Original Article

# Trends in BMI, diet and lifestyle between 1976 and 2005 in North Sydney

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Although the prevalence of overweight and obesity in Australia has increased during the past 30 years, little is known about the dietary and behavioural antecedents of body mass index (BMI). We examined changes in mean BMI, diet, and other lifestyle behaviours between 1976 and 2005 and described the cross-sectional associations between these factors and BMI. A series of biennial biomedical surveys by Sydney Adventist Hospital from 1976 to 2005 allowed examination of BMI trends, while the selection of three surveys enabled detailed examination of likely dietary and lifestyle associations. Subjects included in this study were: 384 men and 338 women in 1976; 160 men and 146 women in 1978; 166 men and 141 women in 1980; 164 men and 142 women in 1982; 177 men and 13 women in 1984; 239 men and 227 women in 1986; 210 men and 225 women in 1988; 165 men and 148 women in 1990; 138 men and 167 women in 1992 and 270 men and 62 women in 2005. Height and weight were measured by hospital staff. Mean BMI increased in the early 1990s. Salt, coffee, cola, alcohol and meat consumption, dieting to lose weight and eating between meals were positively associated with BMI while physical activity, food variety, large breakfasts and consumption of spreads were negatively associated. Food consumption and daily activities have important associations with BMI, though their specific associations differ by sex. "Affluent" lifestyle patterns appear to contribute to higher BMI, while a more "prudent" lifestyle seems to protect from such increases.

**Key Words: BMI, diet, lifestyle, prudent lifestyle, Western lifestyle**

## INTRODUCTION

The prevalence of obesity is increasing worldwide in both developing and developed countries. Approximately 250 million people around the world are obese and the World Health Organization (WHO) has estimated that this number will increase to 300 million by 2025.[1]

In Australia over the last 20 years, there have been increases in the proportions of people who are overweight or obese. Approximately 60% of the adult population is overweight or obese, characterised by a body mass index (BMI) greater than 25 kg/m$^2$. The prevalence of overweight and obesity in Australian adults continued to rise during the 1990s and the current population proportion is two and one-half times higher than that in 1980.[2] Furthermore, 20% of the adult population is obese (characterised by a BMI of greater than 30 kg/m$^2$).[2,3] This increase poses major concerns in terms of health and the economy.[4]

The health consequences of obesity are many and varied. It accounts for much of the excess morbidity and mortality associated with type 2 diabetes, coronary heart disease (CHD), cardiovascular disease (CVD), hypertension, gallbladder disease, the metabolic syndrome, osteoarthritis, sleep apnea, gout and certain types of cancer, as well as premature mortality.[4,5] Furthermore, the stigmatisation associated with the condition creates its own psychosocial problems.[4]

Halting the rise of this epidemic has become an important public health priority and the focus of public health programs in many countries, both industrialised and developing.[6] The reasons for the increase in obesity are unclear but changes in food consumption, physical activity, sedentary behaviour and occupational stresses[7] are likely to have considerable influence. To date there is limited empirical evidence about the possible antecedents of obesity. Increases in energy intake and decreases in physical activity have been broadly implicated for the epidemic.[8] In Australia there have been three National Heart Foundation CHD risk factor prevalence studies during 1980, 1983 and 1989, two National Nutrition surveys conducted in 1986 and 1995, the National Health Surveys conducted in 1989/1990, 1995, 2001 and 2004/2005, various State Health Surveys and the AusDiab surveys conducted in 1999/2000 and 2004/2005.[9-11] Apart from the National Nutrition surveys there have been no studies which have included detailed dietary or lifestyle behavioural assessm-

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ents, along with BMI indices.[11] Consequently, these surveys only provide very crude information about trends in obesity during the last 30 years and provide little information about its likely dietary and lifestyle associations.

It is in this connection that the sentinel data set held by the Sydney Adventist Hospital (SAH) is valuable. Since 1976, the SAH has screened about 1000 people per year to assess the state of their heart, food consumption, other lifestyle factors and various biomedical indices. To the best of our knowledge no other data set in Australia contains such extensive information over the period of radical social, culinary and economic change that occurred in Australia from 1976 to the present time. The aims of the present study were therefore to provide the most detailed examination of changes in BMI, diet and lifestyle among middle to high SES individuals in Australia during the last 30 years and to understand some of the dietary and behavioural antecedents of BMI in specified time periods between 1976 and 2005.

## MATERIAL AND METHODS

### *Participants*

Heart health screening services were offered in northern Sydney to people from diverse social and religious backgrounds. People were invited to attend for screening through an advertising campaign involving local churches, electronic media, newspapers and hospital services. The data set provides unique information about dietary and lifestyle changes that occurred during the rise of the obesity epidemic in Australia.

Data from 1976, 1978, 1980, 1982, 1984, 1986 1988 1990 1992 and 2005 were examined for changes in BMI. Unfortunately, data from 1994 to 2004 was not available due to logistic problems. Each year sample comprised a different set of individuals. Data from three years, approximately 10 years apart: 1976, 1986 and 2005; (1996 was not available due to logistic reasons) were selected to provide detailed examination of the associations of diet and lifestyle with BMI. In effect this enabled the same cross-sectional study to be replicated three times. Using a similar approach but reported elsewhere, the associations between lifestyle and BMI were compared for Seventh-day Adventists (SDA) and non-SDA to examine the effects of a prescriptive lifestyle on the secular changes in BMI.[12]

### *The Instruments*

Respondents were asked to complete a questionnaire by hospital staff at the time of screening which included a food frequency questionnaire, frequency of various moderate and vigorous physical activities, dietary habits, smoking and alcohol usage, and lifestyle.

### *Food frequency questionnaire*

Forty two different foods and drinks, ranging from a variety of meats, cheeses, milks, sweets, desserts, sweet drinks, alcoholic drinks, tea, coffee, spreads (jam, marmalade, syrup and honey), salad dressings, butter, margarine, vegetables, fruit, cereals and breads, were included in the 1976 questionnaire. Dietary practices included: "relative breakfast size" (compared to reference breakfast), "dieting to lose weight", and frequency of "cut fat from meat", "eat between meals" and "add salt at table". These foods and dietary practices were replicated in the 1986 questionnaire, with the addition of fish and cream. The 2005 questionnaire included variables from previous years but scaled down the variety of meats, milks and dessert foods, while including information on the relative size of dinner, and consumption of takeaway, low calorie and low fat foods. Variables measured on a daily basis were converted to weekly by multiplying the midpoint value by seven. For example, a reported food frequency of 3-5 times per day was converted to 4x7 times per week, i.e. 28 per week.

### *Physical activity*

This section of the questionnaire was similar for 1976 and 1986 and included frequency of participation in walking, running, cycling, swimming, tennis, vigorous gardening and other vigorous activity/week. These categorical variables were converted to continuous variables by determining the midpoint of the range for each category (similar to the FFQ conversion). However, in 2005, the respondents recorded the frequency of exercise/week, time (minutes) of each exercise session and intensity (low, moderate, high). Total time exercised was determined by multiplying the time spent in exercise by the frequency.

### *Time urgency*

Time urgency was assessed in 1976 using variables from the Jenkins Activity Survey (JAS) AB subscale[13], and in 1986 using the short version (seven-items) of the Bortner scale.[14] In 2005, time urgency was a part of a larger set of variables, called "quality of life", developed in house by SAH, Centre for Health Management Staff. Principal components analysis (with varimax rotation) was used to reduce the large number of variables in 2005 to a smaller set of four underlying components ("factors") of which time urgency was one. Internal reliabilities, assessed by Cronbach's alpha were: 0.78 (1976: $p<0.01$), 0.63 (1986: $p<0.01$), 0.64 (2005: $p<0.01$).

### *Other lifestyle factors*

Other lifestyle factors examined included hours of sleep per night, smoking status (current, past and never smoked), frequency of alcohol consumption and number of drinks consumed per sitting (1976 and 1986) or per day (2005).

### *Body mass index*

Height and weight used to measure BMI were measured objectively by hospital staff. BMI was calculated as follows: weight (kilograms)/ height (meters) x height (meters), with the unit $kg/m^2$. BMI was further dichotomised into normal weight ($<25$ $kg/m^2$) and overweight/obese ($\geq 25$ $kg/m^2$).

### *Data analysis*

Logistic regression was performed to compare the changes in the proportion that were overweight or obese between 1976 and 2005. Bivariate analyses were conducted to examine the relationships between respondents' BMI and a series of variables which have been associated with BMI in the literature, including age, sex, education, occupation status, and marital status; food consumption

variables, and eating habits (above). Pearson's r was used to assess relationships between BMI and continuous variables. The relationships between nominal or ordinal variables likely to be associated with BMI were examined by Spearman's rank-order correlation using two-tailed tests of significance. Those variables which were significantly related to BMI were subsequently entered into one of three multiple regression analyses of BMI (one analysis for each survey year). A *p*-value of 0.05 was considered significant. Data were analyzed using the Statistical Package for the Social Sciences statistical software package version 12.0 (SPSS Inc., Chicago, IL, USA).

## RESULTS

### *Age*

There were no differences in the mean age of male and female participants in any of the years examined, except 1980 and 1988 (Table 1). Compared to the NSW and Australian populations, the SAH participants in 1976, 1986 and 2005 were older and better educated.[15-17]

### *Trends in mean BMI for men and women*

Differences in trends in BMI for men and women were found (Figure 1). For men, no significant changes in mean BMI occurred until 1990 at which point BMI increased (Figure 1). A further increase occurred in 1992, followed by a marginal increase in 2005. The overall model fit by logistic regression analysis was good (chi-square =124, 10 degrees of freedom, total sample size = 2049, $p<0.001$). The model correctly classified 61.8% of overweight/obese men. Between 5.9% and 7.9% of changes in men's weight were explained by year and age. There was a 1.6 fold increase in the risk of being overweight or obese in 1990 compared to 1976; a 2.2 fold increase in 1992 and a 2.4 fold increase in 2005 compared to 1976 (Table 2).

The mean BMI of women, like that of men, was significantly higher in 1990 than all preceding years, except for 1982 and 1988, and rose further in 1992 (Figure 1). Unlike men however, the women's BMI fell significantly in 2005. The model fit by logistic regression was good (chi-square =108, 10 degrees of freedom, total sample size = 1704, $p<0.001$) and correctly classified 67.3% of all overweight/obese women. Between 6.2% and 8.5% of changes in women's weight were explained by year and age. Among women there was a 1.7 fold increase in being

**Table 1.** Age comparison (independent *t* test) of the samples of men and women studied in the present analysis

| | Men | | | Women | | | *t* | ***p*** |
|---|---|---|---|---|---|---|---|---|
| | n | Age (years) Mean | SE | n | Age (years) Mean | SE | | |
| 1976 | 384 | 44.4 | 0.64 | 340 | 45.7 | 0.75 | -1.32 | 0.189 |
| 1978 | 160 | 43.6 | 1.00 | 146 | 45.5 | 1.20 | -1.22 | 0.225 |
| 1980 | 166 | 47.5 | 0.94 | 141 | 51.4 | 0.85 | -3.12 | 0.002 |
| 1982 | 164 | 47.8 | 0.93 | 142 | 50.5 | 1.05 | -1.91 | 0.057 |
| 1984 | 177 | 49.5 | 0.96 | 130 | 49.5 | 1.19 | 0.05 | 0.961 |
| 1986 | 239 | 44.8 | 0.82 | 227 | 43.8 | 1.09 | 0.78 | 0.439 |
| 1988 | 201 | 46.9 | 1.14 | 225 | 43.5 | 1.05 | 2.21 | 0.027 |
| 1990 | 165 | 45.4 | 1.06 | 148 | 44.3 | 1.16 | 0.69 | 0.491 |
| 1992 | 138 | 45.6 | 0.93 | 167 | 44.7 | 0.98 | 0.68 | 0.497 |
| 2005 | 270 | 49.7 | 0.57 | 62 | 47.6 | 1.26 | 1.56 | 0.119 |

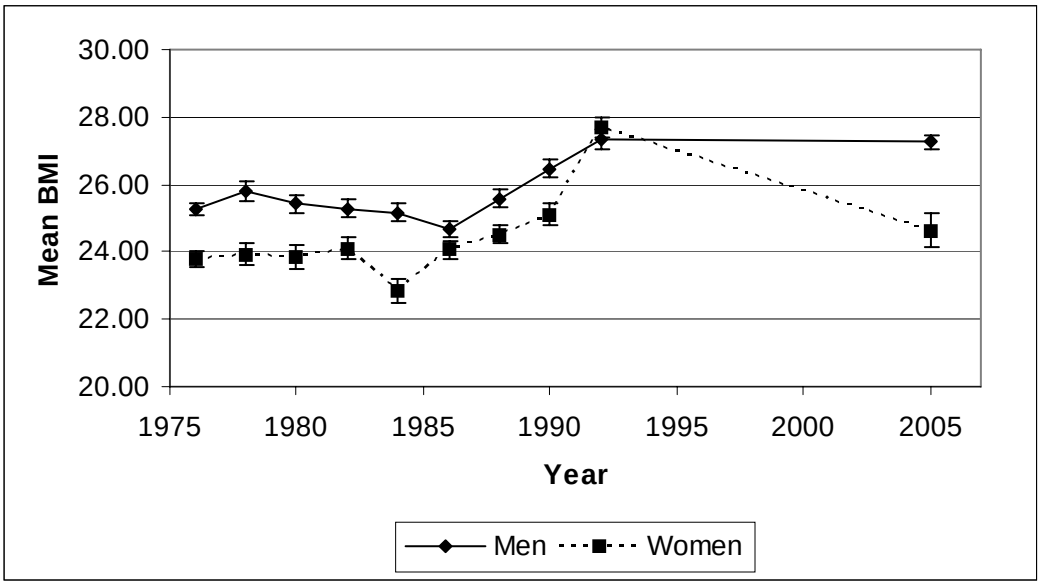


**Figure 1.** Biennial changes in mean BMI between 1976 and 2005 for men and women, Values are means with their standard errors represented by vertical bars. After adjusting for age: men (F=12.20, $p<0.001$) and women (F=7.82, $p<0.001$)

**Table 2.** Logistic regression with regard to risk of overweight or obesity for men and women from 1976 to 2005

| Year | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | OR | *p* | 95% CI† | OR | *p* | 95% CI† |
| 1978 | 1.60 | 0.015 | 1.09 to 2.34 | 0.88 | 0.568 | 0.57 to 1.36 |
| 1980 | 1.02 | 0.915 | 0.71 to 1.48 | 0.87 | 0.516 | 0.56 to 1.34 |
| 1982 | 1.12 | 0.555 | 0.77 to 1.62 | 1.17 | 0.458 | 0.77 to 1.78 |
| 1984 | 0.98 | 0.892 | 0.68 to 1.40 | 0.50 | 0.007 | 0.30 to 0.82 |
| 1986 | 0.74 | 0.069 | 0.53 to 1.02 | 0.89 | 0.539 | 0.61 to 1.30 |
| 1988 | 1.07 | 0.694 | 0.75 to 1.53 | 1.23 | 0.272 | 0.85 to 1.77 |
| 1990 | 1.64 | 0.010 | 1.13 to 2.39 | 1.68 | 0.012 | 1.12 to 2.52 |
| 1992 | 2.19 | <0.001 | 1.45 to 3.32 | 3.85 | <0.001 | 2.59 to 5.71 |
| 2005 | 2.43 | <0.001 | 1.73 to 3.40 | 1.50 | 0.157 | 0.86 to 2.63 |

1976 was used as the reference group. Age was controlled in the logistic regression. † CI = Confidence Interval

overweight or obese in 1990 compared to 1976 and a 3.8 fold increase in 1992 (Table 2). Women's risk of being overweight or obese in 2005 decreased to 1.5 times that compared to 1976 however this was not significant ($p$=0.157) (Table 2).

***Antecedents of BMI in 1976, 1986 and 2005***

Food consumption and daily activities have important associations with BMI, though their associations differed by sex. Exceptions to this were dieting, cola and coffee consumption, which were positively associated with BMI, and spreads consumption, which was negatively related to BMI (Tables 3) in both men and women, but at different times. However, dieting to lose weight was the most consistent predictor of BMI for both sexes (Tables 3), except in 2005, when it was not included in the survey questionnaire.

Indeed there was little consistency among the associates of women's BMI from year to year apart from dieting to lose weight. However, for men the relative size of breakfast was a negative predictor of BMI in each of the three years, 1976, 1986 and 2005 (Table 3). Men who reported consuming the largest breakfasts had lower BMI. In fact, the proportion of men's BMI explained by relative breakfast size remained consistent between 5-6% for all three years analyzed. Physical activity was also a negative predictor of men's BMI in 1986 (2.6%) and 2005 (3.9 %).

For women other foods positively associated with BMI, were margarine, soft drink and whole milk consumption (Table 3). For men, frequency of meat (such as wieners and chicken), salad dressings, alcohol (but only for men between 25 and 34 years (partial correlation = 0.322, $p$=0.011 (two-tailed)), and egg consumption (more than one per sitting) were positively associated with BMI (Table 3). Most of these foods are either high in fat, sugar or both and considered energy dense foods. In addition, men who reported eating between meals once or twice a day had higher BMI than men who never ate between meals, while greater table salt use was also associated with higher BMI (Table 3).

Conversely, time urgency (sense of rush) and butter consumption were negatively associated with women's BMI (Table 3). For men, food variety and spreads consumption were negatively related to BMI (Table 3). Despite the differences in the mix of individual associates in each year, the proportion explaining BMI variance in each year was about 32-35% for men and 20-30% for women except for 2005 (10%).

***Trends in diet and lifestyle factors between 1976 and 2005***

Both men and women consumed eggs, spreads, extra foods, whole milk, grains, vegetables and fruit less frequently in 2005 than in previous years (Figure 2 and 3). Note that the whole milk finding helps validate the study findings, as we know from other sources that consumption dropped during this period.[18] Conversely, cola and alcohol were consumed more frequently by both sexes in 2005 than in previous years (Figure 2 and 3). However the frequency of coffee consumption did not change over the three time periods among women. The frequency of consumption of red meat decreased for both men and women between 1976 and 1986 with little change in 2005. With the decrease in red meat consumption a small increase in the frequency of poultry consumption between 1976 and 1986 was observed for both men and women (0.8 times per week to 1.2 times per week). In terms of energy expenditure, minimal changes in frequency were observed over the three time periods among both men and women.

## DISCUSSION

The findings of this study support data from national studies, which suggest that the obesity epidemic began around the mid 1980's. The increases were observed for both men and women, with the risk of being overweight or obese 1.7 times higher in 1990 than in 1976. However after 1992, women's BMI decreased while men's BMI remained elevated. This decrease may be due to changes in the samples as fewer women were available in the 2005 sample. On the other hand, women living in this higher socio-economic area of North Sydney may be more conscious of weight gain in light of the elicited adverse health and/or beauty effects of being overweight and therefore express restrained behaviours.[19]

The behavioural factors that were associated with changes in BMI were differentially distributed among women and men. However, the consumption of meat and "extra" foods (alcohol, butter, margarine, soft drink, cola, coffee and salad dressings) were positively associated with BMI for men and women. These findings were

**Table 3.** Statistically significant demographic, food and lifestyle associates of BMI in 1976, 1986 and 2005 for men and women

| Variable | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Year | F | *p* | B | $R^2$ (%) | Year | F | *p* | B | $R^2$ (%) |
| Breakfast | | 6.80 | <0.001 | | 6.1 | | | | | |
| Much less(36)* About the same(174) | | | 0.005 | -1.41 | | | | | | |
| Much less(36)* Somewhat or much more(68) | 1976 | | <0.001 | -2.39 | | | | | | |
| Somewhat less(48)* Somewhat or much more(68) | | | 0.002 | -1.63 | | | | | | |
| About same(174)* Somewhat or much more(68) | | | 0.011 | -0.98 | | | | | | |
| Breakfast | | 3.93 | <0.001 | | 5.6 | | | | | |
| Much less(24)* About the same(102) | | | 0.009 | -2.19 | | | | | | |
| Much less(24)* Somewhat less(53) | 1986 | | 0.009 | -1.76 | | | | | | |
| Much less(24)* Somewhat or much more(34) | | | 0.001 | -1.87 | | | | | | |
| Breakfast | | 3.19 | 0.044 | | 5.1 | | | | | |
| ≤Toast, coffee (30)* Substantial(19) | 2005 | | 0.035 | -1.89 | | | | | | |
| ≤Toast, coffee (30)* Moderate(85) | | | 0.022 | -1.48 | | | | | | |
| Dieting to lose weight | 1976 | 20.5 | <0.001 | 2.00 | 6.1 | 1976 | 6.69 | 0.011 | 1.66 | 6.3 |
| | 1986 | 19.1 | 0.004 | 2.54 | 8.7 | 1986 | 11.4 | 0.001 | 2.26 | 5.6 |
| Chicken | 1976 | 8.53 | 0.004 | 0.78 | 2.6 | | | | | |
| Wieners (processed sausages) | 1976 | 4.53 | 0.034 | 0.70 | 1.4 | | | | | |
| Spreads | 1976 | 13.4 | <0.001 | -0.09 | 4.1 | 1986 | 6.29 | 0.013 | -0.15 | 3.2 |
| Food variety | 1976 | 6.15 | 0.014 | -0.18 | 1.9 | | | | | |
| Number of alcoholic drinks per sitting | 1976 | 8.65 | 0.004 | 0.18 | 2.7 | | | | | |
| Alcoholic drinks†age | 1976 | 8.13 | 0.005 | 0.01 | 2.5 | | | | | |
| Age | 1976 | 39.1 | <0.001 | 0.09 | 11 | 1976 | 9.07 | 0.003 | 0.08 | 8.3 |
| | 1986 | 9.30 | 0.048 | 0.05 | 4.4 | 1986 | 4.70 | 0.031 | 0.04 | 2.4 |
| Butter | | | | | | 1976 | 6.02 | 0.016 | -0.07 | 5.7 |
| Soft drink | | | | | | 1976 | 6.57 | 0.012 | 0.55 | 6.2 |
| Whole milk | | | | | | 1986 | 5.24 | 0.023 | 0.11 | 2.7 |
| Coffee | | | | | | 1976 | 8.44 | 0.003 | 0.05 | 4.0 |
| | | | | | | 1986 | 4.10 | 0.044 | 0.06 | 2.1 |
| Margarine | | | | | | 1986 | 4.77 | 0.030 | 0.06 | 2.4 |
| Table salt | | 4.63 | 0.015 | | 6.5 | | | | | |
| Every meal/Very frequently(61)*Never(44) | 1986 | | 0.004 | 2.01 | | | | | | |
| Quite often(43)*Never(44) | | | 0.036 | 1.07 | | | | | | |
| Every meal/Very frequently(61)*Seldom(65) | | | <0.001 | 1.16 | | | | | | |
| Eating between meals | 1986 | 3.20 | 0.023 | | 3.1 | | | | | |
| Never/rarely (90)* 1-2 times per day (85) | | | 0.043 | 0.99 | | | | | | |
| Time urgency | | | | | | 1976 | 9.86 | 0.002 | -0.17 | 9.0 |
| Physical activity‡ | 1986 | 5.26 | <0.001 | -0.10 | 2.6 | | | | | |
| Days exercise per week§ | 2005 | 6.77 | 0.010 | -0.44 | 5.2 | | | | | |
| Number of eggs eaten per sitting | 2005 | 4.99 | 0.027 | 0.78 | 3.9 | | | | | |
| Smoking status | 2005 | 6.21 | 0.003 | | 9.1 | | | | | |
| Never(94)* Past smoker(35) | | | 0.001 | 2.10 | | | | | | |
| Salad dressings | 2005 | 6.38 | 0.006 | | 8.0 | | | | | |
| Sparingly(90)* Moderately(42) | | | 0.001 | 1.80 | | | | | | |
| Cola | 2005 | 8.78 | 0.004 | 1.41 | 6.6 | 2005 | 5.88 | 0.019 | 1.53 | 10.3 |
| Total $R^2$ | 2005 | | | | 31.9 | | | | | 29.3 |
| | 2006 | | | | 34.4 | | | | | 18.7 |
| | 2007 | | | | 33.7 | | | | | 10.3 |

Statistical model: backwards regression; B, unstandardised coefficient; *p*, significance; $R^2$, partial $\eta^2$; * Distinguishes categories with significant differences; ; † interaction with age (frequency of alcohol consumption associated with BMI among 25-34 year old men); ( ) refers to number in cell; ‡ frequency of physical activity per week, § number of days spent in physical activity per week

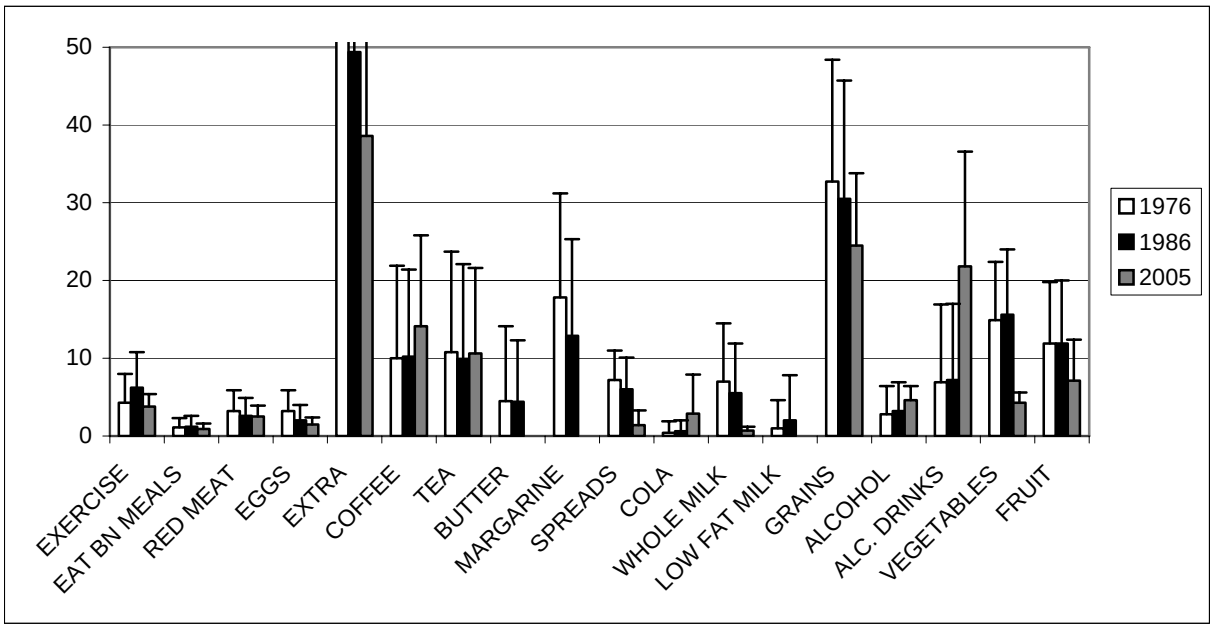


**Figure 2.** Changes in food consumption and other lifestyle patterns between 1976 and 2005 for men, Table shows mean frequency ± standard deviation. Exercise refers to frequency of physical activity; Eat bn Meals refers to frequency of eating between meals per day; Eggs, extra, coffee, butter, margarine, spreads, cola, soft drink, whole milk, low fat milk, grains, alcohol, vegetables, fruit refers to frequency of each food consumed in a week; extra refers to all foods classed as extra foods (cakes, pastries, pudding and jelly, biscuits, lollies, chocolate, sweetened drinks, butter, margarine, cream, ice-cream, dressing); grains refers to cereals, breads, crackers, muffins etc; alcohol refers to wine, beer, liquors, alc.drinks refers to number of alcoholic drinks consumed per sitting (1976, 1986) or per day (2005). Bars indicate years: white - 1976; black - 1986; grey - 2005.

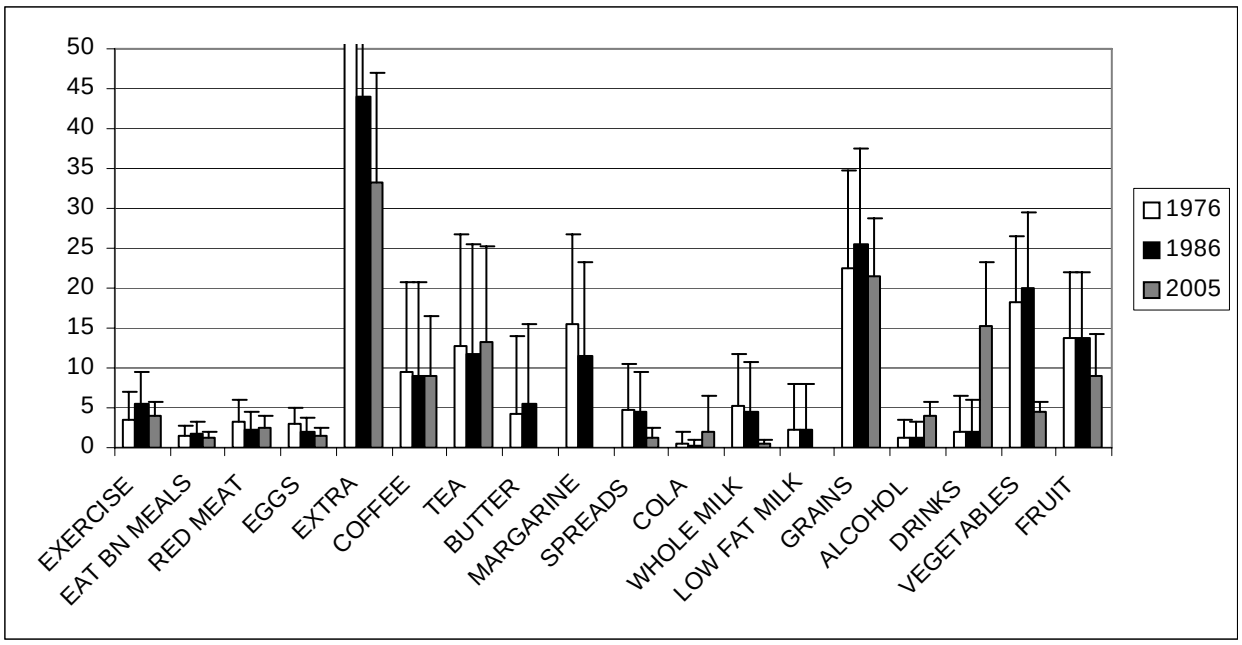


**Figure 3.** Changes in food consumption and other lifestyle patterns between 1976 and 2005 for women, Table shows mean frequency ± standard deviation. Exercise refers to frequency of physical activity; Eat bn Meals refers to frequency of eating between meals per day; Eggs, extra, coffee, butter, margarine, spreads, cola, soft drink, whole milk, low fat milk, grains, alcohol, vegetables, fruit refers to frequency of each food consumed in a week; extra refers to all foods classed as extra foods (cakes, pastries, pudding and jelly, biscuits, lollies, chocolate, sweetened drinks, butter, margarine, cream, ice-cream, dressing); grains refers to cereals, breads, crackers, muffins etc; alcohol refers to wine, beer, liquors, alc.drinks refers to number of alcoholic drinks consumed per sitting (1976, 1986) or per day (2005). Bars indicate years: white - 1976; black - 1986; grey - 2005

expected as most of the foods, which were associated with BMI, are energy dense; i.e. foods that are either high in fat or high in sugar or both, and they are supported by other research.[20-24] Of the energy dense foods found to predict BMI, sweetened drinks (cola and soft drink) were associated with increases in BMI among both men and women. This research supports the associations found in other studies.[25,26] Indeed, the consumption of cola drinks was found to increase in this study, which is inline with other information that sugar used in food manufacturing, particularly soft drinks has increased.[27] Increased consumption of energy dense foods without a corresponding increase in physical activity or decrease in energy intake from other foods will result in energy imbalance and thus overweight and obesity.[4]

In addition, lifestyle patterns such as dieting to lose weight and low levels of physical activity were associated with greater weight in both sexes. The physical activity finding has been found before.[2,28,29] Although the frequency of physical activity was stable between the three years for men and women, the proportion that was physically active decreased between 1986 and 2005. This finding is supported by the Australian National Physical Activity Survey.[30] A related variable, time urgency, was strongly, negatively associated with women's BMI in 1976. It is conceivable that time urgent women may have been more active but may not have consciously associated this with physical activity.

Dieting may lead to increased consumption of energy dense foods throughout the day. It has been associated with eating between meals and periodic disinhibited (binge) eating.[31-33] Furthermore, male respondents who ate between meals had higher BMI than men who never ate between meals, supporting the notion that dietary restraint and lack of disinhibition are important for successful weight maintenance and protection from weight gain.[31,32] This finding suggests that dietary restraint may to be important for a healthy BMI.

On the other hand, food variety and relatively large breakfasts were associated with lower BMI, but among men only. Although various authors have shown associations between breakfast consumption and BMI, none have examined the effect of the reported size of breakfast on BMI.[34-36] In addition, Savige et al [37] have shown that food variety is associated with improved health outcomes, but little is known of the association between dietary variety and BMI. This study therefore confirms and extends the findings currently available on the relationship between breakfast consumption and food variety and BMI.

The negative associations of spread consumption with BMI among men and women in 1976 and 1986 were unexpected as spreads, as define in this study, are high sugar foods. Univariate associations were found between spreads and bread, cereals, fruit and vegetables (data not shown), suggesting that spreads may be a marker for a more prudent diet. These post hoc findings require further confirmation.

The strengths of this sentinel study include the tracking of BMI over a long time series – during the period in which overweight and obesity have become epidemic; the examination of three different population samples - providing replication of the main findings; and large effect sizes in BMI variance, up to 35%, were observed in both men and women for each year analysed. These variances are substantial in the context of the known non modifiable determinants of BMI. These findings highlight the importance of a major health condition in the population, identify the broad population subgroups at higher risk, and identify changes in the population's health status over time.[38] Possible future research would see the establishment of more sentinel sites in high and low SES localities in metropolitan and regional areas around Australia and elsewhere.

Caution in the interpretation of the findings is required because of a number of limitations. In particular, the changes made to the questionnaire by the SAH on four occasions over the 30-year period made it difficult to maintain continuity in variables that showed associations with BMI. It should be emphasised that these questionnaires were not designed for research purposes but rather to aid the SAH's health promotion activities. Other limitations include the voluntary nature of the recruitment strategy, and the cross sectional nature of the surveys, though their replication over the years does confirm the key findings. Furthermore, associations may become statistically significant with large numbers of variables. It is therefore also important to examine effect sizes and these were found to be biologically significant for each year examined.

This study has shown that middle to high SES Australians in the late 20$^{th}$ and early 21$^{st}$ centuries embraced the "affluent, energy-dense dietary and sedentary lifestyle" and moved away from the principles of a "traditional (prudent) lifestyle", advocated in the dietary guidelines.[39] Thus, the results support nutrition policies that aim to shift populations' food intake to a more "prudent lifestyle".

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**AUTHOR DISCLOSURES**

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Original Article

# Trends in BMI, diet and lifestyle between 1976 and 2005 in North Sydney

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# 1976 年至 2005 年澳大利亞北雪梨區居民身體質量指數，飲食和生活型態的趨勢

在過去 30 年，澳大利亞人的過重和肥胖盛行率確有增加，但鮮少探知影響身體質量指數（BMI）的飲食和行為。本研究探討 1976 年至 2005 年間，平均身體質量指數、飲食、和其它生活型態行為的變化，且橫斷性探討這些因子與身體質量指數的關聯。1976 年至 2005 年雪梨 Adventist 醫院所做的每兩年連續的的生物醫學調查，提供 BMI 趨勢檢測。另選擇其中三次調查，詳細檢視可能相關的飲食和生活型態。研究對象包括： 1976 年 384 名男性和 338 名女性，1978 年 160 名男性和 146 名女性，1980 年 166 名男性和 141 名女性，1982 年 164 名男性和 142 名女性，1984 年 177 名男性和 13 名女性，1986 年 239 名男性和 227 名女性，1988 年 210 名男性和 225 名女性，1990 年 165 名男性和 148 名女性，1992 年 138 名男性和 167 名女性及 2005 年 270 名男性和 62 名女性。身高、體重由醫院工作人員測量。1990 初期平均身體質量指數上昇。鹽、咖啡、可樂、酒精和肉類的攝取，節食減肥和兩餐之間進食與 BMI 呈正相關；而身體活動量、食物種類、大量早餐、麵包塗醬攝取和 BMI 呈負相關。食物攝取和日常活動與 BMI 有重要的關聯，但其個別的關聯因性別而異。“富裕”的生活型態顯示導致較高的身體質量指數，而較“謹慎”的生活型態能防止其增加。

**關鍵字：身體質量指數、飲食、生活型態、謹慎生活型態、西方生活型態**