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Gender Differences in Predictors of Body Weight and Body Weight Change in Healthy Adults

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Abstract

Background—Overweight and obesity are important predictors of a wide variety of health problems. Analysis of naturally occurring changes in body weight can provide valuable insights in improving our understanding of the influence of demographic, lifestyle, and psychosocial factors on weight gain in middle-age adults.

Objective—To identify gender-specific predictors of body weight using cross-sectional and longitudinal analyses.

Methods and Procedures—Anthropometric, lifestyle and psychosocial factors were measured at baseline and then quarterly for 1 year in 572 healthy adult volunteers from Central Massachusetts who were recruited between 1994 and 1998. Linear mixed models were used to analyze the relationship between body weight and potential predictors, including demographic (e.g., age, educational level), lifestyle (e.g., diet, physical activity, smoking), and psychosocial (e.g., anxiety, depression) factors.

Results—Over the 1-year study period, on average, men gained 0.3 kg and women lost 0.2 kg. Predictors of lower body weight at baseline in both men and women included current cigarette smoking, greater leisure-time physical activity, and lower depression and anxiety scores. Lower body weights were associated with a lower percentage of caloric intake from protein and greater occupational physical activity levels only among men; and with higher education level only among women. Longitudinal predictors of 1-year weight gain among women included increased

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DISCLOSURE

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total caloric intake and decreased leisure-time physical activity, and among men, greater anxiety scores.

Discussion—Demographic, lifestyle and psychosocial factors are independently related to naturally occurring changes in body weight and have marked differential gender effects. These effects should be taken into consideration when designing interventions for weight-loss and maintenance at the individual and population levels.

INTRODUCTION

Progressive increase in body weight over the years in adulthood is common in many parts of the world, especially in the developed countries of the West (1–5). Several studies have demonstrated an increase in body weight of ~1 lb (~0.5 kg) per year among adults in the United States (5). Further analyses of naturally occurring changes in body weight can provide valuable insights into the relationships between demographic, lifestyle, and psychosocial factors. Understanding the underlying reasons for the secular trend toward the increased prevalence of overweight and obesity (4) has important implications for understanding the patterns of mortality and morbidity and associated healthcare costs (6,7). With increases in obesity being observed in poorer countries (8,9), this also has important implications for global health, not only in high-income countries, but worldwide (10).

The prevalence of obesity is rapidly increasing both in the US population and throughout much of the world. However, it is not clear which demographic, lifestyle, psychosocial, and environmental factors, or combinations of these, are responsible for these changes in body weight (11). Observational research may provide detailed and valuable information on the natural history of changes in body weight in the population. Such information can inform the design of future randomized clinical trials, as well as assist in identifying the important demographic, lifestyle and psychosocial factors contributing to population-level changes in body weight. The Seasonal Variation of Blood Cholesterol Levels (SEASONS) study (12,13) is a longitudinal study that collected serial measures of physical activity and diet, as well as psychosocial and environmental factors. As such, it provides a unique opportunity to examine the natural history of relatively short-term; i.e., seasonal and annual, changes in body weight in a non-experimental setting. The objective of this investigation is to identify gender-specific predictors of body weight using cross-sectional and longitudinal analyses. These predictors include demographic (age, race, ethnicity, education, and employment), lifestyle (diet, physical activity, and cigarette and alcohol consumption) and psychosocial factors (depression and anxiety), while controlling for height and season (14).

METHODS AND PROCEDURES

Participant recruitment and study design

The SEASONS study is an observational longitudinal study of 641 healthy adults designed to quantify the magnitude and timing of seasonal changes in blood lipids and to identify the major factors contributing to this variation (12,13). Further details of the study design and recruitment procedures have been published previously (12,13,15). At baseline and in each of four subsequent quarters of follow-up (at ~90-day intervals), individuals came to the clinic to provide blood samples, have their body weight measured, and to return a series of self-administered questionnaires. Physical activity and diet recalls were collected using three 24-h recall telephone interviews during each of the five data collection points (a total of 15 diet and physical activity interviews were conducted per participant). These unannounced interviews were conducted on two randomly selected weekdays and one weekend day within a 42-day "call window" surrounding each clinic visit (i.e., −28 to +14 days of the visit). Study recruitment was completed between December 1994 and February 1997, and follow-up was completed in March of 1998. The study protocol was approved by the Institutional Review Boards at Fallon Healthcare System and the University of Massachusetts Medical School.

Demographic, anthropometric, lifestyle and psychosocial measures

Demographic data were collected by questionnaire at baseline, whereas anthropometric data were obtained during clinic visits. Body weight and height were measured using a standardized protocol (i.e., with subject standing and not wearing shoes or excess clothing such as coats and sweaters). Psychosocial measures, i.e., the Beck Depression and Anxiety Inventories (16,17) were self-administered and brought to the clinic visits.

Dietary assessment

A total of fifteen 24-h dietary recalls were collected using the Nutrition Data System data entry and nutrient database software, developed and maintained by the Nutrition Coordinating Center at the University of Minnesota, Minneapolis, MN (18,19). Nutrient exposure estimates were computed from this database from information based on the preparation, amount and type of the specific foods consumed. Dietary variables considered in these analyses included total energy intake, macronutrients (i.e., carbohydrates, protein, total fat (as percent of energy intake), fiber, and alcohol intake).

Physical activity assessment

Physical activity was assessed by a series of fifteen 24-h physical activity recalls, which were conducted by the same interviewers as an extension of the dietary recalls. The 24-h physical activity recalls, as well as relative validity studies of the method, have been described in detail elsewhere (15,20). Briefly, trained registered dietitians conducted the 24-h physical activity recall interviews in the same interview session as the 24-h dietary recalls. Participants were asked to recall the number of hours they spent in four intensities of activity on the previous day (light: 1.5–2.9 metabolic equivalents (METs), moderate (3.0–5.9 METs), vigorous (6.0–7.9 METs), and very vigorous (≥8.0 METs), in each of three activity domains (household, occupational, leisure-time). Methods described by Ainsworth *et al.* (21) were employed to calculate estimates of physical activity energy expenditure (MET-hours/day) using standard MET values and reported duration in hours per day of physical activity. Summary scores using the average of all 24-h physical activity recalls were calculated after weighting weekday and weekend day in relation to their sampling frequency.

Statistical analyses

Baseline subject characteristics were summarized using means and s.d. for continuous variables and percentages for categorical variables. Comparisons were made in these characteristics between genders, and differences were tested using a two-group *t*-test for continuous variables and the chi-square test for categorical variables.

Distributions of body weight were examined and met normality assumptions for statistical testing. Relationships between body weight and predictor variables were assessed using linear mixed models. Predictor variables included demographic, lifestyle, and psychosocial variables. To establish the best model to predict body weight, we first conducted bivariate analyses between body weight and predictor variables using linear mixed models with a random intercept for each subject, and within-subject correlation was used as autoregressive of order one. For continuous predictor variables, we examined both (i) the cross-sectional association (between-subject, i.e., the subject-specific average) and (ii) the longitudinal association (within-subject, i.e., quarterly differences from the subject-specific average) in the same model. This method has been used in our previous analyses of the association between dietary carbohydrates and body weight and blood lipids, as well as dietary fiber and serum C-reactive protein (14,22,23). If a potential predictor was significant at $P = 0.20$, it was included in the final model. We then examined the association of body weight and predictors within gender strata. Because it has been shown that there is a seasonal variation in body weight (14), seasonality was accounted for in the analysis using the following categorization (Winter: December 21 to March 20; Spring: March 21 to June 20; Summer: June 21 to September 20 and Fall: September 21 to December 20), Subject height was forced into the final models.

Subjects in the cohort of 641 individuals entering the SEASON study were excluded from the present analyses if they had fewer than two clinic visits in the study ($N = 61$), fewer than two measures of body weight ($N = 7$), and no activity or diet recalls ($N = 1$). After these exclusions, data from 572 men and women were available for analyses. Among these subjects, ~95% had three or more measures of body weight (mean 4.6 measures, s.d. = 0.8) and ~90% completed 12 or more 24-h recalls (mean = 13.3 recalls, s.d. = 1.7 recalls). A total of 7,760 24-h recalls were used for the analyses. Minimum number of completed 24-h recalls per subject was 4, and maximum was 15.

RESULTS

The mean age of the 572 subjects in the final analyses was 47.9 years with no significant gender difference. Participants were predominantly white, married, well-educated, and employed full-time. Men tended to have higher education levels and had a higher frequency of full-time employment than women. The majority of participants were overweight or obese (mean BMI = weight (kg)/height $(m)^2$ = 27.4 kg/m^2); however, women were more likely to be in the normal BMI range than men (Table 1). Occupational physical activity was significantly higher for men than for women; other categories of physical activity were not significantly different for each gender. Mean daily caloric intake was higher in men (2,227 kcal/day) than women (1,644 kcal/day). Percentage of calories from fat was 31.3% overall and was similar between men and women; percentage of calories from carbohydrate was slightly higher in women (53.3% vs. 50.0%). Men had higher total fiber intake, but lower average fiber consumption per unit energy (7.9 g/1,000 kcal vs. 8.8 g/1,000 kcal in women). Approximately 17% of participants reported being current smokers, with no significant gender differences. Women had higher average depression and anxiety scores than men. The average annual change in body weight was +0.3 kg in men and −0.2 kg in women (median annual weight change were +0.4 kg and 0 kg, for men and women, respectively).

Bivariate analyses to understand the uncontrolled associations of body weight (in kilograms), with gender, and with each of the demographic, lifestyle and psychosocial factors are presented in Table 2. In summary, age, race, and ethnicity had no association with body weight; whereas in women (but not men) a higher educational level was significantly associated with lower body weight. Regarding lifestyle factors, among men, cross-sectional analyses showed that percentage of calories from fat and from protein were related to higher body weight, and the percentage of calories from carbohydrates was associated with lower body weight. Longitudinally, increased percentage of calories from protein was associated with weight loss. Among women, cross-sectional analyses showed that a higher percentage of calories from fat was associated with higher body weight, whereas, longitudinally, increases in total caloric intake and percentage of calories from fat were associated with weight gain. Cross-sectional analyses of physical activity revealed that leisure-time physical activity was associated with lower body weight in both men and women; however there were no longitudinal associations between physical activity and body weight. Smoking was associated with a lower body weight among men.

Finally, among psychosocial factors, higher depression and anxiety scores at baseline were related to higher body weight in both genders, and increases in anxiety scores over 1 year were associated with weight gain, but only among men. Anxiety scores were inversely associated with physical activity in both men and women (data not shown).

Multivariable analyses stratified by gender were conducted. The variables included in the final model were demographic, lifestyle and psychosocial variables, as well as height and season of the year, as described in Table 3.

Analyses of demographic variables revealed that age was not related to body weight, but education level had an inverse association with body weight at baseline only among women (an average of −12 kg of body weight for women in the highest vs. lowest educational category).

Analyses of lifestyle variables revealed that total caloric intake was not associated cross-sectionally with body weight in either gender but a higher percentage of calories from protein was associated with higher body weight only among men. Over 1 year, increased caloric intake was associated with weight gain in women. Cross-sectional analyses of leisure-time physical activity revealed an inverse association with body weight in both genders, as did occupational physical activity among men. Longitudinal analyses revealed that increased leisure-time physical activity was related to weight loss in women. Analyses of substance use revealed that current-smoking status, but not alcohol intake, was associated with lower body weight in both genders (~1.3 kg lower than non-smokers). The small number of participants that changed their smoking behavior (started or quit) precluded a precise description of the impact of these changes on body weight.

Cross-sectional analyses of psychosocial variables revealed that greater depression and anxiety scores at baseline were associated with higher body weight only among women; however, this relationship was statistically significant only when either depression or anxiety were considered separately in the model and lost statistical significance when both were included (depression and anxiety scores where highly correlated in this study population, correlation coefficient = 0.8, $P<0.01$). In the longitudinal analyses, however, the anxiety score was associated with weight gain among men, but not women. This association persisted even when depression scores were included in the model.

DISCUSSION

The results from this study highlight the importance of attempting to identify the relative contributions of demographic, lifestyle and psychosocial factors as they relate to body weight and weight change over 1 year in both men and women. Among demographic factors, educational level was related to lower body weight among women. Among lifestyle factors, total caloric intake and leisure-time physical activity were associated with body weight change over 1 year among women, while smoking was inversely related to body weight in both men and women. Finally, among psychosocial factors, both anxiety and depression scores were associated with higher body weight in men and women at baseline; however, increases in anxiety score were related to weight gain over 1 year only among men.

Regarding demographic factors, the relationship between higher levels of education and lower body weight has been extensively described (24), particularly among women (25); however, the mechanism for this association is not well understood (24–27). Obesity, psychosocial characteristics, and socioeconomic characteristics, including educational level, occupation and employment status, probably have complex, reciprocal relationships (26,28–30). Education has been proposed as a modulating factor in the relationship between socioeconomic status, certain psychosocial characteristics (e.g., depression, cynical distrust) and obesity (26). However, more detailed studies are required to better understand the interactions and relative contributions of each component.

As it relates to lifestyle factors, results from this observational study are consistent with the available literature regarding the lack of cross-sectional association between caloric intake and body weight (31) as well as the significant inverse association between physical activity and body weight (32), particularly leisure-time physical activity. The lack of cross-sectional association between total caloric intake and body weight may be the result of a higher caloric intake among physically very active (and usually leaner) people; total caloric intake therefore may be a proxy for physical activity (33). Another explanation is that the fine-tuning of energy balance needed for regulation of body weight is small (e.g., a gain of weight of the average observed in the United States is only 12 kcal/day in excess of energy expenditure) (34), and the fact that heavier individuals have higher levels of resting energy expenditure, which is the primary determinant of total energy expenditure (35).

The observation that changes in total caloric intake and leisure time physical activity, particularly among women, were related to body weight change, even in a “non-interventional” study, underscores the potential efficacy of behavior modification on short-term (1-year) weight loss. On the other hand, although smoking is associated with lower body weight, the potential benefits of a modestly lower body weight are off-set by the greater health risks associated with smoking (36). The observed associations between smoking and lower body weight as well as between a higher depression score and higher body weight may be related through a common link of the relationship between smoking and depression score. It has been suggested that depressed individuals could use nicotine as a form of self-medication to treat their dysphoric mood (37,38). Therefore, lower body weight associated with smoking might be related to improvement in dysphoric mood, due to the effects of nicotine on serotonin, as well as through the secretagogue effects of nicotine which have been shown to regulate food intake and energy expenditure (5,39).

Concerning psychosocial factors, depression has been associated with obesity and *vice versa* (40–44). Furthermore, depressive symptoms in adolescence appear to be predictive of obesity and elevated BMI in early adulthood, even when taking prior BMI into account, indicating that depressive symptoms confer a risk for obesity (45,46). There are even suggestions that obesity might be a clinical manifestation of certain forms of depression (47); based on a theory of a common-disease pathway, regarding the modulating balance between monoaminergic neurotransmitters, believed to be involved in the pathophysiology of depression, as well as in the complex processes regulating energy balance (47). Our results suggest a cross-sectional relationship between depression and body weight in both men and women. We tracked the use of antidepressant medication; however, only 13 participants reported taking this type of medication, though most (10 of 13) reported taking the medication throughout the year. The small number of participants in this subgroup limits any meaningful analysis of the impact of antidepressant medication on body weight. On the other hand, the results of this study indicate that increased anxiety is associated with weight gain among men. This finding is in accordance with literature suggesting a relationship between anxiety and obesity (42,48) that also suggests that the relationship may not be linear, and that it may be mediated via the modulation of eating patterns. We also noted that in our study, higher anxiety scores were associated with lower levels of physical activity in both men and women.

Both men and women had non-statistically significant changes in body weight over the study year. However, men appeared to have a tendency toward gaining weight and women toward losing weight. This finding is in conflict with observational studies, which suggest a progressive weight gain in both genders over time. The temporal change in body weight that we observed (0.4 kg/year) in men was nearly identical to published reports examining the annual change in body weight in middle-aged men (49–55). Women were observed to have a small non-significant decrease in body weight of ~0.2 kg over 12 months of follow-up; a finding that differs from published studies in middle-aged women reporting increases in body weight over time, with a range from 0.012 to 0.71 kg/year (50–54,56,57). Women in the SEASONS study may have responded to their participation in the study and to the periodic self-monitoring that was required for the collection of weight, physical activity and dietary data, by altering their behavior; and thus modifying the expected weight gain. Interventional effects in observational studies are not unknown (58). In subgroup analyses, it appears that obese participants, particularly obese women, tended to lose more weight during the study period (data not shown). This effect is evident even though no physical activity or dietary feedback was provided to them until they had completed the study. Nonetheless, our findings suggest that changes in physical activity and dietary patterns can attenuate age-related gains in body weight.

These findings may have implications for intervention efforts to control obesity worldwide (6,11,59–61). The observed effects of physical activity and diet on weight change are important, not only because of the confirmation of the inter-play of the two sides of the energy balance equation (expenditure vs. intake), but because these observational data identify the determinants of natural changes in body weight in an adult population over a full year, including the interaction of psychosocial and environmental factors, which may facilitate or hinder changes in lifestyle behaviors. These findings are relevant for health promotion efforts because physical activity, diet and certain psychosocial factors, including depression and anxiety, are modifiable risk factors, and therefore may impact adult weight gain and, by extension, the incidence of obesity and its consequences, both at the individual and population levels.

Certain limitations of this study should be considered when interpreting the results. The SEASONS study is based on a convenience sample of participants who consented to repeated assessments of their blood cholesterol, body weight, physical activity, diet, and psychological state at baseline and at four additional time points within a 1-year period. These repeated assessments may have influenced the behavior of some participants in the study, particularly women, at least with respect to changes in body weight. Therefore, our results regarding age-related changes in body weight should be interpreted with caution. However, the “study participation effect” (58) observed here is likely to be present in any study involving repeated observations of body weight, including, perhaps especially, weight loss programs. Also, the relatively short, 12-month, follow-up period limits the direct generalizability of the present findings to studies examining the natural history of body weight change over the life-span. In addition, the relatively small sample size and change in body weight (e.g., effect-size) impose limits on the statistical power available in these data to detect more subtle behavioral effects on change in body weight. However, our sample size allowed for far more detailed analyses of physical activity and diet than are carried out in larger-scale observational studies. Mean weight and height among women in our study was similar to that reported for adult women in the Third National Health and Nutrition Examination Survey (70.0 kg and 161.6 cm vs.70.8 kg and 160.4 cm); however, men in our study sample had significantly higher mean weights and heights than those reported in the Third National Health and Nutrition Examination Survey (87.0 kg and 176.4 cm vs. 80.5 kg and 173.5 cm). The prevalence of overweight was higher in both genders in our study than that reported in the Third National Health and Nutrition Examination Survey, but the prevalence of obesity was similar in both populations (62,63).

Our null longitudinal findings in the temporal analyses of physical activity and body weight in men could be due to the relatively small changes in body weight and physical activity in only 12 months of follow-up, particularly when the levels change in the behaviors that influence the outcome may have orders of magnitude less than the errors we observe in the measurements (64–66).

Analyses of longer periods of follow up (e.g., 2–5 years) and lifestyle intervention studies might result in larger changes in body weight and physical activity and make the actual relationships between these factors more easily detectable due to increased statistical power. Finally, our study population consists of predominantly white, well-educated subjects, most of whom are overweight or obese. Therefore, the results may not be generalized to populations with much lower rates of over-weight or obesity.

In conclusion, demographic, lifestyle and psychosocial factors, as well as seasonal factors are independently associated with cross-sectional levels of, and longitudinal changes in, body weight. The results from this observational study of the natural history of short-term changes in body weight provide further evidence that changes in lifestyle and psychosocial factors contribute significantly to gains in body weight during middle-age. The results also highlight the need for multidisciplinary studies to look at the interaction of environmental, psychosocial and behavioral factors: seasonal effects, education, socioeconomic status, gender, depression, anxiety, dietary practices and physical activity, as well as smoking and alcohol intake, to determine the level and direction of interaction, as well as the mediating patho-physiologic mechanisms. These findings also lend support to continued intervention efforts that focus on increasing the population levels of physical activity and reducing total caloric intake, while introducing interventions that address the psychosocial and environmental factors that may facilitate or impede such behavior changes.

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Table 1

Baseline characteristics of participants, Seasonal Variation of Blood Cholesterol Study, Worcester, Massachusetts, 1994–1998 (*N* = 572)

Variable	Total (*N* = 572) Mean (s.d.)/frequency (%)	Male (*n* = 297) Mean (s.d.)/frequency (%)	Female (*n* = 275) Mean (s.d.)/frequency (%)
Demographic			
Age (years)	47.8 (12.3)	48.3 (12.4)	47.2 (12.0)
Ethnicity/race			
White	484 (86.7)	250 (88.7)	225 (84.6)
Hispanic	44 (7.9)	18 (6.16)	26 (9.8)
Black	15 (2.69)	9 (3.08)	6 (2.26)
Asian	9 (1.61)	3 (1.03)	6 (2.26)
Other/unknown	6 (1.08)	3 (1.03)	3 (1.13)
Education*			
Less than high school	32 (5.6)	13 (4.4)	19 (7.0)
High school or vocational degree	137 (24.1)	58 (19.6)	79 (28.9)
Some college or Associates degree	179 (31.5)	99 (33.4)	80 (29.3)
College/graduate	221 (38.8)	126 (42.6)	95 (34.8)
Employment*			
Full-time	384 (67.4)	224 (75.4)	160 (58.6)
Part-time	87 (15.3)	31 (10.4)	56 (20.5)
Not currently employed	99 (17.4)	42 (14.1)	57 (20.9)
Marital Status			
Single	58 (10.18)	29 (9.80)	29 (10.58)
Married/living with partner	440 (77. 19)	242 (81.76)	198 (72.26)
Separated/divorced	50 (8.77)	21 (7.09)	29 (10.58)
Widowed	22 (3.86)	4 (1.35)	18 (6.57)
Type of employment			
Manual/blue collar (skill or craft/machine operator)	87 (15.21)	61 (20.54)	26 (19.46)
Scientific/technical	39 (6.82)	27 (9.09)	12 (4.36)
Service	50 (8.74)	24 (8.08)	26 (9.45)
Sales/clinical/office	67 (11.71)	17 (5.72)	50 (18. 18)
Administrative/management	214 (37.41)	123 (41.41)	91 (33.09)
Anthropometric			
Height (cm)*	169.3 (10.0)	176.4 (6.7)	161.6 (6.8)
Weight (kg)*	78.7 (18.0)	87.0 (15.4)	70.0 (16.4)
BMI classification*,[a]			
Desirable (18.5–24.9)	205 (37.5)	81 (28.6)	124 (47.0)
Overweight (25–29.9)	210 (38.4)	127 (44.9)	83 (31.4)
Obese (≥30)	132 (24.1)	75 (26.5)	57 (21.6)
BMI Mean*	27.38 (5.5)	27.9 (4.5)	26.8 (6.3)

Variable	Total (N = 572) Mean (s.d.)/frequency (%)	Male (n = 297) Mean (s.d.)/frequency (%)	Female (n = 275) Mean (s.d.)/frequency (%)
Lifestyle factors			
Dietary intake			
Daily caloric intake* (kcal/day)	1,945 (677.2)	2,227 (740.6)	1,644 (434.9)
% calories from fat	31.3 (7.7)	31.8 (8.3)	30.8 (6.9)
% calories from carbohydrate*	51.6 (9.1)	50.0 (9.7)	53.3 (8.1)
% calories protein	16.0 (3.6)	16.1 (3.6)	15.8 (3.6)
Dietary fiber intake* (g/day)	16.1 (7.3)	17.7 (8.1)	14.4 (6.0)
Alcohol drinker* (defined as ≥1 drink/d)	110 (20.0)	79 (27.9)	31 (11.7)
Physical activity (METs-h/d)[b]			
Leisure-time physical activity (METs-h/d)	2.02 (3.1)	2.2 (3.5)	1.8 (2.7)
Occupational physical activity* (METs-h/d)	4.9 (7.0)	6.5 (8.7)	3.3 (4.1)
Household physical activity (METs-h/d)	4.71 (5.0)	4.4 (5.6)	5.0 (4.3)
Total physical activity* (METs-h/d)	30.6 (6.3)	32.2 (7.6)	29.0 (4.0)
Current smoking[c]			
Yes	96 (17.1)	53 (18.4)	43 (15.8)
No[d]	464 (82.9)	235 (81.6)	229 (84.2)
Psychosocial factors			
Beck anxiety score*	4.2 (5.4)	3.5 (4.4)	5.0 (6.1)
Beck depression score*	6.1 (5.5)	5.6 (4.9)	6.6 (6.0)

[a]BMI (weight (kg)/height (m)^2).

[b]METs = metabolic equivalents; i.e., one MET equals energy expenditure at rest.

[c]There were missing values, therefore total *n* for this variable differs from the overall total *n*.

[d]Defined as never having smoked or having quit smoking at least 1 year before enrollment.

*P value < 0.05 comparison values between men and women.

Table 2

Bivariate analyses: body weight and selected demographic, lifestyle, psychosocial and seasonal factors, by gender, Seasonal Variation of Blood Cholesterol Study, Worcester, Massachusetts, 1994–1998 (N = 572)

	Men			Women		
	Coefficient	95% Confidence interval		Coefficient	95% Confidence interval	
Demographic						
Age (years)	−0.036	−0.174	0.101	0.012	−0.150	0.175
Ethnicity/race						
Hispanic ethnicity (non-Hispanic as referent)	−0.932	−3.050	1.186	0.319	−2.201	2.839
African American (white as referent)	2.010	−1.911	5.931	−0.119	−4.292	4.054
Asian (white as referent)	0.203	−2.465	2.871	2.577	−1.597	6.751
Education						
Education: high school or vocational (less than high school as referent)	0.795	−8.134	9.724	−5.320	−13.419	2.779
Education: some college or associate's degree (less than high school as referent)	2.128	−6.452	10.709	−6.421	−14.511	1.668
Education: college or graduate degree (less than high school as referent)	−3.090	−11.556	5.376	−9.747*	−17.710	−1.784
Lifestyle factors						
Dietary intake						
Daily caloric intake (kcal/day) cross-sectional effect	<0.0001	−0.003	0.003	0.005	<0.0001	0.010
Daily caloric intake (kcal/day) longitudinal effect	<0.0001	<0.0001	<0.0001	<0.0001*	<0.0001	0.001
% calories fat cross-sectional effect	0.383*	0.116	0.650	0.568*	0.221	0.915
% calories fat longitudinal effect	0.017	−0.004	0.038	0.025*	0.006	0.043
% calories carbohydrates cross-sectional effect	−0.310*	−0.534	−0.087	−0.001	−0.033	0.031
% calories carbohydrates longitudinal effect	−0.009	−0.027	0.010	0.001	−0.001	0.002
% calories protein cross-sectional effect	0.966*	0.308	1.623	0.227	−0.525	0.978
% calories protein longitudinal effect	−0.050*	−0.088	−0.011	−0.021	−0.054	0.012
Dietary fiber intake (g/day) cross-sectional effect	−0.204	−0.474	0.066	−0.372	−0.778	0.035
Dietary fiber intake (g/day) longitudinal effect	0.002	−0.020	0.024	−0.007	−0.032	0.018
Alcohol drinker (≥1 drink day)	0.353	−0.024	0.730	0.008	−0.401	0.417
Physical activity[a]						
Leisure-time physical activity (METs-h/d) cross-sectional effect	−0.918*	−1.715	−0.121	−1.828*	−2.888	−0.768

	Men			Women		
	Coefficient	95% Confidence interval		Coefficient	95% Confidence interval	
Leisure-time physical activity (METs-/d) longitudinal effect	−0.005	−0.046	0.035	−0.033	−0.077	0.012
Occupational physical activity (METs-h/d) cross-sectional effect	−0.074	−0.330	0.181	0.196	−0.355	0.747
Occupational physical activity (METs-h/d) longitudinal effect	−0.005	−0.027	0.016	0.003	−0.029	0.035
Household physical activity (METs-h/d) cross-sectional effect	−0.200	−0.678	0.279	0.429	−0.248	1.105
Household physical activity (METs-h/d) longitudinal effect	−0.016	−0.039	0.007	−0.010	−0.039	0.019
Total physical activity (METs-h/d) cross-sectional effect	−0.245	−0.564	0.074	−0.098	−0.793	0.598
Total physical activity (METs-h/d) longitudinal effect	−0.015	−0.036	0.006	−0.021	−0.050	0.009
Current smoker (non-smoker as referent)	−0.760*	−1.465	−0.054	−1.016	−2.146	0.114
Psychosocial factors						
Beck Anxiety Score cross-sectional effect	0.448*	0.048	0.848	0.571*	0.210	0.932
Beck Anxiety Score longitudinal effect	0.068*	0.031	0.106	0.004	−0.024	0.032
Beck Depression Score cross-sectional effect	0.372*	0.021	0.724	0.552*	0.235	0.868
Beck Depression Score longitudinal effect	0.026	−0.013	0.064	−0.014	−0.041	0.014
Season of the year						
Spring season (winter as referent)	−0.315*	−0.573	−0.057	−0.259*	−0.493	−0.025
Summer season (winter as referent)	−0.550*	−0.882	−0.218	−0.372*	−0.674	−0.071
Fall season (winter as referent)	−0.271*	−0.531	−0.011	−0.324*	−0.560	−0.087

[a] METs = metabolic equivalents; i.e., one MET equals energy expenditure at rest.

* P value < 0.05 for the coefficient.

Table 3

Multivariable mixed models results for predictors of body weight controlling for selected demographic, behavioral, psychosocial and environmental factors, by gender, Seasonal Variation of Blood Cholesterol Study, Worcester, Massachusetts, 1994–1998 (*N* = 572)

	Men				Women			
	Coefficient	s.e.	95% Confidence interval		Coefficient	s.e.	95% Confidence interval	
Demographic								
Age, cross-sectional effect	−0.0004	0.07	−0.14	0.13	0.03	0.08	−0.14	0.19
Age, longitudinal effect	0.10	0.21	−0.31	0.51	−0.20	0.20	−0.59	0.19
Education								
Education: high school or vocational (less than high school as referent)	−1.24	4.07	−9.22	6.73	−6.10	3.83	−13.61	1.40
Education: some college or associate’s degree (less than high school as referent)	−0.97	3.96	−8.74	6.79	−8.52	3.94	−16.24	−0.80
Education: college or graduate degree (less than high school as referent)	−6.19	4.08	−14.17	1.80	−11.91	4.02	−19.80	−4.03
Anthropometric								
Height (cm)	0.84	0.12	0.61	1.08	0.76	0.13	0.50	1.01
Lifestyle factors								
Dietary intake								
Daily caloric intake, cross-sectional effect	0.001	0.002	−0.003	0.005	0.01	<0.001	<0.001	0.01
Daily caloric intake, longitudinal effect	0.0002	0.0002	−0.0003	0.0003	0.0006	0.0002	0.0002	0.001
% of calories from fat, cross-sectional effect	0.21	0.19	−0.16	0.57	0.15	0.33	−0.49	0.79
% of calories from fat, longitudinal effect	−0.01	0.02	−0.05	0.04	−0.01	0.04	−0.08	0.06
% of calories from carbohydrates, cross-sectional effect	0.03	0.16	−0.28	0.34	−0.09	0.29	−0.66	0.48
% of calories from carbohydrates, longitudinal effect	−0.03	0.02	−0.07	0.02	−0.02	0.03	−0.09	0.04
% of calories from protein, cross-sectional effect	0.84	0.34	0.17	1.51	0.63	0.50	−0.34	1.61
% of calories from protein, longitudinal effect	−0.06	0.03	−0.12	0.00	−0.02	0.04	−0.10	0.06
Dietary fiber intake (g/day), cross-sectional effect	−0.25	0.17	−0.58	0.09	−0.17	0.27	−0.70	0.36
Dietary fiber intake (g/day), longitudinal effect	0.00	0.02	−0.03	0.03	−0.02	0.02	−0.06	0.01
Alcohol consumption (non-drinker as referent)	0.16	0.26	−0.34	0.66	−0.35	0.30	−0.93	0.23
Physical activity in METs-h/d[a]								
Leisure-time physical activity, cross-sectional effect	−0.84	0.38	−1.59	−0.10	−1.10	0.54	−2.15	−0.05
Leisure-time physical activity, longitudinal effect	0.00	0.02	−0.05	0.05	−0.05	0.03	−0.10	−0.002
Occupational physical activity, cross-sectional effect	−0.30	0.14	−0.57	−0.02	−0.12	0.27	−0.41	0.65

	Men				Women			
	Coefficient	s.e.	95% Confidence interval		Coefficient	s.e.	95% Confidence interval	
Occupational physical activity, longitudinal effect	0.00	0.01	−0.03	0.02	−0.02	0.02	−0.06	0.01
Household physical activity, cross-sectional effect	−0.13	0.22	−0.57	0.30	0.33	0.33	−0.31	0.97
Household physical activity, longitudinal effect	−0.02	0.01	−0.04	0.01	−0.02	0.02	−0.06	0.01
Current Smoker (non-smoker as referent)	−1.23	0.38	−1.98	−0.48	−1.27	0.59	−2.43	−0.10
Psychosocial factors[b]								
Beck anxiety score, cross-sectional effect	0.15	0.26	−0.35	0.66	0.22	0.24	−0.24	0.69
Beck anxiety score, longitudinal effect	0.08	0.02	0.03	0.12	0.01	0.02	−0.02	0.04
Beck depression score, cross-sectional effect	0.19	0.22	−0.25	0.62	0.20	0.21	−0.21	0.63
Beck depression score, longitudinal effect	0.00	0.02	−0.04	0.04	−0.02	0.02	−0.06	0.02
Season of the year								
Spring season (winter as referent)	−0.40	0.15	−0.68	−0.11	−0.18	0.13	−0.44	0.08
Summer season (winter as referent)	−0.59	0.19	−0.96	−0.22	−0.34	0.17	−0.67	−0.02
Fall season (winter as referent)	−0.30	0.15	−0.59	−0.01	−0.29	0.13	−0.56	−0.03
Constant	−74.24	26.26	−125.71	−22.78	−62.96	37.90	−137.24	11.32

The final model included the following variables: age (years), education category (with high school or less as the referent), marital status (with married or living with partner as the referent), height (cm), total caloric intake (kcal per day), percentage of calories from fat, percentage of calories from carbohydrates, percentage of calories from protein, total fiber intake (grams per day), alcohol consumption category (with non drinker as the reference), physical activity (in four domains: leisure-time, occupational, household and total; in MET/h/day), smoking status (with non smoker as the referent), Beck Anxiety Inventory score, Beck Depression Inventory score, and season of the year.

[a] METs = metabolic equivalents; i.e., one MET equals energy expenditure at rest.

[b] If only anxiety or depression scores were included separately in the final model; in both of these models there was a significant relationship between either anxiety or depression with baseline body weight. However, when both anxiety and depression scores were included together in the model, there was no cross-sectional relationship between ether depression or anxiety, although anxiety remained as a significant predictor of weight gain over time, but only among men. There was a significant correlation between anxiety and depression scores in this study population $r^2 = 0.81$.