This is the published version of this journal article. To be published as:

Anderson, Rhonda Laurelle and Anderson, Debra J. and Hurst, Cameron P. (2010) *Modeling factors that influence exercise and dietary change among midlife Australian women : results from the Healthy Aging of Women Study*. Maturitas. (In Press)

Modeling exercise and dietary changes among a sample of midlife Australian women

Abstract

In light of the prevalence of weight gain and declining health among midlife women, this study investigated the factors involved in making positive exercise and dietary changes among a sample of 564 Australian women aged 51-66 years.

Survey data were collected on socio-demographics, body mass index (BMI), chronic health conditions, self-efficacy, exercise and dietary behaviour change since age 40, and health-related quality of life. Data analysis utilized descriptive and bivariate statistics and structural equation modeling.

Modeling emphasized the importance of BMI and self-efficacy in exercise and dietary change. Education influenced BMI and self-efficacy in the case of exercise, but not diet.

The study has important implications for programs promoting healthy ageing among women, and highlights that women with low education, high BMI and poor mental health will need considerable support to improve their lifestyles.

1. Introduction

Midlife is often a time of weight gain and increasing health concerns for women. An American study into the health issues of four age groups of American women observed that in the 45-64 age group the number reporting fair or poor health almost doubled compared with those in younger age cohorts [1].

Recent figures indicate that while 30% of Australian women are overweight and 22% are obese [2] the highest rate of obesity is among women aged 55-64 years (21.7%). Researchers are still unclear as to what extent the tendency to gain weight — especially around the abdomen — in midlife, is related to menopause, age, or behaviour such as reduced activity levels [3,4].

Midlife weight gain is an issue of major concern given the link between obesity and degenerative disease and disability [5,6]. Moreover, relative to men, women seem to suffer a disproportionate burden of disease attributable to overweight and obesity, especially after age 45 [7]. Overweight and obesity in middle-aged women have been linked to a range of conditions including diabetes, gallstones, hypertension and colon cancer [8], as well as breast cancer [9]. Midlife women are also susceptible to stroke. American women aged 45-54 have significantly higher odds of having a stroke compared with men of the same age, and this is related to waist circumference and vascular risk factors such as systolic blood pressure and cholesterol levels [10].

Weight gain may also contribute to increased frequency or severity of menopause-related symptoms. An analysis of data from the Australian Longitudinal Study of Women's Health [11] and an English study of women aged 46-55 [12] both concluded that overweight and obese women experience more hot flushes and night sweats than women of normal weight.

Given the range of health problems impacting midlife women, this group clearly needs to be the focus of education initiatives and lifestyle interventions. What is not apparent from the literature, however, is an appreciation of the way in which midlife women relate to preventative behaviours such as exercise and dietary modification that could avert the onset of chronic disease.

Some research [13-15] claims that midlife represents a new beginning for many women. With the demands of raising children behind them, women have an opportunity to focus on themselves, perhaps for the first time in their lives. As such, it could be a prime time for making positive changes to their health. The current study seeks to develop an understanding of some key variables involved in health behaviour change among midlife women. In this context, 'heath behaviour change' refers to changes made to exercise or diet.

The literature identifies self-efficacy, education, and health-related quality of life (HRQOL) as being important in understanding the broader picture of health behaviour. While self-efficacy and education have been shown to be determinants of health behaviour, health-related quality of life may be an outcome.

Self-efficacy is defined as "the conviction that one can successfully execute the behaviour required to produce the outcomes" [16]. It has been argued that self-efficacy is critical to understanding whether or not a person will make changes to their health behaviour [17]. People with high self-efficacy set high goals, stay committed to them, try harder in the face of obstacles, and are generally optimistic, while people with low self-efficacy avoid difficult tasks, have low aspirations and weak commitment to their goals, give up in the face of obstacles, and are susceptible to stress and depression [17]. Finally, self-efficacy relies on four main information sources: mastery experiences, social modeling (i.e. role models), social persuasion (i.e. encouragement) and physical and emotional states (i.e. people's own self-appraisal based on emotional and physical feedback) [18].

Lower education levels have been shown to predict overweight, perhaps because less educated groups are less receptive to health education messages and do not perceive their weight as a health risk [19, 20].

HRQOL encompasses both physical and mental health, and is considered a useful marker of health and well-being. Studies of the relationship between physical activity and HRQOL [21, 22] have shown that more active women have higher HRQOL, and that staying active, even at low levels, is healthier than being sedentary. Studies investigating the link between body mass index (BMI) and HRQOL [23, 24] have found that overweight or obese women tend to have poorer HRQOL, especially in the physical domain. Age also influences HRQOL in that older women appear to lower their performance expectations and view their health more positively than do younger women, so that while they may have poorer physical health, they have better mental health than younger women [25].

2. Method

2.1. Participants

This study was conducted with the Australian cohort participating in a longitudinal, cross-cultural study of midlife Australian and Japanese women, known as the Healthy Ageing of Women Study. The Australian sample was identified between July 2001 and July 2002 from 10,923 women on the electoral roll who met the criteria of being aged 45-60 and living in six selected rural and metropolitan postcodes within Queensland, Australia. From that target population, 1500 women were randomly selected for the study, and of these, 869 participated in the first survey in 2002.

The second survey, four years later, was mailed to 866 participants, since two had indicated that they no longer wished to participate, and notification was received that another was deceased. Completed surveys were received from 564 women aged 51-66 years. The analysis for this paper was conducted on data collected from this second survey. For the purposes of the study, 'midlife' was defined as the years between the ages of 40 and 65. Participants aged 66 were included, however, because it was assumed that their data would not alter the statistical results and conclusions.

2.2. Survey instruments

Socio-demographic data.

The following socio-demographic data were collected: postcode, age, marital status, country of birth, education level, employment status, and annual gross household income.

Body Mass Index.

Participants were asked to report their height and weight for the calculation of BMI. This was calculated by dividing the weight in kilograms by the square of the height in metres (kg/m^2). The BMI categories used were those developed by the World Health Organisation [26].

Chronic health conditions.

Participants were provided with a list of health conditions and asked to indicate whether they previously or recently had been diagnosed with any of them. The list comprised headaches/migraine, stroke, high blood pressure, leaking urine, back problem, coronary heart disease, other heart disease, irritable bowel problem, thyroid disorder, arthritis or rheumatism, diabetes, breast cancer, ovarian cancer, endometrial cancer, cancer (any type), osteoporosis, mental health problem, and other bone or joint problem.

Exercise and dietary self-efficacy.

Bandura's scales for measuring exercise self-efficacy and self-efficacy in adhering to a low fat diet [27] were chosen because of his worldwide standing in the self-efficacy field, even though psychometric information on the scale was limited. Participants were required to indicate, using a scale of 0-100, where 0 represents 'cannot do at all' and 80-100 represents 'highly certain can do', how confident they were that they could stick to an exercise or dietary regime in the face of a range of possible situations, such as 'when I am feeling tired' 'during bad weather', and 'during a vacation' (for exercise) and 'while watching television', 'when depressed', and 'when you are entertaining visitors' (for diet).

While Bandura's exercise self-efficacy scale was adopted in total, the dietary scale was broadened from a focus on 'adhering to a low fat diet' to 'adhering to a healthy diet', although the items were used exactly as they are in the original scale. Since some adjustment was being made to the dietary scale, both scales were tested with a convenience sample of six middle-aged women to ensure that the instructions for completing them were easy to read and understand.

Exercise and dietary change.

Participants were asked (yes/no) whether they had made any deliberate change to their exercise and their diet since age 40 (which was selected to indicate the start of 'midlife'); what changes they had made; whether their exercise/diet had increased/improved or decreased/become worse a small, moderate or large amount; the reason for the change; and their reasons if they had made no change. The questions were tested with a convenience sample of six women whose ages matched the age range of the study sample.

Health-related quality of life.

This was measured using the SF-36 (version 1.0), which is a well-documented scoring system used in clinical practice and research, health policy evaluations, and general population surveys [28]. It is designed to provide information on general health and wellbeing, but also allows for the calculation of aggregate summary scores for physical and mental health. The 35 items are grouped into eight subscales measuring physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health, plus one item that measures change in health status in the last 12 months.

The term 'exercise' was chosen over the more generic 'physical activity' because the focus in this study was on activity undertaken for the purpose of exercising rather than on incidental activity that occurs in the normal course of living. Thus, housework was not considered as exercise unless it was undertaken for the purpose of being active, while taking the stairs more often at work, with the intention of being more active, was regarded as exercise.

2.3. Survey procedures

Ethical clearance was obtained for the study and all women provided written informed consent for their participation. The survey was accompanied by a letter of invitation to participate, a participant information sheet and a reply paid envelope. Reminder letters were sent to ensure that as many completed surveys were returned as possible. As noted previously, 564 were received. A further 32 were returned but not completed. An analysis of responders and non-responders showed minimal difference between the two groups.

Survey data were coded where necessary and entered into a Statistical Packages for the Social Sciences (SPSS) version 13 file. (Versions 14.0 and 16.0 were subsequently used.) Obvious errors and illegible responses were coded as missing data. A random selection of 10% of the data entry was double checked to ensure minimal errors.

2.4. Data analysis

Before undertaking statistical tests, data for continuous variables were checked for normality by investigating indicators of distribution such as the mean and its relationship to the median, standard deviation from the mean, minimum and maximum scores, skewness, and kurtosis.

Descriptive statistics (average, %) were used to summarise data. At the bivariate level, Pearson's r or Spearman's *rho* correlation coefficients were used as a basic measure to analyse relationships between two continuous variables, chi-square tests were used to examine the association between two categorical variables, and t-tests were used to compare differences between two group means. This data contributed to the development of a priori models for structural equation modeling. Statistical significance was defined at the conventional $p < 0.05$ level.

Structural equation modeling (SEM) was used to identify relationships between the main variables. SEM involves hypothesizing a model that is then tested to identify the extent to which it 'fits' or adequately describes the data. This process requires the use of continuous data. While all of the health behaviour change questions were categorical, SEM can treat ordinal data as continuous. Hence the data on the magnitude of the exercise or dietary change that participants had made (large increase, moderate increase, small increase, and so on) were used to measure health behaviour change.

Since SEM cannot be performed on data with missing values, missing data (which accounted for less than 7% of all values) were replaced using regression imputation. Cases with imputed values were then compared with cases with no missing values using univariate statistics. There appeared to be no obvious difference between the two sets of observations, suggesting that the missing values occurred randomly.

The standard method of estimating free parameters in SEM is to use maximum likelihood (ML). AMOS (Analysis of Moment Structures) version 16 software was used for model development and analysis. Initial model design was based on relationships identified between variables in the existing literature. Where further discrimination was needed, bivariate statistical analyses previously carried out were considered. A difficulty inherent in the model design was that the relationships between many variables are probably bi-directional (for example, self-efficacy is likely to impact BMI and BMI could in turn influence self-efficacy). Since AMOS can only accommodate uni-directional relationships, they were represented in the most plausible way that could be identified, but their reciprocal nature needs to be acknowledged when interpreting results.

The statistical output for each model indicated both the extent to which the model reflected the data ('goodness of fit'), and the 'trade-off' between model fit and model complexity. This focused on three statistics: chi-square, scaled chi-square and root mean square error of approximation (RMSEA). While chi-square measures are commonly cited in SEM studies, these are sample size dependent. The scaled chi-square measure is an indication of average lack of fit per parameter, which includes the degrees of freedom, and allows for comparison between studies. Values of between 1.0 and 3.0 were considered to indicate good fit, with values of less than 1.0 reflecting 'overfit', and those above 3.0 reflecting lack of fit. RMSEA measures closeness of fit and unexplained variation, and takes into account the complexity of the model. Values less than 0.05 indicate good fit, and those as high as 0.08 represent reasonable errors of approximation [29].

In light of the observational nature of the study and the types of variables being examined, it was not intended that SEM could indicate causal relationships. The primary intention was to develop sufficient understanding of these relationships to be able to make initial recommendations on how to support midlife women in successfully undertaking health behaviour changes.

3. Results

Key descriptive and bivariate statistics are shown in this section to provide a background to the development and testing of models for exercise and dietary change.

3.1. Socio-demographic profile of participants

The participants were almost evenly distributed across urban and rural areas (52.6% cf. 47.4%) and the groups were not significantly different on the basis of any other socio-demographic variables, BMI or chronic health conditions. Therefore, the data were analysed as a single sample.

The age of the sample ranged from 51 to 66 years, with 56.7% being less than 60.

Participants in the younger group were more likely to be employed ($t_{542} = -7.9$, $p < 0.001$) and have a higher income ($t_{519} = 3.5$, $p = 0.001$), whereas the older group were more likely to have chronic disease i.e. hypertension ($t_{503} = 2.8$, $p = 0.005$) and arthritis ($t_{507} = 2.7$, $p = 0.007$).

Table 1 shows the characteristics of the 564 women who participated in this analysis. In summary, most were married or in a defacto relationship, education was relatively evenly split between those who had finished three years of secondary schooling or less and those who had completed secondary school or further qualifications, and most were from low or medium socio-economic backgrounds.

Table 1.

Frequency distribution of socio-demographic variables

Socio-demographic variables	***n***	**%**
Marital status *(n =554)*		
Married/defacto	425	76.7
Divorced/separated/widowed	106	19.1
Single/never married	23	4.2
Country of birth *(n = 549)*		
Australia	458	83.4
UK/Ireland	59	10.7
Italy	2	0.4
New Zealand	6	1.1
Netherlands	2	0.4
Other	22	4.0
Education level *(n = 546)*		
Grade 10 or less	274	50.2
Completed secondary school	84	15.4
Trade/tech certificate/diploma	70	12.8
University/college	97	17.8
Other	21	3.8
Employment status *(n = 544)*		
Full-time	137	25.2
Part-time	116	21.3
Not in paid employment	291	53.5

***Gross ann. household income** (n = 521)*		
$20,000 and under	113	21.7
$20,001-$40,000	142	27.2
$40,001-$60,000	100	19.2
$60,001 and over	137	26.3
Does not know	29	5.6

3.2. BMI

Almost two-thirds of the sample (63.4%) had a BMI of over 25 — which is considered by WHO standards to be pre-obese or overweight — and almost one-third (30.2%) were obese. Table 2 shows the breakdown of BMI by category.

Table 2.

BMI of participants

Body Mass Index *(n = 506)*	***n***	***%***
Underweight (<18.5)	5	1
Normal weight (18.5-24.9)	180	35.6
Overweight (25-29.9)	168	33.2
Obese (>30-39.9)	153	30.2

3.3. Chronic health conditions

The frequency of chronic health conditions is shown in Table 3. Since bivariate analyses showed no significant relationship between the incidence of these conditions and key variables in the study, these data were not included in later model development and testing.

Table 3.

Incidence of chronic health conditions

Health conditions	***n***	**%**
Back problems *(n=511)*	258	51.1
Arthritis/rheumatism *(n= 515)*	228	45.2
Hypertension *(n=511)*	186	36.6
Incontinence *(n=506)*	171	34.6
Headache/migraine *(n=501)*	162	32.5

3.4. Exercise and dietary self-efficacy

The mean exercise self-efficacy score for participants was 47 (SD = 24), and the range was from 0 to 100. High exercise self-efficacy was considered to be a score of 65 or more (the 75th percentile and above), and low exercise self-efficacy was regarded as 29 or less (the 25th percentile and below). The mean dietary self-efficacy score was 59 (SD = 19), and the range was from 0 to 96. Using the same percentiles, high dietary self-efficacy was considered to be 72 and above, and low dietary self-efficacy was 48 and below.

Bivariate calculations showed that women with high exercise self-efficacy were more likely than women with low exercise self-efficacy to have a university or college education ($\chi^2_{10} = 24.1$, $p = 0.007$), to live in households with a higher annual gross income ($60,000 or more per annum) ($\chi^2_{12} = 22.6$, $p = 0.03$), to have a normal BMI ($\chi^2_{8} = 28.7$, $p < 0.001$), and to make an exercise change after age 40 ($\chi^2_{2} = 16.9$, $p =< 0.001$). Women with high dietary self-efficacy were more likely to have a normal BMI ($\chi^2_{8} = 32.6$, $p < 0 .001$), and to make changes to their diet after age 40 ($\chi^2_{2} = 11.8$, $p = 0.003$).

3.5. Exercise and dietary health behaviour change

Approximately one-third of the sample (34.6%) made a positive change to their exercise (usually walking more) since age 40, and most of those (86.2%) believed that they had increased their exercise by a large or moderate amount. Women who made a change to their exercise were likely to have a higher education level than women who did not make a change ($\chi^2_{5} = 20.2$, $p = 0.001$).

Approximately 60% made a positive dietary change (usually eating less fat) since turning 40, and again most of those (87.8%) believed they had increased their intake of healthy food by a large or moderate amount. Women with higher education levels were more likely to make a dietary change (χ^2_5 =15.3, $p = 0.009$).

The main reasons for making an exercise change were to improve health (12.8%), lose weight or avoid gaining weight (12.1%), or in response to illness, injury or medical advice (12.8%). The main reasons for making a dietary change were similar: to lose weight or avoid gaining weight (25.1%), in response to illness or medical advice (21.5%), or to live a longer, healthier, life (14.9%).

Of those who had not made a change to their exercise, 64 (20.1%) had no intention of doing so, 156 (48.9%) indicated that they would like to but hadn't, and 99 (31.0%) were already regular exercisers. Of those who had not made a dietary change, 22 (9.3%) had no intention of it, 70 (29.5%) would like to but hadn't, and 145 (61.5%) believed they already ate healthily.

3.6 Health-related quality of life

There were no clinically significant differences between the scores from this study and the Australian norm scores for women aged 55-64 years. When the socio-demographic variables were considered, education was shown to be significantly related to physical health (PCS) (χ^2_5 = 13.4 $p = 0.02$) and age was shown to be significantly related to mental health (MCS), ($r = 0.10$, n = 483, p = 0 .03).

Significant relationships were also shown between exercise self-efficacy and both PCS ($r = 0.24$, $n = 424$, $p < 0.001$) and MCS ($r = 0.11$, $n = 424$, $p = .02$), although neither PCS ($r = 0.05$, $n = 442$, $p = 0.31$) nor MCS was significantly related to dietary self-efficacy ($r = 0.09$, $n = 442$, $p = 0.06$).

Making an exercise change was significantly related to PCS ($\chi^2_{10} = 36.3$, $p < 0.001$), but not to MCS ($\chi^2_{10} = 11.6$, $p = 0.31$). Making a dietary change was not significantly related to either physical ($\chi^2_{10} = 6.6$, $p = 0.76$), or mental health ($\chi^2_{10} = 6.0$, $p = 0.81$). Consequently, making a positive health behaviour change results in higher health-related quality of life with respect to exercise, but not diet, and brings about better physical health.

3.7 Exercise modeling

A range of exercise models was developed based on the literature and previous statistical calculations. It should be noted that the relationships between variables in the most powerful models did not always reflect the relationships shown by the bivariate statistics. The model shown in figure 1 provided the best fit for the data ($\chi^2_{12} = 29.7$, scaled $\chi^2 = 2.5$, RMSEA = 0.05). P-values showed all relationships to be significant at the .05 level.

The strongest relationships (based on standardized β values) were between BMI and self-efficacy, BMI and PCS, and self-efficacy and PCS. As BMI increases it could be expected that self-efficacy and PCS would decrease. BMI impacted self-efficacy, which impacted whether women made a change to their exercise level. Self-efficacy, BMI, exercise change and PCS are likely to influence each other back and forth in a continuous fashion

Education was shown to influence both self-efficacy and BMI, suggesting that women with lower education may be more vulnerable to weight gain and low self-efficacy. While BMI and self-efficacy influenced physical health, this was not the case with mental health. As might be expected, exercise change affected physical health. Age had a bearing on mental health, reflecting both the literature and the SF-36 results showing that postmenopausal women seem to experience better mental health than women in the earlier stages of the menopausal transition. Although mental health did not appear to play a central part in bringing about exercise change, the data fit was stronger when it was included as part of the process involved in health behaviour change.

The model also reinforces the potential impact of a range of variables coinciding. For example, women with low education, high BMI, and low MCS (possibly reflecting depression or anxiety) would be likely to have low self-efficacy and need considerable support to increase their exercise.

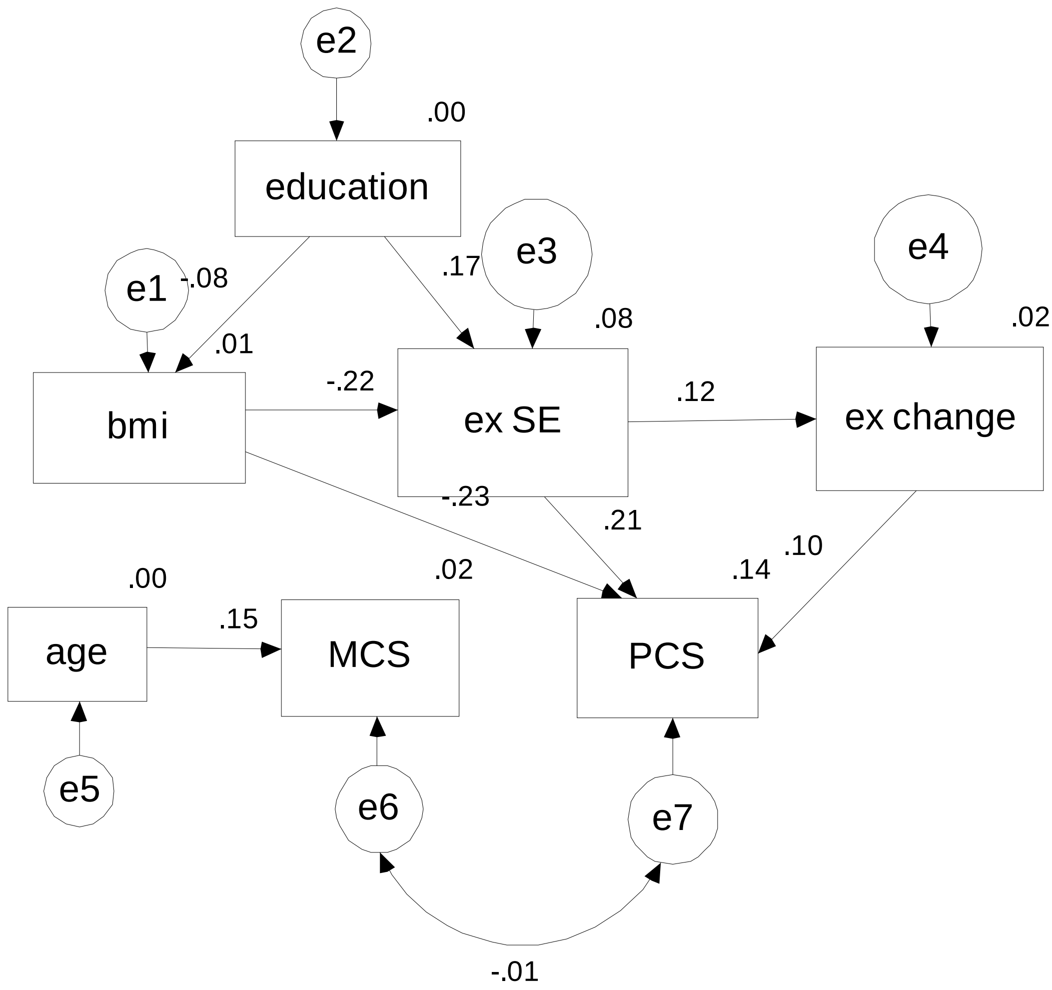

Fig. 1. Exercise change model

3.8 Dietary modeling

The strongest of the dietary models is shown in figure 2 (χ^2_{10} = 19.2, scaled χ^2 = 1.9, RMSEA = 0.04). All relationships between variables were strong based on standardized β values, and all p-values were significant. This model again shows BMI influencing self-efficacy, which influences behaviour change. Age again influences mental health, and BMI influences physical health.

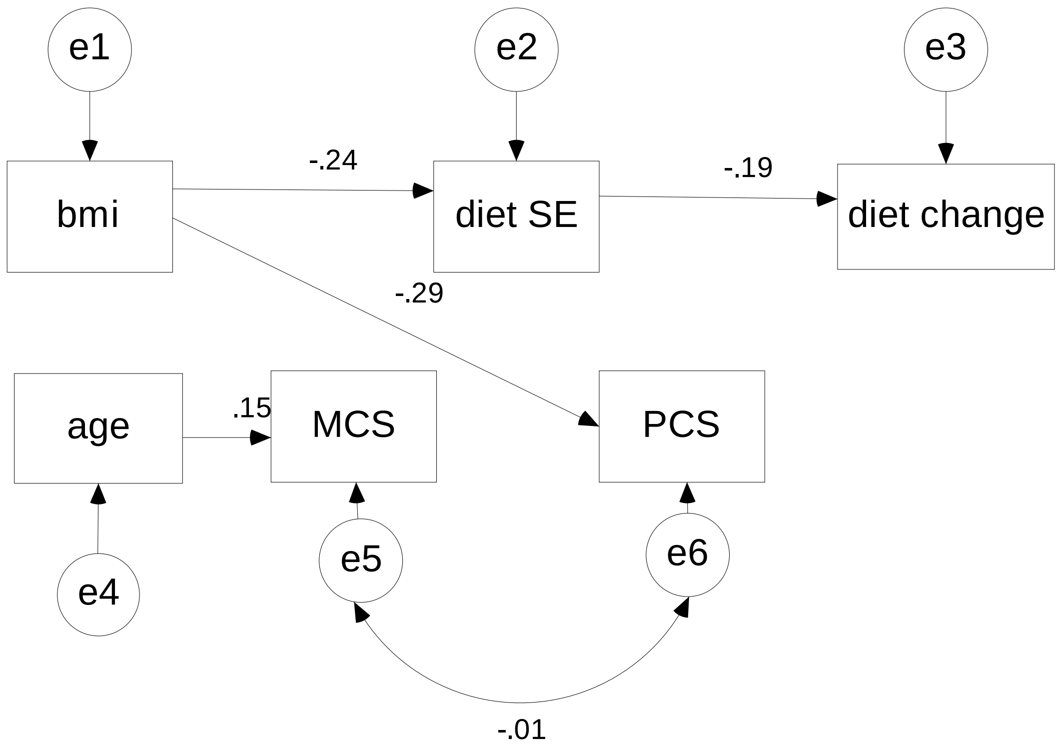

Fig. 2. Dietary change model.

As for exercise, the dietary model showed that BMI can have considerable influence on self-efficacy and PCS, and is important in understanding the factors that promote or inhibit dietary change.

This model showed that midlife women who have high self-efficacy for diet will be likely to make a positive change to their dietary behaviour, but that there is no evidence for a relationship between making a dietary change and having high health-related quality of life.

In summary, the relationships between BMI and self-efficacy, self-efficacy and health behaviour change, BMI and PCS, and age and PCS were common to both models. The differences were that the exercise model included the influence of education on BMI and self-efficacy, and a significant relationship between exercise change and physical health

While the two models presented were a good fit for the data, it is important to acknowledge that other models not investigated could fit the data equally well.

4. Discussion

Both the exercise and dietary models showed a relationship between BMI and self-efficacy, and between self-efficacy and making a behaviour change. Although weight gain was an impetus for women to improve their exercise and diet, perhaps there is a weight threshold, beyond which, women become resigned and lose confidence in their ability to make changes. This is likely to vary from women to woman, and may be different for exercise and diet. The relationship between self-efficacy and health behaviour change in both models reinforced previous assertions [16-18] regarding the importance of self-efficacy in behaviour change. This implies that mastery experiences, role models, encouragement, and positive self-appraisal are important in facilitating positive exercise and dietary change among midlife women.

The modeling also showed that BMI has an effect on physical health status for exercise and diet, reinforcing earlier studies [23, 24]. The fact that mental health does not seem to be affected by BMI nearly as much as physical health may suggest that by this age women are more aware of the physical consequences of carrying excess weight, such as mobility limitations, back pain and so on.

Exercise change was related to physical health, but dietary change was not. Although women are more willing to make dietary changes than to do more exercise, perhaps women who exercise experience more tangible physical benefit. Neither exercise nor dietary change had an impact on mental health. There could be various explanations for

this. Perhaps other life stresses outweighed the emotional benefits of making lifestyle improvements, or perhaps it is simply difficult to identify a relationship between lifestyle changes made over a long period (up to 25 years in the case of 65 year olds) and HRQOL which reflects experiences within the previous 4 weeks.
The role of education identified previously [19, 20] was confirmed in this study, although education was not identified as a component of the dietary model. Education influenced both BMI and exercise self-efficacy in relation to exercise change. Women with lower education levels appear less likely to believe that they can exercise regularly, and are more likely to be overweight or obese compared to women with more education. This group might also have less appreciation of the value of exercise in preventing chronic disease.

This is not helped by media messages that mainly portray exercise and diet as ways to improve appearance, and pay little attention to the link between obesity and disease, disability, menopausal symptoms, and anxiety and depression. Similarly, media messages rarely indicate that being active is critical to women's quality of life as they age. More information needs to be made available to women on the potential benefits of adopting a healthy lifestyle, beyond appearance.

The results suggest that when a woman is dealing with a range of variables that could impact self-efficacy (e.g., low education level, a high BMI, and poor mental health) it may be extremely difficult for her to adopt positive health behaviours. This needs to be considered in the design of health promotion programs. It also implies that overweight and obese girls who leave school at a young age are at risk of moving down a path that could lead to chronic disease later in life.

Finally, the relationship identified in the literature between age and mental health [25] was supported in both models. Women in their 60s seem more accepting of health and bodily changes and to have a more positive view of their well-being than do women in their 50s. This also has implications for lifestyle programs targeting women in these age groups. The younger group is likely to be more physically able but need support in adapting to the bodily changes that occur with ageing, while the older women will need greater physical assistance but are likely to be accepting of that.

While exercise and dietary change have been examined separately in this study, the processes involved in each clearly overlap. Making a change in one area may predispose a woman to making a change in the other area. Since most women preferred making dietary changes to exercising more, perhaps lifestyle modification programs need to start with dietary changes and encourage women to be more active as a second stage. The most effective approaches to preventing and managing disease conditions can be expected to target multiple health behaviours.

The study had several limitations. First, since it was observational, no inferences can be made regarding causality in assessing the relationships between variables. Second, the participants were predominantly white, Anglo-Australian, married and relatively homogenous. As such, their responses did not reflect the experiences of women from other racial and cultural backgrounds or lesbian women, although they probably reflected the majority of Queensland and Australian women in their 50s and 60s. Third, the women were asked to recall whether they had made a change to their exercise behaviour since turning 40. The oldest women in the sample were expected to recall their behaviour over a period of around 25 years. Most women who made changes indicated that those changes occurred much later than age 40, but the reliance on recall is none-the-less a limitation. Fourth, BMI data was calculated from self-reported height and weight, which is also a limitation. Despite this, the results still reflected high levels of overweight and obesity.

A strength of the study was the strong sample size which enabled a robust initial investigation of processes involved in exercise and dietary change among middle-aged women. Future research opportunities include the application of the findings in an intervention study to verify the relationships identified, investigation of these relationships within other samples, and consideration of other health behaviours (such as stress management). A greater understanding of women's relationship to health behaviour change in midlife will make an important contribution to the design and delivery of health promotion and disease prevention programs targeting this group.

Acknowledgements

This study was supported by the Queensland University of Technology.

References

[1] Wyn R, Solis B. Women's health issues across the lifespan. Women's Health Issues 2001; 11 (3): 148-159.

[2] Australian Institute of Health and Welfare. Australia's Health. 2006 Canberra.

[3] Douchi T, Yonehara Y, Kawamura Y, Kuwahata A, Kuwahata T, Iwamoto I. Difference in segmental lean and fat mass components between pre- and postmenopausal women. The Journal of the North American Menopause Society 2007; 14 (5): 875-878.

[4] Sternfeld B, Bhat A, Wang H, Sharp T, Quesenberry C. Menopause, physical activity, and body composition/fat distribution in midlife women. Medicine & Science in Sports & Exercise 2005; 37 (7): 1195-1202.

[5] Adams K, Schatzkin A, Harris T, Kipnis V, Mouw T, Ballard-Barbash R et al. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. The New England Journal of Medicine 2006; 355 (8): 763-778.

[6] Janssen I, Mark A. Separate and combined influence of body mass index and waist circumference on arthritis and knee osteoarthritis. International Journal of Obesity 2006; 30: 1223-1228.

[7] Muennig P, Lubetkin E, Haomiao J, Franks P. Gender and the burden of disease attributable to obesity. American Journal of Public Health 2006; 96 (9): 1662-1668.

[8] Field A, Coakley E, Must A, Spadano J, Laird N, Dietz W et al. Impact of overweight on the risk of developing common chronic diseases during a ten year period. Archive of Internal Medicine 2006; 161 (13): 1581-1586.

[9] Eliassen AH, Colditz G, Rosner B, Willett W, Hankinson S. Adult weight change and risk of postmenopausal breast cancer. Journal of the American Medical Association 2006; 296 (2): 193-201.

[10] Towfighti A, Saver J, Engelhardt R, Ovbiagele B. A midlife stroke surge among women in the United States. Neurology 2007: 69: 1898-1904.

[11] Williams L. Factors affecting weight change in mid-aged women. Doctoral thesis 2007, Research Centre for Gender and Health, University of Newcastle, Australia.

[12] Daley A, MacArthur C, Stokes-Lampard H, McManus R, Wilson S, Mutrie, N. Exercise participation, body mass index, and health-related quality of life in women of menopausal age. British Journal of General Practice 2007; 57: 130-135.

[13] Utian WH, Boggs PP. The North American Menopause Society Survey, Part 1: Postmenopausal women's perceptions about menopause and midlife. Menopause 1998: 6 (2): 122-128.

[14] Finn SC. Women in midlife: A nutritional perspective. Journal of Women's Health & Gender-Based Medicine 2000; 9 (4): 351-356.

[15] Sampselle C, Harris V, Harlow SD, Sowers M. Midlife development and menopause in African American and Caucasian women. Health Care for Women International 2002; 23: 351-363.

[16] Bandura A. Self-efficacy: The exercise of control 1997. New York: Freeman.

[17] Bandura A. Self-efficacy: Toward a unifying theory of behavioural change. Psychological Review 1977; 84 (2): 191-215.

[18] Bandura A. Swimming against the mainstream: The early years from chilly tributary to transformative mainstream. Behaviour Research and Therapy 2004; 42: 613-630.

[19] Roskam AJ, Kunst AE. The predictive value of different socio-economic indicators for overweight in nine European centres. Public Health Nutrition 2008; 11 (12): 1256-66.

[20] Gregory CO, Blanck HM, Gillespie C, Maynard LM, Serdula, MK. Perceived health risk of excess body weight among overweight and obese men and women: differences by sex. Preventive Medicine 2008; 47 (1): 46-52.

[21] Heesch K, Miller Y, Brown W. The impact of changes in physical activity on quality of life among mid-age and older women. Paper delivered at 6th annual conference of the International Society for Behavioural Nutrition and Physical Activity, Oslo. 2007

[22] Brown WJ, Mishra G, Lee C, Bauman A. Leisure time physical activity in Australian women: relationship with wellbeing and symptoms. Research Quarterly for Exercise and Sport 2000; 71 (3): 206-216.

[23] Hopman W, Berger C, Joseph L, Barr S, Gao Y, Prior J et al. The association between body mass index and health-related quality of life: data from CaM*os*, a stratified population study. Quality of Life Research 2007; 16: 1595-1603.

[24] Huang I-C, Frangakis C, Wu A. The relationship of excess body weight and health-related quality of life: evidence from a population study in Taiwan. International Journal of Obesity 2006; 30: 1250-1259.

[25] Tannenbaum C, Ahmed S, Mayo N. What drives older women's perceptions of health-related quality of life? Quality of Life Research 2007: 16: 593-605.
[26] World Health Organisation. Global database on body mass index/BMI classification. Retrieved October 18, 2008, from http://www.who.int/bmi/index

[27] Bandura A. Self-efficacy scales for exercise and for adhering to a low fat diet. 1997. Retrieved 1 September, 2005 from http://www.des.emory/mfp/self-efficacy.html

[28] Ware J, Sherbourne C. The MOS 36-item short-form health survey (SF-36). Conceptual framework and item selection. Medical Care 1992; 30: 473-483.

[29] Browne M, Cudeck R. Alternative ways of assessing model fit. In: K.A. Bollen KA, Long JS, eds. Testing Structural Equation Models: Sage, 2003; 445-455.