RESEARCH LETTER

Trends in Mean Waist Circumference and Abdominal Obesity Among US Adults, 1999-2012

Waist circumference is a simple and valuable anthropometric measure of total and intra-abdominal body fat. The clinical guidelines from the National Heart, Lung, and Blood Institute on the identification, evaluation, and treatment of overweight and obesity in adults recommend that clinicians assess waist circumference of their patients. Although the prevalence of abdominal obesity has increased in the United States through 2008, its trend in recent years is unknown. Therefore, our objective was to provide recent information about the trends in mean waist circumference and prevalence of abdominal obesity among adults in the United States from 1999 to 2012.

Methods | We used data from seven 2-year cycles of the National Health and Nutrition Examination Survey (NHANES) starting with 1999-2000 and concluding with 2011-2012. NHANES is a national health survey of the civilian noninstitutionalized US population in which a sample is selected by using a complex, multistage, probability sampling design. The examination response rates across the survey cycles ranged from 69.5% to 79.6%. The surveys received institutional review board approval and participants provided written informed consent.

In the mobile examination center, the waist circumference of participants was measured just above the iliac crest to the nearest 1 mm using a steel measuring tape. Abdominal obesity was defined as a waist circumference greater than 102 cm in men and greater than 88 cm in women.

Because the unadjusted and age-adjusted results were similar, we report only the latter. Tests for linear trend were conducted using orthogonal polynomial coefficients. Analyses, which take into account the complex sampling design of the surveys, were conducted using SAS version 9.3 (SAS Institute Inc) and SUDAAN version 11.0.0 (Research Triangle Institute) software. Two-sided P < .05 was considered statistically significant.

Results | Data from 32 816 men and nonpregnant women aged 20 years or older were analyzed. The overall age-adjusted mean waist circumference increased progressively and significantly from 95.5 cm (95% CI, 94.2-96.8 cm) in 1999-2000 to 98.5 cm (95% CI, 97.5-99.4 cm) in 2011-2012 (Table 1). Significant increases occurred in men, women,

### Table 1. Age-Adjusted Waist Circumference Among Adults in the National Health and Nutrition Examination Survey 1999-2012

<table>
<thead>
<tr>
<th></th>
<th>Mean Waist Circumference (95% CI), cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>95.5 (94.2-96.8)</td>
</tr>
<tr>
<td>Men</td>
<td>99.0 (97.9-100.2)</td>
</tr>
<tr>
<td>Women</td>
<td>92.2 (90.5-93.9)</td>
</tr>
<tr>
<td>Non-Hispanic whitec</td>
<td>95.5 (93.9-97.0)</td>
</tr>
<tr>
<td>Men</td>
<td>99.8 (98.6-101.0)</td>
</tr>
<tr>
<td>Women</td>
<td>91.2 (89.1-93.3)</td>
</tr>
<tr>
<td>Non-Hispanic blackc</td>
<td>96.9 (95.7-98.1)</td>
</tr>
<tr>
<td>Men</td>
<td>95.2 (94.2-96.2)</td>
</tr>
<tr>
<td>Women</td>
<td>98.4 (96.4-100.3)</td>
</tr>
<tr>
<td>Mexican Americanc</td>
<td>96.1 (94.8-97.3)</td>
</tr>
<tr>
<td>Men</td>
<td>98.6 (97.6-99.7)</td>
</tr>
<tr>
<td>Women</td>
<td>93.3 (90.9-95.8)</td>
</tr>
</tbody>
</table>

a Age adjustment was performed using the direct method using the projected year 2000 US population aged 20 years or older. P < .001 for linear trend for all groups except non-Hispanic whites (P = .01 for trend) and non-Hispanic white men (P = .01 for trend).

b During 2011-2012, the age-adjusted mean waist circumference was 87.4 cm (95% CI, 86.4-88.4 cm) for all Asian participants, 90.2 cm (95% CI, 89.0-91.3 cm) for Asian men, and 84.9 cm (95% CI, 83.6-86.1 cm) for Asian women.

c Race and ethnicity were self-reported (fixed categories were presented to participants).
The overall age-adjusted prevalence of abdominal obesity increased significantly from 46.4% (95% CI, 42.1%-50.8%) in 1999-2000 to 54.2% (95% CI, 51.3%-57.0%) in 2011-2012 (Table 2). Significant increases were present in men, women, non-Hispanic whites, non-Hispanic blacks, and Mexican Americans.

Discussion | Previous analyses of data from NHANES show that the prevalence of obesity calculated from body mass index (BMI) did not change significantly from 2003-2004 to 2011-2012.\textsuperscript{5} Positive developments in energy expenditure and intake have given hope that the decades-long increase in the prevalence of obesity in the United States may have crested.

In contrast, our analyses using data from the same surveys indicate that the prevalence of abdominal obesity is still increasing. The reasons for increases in waist circumference in excess of what would be expected from changes in BMI remain speculative, but several factors, including sleep deprivation, endocrine disruptors, and certain medications, have been proposed as potential explanations.\textsuperscript{6}

Limitations to this analysis include the absence of data for Asians prior to 2011-2012, specific Asian populations, and specific Hispanic populations. Because of the nature of the sampling design, institutionalized adults were not included in the surveys.

At a time when the prevalence of obesity may have reached a plateau, the waistlines of US adults continue to expand. Our results support the routine measurement of waist circumference in clinical care consistent with current recommendations as a key step in initiating the prevention, control, and management of obesity among patients.\textsuperscript{2}

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Statistical analysis: Ford.

Administrative, technical, or material support: Maynard.

Study supervision: Ford.

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COMMENT & RESPONSE

Diabetes Prevalence Among Youth

To the Editor The SEARCH investigators assessed the burden of diagnosed diabetes among youth.1 We wish to discuss 2 important limitations of the SEARCH study design.

First, the SEARCH study design cannot account for undiagnosed type 2 diabetes and therefore underestimates disease burden. The authors acknowledged this limitation but speculated that the number of cases was small based on only 2 specific citations: the first citation was from a geographically homogenous sample and the second was from a sample of sixth graders, thus underestimating the rates among older adolescents.

Alternatively, our recent report2 among a nationally representative sample of adolescents aged 12 to 19 years suggests that 34% of adolescents with type 2 diabetes are undiagnosed. Although this may be an overestimate due to lack of repeat laboratory testing, the results suggest a potentially meaningful burden of undiagnosed type 2 diabetes in adolescents.

Second, we disagree with the statement made by Dr Dabelea and colleagues3 that the populations giving rise to SEARCH diabetes cases “reasonably represented the US population.” Because the authors deemed racial/ethnic and income distributions to be similar between the SEARCH and US populations, the reasoning follows that diabetes rates are also similar and implies that racial- or ethnic-specific rates (and disparities) are constant across regions.

However, structural and societal factors linked to discrimination and stigma can differentially influence racial- or ethnic-specific rates across regions. The implications for the interpretation of the SEARCH results, which are heavily based on samples from the West and Midwest with no Southern representation aside from 4 counties in South Carolina, are important. Without considering the true underlying factors that drive known disparities, crude race- or ethnic-specific analyses should not be generalized to all members of those groups.

A national surveillance system for monitoring diabetes among youth that is capable of precisely estimating undiagnosed diabetes and regional variation in rates of total diabetes is needed and would pay long-term dividends for population health.

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In Reply Accurate estimation of the prevalence of childhood diabetes is challenging. Dr Demmer and colleagues raised 2 issues: undiagnosed diabetes and geographic representativeness.

The SEARCH study design cannot estimate undiagnosed diabetes and, while not an issue for type 1 diabetes, the SEARCH study design will underestimate total type 2 diabetes burden. We expect this underestimation to be small, based on the only 2 available studies, which were mentioned by Demmer and colleagues. Nevertheless, they represent the only studies of screening that confirmed undiagnosed type 2 diabetes in youth.

In the Princeton Study that included 2501 adolescents in grades 5 through 12,1 seven adolescents with “near diabetes” were identified but only 1 was confirmed as having type 2 diabetes, for a true prevalence of 0.04%. In the HEALTHY Study of 6358 children,2 only 1 of 6 youths with elevated fasting glucose was confirmed as having type 2 diabetes, for a true prevalence of 0.02%. These estimates compare with an unweighted prevalence of elevated fasting glucose of...