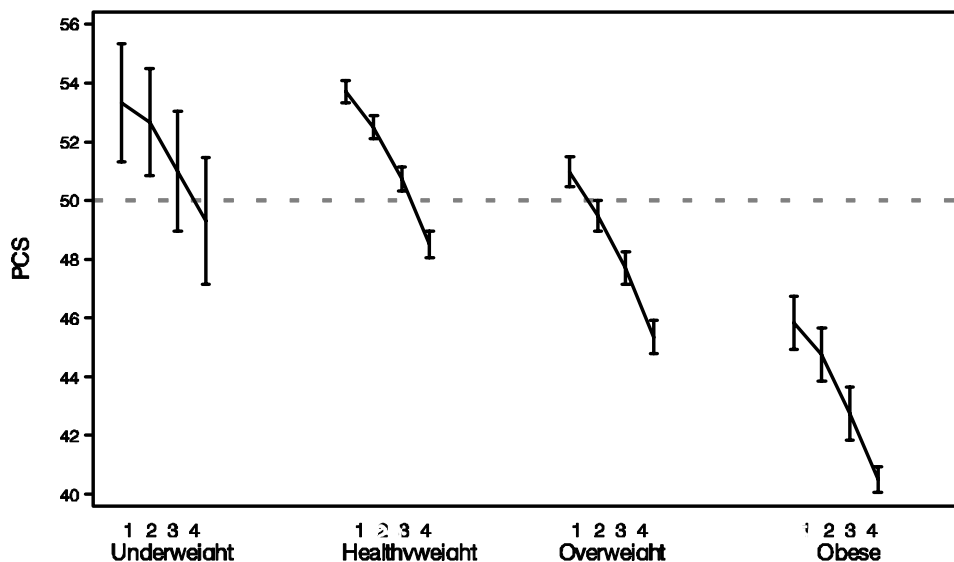


Figure 4-6: Average physical health component scores (PCS) at Surveys 1, 2, 3 and 4 by BMI category at Survey 1 for the Older cohort.

## 4.5. Weight change by physical and mental health for the Younger, Mid-aged and Older cohort

Trends in physical health and mental health were observed among women classified by their weight change over the study period to date. Therefore most common trajectories of weight changes were selected for analysis. Weight change between two surveys was defined as average percent change in weight in kilograms per year, compared to the weight reported at the previous survey. This change was categorised as:

- Stable (S) (gained or lost less than 2.5% per year)

- Gain (G) (gained greater than or equal to 2.5% per year)
- Lost (L) (lost greater than or equal to 2.5% per year).

Mental health among the Younger cohort was best in women who kept their weight stable throughout the study period. The group with poorest mental health were those who gained weight between Surveys 2 and 3 and between Surveys 3 and 4. A trajectory which included losing at a rate of 2.5% per year of body weight in between two surveys was not one of the most common trajectories and was therefore not observed (Figure A7).

A large number of the Mid-aged women had a stable weight throughout the period. As for the Younger cohort, these women reported the best mental health. In contrast women with an unstable weight pattern reported poorer mental health. Those women who lost weight between two surveys experienced a decline in mental health around the time of the weight loss (Figure A8).

For the Older cohort, the best mental health was reported among those who stayed the same weight. Weight gain between two surveys consistently lead to better mental health, in contrast to weight loss which was more likely to result in poorer mental health. Weight loss in Older women is often related to disease, so that the appearance of a disease may have led to the weight loss and poorer mental health (Figure A9).

The results for physical health showed different patterns from those for mental health except for the Younger cohort. Younger women who did not change their weight had the best physical health and those who experienced most weight gain over the period reported the poorest physical health. Additionally a weight gain between two surveys resulted in a deterioration of physical health. Furthermore, women with stable weight did not experience major changes in physical health, in contrast to all the other groups of women who showed deterioration in physical health (Figure A10).

Physical health for the Mid-aged cohort showed opposite pattern to mental health. Women in all groups showed poorer physical health in each subsequent survey (whereas mental health increased). Mid-aged women who lost weight between two surveys improved their physical health around the time of weight loss (Figure A11).

Older women showed the same pattern as the Mid-aged women with a deterioration in physical health in all groups. Older women who had a stable weight throughout the period had better physical health at Survey 1 but experienced similar decline in physical health as women in the other groups (Figure A12).

## **4.6. Weight, weight gain and chronic disease**

Overweight and obesity have long been known to be associated with a number of chronic conditions, including cardiovascular disease, lung disease, and bone and joint conditions. For ALSWH this is illustrated in Figure A13 for the Younger cohort (from WJ Brown et al, 2000, (included in Appendix 1) and in Figure A14 for the Mid-aged cohort (from WJ Brown et al, 1998 (included in Appendix 1). What is less well known is the extent to which a weight change can affect the risk of these chronic conditions. The Australian Longitudinal Study on Women's Health offers the opportunity to investigate the relative importance of weight gained in early life,

including young adulthood, and gradual weight gain throughout middle age and how these factors contribute to risk of chronic disease. So far we have investigated the incidence of diabetes and our early results show that body mass index at Survey 1 was a much stronger predictor of subsequent diagnosis of diabetes than weight change in any of the intervening times (Mishra et al., 2007).

## **4.7. Women's comments**

Although physical health is deteriorating in the Older cohort and weight changes did not seem to influence this deterioration, the following case shows that positive changes in a women's lifestyle can contribute to weight loss even in older age.

### **I began doing water aerobics...I threw my walking stick away**

While the quantitative results highlight the health problems associated with weight gain, this case study offers some observations on the benefits of healthy weight loss. Older participant Meredith had a BMI of 34 at Survey 1, placing her in the obese category. Despite her weight she feels 'healthy for (her) age' and attributes 'aches and pains' to normal ageing:

*I am overweight and would like to weigh three stone less, but have tried over the years without success. I am not a large eater and do not eat anything that is fattening.*

At Survey 2, with a BMI of 32, Meredith continued to feel healthy for her age and commented on her preference for alternative medical practitioners. She believed her good diet, regular flu injection, and vitamin intake resulted in vitality and good health.

By Survey 3 Meredith had started regular physical activity and experienced an improvement in health and wellbeing:

*My health has changed dramatically since April 2001, when I began doing water aerobics three times a week for three hours. After a very short period (three visits) I was able to throw my walking stick away and I haven't used it since. After this I went on a diet and lost 20kg. I was originally 90kg.*

Meredith's BMI was then 26, placing her just inside the overweight category, she commented:

*I am so much more active and I am very healthy. I haven't felt this well for many years.*

By Survey 4 Meredith continued to report good health and wellbeing. Unfortunately she did not report her weight at this survey, so her BMI at this time is unknown. This case study clearly demonstrates the health benefits of a reduction in BMI brought about by increased physical activity and the introduction of a weight reducing diet.

## **4.8. Discussion**

PCS and MCS provide general measures of physical and mental health, not related to specific medical conditions.

A previous publication using data from the Mid-aged cohort examined weight change between the first two surveys (Survey 1 in 1996, Survey 2 in 1998), and assessed the relationship between weight change and physical and mental well-being. Weight gain ( $\geq 2.25$  kg) was found to be negatively associated with physical well-being, whereas both weight loss and weight gain were associated with poorer mental well-being (Williams, Young & Brown, 2006).

Even in the Younger cohort there were large differences between mental and physical health for obese women compared to women with healthy weight. Subscales of the SF-36 instrument have been used previously to examine the relationships between body mass index and well-being in young Australian women. Mean scores for physical functioning, general health and vitality were highest for women with BMI in the range 18.5 – 25. Additionally, women in the highest BMI category ( $>30$ ) were more likely to report hypertension, asthma, headaches, backpain, sleeping difficulties, irregular periods, and more visits to their medical practitioner (Brown, Mishra, Kenardy & Dobson, 2000). On the other hand, underweight women reported irregular periods and low iron. These findings illustrate the adverse effects of overweight that can be seen at a comparatively young age.

Further research on well-being and weight change was conducted using data from the Younger cohort, looking at weight change and changes in life satisfaction and aspirations between Survey 1 (1996) and Survey 2 (2000) (Ball, Crawford & Kenardy, 2004). Obese women reported more dissatisfaction with work/career/study, family relationships, partner relationships, and social activities. The results show that being overweight or obese early in life can have lasting effects on a women's life satisfaction and their future life aspirations.

## **4.9. References**

Ball K, Crawford D & Kenardy J. Longitudinal relationships among overweight, life satisfaction and aspirations in young women. *Obesity Research*, 2004; 12(6): 1019-1030.

Brown WJ, Dobson AJ, Mishra G. What is a healthy weight for middle aged women? *International Journal of Obesity* 1998, 22. 520-528.

Brown WJ, Mishra G, Kenardy J & Dobson AJ. Relationships between body mass index and well-being in young Australian women. *International Journal of Obesity*, 2000; 24(10): 1360-1368.

Mishra G, Carrigan G, Brown W, Barnett A, & Dobson A. Short-term weight change and the incidence of diabetes in midlife: results from the Australian Longitudinal Study on Women's Health. *Diabetes Care*, In Press.

Williams L, Young A & Brown W. Weight gained in two years by a population of Mid-aged women: How much is too much? *International Journal of Obesity*, 2006; 30: 1229-1233.



## 5. Weight, physical activity and health care usage

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### 5.1. Key findings

**Total charges** - the aggregate total cost in dollars incurred by each participant

- Among the Younger women total charges increased in all BMI categories, but there was no difference in total charges according to BMI category.
- Total charges increased at each survey in Mid-aged women in the healthy, overweight and obese groups, and women in the obese group had higher total charges at each survey compared with women in the healthy weight group. In 2004, the mean annual cost for obese Mid-aged women was \$760 [\$710, \$810], whereas the mean cost for women in the healthy weight BMI range was \$636 [\$610, \$662].
- Younger women in the 'none' physical activity group had significantly higher total charges than in all other groups at Survey 2. In 2003, the mean annual cost for Younger women in the 'none' physical activity group was \$621 [\$524, \$718]. This compares with a mean cost of \$417 [\$387, \$446] per woman in the 'high' physical activity group.
- Total charges for the Mid-aged cohort were higher at all surveys for women in the 'none' physical activity group compared to women in the 'high' physical activity group. In 2004, the mean cost for Mid-aged women in the 'none' physical activity group was \$818 [\$752, \$885].

### GP visits

- In the Younger and Mid-aged cohorts, obese women had more GP visits than women in the healthy and overweight group.
- Number of GP visits tended to be lower for Mid-aged women who maintained stable weight between all surveys than for women who experienced weight change.
- There was a trend for Younger women in the 'none' physical activity group to have more GP visits than women in the 'high' physical activity group.
- Mid-aged women in the 'none' physical activity group had significantly more GP visits at all surveys compared to all other physical activity groups.

### Number of Medicare claims

- Total number of Medicare claims increased over time but did not differ according to BMI categories for the Younger cohort.

- In the Mid-aged cohort, total number of Medicare claims increased over time in the healthy, overweight and obese BMI categories and was highest for women in the obese group, compared to women in the healthy and overweight group. Mid-aged women in the obese group, had a mean of 19.4 [18.2, 20.6] Medicare claims for 2004, compared with 14.4 [14.0, 15.0] for women in the healthy weight group.
- Mid-aged women in the ‘low’ physical activity group made more Medicare claims if they were obese compared to women with healthy weight. Women in the ‘low’ physical activity group who were also obese had a mean of 17.8. [16.3, 19.3] Medicare claims for 2004, whereas women in the ‘low’ physical activity group who were of healthy weight had a mean of 13.8 [12.8, 14.9] Medicare claims for that year.
- There was a trend for Younger women in the ‘none’ physical activity group to have more total Medicare claims than women in the ‘high’ physical activity group.
- Mid-aged women in the ‘none’ physical activity group had more total Medicare claims at all surveys compared to all other physical activity groups.

## 5.2. Introduction

### 5.2.1. Health care usage and BMI

In the following section we compare health care usage according to women’s weight (BMI) and change in weight. Health care usage was assessed from Medicare data for consenting women. For the Mid-aged cohort Medicare data were available for 1998, 2001 and 2004 corresponding to Surveys 2, 3 and 4. For the Young cohort, data were available for 2000 and 2003 corresponding to Surveys 2 and 3. From these data, we calculated:

**Total Charge** - the aggregate total cost in dollars incurred by each participant expressed as the mean and 95% confidence interval (95%CI);

**Total Claims** - the aggregate number of Medicare claims for each participant (mean and 95% CI);

**GP visits** - the aggregate number of GP visits (claims) for each participant (mean and 95% CI).

### 5.2.2. Total charges and BMI

Total health care charges for Survey 2, Survey 3 and Survey 4 for women in each BMI category (as reported at Survey 1) are shown in Figure 5-1 and Figure 5-2. For the Younger women there were no differences in total charges according to BMI category, but charges were higher at Survey 3 compared with Survey 2. Among Mid-aged women, charges increased at each survey for women in the healthy, overweight and obese groups. Women in the obese BMI category had higher total charges at each

survey compared with women in the healthy weight group and higher charges at Survey 4 compared with the overweight women (Mean total charges in 2004 for obese women: \$760 [\$710, \$810]; and women with healthy weight: \$636 [\$610, \$662]). Total charges for women in the underweight group were also higher than for the healthy weight group, but these estimates are imprecise (with wide confidence intervals).

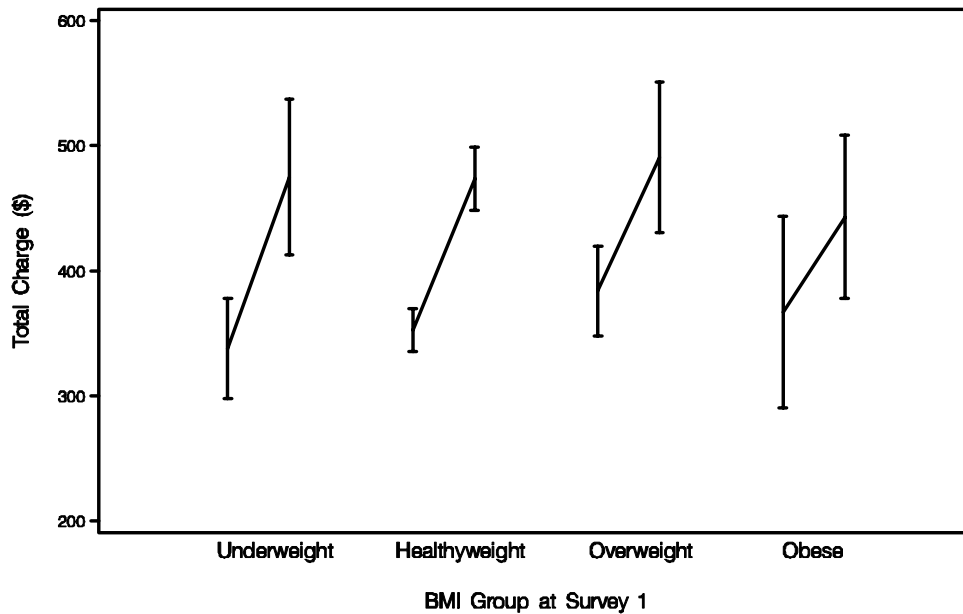


Figure 5-1: Total Charges at Surveys 2 and 3 by BMI category at Survey 1 for Younger women.

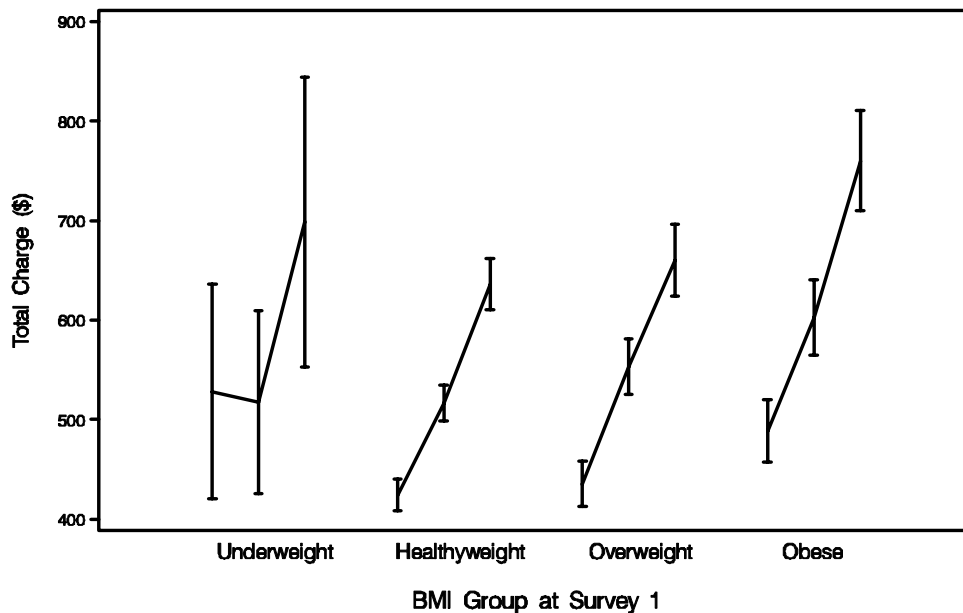


Figure 5-2: Total Charges at Surveys 2, 3 and 4 by BMI category at Survey 1 for the Mid-aged cohort.

### 5.2.3. Number of GP visits by BMI

The numbers of GP visits according to BMI category are shown in Figure 5-3 and Figure 5-4. Younger women in the obese group had more GP visits at both surveys

(around 5 visits for the year) than did women in the healthy weight group (around 3.9 visits for 2003). Mid-aged women in the obese category had more visits than women in the healthy weight and overweight groups at all surveys. However, within each BMI category, there was not a consistent trend for more visits at each survey. Women in the healthy weight and overweight groups made slightly more visits at Survey 3 than at Survey 2 (an increase of around 0.5 visits), but there was no significant increase in visits at Survey 4.

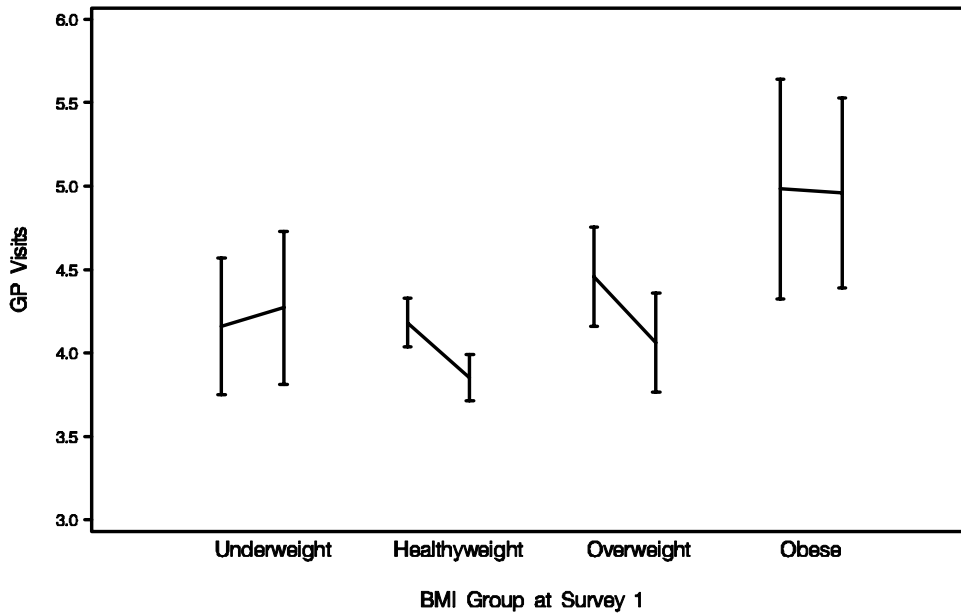


Figure 5-3: Number of GP visits at Surveys 2 and 3 by BMI at Survey 1 for the Younger cohort.

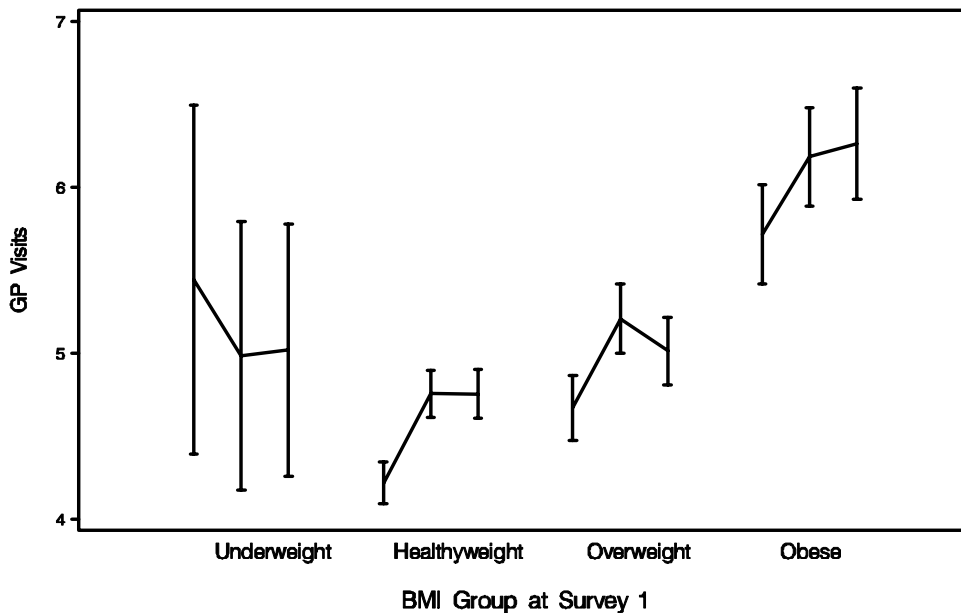


Figure 5-4: Number of GP visits at Surveys 2, 3 and 4 by BMI at Survey 1 for the Mid-aged cohort.

## 5.2.4. Total Medicare claims by BMI category

For Younger women, total number of Medicare claims did not differ according to BMI category (Figure 5-5). For Mid-aged women, the total number of Medicare claims was highest at each survey for women in the obese group compared with claims for women in the healthy weight and overweight groups. There was a steep increase in Medicare claims for women in the obese group at Survey 4 (Figure 5-6). Mid-aged women in the obese group, had a mean of 19.4 [18.2, 20.6] Medicare claims for 2004. This compares with 14.5 [14.0, 15.0] for women in the healthy weight group.

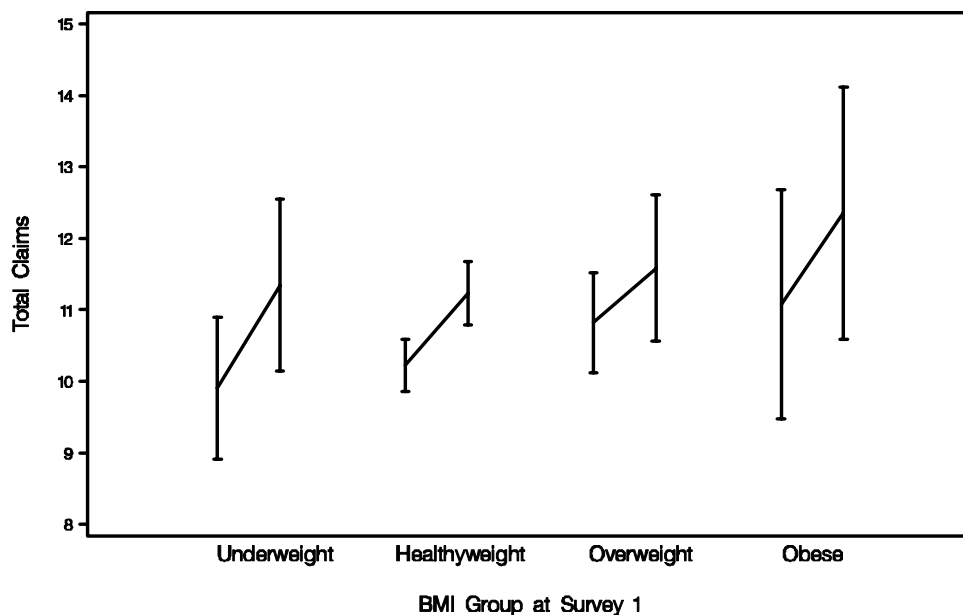


Figure 5-5: Total Medicare claims by at Surveys 2 and 3 BMI at Survey 1 for the Younger cohort.

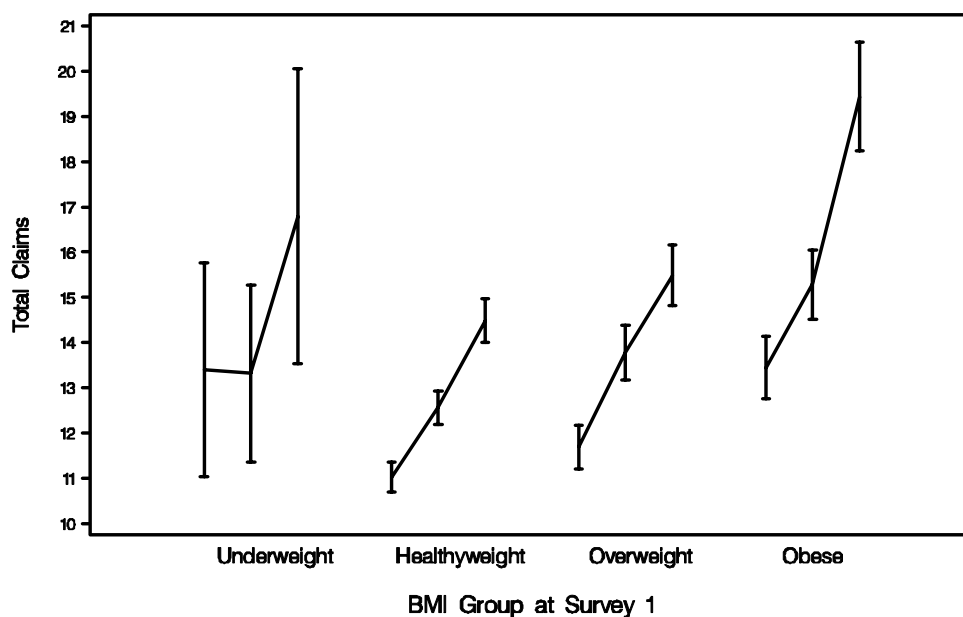


Figure 5-6: Total Medicare claims at Surveys 2, 3 and 4 by BMI at Survey 1 for the Mid-aged cohort.

### **5.2.5. Health care costs and weight change**

The previous results were based on BMI category reported at Survey 1. However, many women's weight changed between surveys and so their patterns of health care use may reflect their new weight or the change in weight. To address this possibility, we also looked at health care costs according to patterns of weight change. Weight change between surveys was measured as average percent change in weight in kilograms per year, compared to the weight reported at the previous survey. This change was categorised as:

- Stable (S) (gained or lost less than 2.5% per year)
- Gain (G) (gained greater than or equal to 2.5% per year)
- Lost (L) (lost greater than or equal to 2.5% per year).

Over the course of four surveys women had various trajectories or patterns of weight gain or loss. For example, a woman who gained weight between Survey 1 and Survey 2, maintained a stable weight between Survey 2 and Survey 3, and who gained more weight between Survey 3 and Survey 4 would be designated "GSG". Health care costs associated with the major patterns of change were examined (patterns that included fewer than 200 women were not used for this analysis).

### **5.2.6. Total charges, total Medicare claims and weight change**

Among Younger women, total charges tended to increase for all weight change groups, but there were few differences between groups on total charges, or total Medicare claims (Figure A15 and Figure A16). Mid-aged women in the stable weight group had lower charges (at Survey 2 and Survey 3) and fewer Medicare claims (at all Surveys) than women in the SGS group. These women also had lower charges and fewer Medicare claims than the LGS group (at Survey 2 and Survey 4) (Figure 5-7 and Figure 5-8).

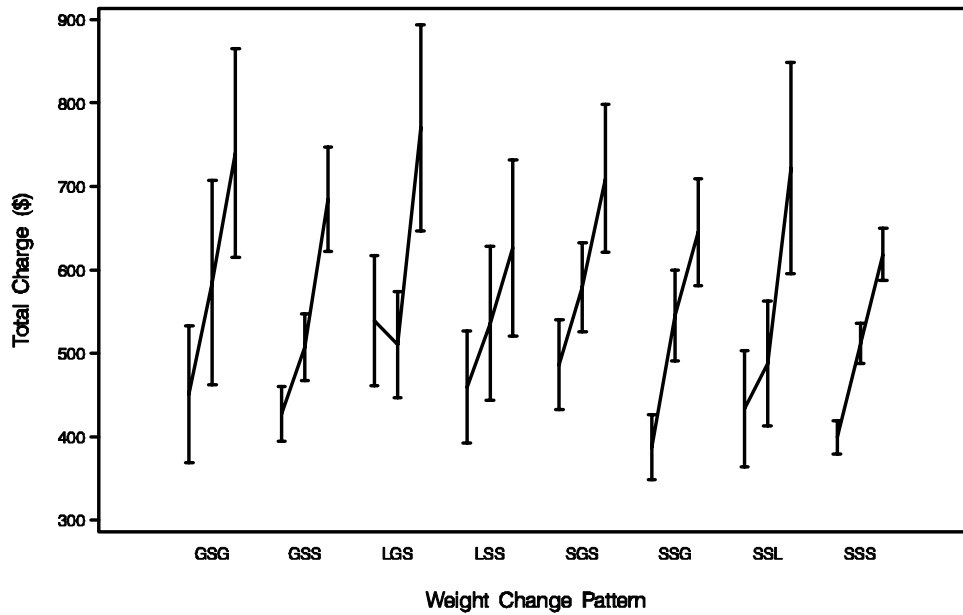


Figure 5-7: Total charges at Surveys 2, 3 and 4 by weight change trajectory for the Mid-aged cohort: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

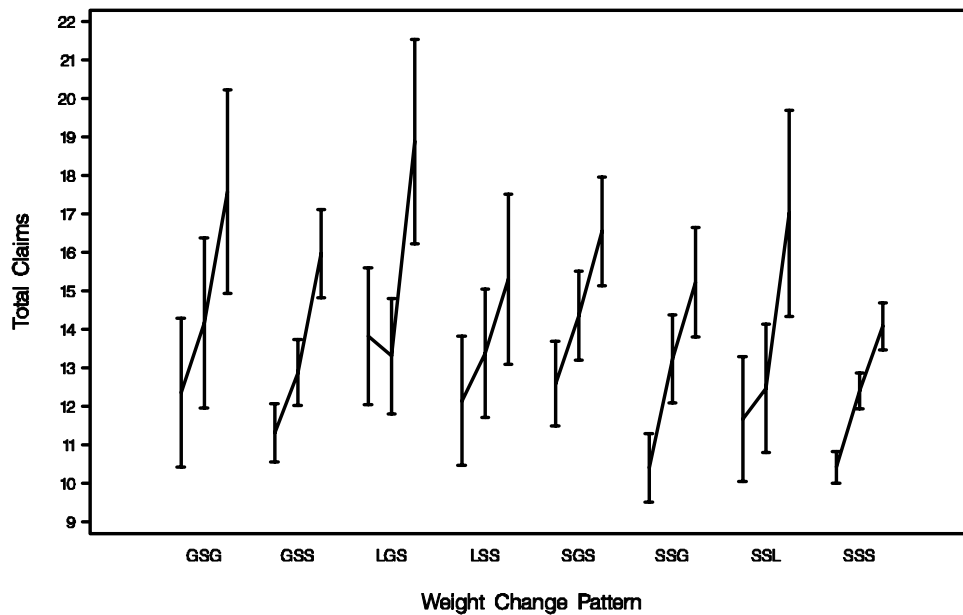
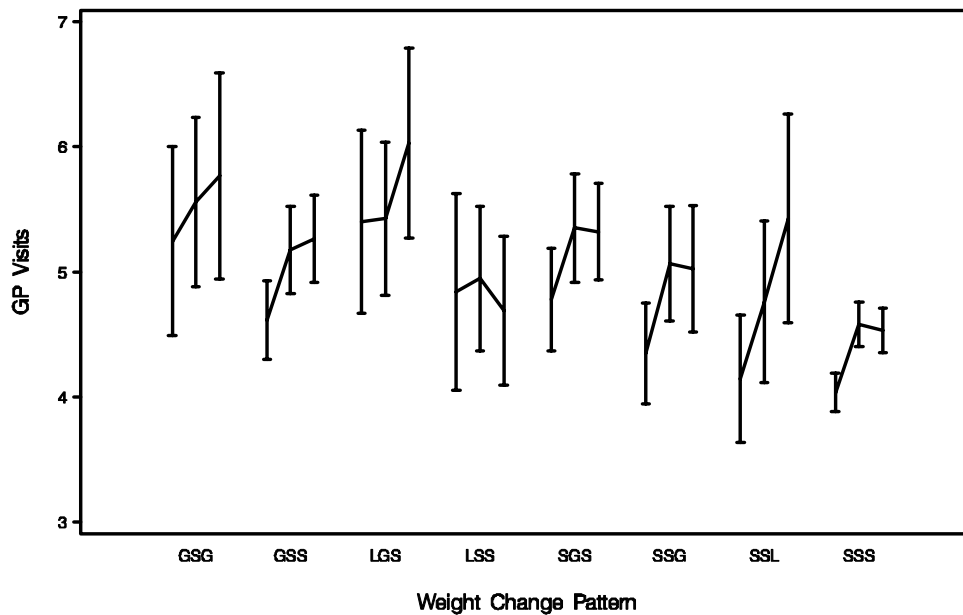


Figure 5-8: Total Medicare claims at Surveys 2, 3 and 4 by weight change trajectory for the Mid-aged cohort: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

### 5.3. Number of GP visits and weight change

Among Younger women, there were no significant differences in the number of GP visits according to weight change groups (Figure A17). Mid-aged women who maintained stable weight between all surveys also tended to have a lower number of GP visits when compared with GSG, GSS, LGS, and SGS groups (on all Surveys). The number of visits for these women increased from Survey 2 to Survey 3 but then remained stable, at around 4.5 visits per year [4.4, 4.7]. Trends in GP visits for the other weight change groups are hard to interpret due to the large confidence intervals.



**Figure 5-9: Number of GP visits at Surveys 2, 3 and 4 by weight change trajectory for the Mid-aged cohort: S=no weight change G=weight gain L=weight loss between two consecutive surveys.**

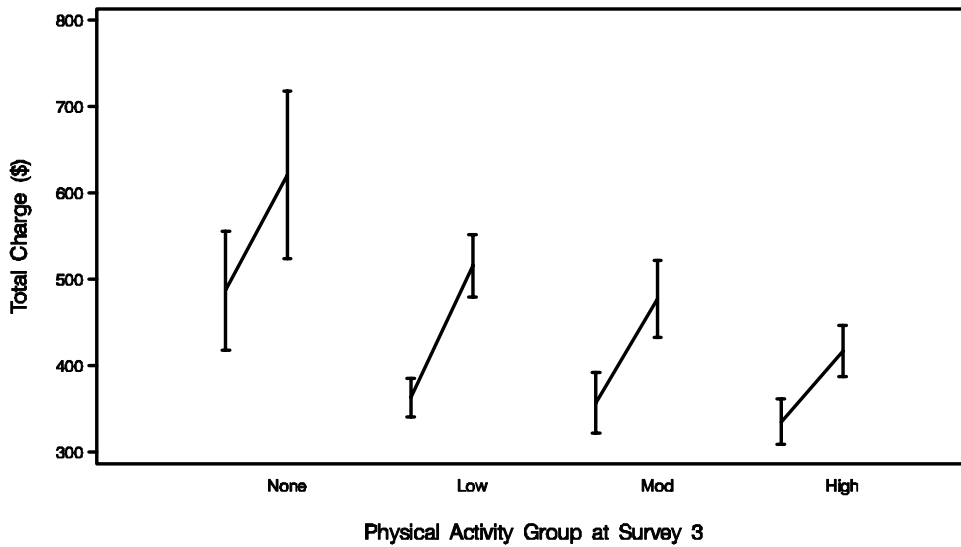
## 5.4. Health care usage and physical activity

Physical activity was classified at each survey into four groups: ‘none’, ‘low’, ‘moderate’, and ‘high’ physical activity (see Appendix 3, Section A3.4 for more details).

### 5.4.1. Total charges, total claims and physical activity

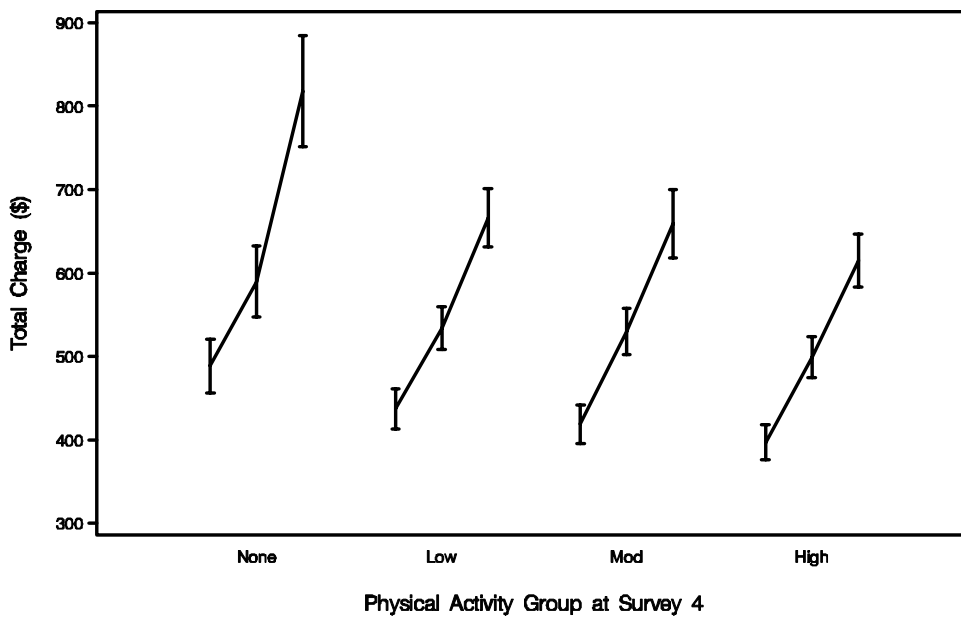
Among Younger women, there was a trend towards lower charges for those with higher levels of physical activity, however the confidence intervals are wide and the differences between the ‘low’, ‘moderate’ and ‘high’ physical activity groups are not significant. The main difference is between the ‘none’ group (at Survey 2) and particularly between this group and the ‘high’ physical activity group (at Survey 3). Total charges were higher in the ‘none’ group than in all other groups at Survey 2, and higher than the ‘moderate’ and ‘high’ physical activity groups at Survey 3. In 2003, mean charges for the ‘none’ group were \$621 [\$524, \$718] which is around \$200 higher than the total charges for the ‘high’ physical activity group (\$417 for the year [\$387, \$446]). The ‘low’ physical activity group had an intermediate value of \$516 [\$479, \$552] (Figure 5-10). A similar pattern was seen for total Medicare claims (Figure A18). Separate analyses were undertaken to explore the interaction between BMI and physical activity. While the confidence intervals overlap, women with lower levels of physical activity tended to have more total Medicare claims, regardless of their BMI category (Figure A19 to Figure A22).





**Figure 5-10: Total Charges at Surveys 2 and 3 according to physical activity group at Survey 3 for the Younger cohort.**

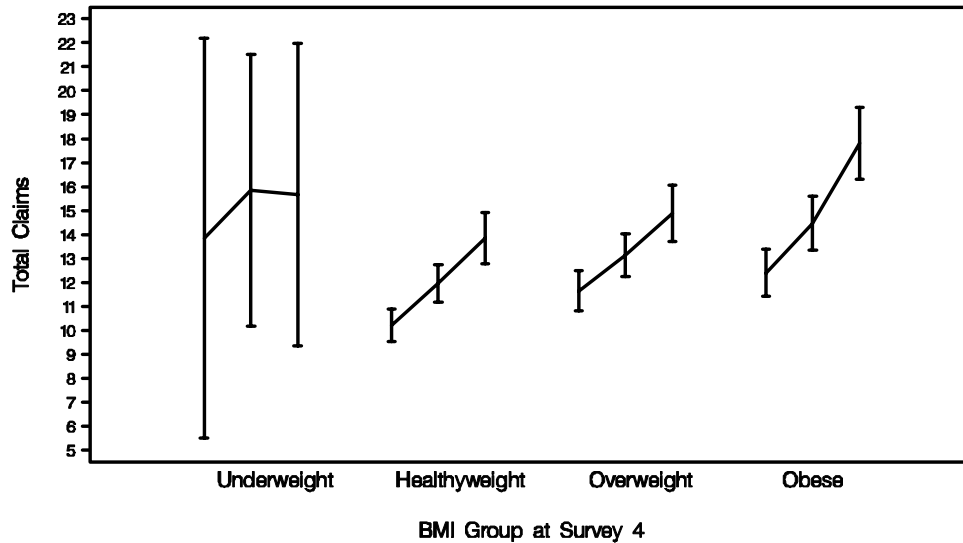
Total charges for Mid-aged women were higher at all surveys for women in the ‘none’ physical activity group compared with women in the ‘high’ physical activity group. Women in this group also had a greater increase in charges by Survey 4, and at this time the charges for women in this category were higher than the charges for women in any other physical activity group (at around \$818 [\$752, \$885] for the year) and were almost \$200 higher on average than the charges for women in the ‘high’ physical activity group. Charges did not differ between ‘low’, ‘moderate’ and ‘high’ physical activity groups, although they did increase at each survey for all groups (Figure 5-11). Total Medicare claims followed a similar pattern (Figure A23).



**Figure 5-11: Total Charges at Surveys 2, 3 and 4 according to physical activity group at Survey 4 for the Mid-aged cohort.**

Among Mid-aged women in the ‘none’ physical activity group, there was no difference in total claims according to BMI category (Figure A23). Women in the ‘low’ physical activity group, made more claims if they were in the obese BMI category compared to women with healthy weight (Figure 5-12). Women in the ‘low’ physical activity group who were also obese had a mean of 17.8 [16.3, 19.3] claims for 2004, whereas women in the ‘low’ physical activity group who were of healthy weight had a mean of 13.8 [12.8, 14.9] claims for that year.

There were no differences between BMI categories in the other physical activity groups.



**Figure 5-12: Total Medicare claims at Surveys 2, 3 and 4 in the ‘low’ physical activity group by BMI category at Survey 3 for the Mid-aged cohort.**

### 5.4.2. Number of GP visits and physical activity

There was a trend for Younger women in the ‘none’ physical activity group to have more GP visits than women in the ‘higher’ physical activity group (Figure 5-13). However, the confidence intervals overlap and so the differences between groups were not significant except at Survey 2 when the ‘none’ group had more GP visits than the ‘moderate’ and ‘high’ physical activity groups.

Mid-aged women in the ‘none’ physical activity group had significantly higher numbers of GP visits at all surveys compared to all other physical activity groups (Figure 5-14). Women in this group had a mean of 6.4 [6.0, 6.8] visits in 2004.

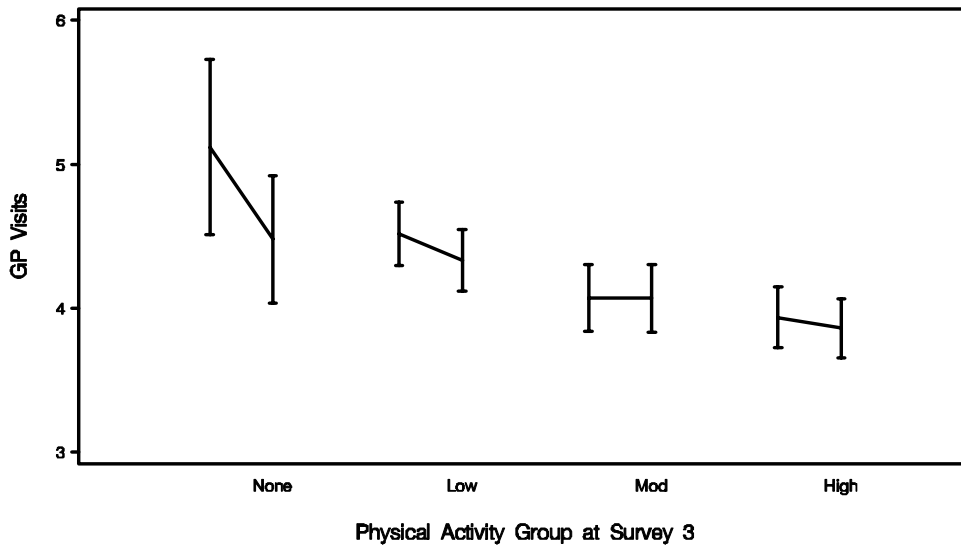


Figure 5-13: Number of GP visits at Surveys 2 and 3 according to physical activity group at Survey 3 for the Younger cohort.

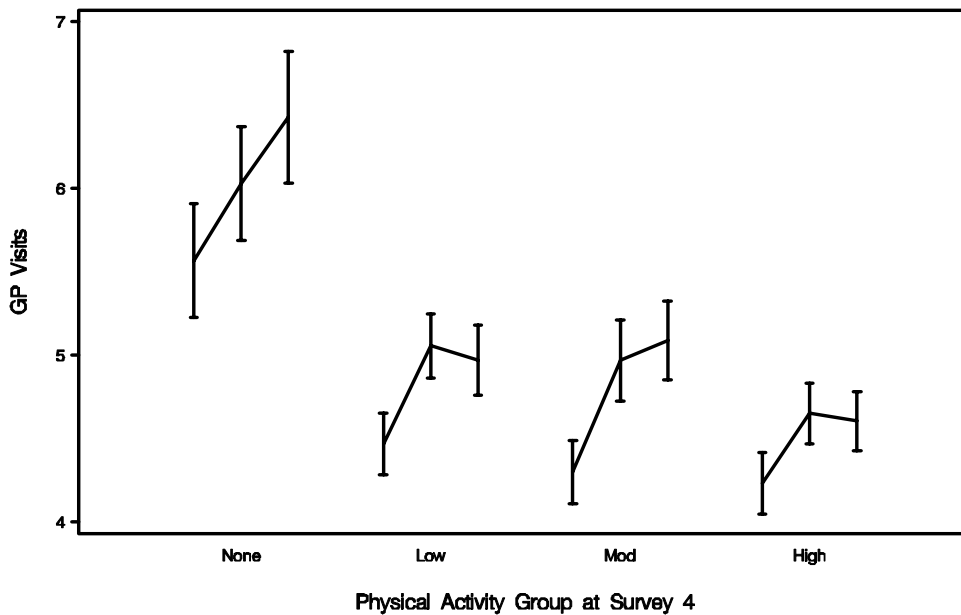


Figure 5-14: Number of GP visits at Surveys 2, 3 and 4 according to physical activity group at Survey 4 for the Mid-aged cohort.

## 5.5. Case study

The quantitative data indicate that overweight and obesity are related to increased use of health services, and by extrapolation to the costs associated with health service use. Mid-aged participant Jenni commented on these issues. At Survey 1, Jenni had a BMI of 36 and commented that she would like to lose and maintain a lower weight for health reasons. Jenni wrote that a holistic approach to weight loss would be advantageous:

*I do not feel that the medical profession treats this (weight loss) as a serious problem with needs for many areas of assistance, eg, psychological, dietician, physical trainer. This problem needs to be helped by a combined treatment as the ad hoc manner now employed leaves the patient floundering.*

By Survey 2 Jenni had experienced some stressful life events and was 'on a slow weight loss diet' as a result of 'having high cholesterol and mild diabetes.' Perhaps as a result of the diet, her BMI fell to 35 at this time. At Survey 3, with a BMI still at 35, Jenni had stopped most physical activities as a result of a 'severe joint inflammation.'

Jenni's health problems at Survey 4 caused both physical and social health problems. Despite these difficulties, her BMI had fallen to 32. However, this still places her in the obese category. The costs of medication, tests, and medical appointments were impacting the family finances:

*Continuing bad health leads to excessive costs for medication, tests and medical appointments which takes almost all my small pension and means my husband cannot retire due to having to pay normal household bills without my income.*

Jenni had 'severe arthritis' which meant she could no longer undertake physical activities, which in turn made 'managing weight a problem and a worry.'

This case study highlights a number of important issues: a lack of integration between allied, complimentary and medical services can lead to frustration and confusion; an increasing need for services can adversely impact financial and retirement planning; in turn, a lack of money can limit service access; which in turn can lead to difficulty in seeking help with weight loss. Furthermore, unresolved health issues can impede weight loss. The inter-related nature of these issues points to the complexity that surrounds achieving weight loss for some women.

## **5.6. Discussion**

There are clear associations between weight and health care usage. Among Younger women, these associations are less strong than among the other cohorts, and there is no difference in total charges according to BMI group. Younger women in the obese group did make more Medicare claims for GP visits than did Younger women in the healthy weight group. Among Mid-aged women, women in the obese group had higher total charges, higher total claims, and more GP visits at each survey when compared to women in the healthy weight range. Women in the obese group also had more claims and more GP visits than women in the overweight group at all surveys, and had higher total charges than overweight women at Survey 4. In 2004, total charges for women in the obese group were around \$130 higher per woman (on average) than charges for women in the overweight group. Mid-aged women who maintained a stable weight across all surveys tended to have lower charges, fewer GP visits and fewer total Medicare claims.

These findings are consistent with earlier analyses that have identified a clear association between diabetes and health care costs. Young et al. analysed survey data 1996-1999 for the Mid-aged women (1.9% with diabetes) and the Older women (8.1% with diabetes). The survey data were linked with Medicare claims data to

identify the number of general practice and specialist visits and use of glycosylated haemoglobin (HbA1c), lipids and microalbuminuria tests. Women with diabetes were more likely to have hypertension, heart disease and eyesight problems, have high rates of polypharmacy (four or more medications: Mid-aged 32%, Older 64%) and more consultations with general practitioners and specialists than women without diabetes. Having more frequent consultations with a general practitioner was significantly associated with having tests that are recommended for routine monitoring of diabetes. Thus, while there was an increasing use of services by women with diabetes, in part this was due to an increase in compliance with guidelines for the management of diabetes.

## **5.7. References**

Young A, Lowe J, Byles J & Patterson A. Trends in health service use for women in Australia with diabetes. *Australian and New Zealand Journal of Public Health*, 2005; 29: 422-428.

## 6. Appendices

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<b>APPENDIX 1:</b>	<b>PAPERS</b> .....	<b>63</b>
<b>APPENDIX 2:</b>	<b>THE AUSTRALIAN LONGITUDINAL STUDY ON WOMEN'S HEALTH..</b> .....	<b>64</b>
A 2.1:	PARTICIPATION AND RETENTION .....	65
A 2.2:	CASE STUDIES .....	70
<b>APPENDIX 3:</b>	<b>ABBREVIATIONS AND DEFINITIONS</b> .....	<b>71</b>
A 3.1:	AREA OF RESIDENCE (RRMA).....	71
A 3.2:	BODY MASS INDEX (BMI) .....	71
A 3.3:	MENTAL HEALTH COMPONENT SCORE (MCS) AND PHYSICAL HEALTH COMPONENT SCORE (PCS).....	71
A 3.4:	PHYSICAL ACTIVITY .....	72
A 3.5:	REFERENCES.....	72
<b>APPENDIX 4:</b>	<b>TABLES</b> .....	<b>74</b>
<b>APPENDIX 5:</b>	<b>GRAPHS</b> .....	<b>77</b>

## **Appendix 1: Papers**

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A collection of published and unpublished papers on findings on women's weight can be found in the supplementary document.

## Appendix 2: The Australian Longitudinal Study on Women's Health

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The Australian Longitudinal Study on Women's Health (ALSWH) – widely known as Women's Health Australia - is a longitudinal population-based survey, funded by the Australian Government Department of Health and Ageing. The Project began in 1996 and examines the health of over 40,000 Australian women (Brown et al., 1998).

The ALSWH involves three large, nationally representative, cohorts of Australian women representing three generations:

- The Younger women, aged 18-23 when first recruited in 1996 (n=14247), are in their late 20s – early 30s, the peak years for relationship formation, childbearing, and establishing adult health habits (e.g. physical activity, diet) and paid and unpaid work patterns.
- The Mid-aged women, initially aged 45-50 (n=13716), are experiencing menopause, as well as changes in household structure, family care giving, and impending retirement, which are common at this life stage. Some are showing early signs of age-related physical decline, while some are adopting new health behaviours in preparation for a healthy old age.
- The Older women, aged 70-75 when first recruited (n=12432), are in their 80s and facing the physical, emotional and social challenges of old age.

Features of the Study design include:

- Women were randomly selected from the Medicare Australia database and invited to participate in the longitudinal Study.
- Women in rural and remote areas of Australia were intentionally over-sampled to ensure adequate numbers for statistical analysis.
- After Survey 1 in 1996, the three age cohorts have been surveyed sequentially, one cohort per year, on a rolling basis starting in 1998.

The Study was designed to explore factors that influence health among women who are broadly representative of the entire Australian population. The Study assesses:

- Physical and emotional health (including well-being, major diagnoses, symptoms)
- Use of health services (GP, specialist and other visits, access, satisfaction)
- Health behaviours and risk factors (diet, exercise, smoking, alcohol, other drugs)
- Time use (including paid and unpaid work, family roles, and leisure)



- Socio-demographic factors (location, education, employment, family composition)
- Life stages and key events (such as childbirth, divorce, widowhood).

The Project provides a valuable opportunity to examine associations over time between aspects of women's lives and their physical and emotional health. It provides an evidence base to the Australian Government Department of Health and Ageing – as well as other Australian and State/Territory Departments – for the development and evaluation of policy and practice in many areas of service delivery that affect women. An overview of the Study and investigators, copies of the questionnaires, and abstracts of publications and presentations can be located on the study's website [www.alswh.org.au](http://www.alswh.org.au)

## A 2.1: Participation and retention

Participation response rates to Survey 1 (1996) cannot be exactly specified as some women selected for the sample may not have received the invitation. For example, deaths or changes of address may not have been notified to the Health Insurance Commission (now Medicare Australia). It is estimated that 41-42% of the Younger women, 53-56% of the Mid-aged women and 37-40% of the Older women agreed to participate in the longitudinal Study. Comparison with the 1996 Census showed that the respondents were broadly representative of the general population of women of the same age, with some over-representation of women with tertiary education and under-representation of immigrant women of non-English speaking background.

The Project has been able to retain a very high proportion of the original participants, particularly among the Mid-aged and Older women.

**Table A1: Participation and retention of Younger women.**

	Survey 1	Survey 2	Survey 3	Survey 4
Age in years	18-23	22-27	25-30	28-33
Eligible at previous survey		14247	14116	13886
Ineligible				
deceased between surveys		22	10	15
frailty (e.g. dementia, stroke)		3	6	4
withdrawn before mailout survey date		106	214	311
<i>Total ineligible</i>		<i>131</i>	<i>230</i>	<i>330</i>
Eligible at current survey		14116	13886	13556
Non-respondents				
withdrawn from the study		124	200	157
contacted but did not return		1332	653	1390
unable to contact participant		2972	3952	3029
<i>Total non-respondents</i>		<i>4428</i>	<i>4805</i>	<i>4576</i>
Respondents				
completed survey	14247	9688	9081	8980
Retention rate as % eligible		68.6%	65.4%	66.2%

Among the Younger women, 69% responded to Survey 2 in 2000, 65% to Survey 3 in 2003 and 66% have responded to Survey 4 in 2006 (Table A1). This retention compares well with other surveys of this highly mobile age group. The major reason for non-response among the Younger women was that the research team was unable

to contact the women (21% of eligible women at Survey 2, 28% at Survey 3 and 22% at Survey 4), despite using all possible methods of maintaining contact (Lee et al., 2000; Lee et al., 2005). Younger women in their twenties are characterised by high levels of mobility, change of surnames on marriage, often not having telephone listings and not being registered to vote, and making extended trips outside Australia for work, education or recreation.

Demographic characteristics (country of birth, marital status, education, employment and living arrangements) of the Younger respondents at Survey 1 (1996) and Survey 2 (2000) were compared with those of women of the same age in the Australian population, using data from the 1996 and 2001 Censuses respectively. The comparisons revealed few differences; however, there was some under-representation of women from non-English language countries at both surveys. The disparity in education increased between 1996 and 2001. Whereas at the 1996 Census almost 70% of women in the Younger cohort had no post school qualifications (ALSWH and the general population), 31% and 49% had no post school qualifications in the ALSWH sample and the 2001 Census respectively. Some of these differences will be due to overseas graduates returning home and Australian graduates working overseas. ALSWH women were less likely to be employed compared with women of the same age in the 1996 Census (52% versus 60%). When many were still students, they were more likely to be employed than women of the same age in the 2001 Census (85% versus 67%).

**Table A2: Participation and retention of Mid-aged women.**

	Survey 1	Survey 2	Survey 3	Survey 4
Age in years	45-50	47-52	50-55	53-58
Eligible at previous survey		13716	13606	13309
Ineligible				
deceased between surveys		50	66	88
frailty (e.g. dementia, stroke)		7	14	14
withdrawn before mailout survey date		53	217	229
<i>Total ineligible</i>		<i>110</i>	<i>297</i>	<i>331</i>
Eligible at current survey		13606	13309	12978
Non-respondents				
withdrawn from the study		156	155	136
contacted but did not return		254	999	887
unable to contact participant		858	929	1052
<i>Total non-respondents</i>		<i>1268</i>	<i>2083</i>	<i>2075</i>
Respondents				
completed survey	13716	12338	11226	10903
Retention rate as % eligible		90.7%	84.3%	84.0%

Retention has been much higher among the Mid-aged women; 91% responded to Survey 2 in 1998 and 84% responded to Survey 3 in 2001 and Survey 4 in 2004 (Table A2). The major reasons for non-response among Mid-aged women were that the research team was unable to contact the women (6%, 7% and 8% of eligible women at Survey 2, Survey 3 and Survey 4 respectively) and non-return of questionnaires by women who could be contacted (2%, 8% and 7% of eligible women at the second, third and fourth surveys). Mid-aged women typically lead busy lives, often working as well as caring for their parents and children. Our data revealed that the women who could not be contacted were more likely to be separated, divorced or widowed.

Data from the 1996 and 2001 Censuses were used to compare demographic characteristics (country of birth, marital status, education, employment and living arrangements) of women of the same age in the Australian population with Mid-aged respondents at Survey 1 (1996) and Survey 3 (2001). There were few differences, however there was some under-representation of women from non-English speaking countries and women who were separated or divorced at both surveys.

**Table A3: Participation and retention of Older women.**

	Survey 1	Survey 2	Survey 3	Survey 4
Age in years	70-75	73-78	76-81	79-84
Eligible at previous survey		12432	11535	10187
Ineligible				
deceased between surveys		529	569	769
frailty (e.g. dementia, stroke)		106	264	381
withdrawn before mailout survey date		262	515	507
<i>Total ineligible</i>		<i>897</i>	<i>1348</i>	<i>1657</i>
Eligible at current survey		11535	10187	8530
Non-respondents				
withdrawn from the study		311	385	267
contacted but did not return		481	860	592
unable to contact participant		309	295	513
<i>Total non-respondents</i>		<i>1101</i>	<i>1540</i>	<i>1372</i>
Respondents				
completed survey	12432	10434	8647	7158
Retention rate as % eligible		90.5%	84.9%	83.9%

Of the Older women, 91% responded to Survey 2 in 1999, 85% to Survey 3 in 2002 and 84% to Survey 4 in 2005 (Table A3). Among Older women the major reason for non-response was non-return of the questionnaire (4% of eligible women at Survey 2, 8% at Survey 3 and 7% at Survey 4). These and other non-respondents tended to report poorer self-rated health at Survey 1 than respondents.

Demographic characteristics (country of birth, marital status, education and living arrangements) of the Older respondents at Survey 1 (1996) and Survey 3 (2002) were compared with those of women of the same age in the Australian population, using data from the 1996 and 2001 Censuses respectively. Comparisons showed few differences. There was some under-representation of women from non-English speaking countries in the ALSHW sample at both surveys. The high level of missing data in the Census made comparisons difficult for marital status and educational qualifications.

Data are available for the Younger cohort at Survey 1 (1996), Survey 2 (2000), Survey 3 (2003) and Survey 4 (2006), for the Mid-aged cohort at Survey 1 (1996), Survey 2 (1998), Survey 3 (2001) and Survey 4 (2004) and for the Older cohort at Survey 1 (1996), Survey 2 (1999), Survey 3 (2002) and Survey 4 (2005). The following tables provide information on completion of surveys.

**Table A4: Completion of surveys by Younger women (n=14247).**

Completion of Surveys	n
Respondent at Surveys 2, 3 and 4	6755
Respondent at Surveys 2 and 3, non-respondent at Survey 4	1017
Respondent at Surveys 2 and 3, deceased/ withdrawn due to frailty at Survey 4	9
Respondent at Surveys 2 and 3, other ineligible at Survey 4	9
Respondent at Survey 2, non-respondent at Survey 3, respondent at Survey 4	795
Respondent at Survey 2, non-respondent at Surveys 3 and 4	954
Respondent at Survey 2, non-respondent at Survey 3, deceased/ withdrawn due to frailty at Survey 4	3
Respondent at Survey 2, non-respondent at Survey 3, other ineligible at Survey 4	108
Respondent at Survey 2, deceased/ withdrawn due to frailty by Survey 3	9
Respondent at Survey 2, other ineligible by Survey 3	29
Non-respondent at Survey 2, respondent at Surveys 3 and 4	886
Non-respondent at Survey 2, respondent at Survey 3, non-respondent at Survey 4	400
Non-respondent at Survey 2, respondent at Survey 3, deceased/ withdrawn due to frailty at Survey 4	1
Non-respondent at Survey 2, respondent at Survey 3, other ineligible at Survey 4	4
Non-respondent at Surveys 2 and 3, respondent at Survey 4	544
Non-respondent at Surveys 2, 3 and 4	2205
Non-respondent at Surveys 2 and 3, deceased/ withdrawn due to frailty at Survey 4	6
Non-respondent at Surveys 2 and 3, other ineligible at Survey 4	190
Non-respondent at Survey 2, deceased/ withdrawn due to frailty at Surveys 3 and 4	7
Non-respondent at Survey 2, other ineligible at Surveys 3 and 4	185
Deceased/ withdrawn due to frailty by Survey 2	25
Other ineligible by Survey 2	106

The numbers of Younger women who completed different surveys are shown in Table A4. Forty-seven percent completed Surveys 1, 2, 3 and 4, 19% completed three of the four surveys and a further 14% completed two of the four surveys. Few Younger women were deceased (n=47) and 13 were too ill to complete further surveys.

**Table A5: Completion of Surveys by Mid-aged women (n=13716).**

Completion of Surveys	n
Respondent at Surveys 2, 3 and 4	9874
Respondent at Surveys 2 and 3, non-respondent at Survey 4	823
Respondent at Surveys 2 and 3, deceased/ withdrawn due to frailty at Survey 4	74
Respondent at Surveys 2 and 3, other ineligible at Survey 4	38
Respondent at Survey 2, non-respondent at Survey 3, respondent at Survey 4	577
Respondent at Survey 2, non-respondent at Surveys 3 and 4	701
Respondent at Survey 2, non-respondent at Survey 3, deceased/ withdrawn due to frailty at Survey 4	15
Respondent at Survey 2, non-respondent at Survey 3, other ineligible at Survey 4	122
Respondent at Survey 2, deceased/ withdrawn due to frailty by Survey 3	63
Respondent at Survey 2, other ineligible by Survey 3	51
Non-respondent at Survey 2, respondent at Surveys 3 and 4	299
Non-respondent at Survey 2, respondent at Survey 3, non-respondent at Survey 4	107
Non-respondent at Survey 2, respondent at Survey 3, deceased/ withdrawn due to frailty at Survey 4	5
Non-respondent at Survey 2, respondent at Survey 3, other ineligible at Survey 4	6
Non-respondent at Surveys 2 and 3, respondent at Survey 4	153

Non-respondent at Surveys 2, 3 and 4	444
Non-respondent at Surveys 2 and 3, deceased/ withdrawn due to frailty at Survey 4	8
Non-respondent at Surveys 2 and 3, other ineligible at Survey 4	63
Non-respondent at Survey 2, deceased/ withdrawn due to frailty at Surveys 3 and 4	17
Non-respondent at Survey 2, other ineligible at Surveys 3 and 4	166
Deceased/ withdrawn due to frailty by Survey 2	57
Other ineligible by Survey 2	53

Table A5 shows the numbers of Mid-aged women who were enrolled in Survey 1 according to their history of completing Surveys 2, 3 and 4. Seventy-two percent of the Mid-aged women completed all four surveys. A further 12% completed three of the four surveys and 9% completed two of the four surveys. Women were mainly ineligible to continue in the Study due to withdrawal.

**Table A6: Completion of Surveys by Older women (n=12432).**

Completion of Surveys	n
Respondent at Surveys 2, 3 and 4	6721
Respondent at Surveys 2 and 3, non-respondent at Survey 4	727
Respondent at Surveys 2 and 3, deceased at Survey 4	579
Respondent at Surveys 2 and 3, withdrawn due to frailty at Survey 4	274
Respondent at Surveys 2 and 3, other ineligible at Survey 4	97
Respondent at Survey 2, non-respondent at Survey 3, respondent at Survey 4	234
Respondent at Survey 2, non-respondent at Surveys 3 and 4	383
Respondent at Survey 2, non-respondent at Survey 3, deceased at Survey 4	128
Respondent at Survey 2, non-respondent at Survey 3, withdrawn due to frailty at Survey 4	70
Respondent at Survey 2, non-respondent at Survey 3, other ineligible at Survey 4	331
Respondent at Survey 2, deceased by Survey 3	497
Respondent at Survey 2, withdrawn due to frailty by Survey 3	220
Respondent at Survey 2, other ineligible by Survey 3	173
Non-respondent at Survey 2, respondent at Surveys 3 and 4	144
Non-respondent at Survey 2, respondent at Survey 3, non-respondent at Survey 4	67
Non-respondent at Survey 2, respondent at Survey 3, deceased at Survey 4	18
Non-respondent at Survey 2, respondent at Survey 3, withdrawn due to frailty at Survey 4	15
Non-respondent at Survey 2, respondent at Survey 3, other ineligible at Survey 4	5
Non-respondent at Surveys 2 and 3, respondent at Survey 4	59
Non-respondent at Surveys 2, 3 and 4	195
Non-respondent at Surveys 2 and 3, deceased at Survey 4	44
Non-respondent at Surveys 2 and 3, withdrawn due to frailty at Survey 4	22
Non-respondent at Surveys 2 and 3, other ineligible at Survey 4	74
Non-respondent at Survey 2, deceased at Surveys 3 and 4	72
Non-respondent at Survey 2, withdrawn due to frailty at Surveys 3 and 4	44
Non-respondent at Survey 2, other ineligible at Surveys 3 and 4	342
Deceased by Survey 2	529
Withdrawn due to frailty by Survey 2	106
Other ineligible by Survey 2	262

The numbers of Older women who completed different surveys are shown in Table A6. Fifty-four percent of Older women completed Surveys 2, 3 and 4, 9% completed

three of the four surveys and a further 15% completed two of the four surveys. Not unexpectedly in this age group, discontinuation was commonly due to death or frailty.

## **A 2.2: Case studies**

The case studies provided throughout the current report were developed by analysing free text comments made by participants in response to the survey question asking: *Have we missed anything? If you have anything else you would like to tell us, please write on the lines below.* At each survey time point participants in the Australian Longitudinal Study on Women's Health are provided with this opportunity and many choose to share specific aspects of their health and well-being. While acknowledging that there are limitations in the use of these data, they provide the researchers with a unique opportunity to gain further insight and understanding into specific issues.

The case studies included in the current report were chosen to illustrate the quantitative findings. The qualitative data were searched using the terms, 'weight', 'exercise', and 'diet'. All comments were then reviewed to determine those that provided the greatest level of detail concerning the issues at hand. BMI data included with the case studies were extracted from the quantitative databases.

At each Survey, women were asked about diagnosed medical conditions. For the earlier surveys this question was framed as "Have you ever been told by a doctor that you have (list of conditions)?" However this question was revised for later surveys to read: "In the past three years have you been diagnosed or treated for (list of conditions)?" The list of conditions differed for each cohort, and changed slightly with each survey as the women aged.

The prevalence of these conditions has been calculated for all women in the Study. The prevalence of conditions at Survey 1 is based on the number of women who indicated they had "ever been told by a doctor" that they had had the condition (the numerator), divided by the total number of women who provided any information about that condition (the denominator). Women who did not provide information at Survey 1, but who subsequently reported not having the condition could be considered as not having the condition at Survey 1 and so were included in the denominator for this Survey.

## Appendix 3: Abbreviations and Definitions

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### A 3.1: Area of residence (RRMA)

Throughout this report area of residence has been classified according to the Rural, Remote and Metropolitan Areas classification scheme (RRMA, 1994). The classification uses postcodes to produce seven categories (2 metropolitan, 3 rural and 2 remote areas) that are based primarily on population numbers and an index of remoteness. For all area of residence analyses these categories were collapsed into four groups: ‘urban’ including capital cities and other metropolitan centres, ‘large rural centres’, ‘small rural centres’ and ‘other rural/remote areas’. When area of residence is not shown, estimates (such as prevalence and incidence) have been weighted to correct for the purposeful over-sampling of women from rural and remote areas, so that the Study populations are representative of the Australian population of women in these age groups.

### A 3.2: Body Mass Index (BMI)

At each survey women are asked to report their height and weight. These self-reported data are used to calculate body mass index (BMI). BMI is calculated as weight (kg) divided by the square of height (m). It is then categorised as: underweight < 18.5; healthy weight [18.5, 25); overweight [25, 30); obese ≥ 30).

### A 3.3: Mental Health Component Score (MCS) and Physical Health Component Score (PCS)

MCS and PCS reduce the SF-36 from an eight-scale profile to two summary measures without substantial loss of information, measuring respectively mental and physical health. Scoring MCS and PCS measures involves three steps. First, the eight SF-36 scales are standardized using means and standard deviations from each cohort.

$$\text{Standardized Scale} = \frac{(\text{Transformed Scale} - \text{Population Mean})}{\text{Population Standard Deviation}}$$

Second, they are aggregated using cohort specific weights (factor score coefficients). Third, these scores have been normalized to have a mean of 50 and a standard deviation of 10 using the Survey 1 data separately for each cohort (Mishra G, Schofield MJ. 1998).

$$\text{Component Score} = (\text{Weighted Sum of Standardized SF} - 36 \text{ scales} \times 10) + 50$$

This means that the results are not comparable across cohorts so they are shown in different figures which depict trends over time.

## **A 3.4: Physical Activity**

Women in all three cohorts have answered questions about physical activity (PA) in all surveys. At Survey 1 in 1996, there were two questions about physical activity. They asked how many times in a normal week women engaged in vigorous exercise (e.g., aerobics, jogging) or less vigorous exercise (e.g., walking, swimming) lasting for 20 minutes or more (Brown et al., 2004). Responses were used to derive a PA score based on frequency of participation in 'vigorous' (7.5 METs) and 'less vigorous' (4 METs) physical activity lasting at least 20 minutes. [PA score =  $\sum$ {frequency \* 20mins \* 4 (less vigorous) + frequency \* 20mins \* 7.5 (vigorous)}] MET.mins. MET.mins are units of energy expenditure – 600 MET.mins is equivalent to 150 minutes of moderate intensity (4 METs) physical activity per week.

At Survey 2, Survey 3 and Survey 4, physical activity was assessed using questions based on those developed for the evaluation of the National Active Australia campaign in 1997, and for national monitoring of physical activity in Australia (National physical activity guidelines for Australians, 1999). The questions asked about the frequency and total duration of walking (for recreation or transport), and of vigorous (e.g., aerobics, jogging) and moderate intensity activity (e.g., swimming, golf) in the last week. In Survey 2 for Mid-aged women gardening was also included as an example of moderate intensity physical activity. These items have been shown to have acceptable reliability and validity for population measurement of physical activity (Sallis et al., 1999; Trost et al., 2002). A PA score was derived from reported duration of time spent in each form of physical activity during the last week [ $\sum$  {(walking mins \* 3.5) + (moderate mins \* 4.0) + (vigorous mins \* 7.5)} MET.mins] (Australia's Health, 2004).

Women in each cohort were grouped into four physical activity categories (none: < 40; low: 40 - <600; moderate 600 - < 1200; high  $\geq$  1200 MET.mins/week). The National Physical Activity Guidelines suggest that, for health benefit, all Australians should accumulate at least 30 minutes of at least moderate intensity physical activity on most, if not all, days of the week (National physical activity guidelines for Australians.). The ALSWH researchers use a cut-off of 600 MET.mins per week (30 minutes X 5 sessions X 4 METs) to define whether women are accumulating sufficient physical activity for health benefit, that is, women in the 'moderate' and 'high' categories meet the guidelines.

## **A 3.5: References**

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## Appendix 4: Tables

**Table A7: Number of women in each BMI category at Surveys 1, 2, 3 and 4 for the Younger, Mid-aged and Older cohort.**

Cohort	Survey	BMI category							
		Under		Healthy		Over		Obese	
		N	Row%	N	Row%	N	Row%	N	Row%
Younger	1	448	9.3	3364	69.7	726	15.0	291	6.0
	2	324	6.7	3140	65.0	918	19.0	447	9.3
	3	215	4.5	2958	61.3	1022	21.2	634	13.1
	4	186	3.9	2747	56.9	1134	23.5	762	15.8
Mid-aged	1	120	1.5	4111	52.5	2220	28.4	1374	17.6
	2	132	1.7	3768	48.2	2449	31.3	1476	18.9
	3	108	1.4	3409	43.6	2514	32.1	1794	22.9
	4	87	1.1	3157	40.3	2636	33.7	1945	24.9
Older	1	115	2.2	2614	51.1	1753	34.3	633	12.4
	2	135	2.6	2525	49.4	1801	35.2	654	12.8
	3	163	3.2	2461	48.1	1761	34.4	730	14.3
	4	222	4.3	2519	49.2	1689	33.0	685	13.4

**Table A8: Number of women in each physical activity (PA) category at Surveys 2, 3 and 4 by BMI category at Survey 2 for the Younger cohort.**

Younger cohort		PA group							
	Survey	None		Low		Moderate		High	
		N	Row%	N	Row%	N	Row%	N	Row%
Underweight	2000	40	12.0	116	34.9	83	25.0	93	28.0
	2003	27	8.1	116	34.9	76	22.9	113	34.0
	2006	46	13.9	122	36.7	75	22.6	89	26.8
Healthyweight	2000	244	7.6	1074	33.6	786	24.6	1097	34.3
	2003	236	7.4	1108	34.6	740	23.1	1117	34.9
	2006	321	10.0	1213	37.9	766	23.9	901	28.1
Overweight	2000	78	8.0	333	34.1	242	24.8	323	33.1
	2003	79	8.1	316	32.4	227	23.3	354	36.3
	2006	100	10.2	376	38.5	241	24.7	259	26.5
Obese	2000	67	13.2	204	40.2	113	22.3	123	24.3
	2003	52	10.3	199	39.3	125	24.7	131	25.8
	2006	73	14.4	191	37.7	112	22.1	131	25.8

**Table A9: Number of women in each physical activity (PA) group at Surveys 3 and 4 by BMI category at Survey 3 for the Mid-aged cohort.**

*Mid-aged cohort*

		<i>PA group</i>							
		<i>None</i>		<i>Low</i>		<i>Moderate</i>		<i>High</i>	
		<i>N</i>	<i>Row%</i>	<i>N</i>	<i>Row%</i>	<i>N</i>	<i>Row%</i>	<i>N</i>	<i>Row%</i>
<i>Underweight</i>	<i>2001</i>	21	17.2	43	35.2	26	21.3	32	26.2
	<i>2004</i>	23	18.9	33	27.0	16	13.1	50	41.0
<i>Healthyweight</i>	<i>2001</i>	442	12.4	1248	35.1	823	23.2	1041	29.3
	<i>2004</i>	416	11.7	1011	28.4	853	24.0	1274	35.8
<i>Overweight</i>	<i>2001</i>	427	16.0	1024	38.5	541	20.3	671	25.2
	<i>2004</i>	417	15.7	779	29.3	630	23.7	837	31.4
<i>Obese</i>	<i>2001</i>	463	24.8	729	39.0	325	17.4	350	18.7
	<i>2004</i>	398	21.3	619	33.2	406	21.7	444	23.8

**Table A10: Number of women in each physical activity (PA) group at Surveys 2, 3 and 4 by BMI category at Survey 2 for the Older cohort.**

*Older cohort*

		<i>PA group</i>							
		<i>None</i>		<i>Low</i>		<i>Moderate</i>		<i>High</i>	
		<i>N</i>	<i>Row%</i>	<i>N</i>	<i>Row%</i>	<i>N</i>	<i>Row%</i>	<i>N</i>	<i>Row%</i>
<i>Underweight</i>	<i>1999</i>	29	25.0	31	26.7	28	24.1	28	24.1
	<i>2002</i>	31	26.7	38	32.8	17	14.7	30	25.9
	<i>2005</i>	38	32.8	38	32.8	17	14.7	23	19.8
<i>Healthyweight</i>	<i>1999</i>	406	19.6	694	33.5	406	19.6	566	27.3
	<i>2002</i>	539	26.0	635	30.6	371	17.9	527	25.4
	<i>2005</i>	726	35.0	560	27.0	353	17.0	433	20.9
<i>Overweight</i>	<i>1999</i>	436	28.8	489	32.3	244	16.1	347	22.9
	<i>2002</i>	558	36.8	422	27.8	245	16.2	291	19.2
	<i>2005</i>	678	44.7	418	27.6	194	12.8	226	14.9
<i>Obese</i>	<i>1999</i>	251	44.0	169	29.6	75	13.1	76	13.3
	<i>2002</i>	315	55.2	127	22.2	66	11.6	63	11.0
	<i>2005</i>	369	64.6	99	17.3	52	9.1	51	8.9



## Appendix 5: Graphs

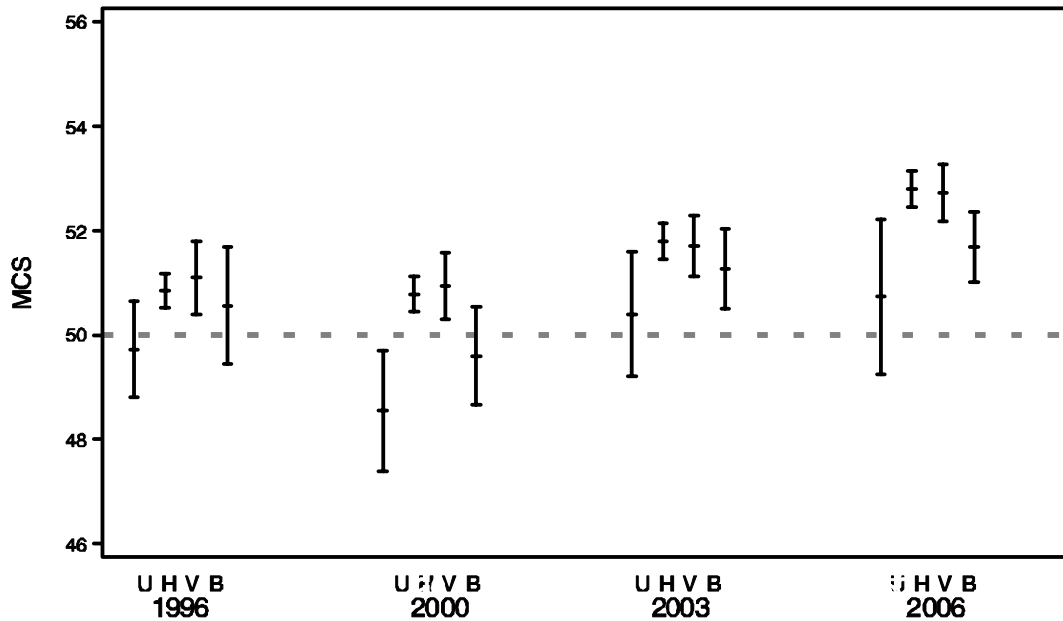


Figure A1: Mean mental health component scores (MCS) and 95% confidence intervals in the Younger cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.

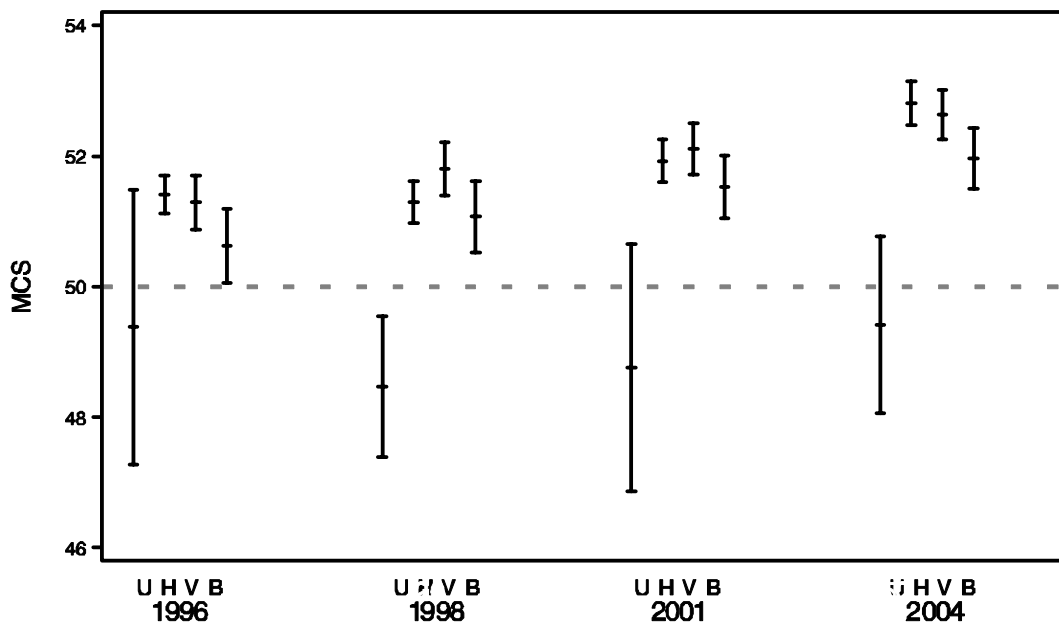


Figure A2: Mean mental health component scores (MCS) and 95% confidence intervals in the Mid-aged cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.

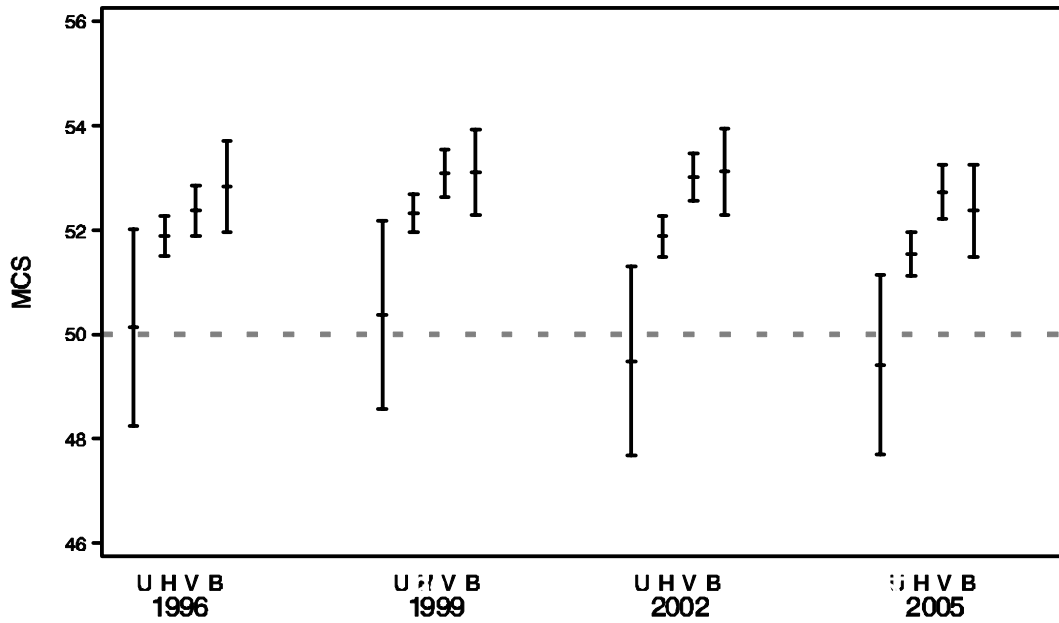


Figure A3: Mean mental health component scores (MCS) and 95% confidence intervals in the Older cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.

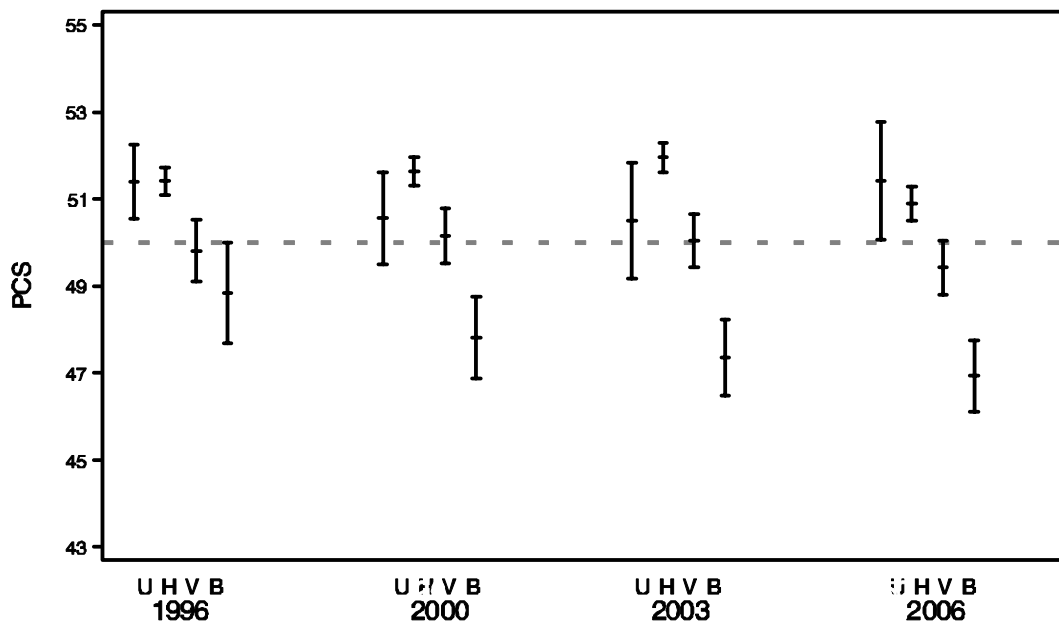


Figure A4: Mean physical health component scores (PCS) and 95% confidence intervals in the Younger cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.

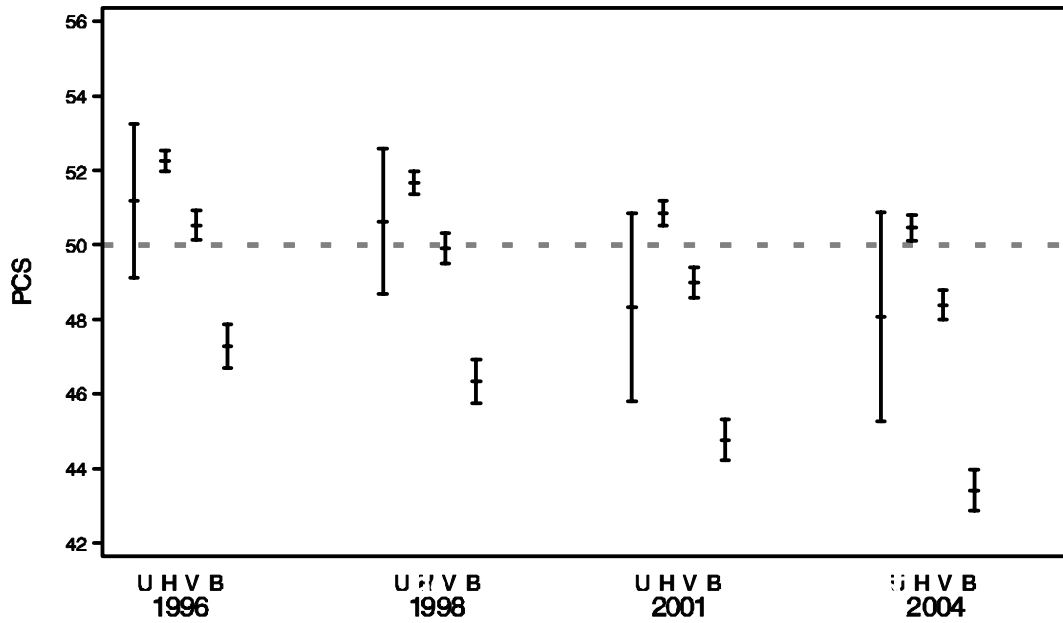


Figure A5: Mean physical health component scores (PCS) and 95% confidence intervals in the Mid-aged cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.

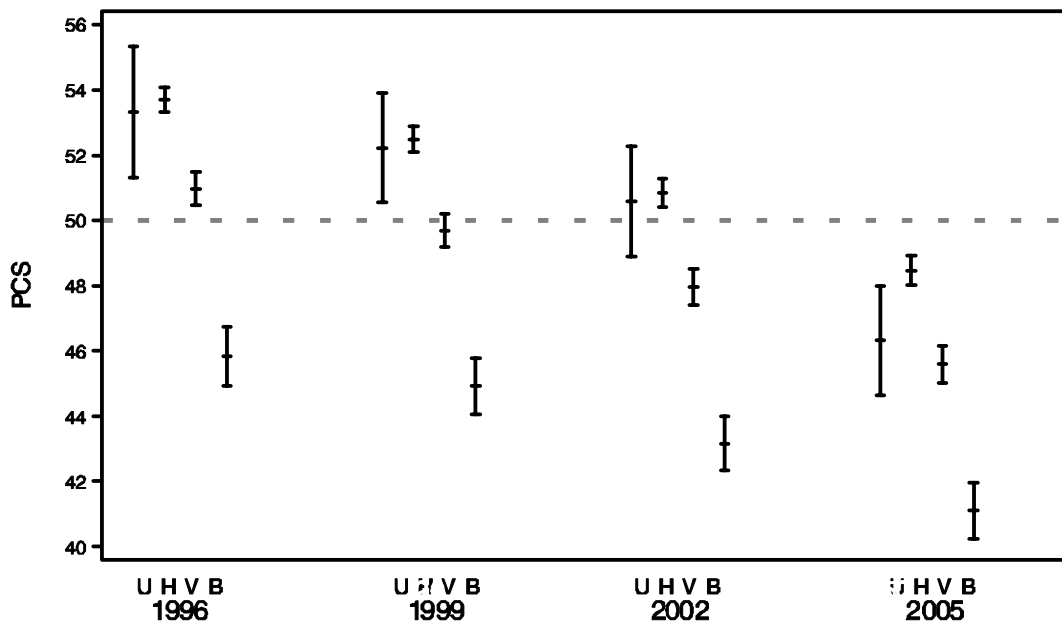


Figure A6: Mean physical health component scores (PCS) and 95% confidence intervals in the Older cohort by BMI category for Surveys 1, 2, 3 and 4: U=Underweight H=Healthy weight V=Overweight B=Obese.

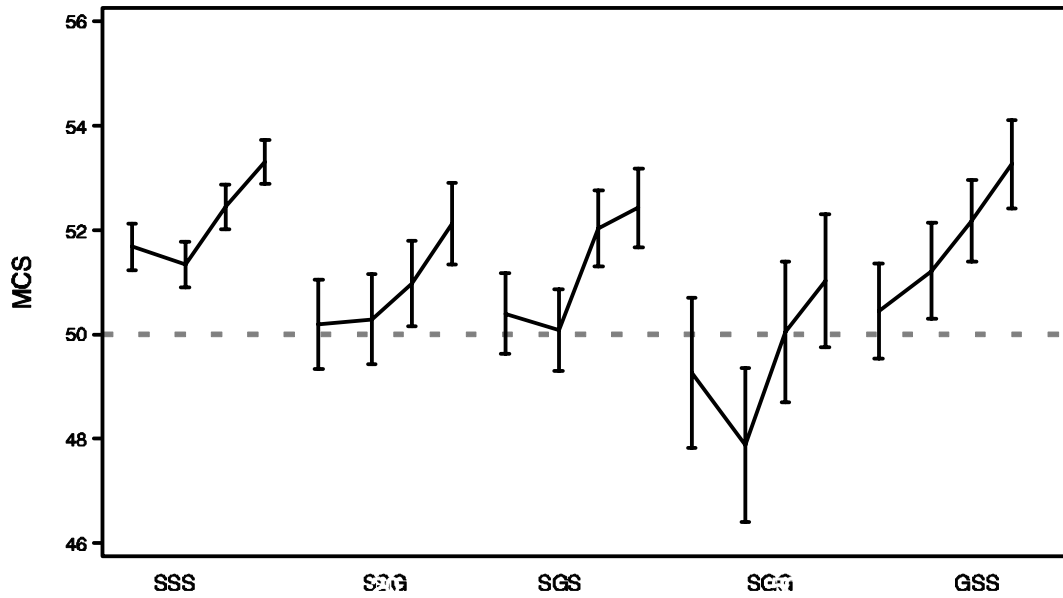


Figure A7: Mental health component scores (MCS) for the Younger cohort for most commonly occurring weight change patterns from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

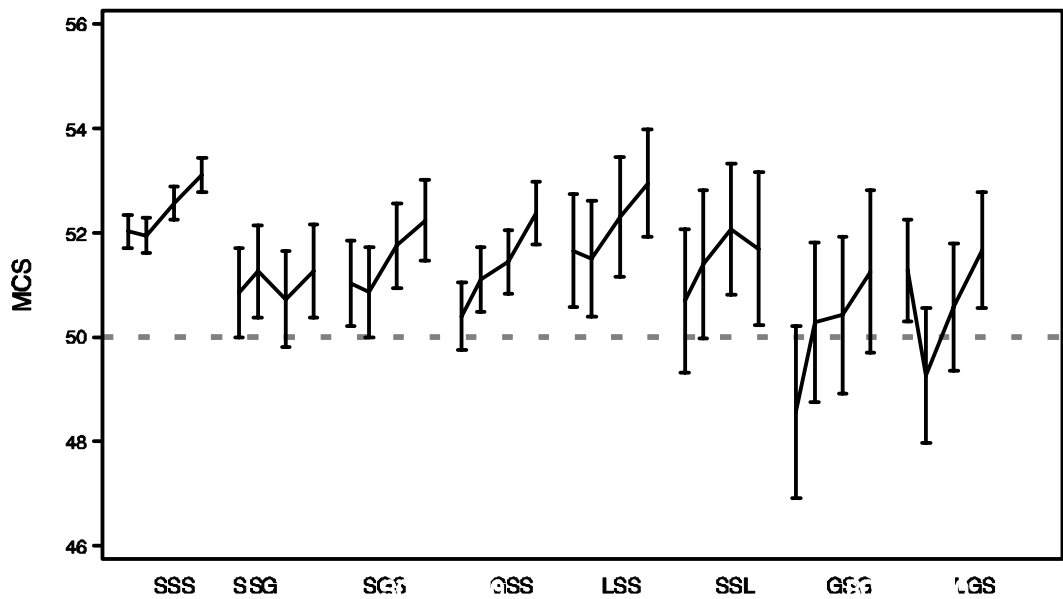


Figure A8: Mental health component scores (MCS) for the Mid-aged cohort for most commonly occurring weight change patterns from 1996 to 2004: S=no weight change G=weight gain L=weight loss between two consecutive surveys.



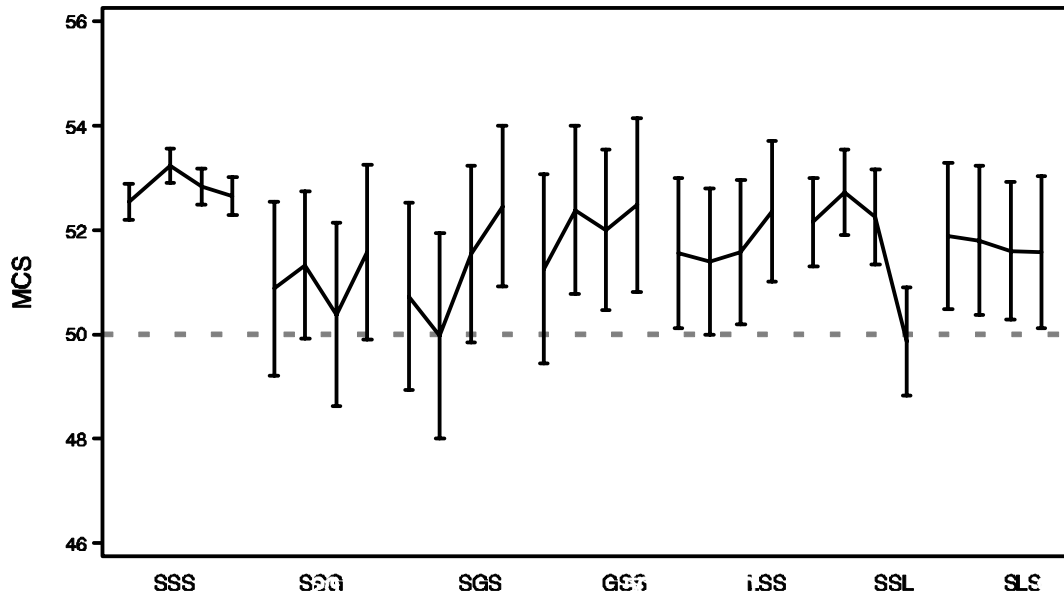


Figure A9: Mental health component scores (MCS) for the Older cohort for most commonly occurring weight change patterns from 1996 to 2005: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

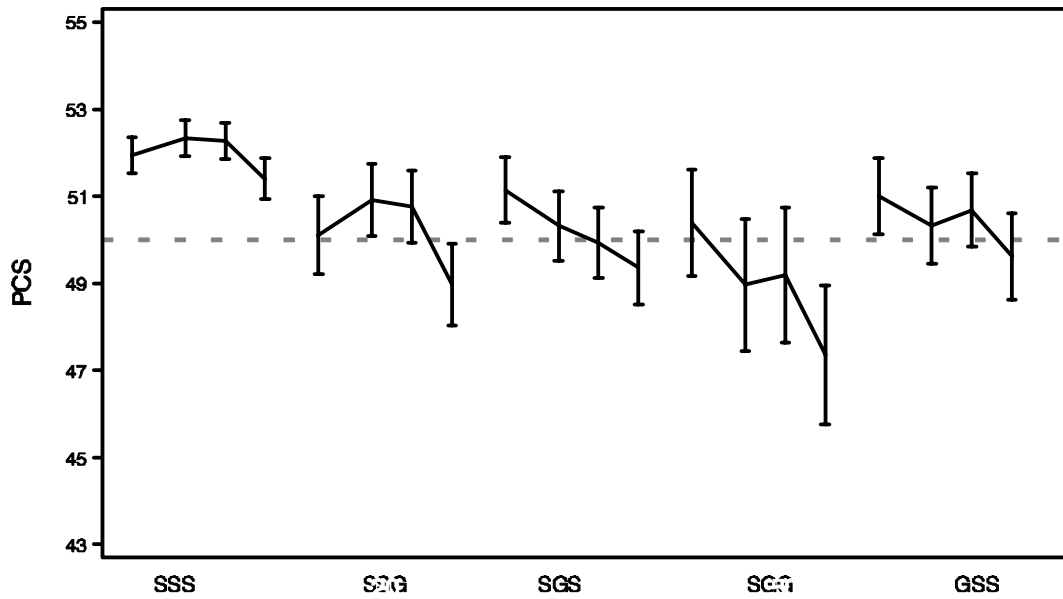


Figure A10: Physical health component score (PCS) for the Younger cohort for most commonly occurring weight change patterns from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

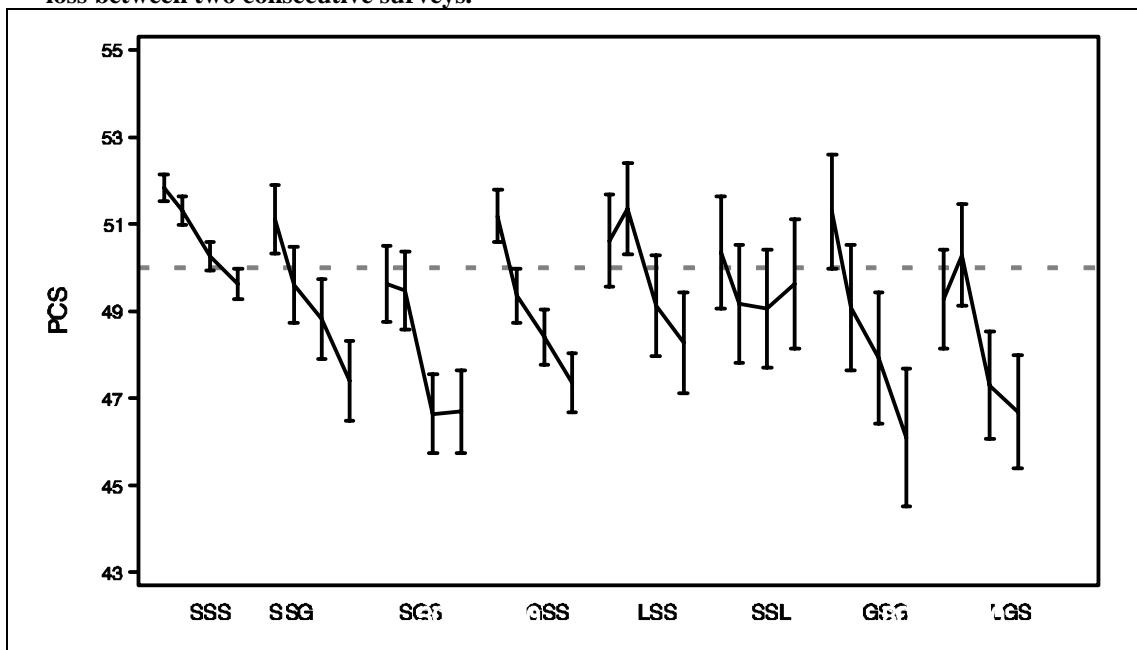


Figure A11: Physical health component scores (PCS) for the Mid-aged cohort for most commonly occurring weight change patterns from 1996 to 2004: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

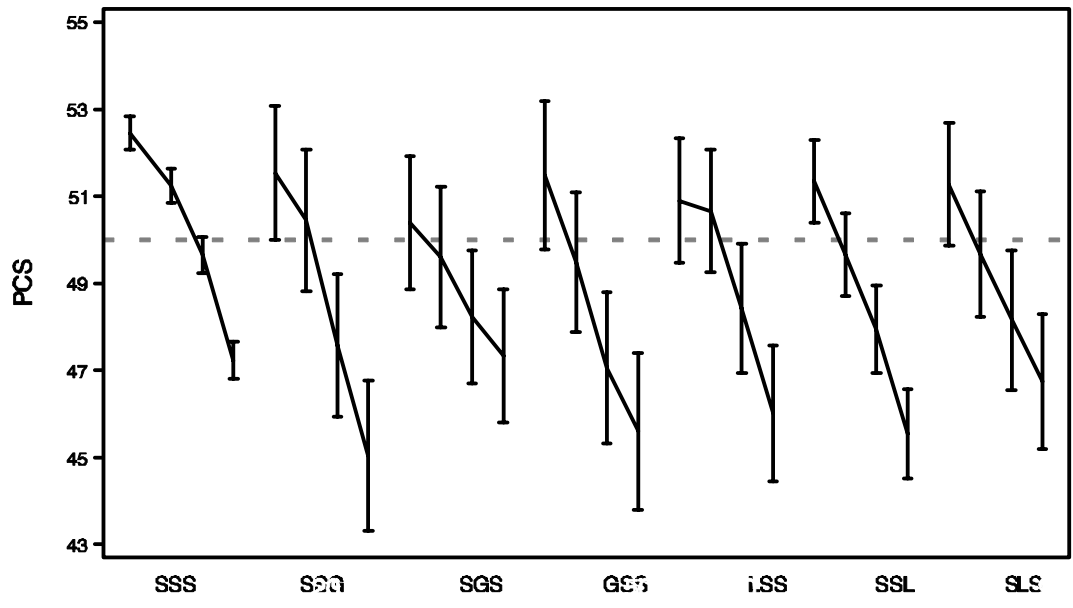
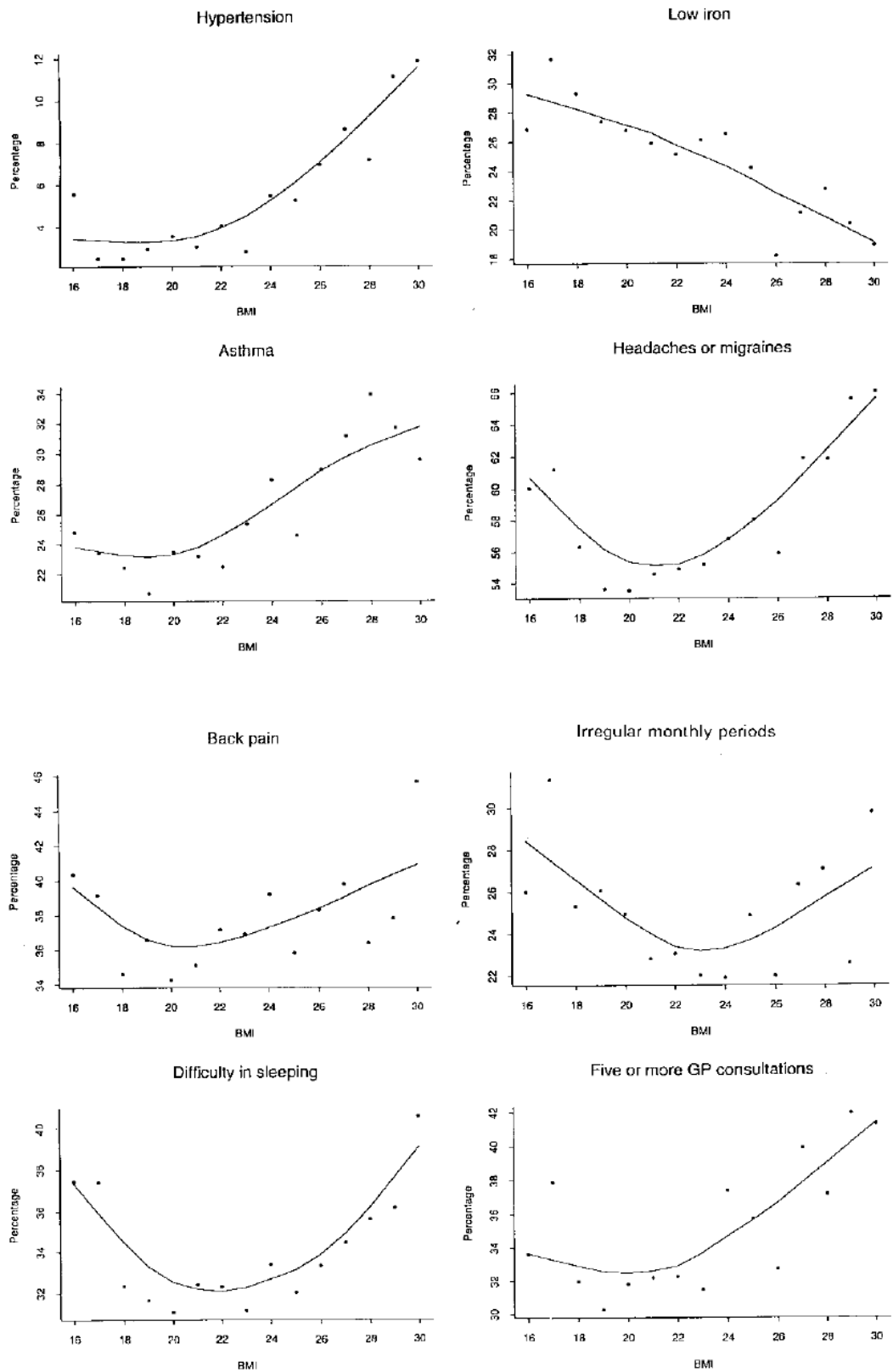


Figure A12: Physical health component scores (PCS) for the Older cohort for most commonly occurring weight change patterns from 1996 to 2005: S=no weight change G=weight gain L=weight loss between two consecutive surveys.



**Figure A13: Relationship between BMI (in intervals of 1 kg/m<sup>2</sup>) and percentage of Younger women reporting medical problems, surgical procedures, symptoms and GP visits at Survey 1. Data from Younger women with BMI > 30kg/m<sup>2</sup> are included in the BMI category labeled 30.**

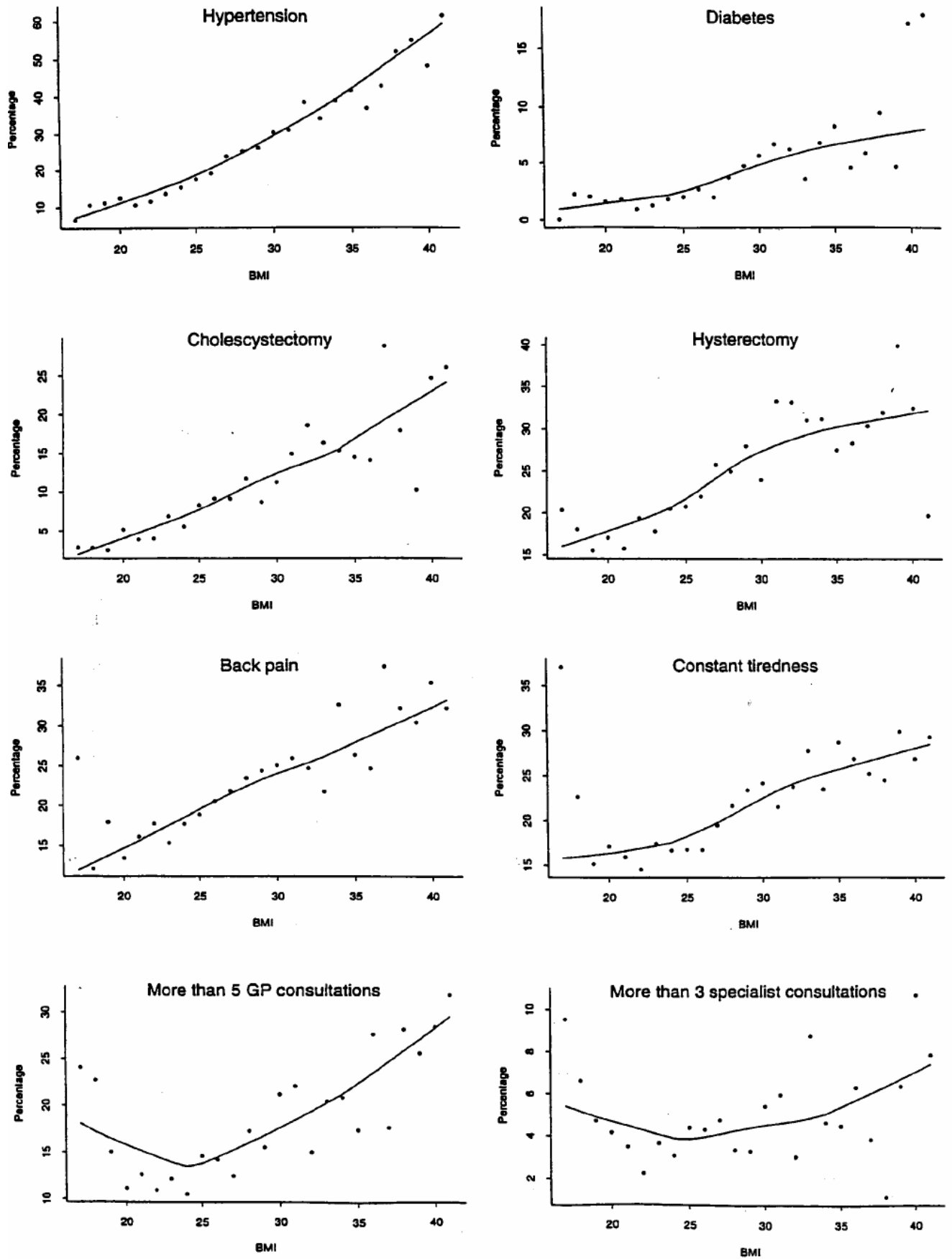


Figure A14: Relationship between BMI (in intervals of 1 kg/m<sup>2</sup>) and percentage of Mid-aged women reporting medical problems, surgical procedures, symptoms and health care utilizations at Survey 1.

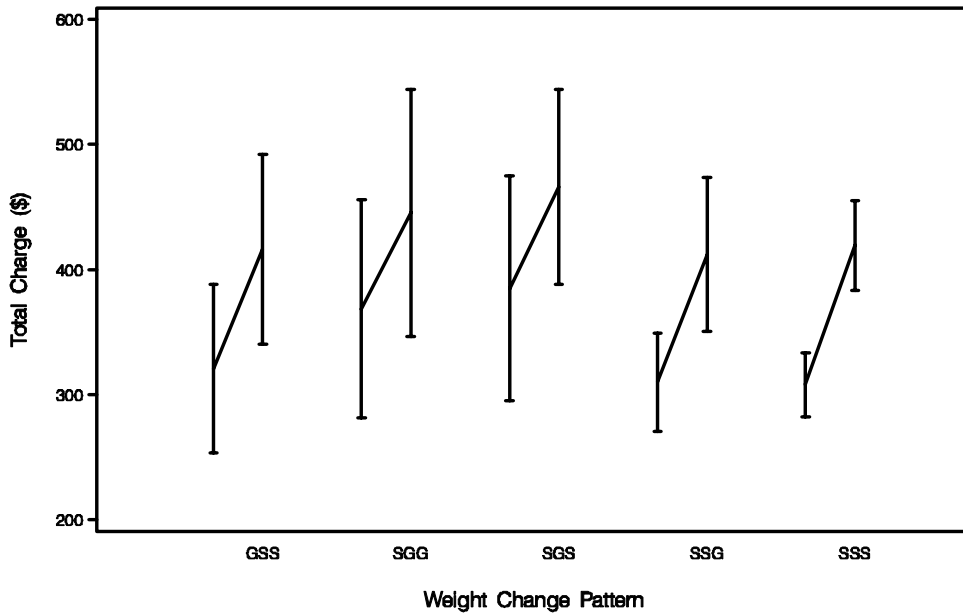


Figure A15: Total charges at Surveys 2 and 3 by most commonly occurring weight change patterns for the Younger cohort from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

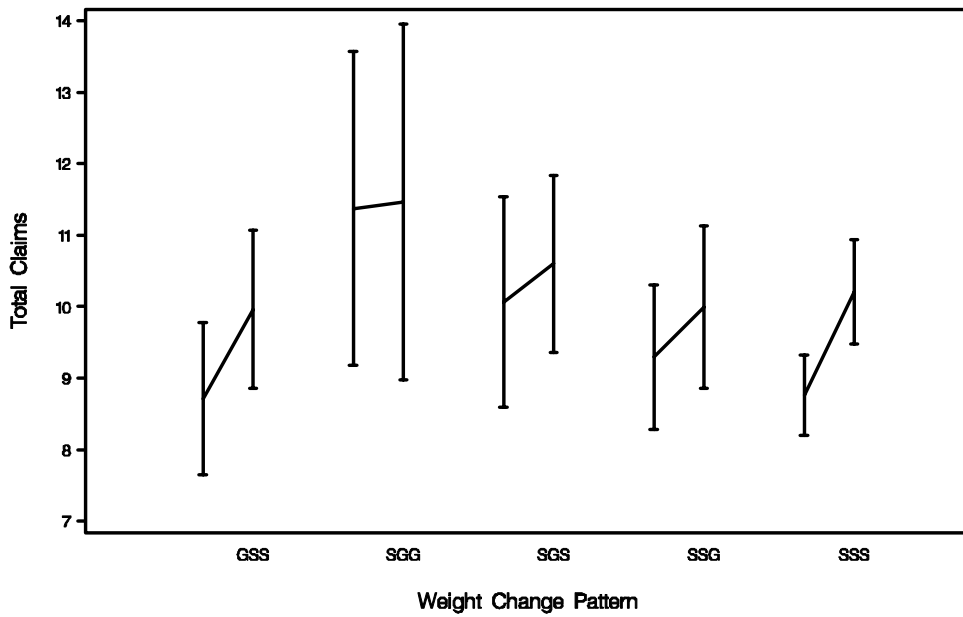


Figure A16: Total number of Medicare claims at Surveys 2 and 3 by most commonly occurring weight change patterns for the Younger cohort from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

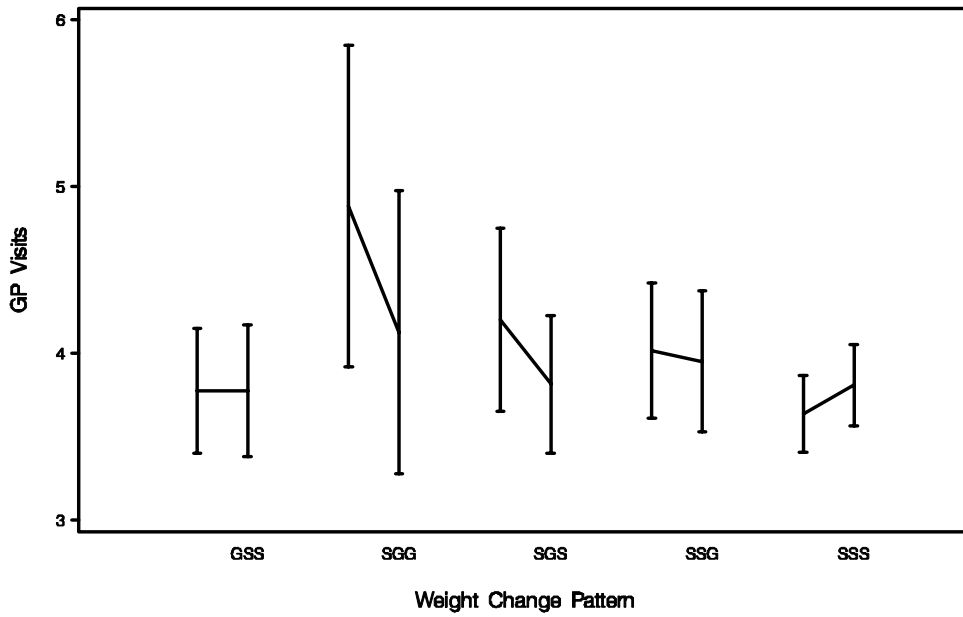


Figure A17: Number of GP visits at Surveys 2 and 3 by most commonly occurring weight change patterns for the Younger cohort from 1996 to 2006: S=no weight change G=weight gain L=weight loss between two consecutive surveys.

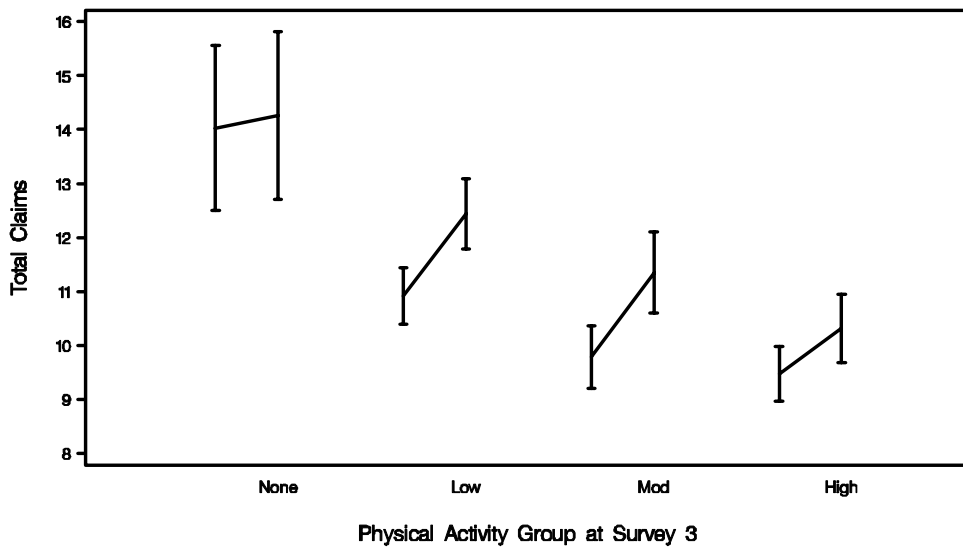
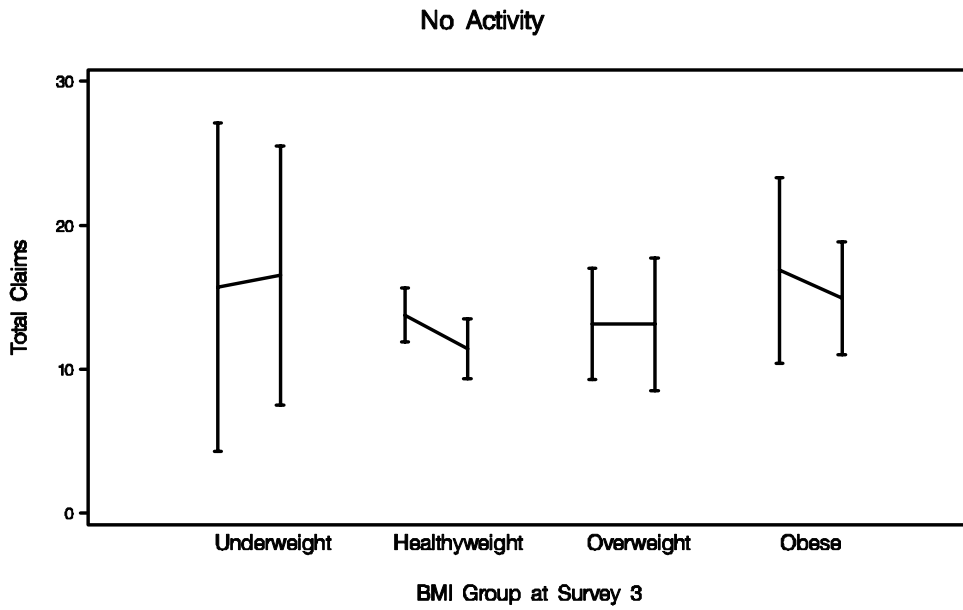
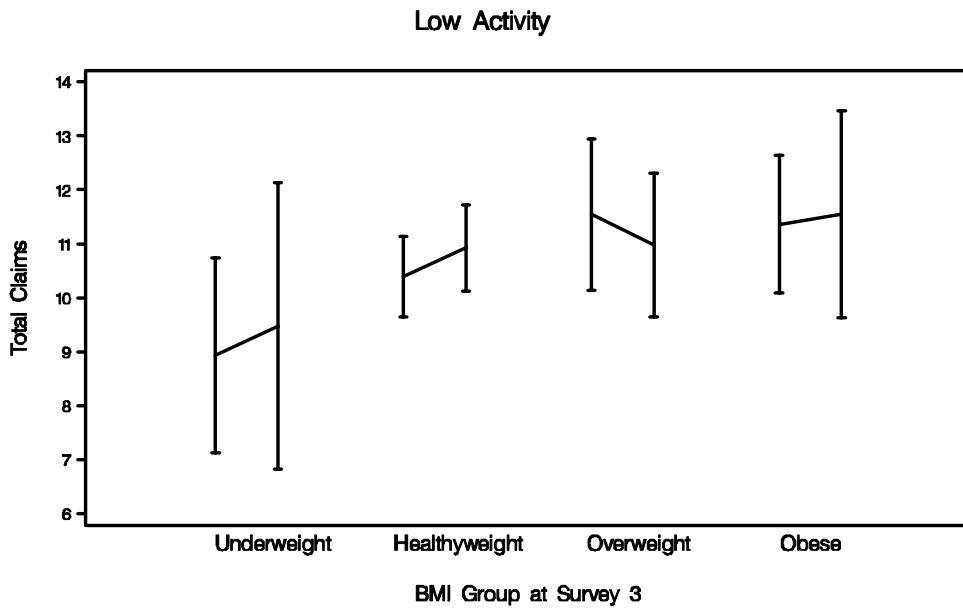


Figure A18: Total number of Medicare claims at Surveys 2 and 3 by physical activity group at Survey 3 for the Younger cohort.

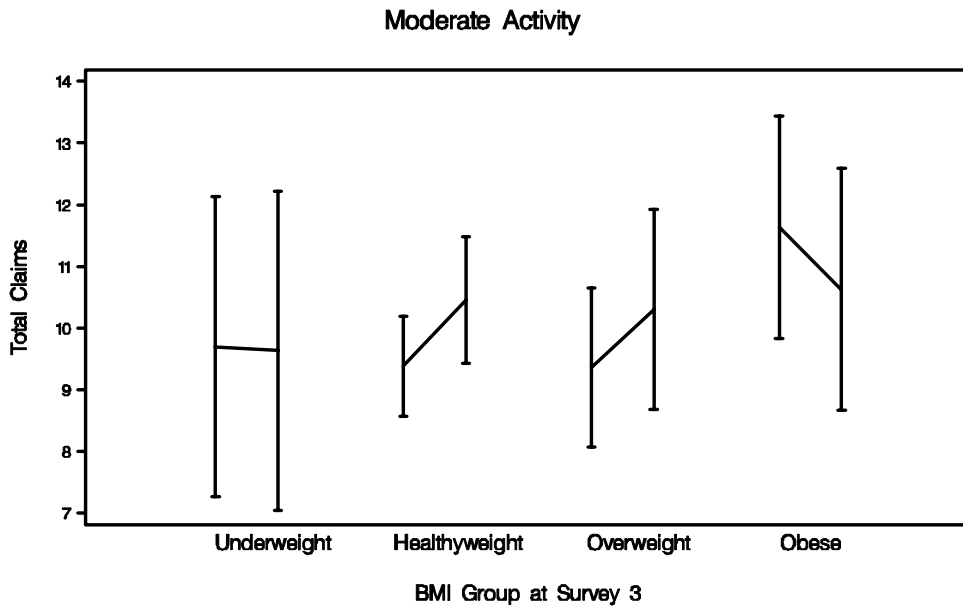


**Figure A19:** Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'no activity' group at Survey 3.

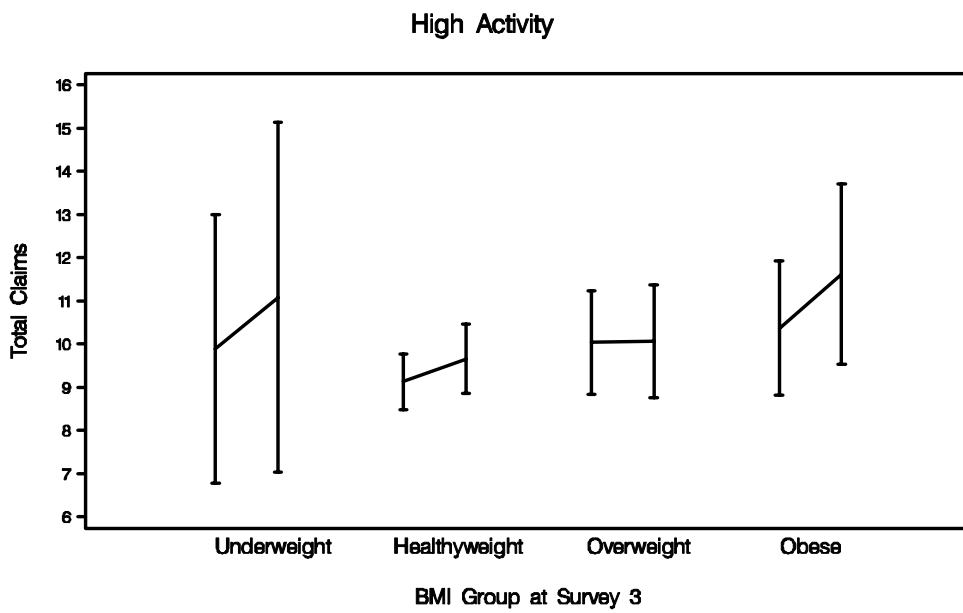


**Figure A20:** Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'low activity' group at Survey 3.

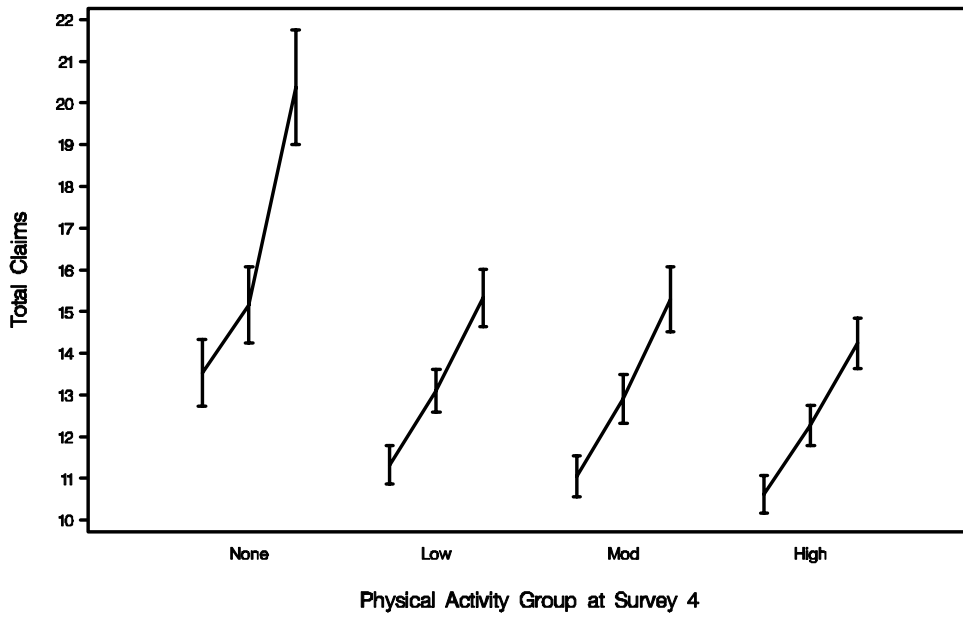




**Figure A21:** Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'moderate activity' group at Survey 3.



**Figure A22:** Total number of Medicare claims at Surveys 2 and 3 by BMI category at Survey 3 for Younger women in the 'high activity' group at Survey 3.



**Figure A23: Total number of Medicare claims at Surveys 2, 3 and 4 by physical activity group at Survey 4 for the Mid-aged cohort.**