Consistently Stable or Decreased Body Mass Index in Young Adulthood and Longitudinal Changes in Metabolic Syndrome Components

The Coronary Artery Risk Development in Young Adults Study

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Background—Data are sparse regarding the association of stable body mass index (BMI) over the long term with metabolic syndrome components in young adults.

Methods and Results—Participants in the Coronary Artery Risk Development in Young Adults Study, including white and black adults 18 to 30 years of age at the initial examination in 1985 to 1986, were stratified into groups by baseline BMI and change in BMI (stable/decreased, increased >2 kg/m², or fluctuating) across all 6 examinations between years 0 and 15 of the study. Changes in metabolic syndrome components were compared between groups. Among 1358 men and 1321 women, 16.3% maintained a stable BMI, 73.9% had an increased BMI, and 9.8% had a fluctuating BMI. Over 15 years, participants with stable BMI had essentially unchanged levels of metabolic syndrome components, regardless of baseline BMI, whereas those with increased BMI had progressively worsening levels. For example, men with a baseline BMI of 20.0 to 24.9 kg/m² and stable BMI during follow-up had a mean increase of only 15 mg/dL in fasting triglycerides over 15 years compared with 65 mg/dL (P<0.001) in those whose BMI increased. Incidence of metabolic syndrome at year 15 was lower in the stable BMI group (2.2%) compared with the increased BMI group (18.8%; P<0.001).

Conclusions—Adverse progression of metabolic syndrome components with advancing age may not be inevitable. Young adults who maintained stable BMI over time had minimal progression of risk factors and lower incidence of metabolic syndrome regardless of baseline BMI. Greater public health efforts should be aimed at long-term weight stabilization. (Circulation. 2007;115:1004-1011.)

Key Words: diabetes mellitus ■ metabolism ■ obesity ■ prevention ■ risk factors

The metabolic syndrome is a cluster of cardiovascular disease risk factors associated with overweight and obesity, including visceral adiposity, atherogenic dyslipidemia, elevated blood pressure, and impaired glucose metabolism.1–3 The presence of the metabolic syndrome has been shown to increase substantially the risk for development of cardiovascular disease in either the presence or absence of overt diabetes.4–10 Overweight and obesity are clearly associated in cross-sectional studies with more adverse levels of the risk factor components that make up the metabolic syndrome.11,12 However, cross-sectional data cannot provide information about differential contributions of baseline weight and longitudinal weight gain to the development of metabolic syndrome. Weight gain has been associated with worse levels of metabolic syndrome components and thus increased prevalence and incidence of metabolic syndrome.13 Weight loss has been associated with improvements in these components,14,15 but maintaining lower weight after weight loss is difficult over time.16

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It is not known whether maintaining stable weight through young adulthood (compared with increasing weight) might influence the pattern and magnitude of change of metabolic syndrome components and the eventual development of the metabolic syndrome. Similarly, data are sparse regarding whether metabolic syndrome components increase with advancing age when weight remains stable throughout young
adulthood for both normal-weight and overweight people. Given the current epidemic of obesity in the United States,\textsuperscript{17,18} it is important to gain greater understanding of the longitudinal relationship between body weight and the development of adverse risk factors associated with metabolic syndrome during young adulthood, when contact with the medical system may be rare.

The Coronary Artery Risk Development in Young Adults (CARDIA) study provides a unique opportunity to examine longitudinal trends in weight and associated changes in metabolic syndrome component risk factors from young adulthood to middle age in black and white men and women. Knowledge of the effects of weight stabilization through young adulthood could inform public health efforts aimed at reducing the progression of risk factors and decreasing the incidence and impact of metabolic syndrome. In the present analysis, we hypothesized that young adults who maintained stable weight over 15 years would have significantly less deterioration of risk factor levels and therefore a lower incidence of metabolic syndrome and impaired fasting glucose or diabetes compared with those who gained weight, even in the presence of baseline overweight.

Methods

Study Sample

Details of participant enrollment and study procedures have been published elsewhere.\textsuperscript{19} Briefly, 5115 black and white men and women 18 to 30 years of age were enrolled in 1985 to 1986 at 4 centers in Birmingham, Ala (University of Alabama at Birmingham); Chicago, Ill (Northwestern University); St Paul, Minn (University of Minnesota); and Oakland, Calif (Kaiser Permanente Oakland). Participants were balanced on age, sex, race, and education status at each center. Participants were examined at baseline (year 0) and at follow-up examinations in years 2, 5, 7, 10, and 15. All participants signed informed consent at each examination, and all study protocols were approved by the institutional review boards at each site.

For the present analysis, we sought to examine changes in body mass index (BMI) and metabolic syndrome component risk factors between the year 0 and 15 examinations. Of the initial 5115 participants, 3672 attended the year 15 examination. After the exclusion of participants who were at the extremes of BMI (<20 or \(\geq 35\) kg/m\(^2\)) or missing BMI at year 0 (n = 606), who self-reported being pregnant at the time of any examination (n = 158), who did not fast at least 8 hours at year 0 (n = 70), who were diabetic at year 0 (defined as fasting glucose \(\geq 126\) mg/dL or use of medications for diabetes; n = 14), and who did not fulfill the definitions of the 3 BMI change groups (defined below; n = 144) and 1 participant who underwent a sex change operation, there were 2679 participants eligible for the study.

We stratified participants into the following 3 groups according to their BMI at the baseline examination: 20.0 to 24.9, 25.0 to 29.9, or 30.0 to 34.9 kg/m\(^2\). We further stratified them according to change in BMI over time. Participants whose BMI increased by \(> 2\) kg/m\(^2\) (or \(\approx 1\) lb/y) between year 0 and 15 were defined a priori as the increased BMI group; those who were able to maintain a BMI within 2 kg/m\(^2\) of their baseline BMI at all 6 examinations or who lost \(> 2\) kg/m\(^2\) by year 15 were defined as the stable or decreased BMI group. A third group of participants (fluctuating BMI group) therefore included those who had BMI within 2 kg/m\(^2\) of baseline at year 15 but who had at least 1 value \(> 2\) kg/m\(^2\) away from baseline at one of the interim follow-up examinations.

Risk Factor Measurements

At each examination, weight and height were measured with subjects in light clothing and without shoes. BMI was calculated as the weight in kilograms at each examination divided by the square of baseline height in meters. Three separate blood pressure measurements were recorded by a trained technician using a random-zero sphygmomanometer after the participant was seated at rest for 5 minutes. The averages of the last 2 measurements of systolic and diastolic blood pressures were used. Samples of blood lipids, glucose, and insulin were collected according to standardized CARDIA protocols\textsuperscript{19} after participants had fasted for at least 12 hours and were processed at central laboratories as described previously.\textsuperscript{19–21} Insulin was measured by radioimmunoassay.\textsuperscript{21} Glucose and insulin levels were not measured at the year 2 and 5 examinations.

Definitions

We used the National Cholesterol Education Program Adult Treatment Panel III definition for metabolic syndrome.\textsuperscript{1} Briefly, metabolic syndrome was defined as the presence of \(\geq 3\) of the following 5 conditions: (1) abdominal obesity (waist circumference >102 cm \([> 40\) in\]) in men and >88 cm \([> 35\) in\]) in women), (2) fasting triglycerides \(\geq 150\) mg/dL, (3) high-density lipoprotein cholesterol \(< 40\) mg/dL in men and \(< 50\) mg/dL in women, (4) blood pressure \(\geq 130\) mm Hg systolic or \(\geq 85\) mm Hg diastolic or use of antihypertensive medications, and (5) fasting glucose \(\geq 100\) mg/dL or use of diabetes medications.

Statistical Analysis

We first calculated the mean values of risk factors according to strata of sex, baseline BMI, and change in BMI. To take advantage of the data on risk factors measured at each examination and to model the changes in each risk factor over time, we used generalized estimating equations\textsuperscript{22} to compare average annual changes in risk factors between those whose BMI was stable or decreased, those whose BMI increased, and those with fluctuating BMI by baseline BMI and gender groups. All generalized estimating equation models were adjusted for age and race. The average annual change in each risk factor for the stable or decreased BMI group was estimated from the parameter estimate for time (years after the baseline examination). Average annual changes in risk factor values for the groups with fluctuating or increased BMI were estimated by including years after baseline examination and an interaction term between BMI change strata and years after baseline examination. The 6 repeats of each outcome variable were the dependent variable, except in the analyses of systolic and diastolic blood pressures. In those analyses, we used the values from the examination at year 2 as the baseline, given the presence of significant adaptation and lowering of blood pressure values from year 0 to 2.

To examine the joint influence of baseline BMI and BMI change on changes in risk factor levels over time, we pooled participants in the normal-weight and overweight groups at baseline and performed generalized estimating equation models with additional adjustment for baseline BMI and baseline BMI-by-year interaction. We first examined models that also included categorical covariates for the increased BMI and fluctuating BMI groups, as well as interaction terms between these groups and follow-up year. In separate models, we included change in BMI as a continuous variable, time, and an interaction term with follow-up time.

Finally, we compared the incidence of metabolic syndrome and of impaired fasting glucose or diabetes between the stable/decreased, fluctuating, and increased BMI groups using Fisher’s exact tests separately for men and women. In these analyses of incidence, participants with metabolic syndrome or impaired fasting glucose/diabetes at baseline were excluded. All statistical analyses were performed with SAS statistical software, release 8.2 (SAS Institute, Cary, NC). A 2-tailed value of \(P<0.05\) was considered statistically significant.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the
manuscript as written, and the manuscript was approved by the CARDIA Steering Committee.

Results

Study Sample

There were 567 black men, 791 white men, 674 black women, and 647 white women in the study sample. Mean age at baseline was 25.2 ± 3.6 years. Table 1 shows the number of participants according to baseline BMI group and BMI change group separately for men and women. At higher levels of baseline BMI, the proportion of those who maintained stable or decreased BMI was lower. Overall, only 16.3% of participants had stable (14.1%) or decreased (2.2%) BMI over 15 years, whereas 73.9% had increased BMI and 9.8% had fluctuating BMI. Notably, very few participants (6.0%) with a baseline BMI of 30 to 34.9 kg/m² had a stable/decreased or fluctuating BMI over 15 years. The small numbers in these strata (14 and 29, respectively) precluded reliable estimates of changes in their risk factors.

Changes in Metabolic Syndrome Components

The graphs in Figure 1 show the mean levels of each risk factor from years 0 to 15 stratified by sex, baseline BMI, and change in BMI. As expected, at higher baseline BMI, there were generally higher levels of triglycerides, glucose,

<table>
<thead>
<tr>
<th>Baseline BMI, kg/m²</th>
<th>BMI Change</th>
<th>Men (N=1358), n</th>
<th>Women (N=1321), n</th>
<th>Total (N=2689), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0–24.9</td>
<td>Stable/decreased</td>
<td>177 (13.2)</td>
<td>154 (11.5)</td>
<td>331 (19.6)</td>
</tr>
<tr>
<td></td>
<td>Fluctuating</td>
<td>62 (4.6)</td>
<td>84 (6.2)</td>
<td>146 (8.6)</td>
</tr>
<tr>
<td></td>
<td>Increased</td>
<td>616 (45.3)</td>
<td>598 (45.3)</td>
<td>1214 (71.8)</td>
</tr>
<tr>
<td>25.0–29.9</td>
<td>Stable/decreased</td>
<td>74 (5.4)</td>
<td>19 (1.4)</td>
<td>93 (5.3)</td>
</tr>
<tr>
<td></td>
<td>Fluctuating</td>
<td>47 (3.4)</td>
<td>40 (3.0)</td>
<td>87 (5.1)</td>
</tr>
<tr>
<td></td>
<td>Increased</td>
<td>292 (21.3)</td>
<td>283 (21.3)</td>
<td>575 (33.6)</td>
</tr>
<tr>
<td>30.0–34.9</td>
<td>Stable/decreased</td>
<td>6 (0.4)</td>
<td>8 (0.6)</td>
<td>14 (0.8)</td>
</tr>
<tr>
<td></td>
<td>Fluctuating</td>
<td>7 (0.5)</td>
<td>22 (1.7)</td>
<td>29 (1.7)</td>
</tr>
<tr>
<td></td>
<td>Increased</td>
<td>77 (5.6)</td>
<td>113 (8.5)</td>
<td>190 (11.2)</td>
</tr>
</tbody>
</table>

Figure 1. Mean levels of risk factors associated with the metabolic syndrome at each examination according to baseline BMI and change in BMI over 15 years separately for men (top 3 graphs for each risk factor) and women (bottom 3 graphs). Left, Those with stable or decreased BMI; middle, those with fluctuating BMI; right, those with increased BMI over time. The lines in the graphs represent the baseline BMI groups (solid, baseline BMI of 20.0 to 24.9 kg/m²; dashed, baseline BMI of 25.0 to 29.9 kg/m²; dotted, baseline BMI of 30.0 to 34.9 kg/m²). Baseline differences in risk factor levels according to baseline BMI can be seen in the data points at year 0. The lines represent the trends in risk factors over time. The small number of participants in the stratum with baseline BMI of 30.0 to 34.9 kg/m² and stable or fluctuating BMI over the study period precluded our ability to provide reliable estimates of risk factor trends in these strata.
TABLE 2. Average Annual Changes in Risk Factors (Adjusted for Age and Race) Over 15 Years for Men and Women by Baseline BMI Level and Change in BMI Over Time

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Age- and Race-Adjusted Average Annual Change in Risk Factor Values Over 15 Years</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stable/Decreased BMI</td>
<td>Fluctuating BMI</td>
<td>Increased BMI</td>
</tr>
<tr>
<td>Baseline BMI, 20.0–24.9 kg/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides, mg · dL⁻¹ · y⁻¹</td>
<td>1.01</td>
<td>1.00</td>
<td>4.34*</td>
</tr>
<tr>
<td>HDL cholesterol, mg · dL⁻¹ · y⁻¹</td>
<td>0.04</td>
<td>-0.24§</td>
<td>-0.54*</td>
</tr>
<tr>
<td>Fasting glucose, mg · dL⁻¹ · y⁻¹</td>
<td>-0.08</td>
<td>-0.01</td>
<td>0.31*</td>
</tr>
<tr>
<td>Fasting insulin, μU · mL⁻¹ · y⁻¹</td>
<td>-0.07</td>
<td>0.00</td>
<td>0.27*</td>
</tr>
<tr>
<td>Systolic BP, mm Hg/y</td>
<td>0.14</td>
<td>-0.04</td>
<td>0.31§</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg/y</td>
<td>0.41</td>
<td>0.36</td>
<td>0.57§</td>
</tr>
<tr>
<td>Baseline BMI, 25.0–29.9 kg/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides, mg · dL⁻¹ · y⁻¹</td>
<td>0.84</td>
<td>1.65</td>
<td>4.11*</td>
</tr>
<tr>
<td>HDL cholesterol, mg · dL⁻¹ · y⁻¹</td>
<td>-0.18</td>
<td>-0.16</td>
<td>-0.46†</td>
</tr>
<tr>
<td>Fasting glucose, mg · dL⁻¹ · y⁻¹</td>
<td>0.04</td>
<td>0.74</td>
<td>0.34§</td>
</tr>
<tr>
<td>Fasting insulin, μU · mL⁻¹ · y⁻¹</td>
<td>-0.02</td>
<td>-0.04</td>
<td>0.42*</td>
</tr>
<tr>
<td>Systolic BP, mm Hg/y</td>
<td>0.17</td>
<td>0.36</td>
<td>0.38</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg/y</td>
<td>0.32</td>
<td>0.45</td>
<td>0.61†</td>
</tr>
</tbody>
</table>

BP indicates blood pressure.

*P<0.0001, †P<0.001, §P<0.005, §P<0.05, adjusted for age and race vs stable/decreased BMI for same sex.
were of similar magnitude regardless of whether participants
had an increase in BMI of 2 kg/m² and 9.8% had fluctuating BMI. Maintenance of stable or decreased BMI over the long term, regardless of baseline BMI, was associated with markedly lower incidence of metabolic syndrome (and impaired fasting glucose or diabetes) by middle age and stable or only minimally adverse changes in its component risk factor levels regardless of baseline BMI. Among those whose BMI increased, whites had somewhat greater increases in mean triglycerides, whereas blacks had larger increases in mean glucose and blood pressure.

Incidence of Metabolic Syndrome and Impaired Fasting Glucose or Diabetes

Figure 2 displays the incidence of metabolic syndrome at year 15. Consistent with the changes in metabolic syndrome components described above, the incidence of metabolic syndrome was markedly lower among all participants (men and women combined) with stable or decreased BMI (2.2%) compared with those whose BMI increased (18.8%; P<0.001). Men with fluctuating BMI had a low incidence of metabolic syndrome, whereas women with fluctuating BMI had a significantly higher incidence at year 15 compared with women who had stable/decreased BMI. Among men and women combined, the incidence of impaired fasting glucose or diabetes (Figure 3) was only 3.5% in those with stable BMI compared with 8.2% among those with increased BMI (P=0.001) and 5.5% among those with fluctuating BMI (P=0.36).

Discussion
Principal Findings
In this contemporary longitudinal cohort study, only 16.3% of young adult participants maintained consistently stable or decreased BMI over 15 years of follow-up, whereas 73.9% had an increase in BMI of >2 kg/m² and 9.8% had fluctuating BMI. Maintenance of stable or decreased BMI over the long term, regardless of baseline BMI, was associated with markedly lower incidence of metabolic syndrome (and impaired fasting glucose or diabetes) by middle age and stable or only minimally adverse changes in its component risk factor levels over time. Conversely, increased BMI over time was associated with a greater incidence of metabolic syndrome and significant adverse changes in component risk factors that were of similar magnitude regardless of whether participants

were normal weight or overweight at baseline. These data suggest the hypothesis that “age-related” progression of cardiovascular risk factors in young adulthood may not be inevitable and that, by maintaining a stable weight during these years, individuals can avoid metabolic syndrome.

Implications
Metabolic syndrome has been shown to increase risk, even after adjustment for other traditional risk factors, by 1.5- to 3-fold for coronary events and 2- to 3-fold for stroke. In conjunction with the epidemic of overweight and obesity, the prevalences of the metabolic syndrome and diabetes have been increasing in the United States, with estimated prevalences of 27.0% and 8.1%, respectively, among adults in 2000. These alarming increases in metabolic syndrome and diabetes could lead to a reversal of the decades-long trend of decreases in cardiovascular disease morbidity and mortality. At a minimum, the increased prevalence of metabolic syndrome and diabetes will lead to increases in healthcare costs.

The adverse consequences of weight gain on cardiovascular risk factors and metabolic syndrome have been well described in CARDIA and other cohorts. To date, however, the beneficial effects of weight stabilization on components of the metabolic syndrome have received little attention. In particular, the finding that weight gain appears to play a greater role than baseline weight in metabolic syndrome incidence and risk factor progression has not been widely appreciated. Validation of this finding in other cohorts would be useful. Our findings also suggest that the adverse effects of being overweight on the development of metabolic syndrome and risk factor progression may not be firmly established by 18 to 30 years of age.

Cross-sectional studies of different individuals at selected ages have demonstrated an association between higher BMI and metabolic syndrome components. These studies suggest progressive age-related increases in
many of the metabolic syndrome components. Such studies are limited, however, in that they cannot examine the effect of prior weight and the dynamic effects of weight change on risk factors. This CARDIA study benefited from repeated examination of the same individuals with standardized examinations over a prolonged period, which allowed us to examine the contributions of baseline BMI and change in BMI over time to changes in metabolic syndrome components. Although common, we observed that adverse changes in risk factors with advancing age are not inevitable; rather, for individuals who maintain a stable weight from young adulthood to middle age, much or all of the adverse changes may be delayed or prevented. As a consequence, we also observed that the age-related increase in metabolic syndrome\textsuperscript{31} may be avoided in young adults who maintained a stable or decreased BMI.

These data underscore the importance of primordial prevention of cardiovascular disease risk factors. Preventive medicine has typically focused on primary prevention of disease through screening and treatment of established risk factors (hypercholesterolemia, hypertension, diabetes) once they have developed. However, major public health efforts are needed to prevent the development of these risk factors at earlier stages, possibly preventing asymptomatic organ damage that is not fully reversible by the time that unequivocal risk factor abnormalities have emerged. Recent data suggest that primordial prevention of risk factors can provide enormous dividends by decreasing long-term\textsuperscript{32–34} and lifetime risks\textsuperscript{35} for cardiovascular disease, increasing longevity\textsuperscript{32,35} and increasing health-related quality of life into later years,\textsuperscript{36} as well as reducing total healthcare expenditures in later years.\textsuperscript{26,37,38} Our data suggest that weight stabilization may be an important first step in achieving primordial prevention. Promoting healthier lifestyles in younger individuals may be a critical component in accomplishing these goals, for if any risk factors are present by middle age, much of the benefits are lost.\textsuperscript{35}

Our results provide a call to action for patients, clinicians, policy makers, and public health experts to stop the as-yet unchecked adverse consequences of the obesity epidemic. Strategies designed to foster weight stabilization in young adults, which should be easier to achieve than weight reduction, should be a new minimum goal. As a starting point, modest reductions in caloric intake and increases in physical activity should be urged to bring the caloric equation into balance and to achieve weight stabilization.

These data also suggest that the metabolic syndrome, as currently conceived, may represent only a portion of the adverse consequences in cardiovascular risk factors associated with weight gain. Metabolic syndrome is not a discrete disease entity with a common underlying cause.\textsuperscript{2} Clearly, the complex interactions of visceral adipose tissue, insulin resistance, and other metabolic tissues and pathways promote the adverse progression of risk factors and accumulating risk for development of diabetes and cardiovascular disease.\textsuperscript{2} Despite the uncertainty regarding mechanisms, our data suggest that the bulk of the adverse changes in risk factors in young and middle-aged adults are attributable to weight gain and may be mitigated or avoided by weight stabilization, even in those who are overweight in young adulthood.

Participants with fluctuating BMI had intermediate changes in metabolic syndrome components that were generally more similar to the pattern observed in the stable/decreased BMI group. These results should be interpreted with caution, however. There were a limited number of participants in this stratum. By definition, all of the participants in this stratum had a BMI at year 15 within 2 kg/m\textsuperscript{2} of their baseline BMI. However, they had widely varying patterns of BMI change over the study period, with most having increases and then decreases in BMI compared with baseline, a few having marked decreases and then increases in BMI, and some having both patterns. Further study is needed to understand better the consequences of weight cycling. Controversy persists as to whether weight cycling is associated with less favorable outcomes.\textsuperscript{39}

Several limitations should be acknowledged. First, we had limited power to assess changes in risk factors among those who were obese at baseline and maintained stable or decreased BMI. This finding illustrates the difficulty of stabilizing or reversing obesity once it has developed, further highlighting the need for earlier prevention strategies. Because we focused on consistently stable BMI and changes in risk factors over time, we included only those individuals who attended all of the CARDIA examinations to date. We chose to take advantage of the best available data from CARDIA, which provides a unique, longitudinal perspective from a biracial cohort. Those who were excluded were somewhat more likely to have the following baseline characteristics: younger age, male sex, black race, lower systolic and diastolic blood pressures, higher insulin, and lower waist circumference. Whereas some of these differences in means were statistically significant, given the large sample sizes, they were small from a clinical perspective. There was no statistically significant difference in mean baseline BMI between the excluded and included groups, although there was a difference in the distribution of BMI groups, with somewhat higher proportions of overweight and obese individuals at baseline included in the analyses. Among those excluded who attended a follow-up examination, the majority had at least 1 follow-up BMI value \(\geq 2\) kg/m\textsuperscript{2} above their baseline, indicating that they would have been in the fluctuating or increased BMI groups. Although we have no data regarding whether weight loss was intentional among those whose BMI decreased, there is much less concern than there would be for older adults regarding chronic or terminal medical conditions causing inanition. Of the few deaths that have occurred in the young adult CARDIA cohort, the vast majority have been due to trauma, suicide, or homicide. Finally, it is possible that insulin resistance at baseline led to greater weight gain and changes in risk factors. However, there were no significant differences in insulin levels between those with subsequent stable or
increased BMI among individuals in the same baseline BMI stratum.

Conclusions
Young adults who maintain stable BMI into middle age may prevent the progression of other cardiovascular risk factors and the development of metabolic syndrome, even if they are already overweight. Weight control before young adulthood should still be emphasized because baseline BMI was not unimportant and because those with higher BMI at baseline appear to be more likely to continue to increase their BMI. Nonetheless, greater public health efforts should be aimed at weight stabilization over the long term as a minimum goal for young adults to prevent the development of metabolic syndrome and its adverse consequences.

Source of Funding
Work on this article was supported by contract N01-HC-48049 from the National Heart, Lung, and Blood Institute.

Disclosures
None.

References


CLINICAL PERSPECTIVE

The current epidemic of overweight and obesity is expected to have profound implications for the future incidence of diabetes, metabolic syndrome, and cardiovascular disease. Previous studies have demonstrated that obesity is associated concurrently with adverse cardiovascular risk factor levels and that weight gain is associated with worsening risk factors. Similarly, it is known that weight loss has beneficial effects on risk factors. The impact of maintaining consistently stable weight through young adulthood on risk factor levels has not been examined in detail, however. In the present study, we followed up 2679 men and women 18 to 30 years of age at baseline who were examined 6 times over 15 years. In all, only 16.3% maintained a stable body mass index at all 6 examinations, but these participants had essentially unchanged levels of metabolic syndrome risk factors regardless of their baseline body mass index. In contrast, those whose body mass index increased by >2 kg/m² had progressively worsening risk factor levels. Risk factor levels worsened by similar amounts among those who gained weight whether they were normal weight or overweight at baseline. Conversely, maintenance of stable weight through young adulthood, even among those who were already overweight, was associated with no further progression of adverse risk factor levels. These findings suggest that, at a minimum, weight maintenance should be urged as a public health goal for all young adults regardless of current weight. Weight stabilization, which is associated with clear benefits in risk factor levels, may be easier to achieve than significant weight loss for many people.

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Circulation. 2007;115:1004-1011; originally published online February 5, 2007; doi: 10.1161/CIRCULATIONAHA.106.648642

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