Obesity is an important modifiable risk factor that leads to many diseases, including diabetes, hypertension, dyslipidemia, coronary heart disease, and stroke.1-3 Globally, an estimated 1.9 billion adults are overweight, and an additional 650 million are obese.4 Obesity can potentially be mitigated by lifestyle modifications, including a healthy diet and increased physical activity. Moreover, obesity-related health complications can be substantially reduced by using effective, inexpensive medications. Nevertheless, as many as half of the obese individuals are unaware of the health risks thus incurred.5 Consequently, many of them have undiagnosed diabetes and hypertension,6,7 indicating that there are missed opportunities to decrease the global burden of disease related to obesity. With the aim of reducing the risk of cardiovascular diseases, screening programs for obesity and cardiovascular risk factors and associated lifestyle intervention programs have been implemented in many countries. However, evidence is limited as to whether population-level screening programs and accompanied lifestyle interventions for obesity and cardiovascular risk factors reduce mortality or the incidence of cardiovascular diseases.8

In 2008, Japan introduced a nationwide screening program to identify individuals with high obesity and cardiovascular risks (known as metabolic syndrome) and to provide...
national health guidance intervention (in addition to receiving a summary report of screening results). Those who were taking antihypertensive, antidiabetic, and antihyperlipidemic drugs—individuals who presumably are cared for and given guidance by clinicians—were not required to undergo the health guidance intervention. Participants who did not meet these criteria received a summary report of screening results via mail (did not undergo the health guidance intervention). The insurers used mail or telephone calls to reach out to participants who were assigned to the health guidance intervention (ie, those determined to be at high risk).

Japan’s national health guidance intervention includes content related to exercise, diet, and medical visits. The intervention is provided by trained instructors supervised by physicians, public health nurses, and dietitians (many instructors themselves are qualified as dietitians or public health nurses). The health guidance intervention was provided through an initial interview by the instructor (individual support ≥20 minutes or group support ≥80 minutes), followed by continuous support for a duration of 3 months or more if determined necessary by the assigned instructor based on the participant’s cardiovascular risk factors (eAppendix A in the Supplement). For those participants who still have a waist circumference greater than the threshold (plus 1 or more risk factors) after receiving the health guidance intervention in the prior year, another health guidance intervention would be provided as a de novo intervention (not as a continuation of guidance provided in the first year). The government subsidizes the cost of the guidance conduct by insurers. The estimated cost of the health guidance intervention was $150 million (1 US dollar = 106 Japanese yen) per year. More details about the government’s guideline for the national health guidance intervention is available in eAppendix A and eFigure 1 in the Supplement.

Participants Among 127,322 men aged 40 to 74 years who were eligible for the screening program, 102,764 (80.7%) received baseline screening. We excluded participants without follow-up screening (n = 11,684). After excluding those with any missing covar-

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**Key Points**

**Question** Is the Japanese national health guidance intervention for obesity and cardiovascular risks associated with improved population health outcomes?

**Findings** In this national cohort study of 74,693 working-age men in Japan, assignment to the health guidance intervention was associated with a small decrease in weight (−0.29 kg; 95% CI, −0.50 to −0.08) 1 year after the screening, an association that attenuated over time and was no longer significant by years 3 to 4. No evidence was found that the health guidance intervention was associated with changes in blood pressure, hemoglobin A\(_1c\) level, or low-density lipoprotein cholesterol level in years 1 to 4.

**Meaning** Among working-age men in Japan, the national health guidance intervention was not associated with clinically meaningful weight loss or other cardiovascular risk factor reduction; further research is warranted to understand the specific design of lifestyle intervention programs that are more effective in improving population health.
iates (n = 16 387), we analyzed 74 693 men (eFigure 2 in the Supplement). We focused on the working-age male population because of the small number of women who were corporate employees (n = 11 235), of which only a small proportion (11%) met criteria to receive the health guidance intervention. Nevertheless, as a secondary analysis, we also examined the association of the health guidance intervention with health outcomes among female employees.

**Health Outcomes**

Our main outcomes were changes in obesity status—body weight, BMI, and waist circumference—1 year after the screening program. Our secondary outcomes were changes in cardiovascular risk factors 1 year after the screening program—systolic blood pressure, diastolic blood pressure, HbA1c level, and LDL cholesterol level. We also examined longer term (2-4 years after the screening) association of the national health guidance intervention (using the 2016-2018 data).

**Statistical Analysis**

To estimate the association of the health guidance intervention with health outcomes, we used a quasiexperimental RD design. The RD design takes advantage of clinical or policy decision rules in which participants are differentially assigned to interventions or control groups if they fall above or below an arbitrary cutoff for a continuous variable.15-19 In this study, we used the RD model with waist circumference as the assignment variable, noting that participants with waist circumferences above the arbitrary cutoff (85 cm) had a higher probability of receiving an intervention (ie, health guidance intervention) relative to those with waist circumferences below this cutoff. The RD design compares individuals whose value of the assignment variable (waist circumference) is within the selected bandwidth (6 cm in our study) just above vs below the cutoff level. The RD method is appropriate in this case because individuals who fell just above or below the cutoff value were similar in most aspects except whether they received the intervention. The RD design is preferable to a difference-in-differences method because the latter has an untestable assumption that the outcome variable of treatment and control groups follow parallel trajectories in the absence of the intervention. In sharp RD designs, the value of the assignment variable deterministically determines whether participants receive the intervention; the receipt of intervention is probabilistically determined in fuzzy RD designs.20 In this study, we used the fuzzy RD design because the assignment to health guidance intervention was determined based not only on the value of waist circumference, but on several other factors (eAppendix C in the Supplement). Our data confirmed that the probability of assignment to the health guidance intervention changed dramatically at the threshold level of waist circumference, supporting the validity of our method (eFigure 3 in the Supplement).

In our main RD model, we used a local linear RD estimation with robust bias-corrected CIs to avoid overfitting of the data.21 To account for potential differences in other charac-

| Table 1. Participant Characteristics in the Total Sample and Participants Within Optimal Bandwidths |
|---------------------------------------------------------------|
| Characteristic | Total (n = 74 693) | Waist circumference within bandwidth of 6 cm from the threshold |
| | | −6 to <0 cm (n = 19 818) | 0 to ≤6 cm (n = 19 343) |
| Age, y | 52.1 (7.8) | 52.1 (7.8) | 52.8 (7.9) |
| Baseline obesity status | | | |
| Waist circumference, cm | 86.3 (9.0) | 82.2 (1.6) | 87.7 (1.7) |
| Body weight, kg | 71.4 (11.0) | 66.8 (5.0) | 72.45 (5.4) |
| Body mass index* | 24.5 (3.4) | 23.1 (1.5) | 24.8 (1.6) |
| Baseline cardiovascular risk factors | | | |
| Blood pressure, mm Hg | | | |
| Systolic | 126.5 (16.3) | 124.9 (15.9) | 127.1 (15.6) |
| Diastolic | 79.6 (11.3) | 78.5 (11.1) | 80.2 (10.8) |
| Hemoglobin A1c, % | 5.7 (0.8) | 5.6 (0.6) | 5.7 (0.7) |
| LDL cholesterol, mg/dL | 128.1 (31.7) | 127.9 (31.2) | 130.8 (31.7) |
| Baseline lifestyle variables, No. (%) | | | |
| Current smoking | 27 098 (36.3) | 6884 (34.7) | 6895 (35.6) |
| Drinking alcohol, No. (%) | | | |
| Not every day | 40 752 (54.6) | 10 300 (52.0) | 10 107 (52.3) |
| Every day, small amount | 22 607 (30.3) | 6445 (32.5) | 6123 (31.7) |
| Every day, large amount | 11 334 (15.2) | 3073 (15.5) | 3113 (16.1) |
| Exercise habits | 32 259 (43.2) | 9059 (45.7) | 8324 (43.0) |
| Baseline medication, No. (%) | | | |
| Antihypertensive drugs | 14 762 (19.8) | 2831 (14.3) | 4205 (21.7) |
| Antidiabetic drugs | 4777 (6.4) | 845 (4.3) | 1185 (6.1) |
| Antihyperlipidemic drugs | 8180 (11.0) | 1730 (8.7) | 2290 (11.89) |

Abbreviation: LDL, low-density lipoprotein.

* Calculated as weight in kilograms divided by height in meters squared.

SI conversion factors: To convert LDL cholesterol to mmol/L, multiply by 0.0259. To convert percentage of total hemoglobin to proportion of total hemoglobin, multiply by 0.01.
teristics around the threshold of waist circumference, we adjusted for participants’ age, current smoking status (yes/no), alcohol use (not every day; every day; small amount; or every day, large amount), exercise habit (yes/no), systolic and diastolic blood pressure, HbA1c level, LDL cholesterol level, and medication use (indicator variables for antihypertensive drugs, antidiabetic drugs, and antihyperlipidemic drugs) at baseline (measured during the initial screening). We implemented the bias-corrected nonparametric inference procedure, which would be robust to wide bandwidth selection. In the RD model, we used a triangular kernel function, which gave more weight to participants near the threshold level.

The primary focus of this study was to examine the association of the assignment to the health guidance intervention with health outcomes (ie, the intention-to-treat effect). However, we were also interested in the association of the actual receipt of the health guidance intervention with outcomes (ie, the treatment-on-the-treated [ToT] effect). Data on actual receipt of the health guidance intervention were available only for 2017 to 2018; therefore, we investigated the association of the receipt (the ToT effect) of the health guidance intervention in 2017 with health outcomes in 2018 using the RD model.

Secondary Analyses
We conducted several secondary analyses. First, we investigated how the probability of assignment to the health guidance intervention changed around the cutoff value of the participants’ waist circumferences. Second, we tested whether the density of waist circumference changed smoothly at the threshold using the McCray test. Third, to test the smooth continuity of observed covariates at the threshold level of waist circumference, we conducted the RD model using covariates as the outcome variable and waist circumference as the explanatory variable. Fourth, we varied bandwidth to test the robustness of our findings based on the selection of bandwidth. Fifth, to evaluate whether our findings were sensitive to the selection of adjustment variables in the RD model, we reanalyzed the data without adjusting for covariates. Sixth, to investigate the effect of some participants having received the same health guidance intervention in the prior year, we reanalyzed the data, restricting our sample to participants who were not assigned to the health guidance intervention in 2013. Seventh, the data on health outcomes were missing for 11.4% (11,684 of 102,764) of participants due to loss to follow-up. To test how this affects our findings, we conducted a weighted RD analysis in which weights were generated on the basis of the inverse probability of health outcome data being observed. Eighth, as a falsification test, we conducted the RD assessing the association of assignment to the health guidance intervention in 2014 with their health outcomes in 2013. Ninth, we examined the impact of the health guidance intervention on changes in the proportion of participants taking relevant drugs (antihypertensive, antidiabetic, and antihyperlipidemic drugs), their smoking status, and exercise habits. Finally, to test whether the association of the health guidance intervention with health outcomes varies between men and women employees, we also investigated the association of the health guidance intervention with health outcomes among working women.

All tests were 2-sided; P values less than .05 were considered statistically significant. All analyses were performed using Stata, version 16.1 (StataCorp).
The probability of assignment to the health guidance intervention sharply increased as the participant’s waist circumference rose above the threshold level, as expected (eFigure 3 in the Supplement). The result of the McCray test showed no evidence of manipulation of the waist circumference value by the treatment assignment.
participants or examiners during the screening (eAppendix B in the Supplement). We found no discontinuities in observed covariates at the threshold of waist circumference (eTable 1 in the Supplement).

Our findings were qualitatively unaffected by the use of different bandwidth selections, the analysis without covariates adjustments; restriction of our sample to participants who were not assigned to the health guidance intervention a year before; or accounting for missing data on health outcomes using inverse probability weights in the regression models (eTables 2-5 in the Supplement). The results of our falsification test showed no evidence of the effect of the guidance in 2013 on health outcomes in 2014, as expected (eTable 6 in the Supplement). We found no evidence that the health guidance intervention was associated with changes in the rates of drug use, smoking status, and exercise habits (eTable 7 in the Supplement). We found similar results for women, but CIs were larger owing to a smaller sample size (eTable 8 in the Supplement).

Discussion

Among working-age men who underwent the national health screening program in Japan, we found that the government-implemented health guidance intervention was associated with very small weight loss; the magnitude of weight loss was not clinically meaningful and no longer significant in the longer follow-up. We found no evidence that the health guidance intervention was associated with improvement in cardiovascular risk factors.

The observed effect size of a weight reduction of approximately 0.4% (a reduction of 0.29 kg from the baseline mean weight of 71.4 kg) was modest at best. However, it was the intention-to-treat effect (an estimated effect of assignment to the health guidance intervention), and we also found that ToT effect (effect of receipt of the guidance) was 5 to 6 times greater. The observed weight loss (ToT effect) of ~2.2% (1.56 kg reduction) in our study was smaller than other lifestyle interven-
in randomized clinical trials (RCTs) (efficacy) because participants recruited for obesity implemented in the real world (effectively healthy. It may also be the case that the influence of an intervention for obesity implemented in this intensive risk reduction program need to be reevaluated and retooled to more effectively improve population health outcomes.

We found no evidence that health guidance intervention was associated with improvements in blood pressure, HbA1c level, and LDL cholesterol level. There are several potential explanations. First, the marginal population with waist circumferences around the threshold value was relatively healthy; therefore, the magnitude of the improvement, even if it existed, might be too small to be detected even with the large sample size of our study. Second, the health guidance intervention focused on improving obesity, and improving cardiovascular risk factors was secondary. Third, given that participants were relatively healthy, the proportion of participants who required medical interventions, which may be needed to improve cardiovascular risk factors, was small. Lastly, although the health guidance intervention in Japan was implemented as a mandatory program, it has not been effectively enforced (only 15.9% of eligible participants actually received the intervention in 2017), which may explain why we did not observe clinically meaningful improvements in health outcomes.

Our findings were consistent with existing evidence that found very small, short-term (no clinically meaningful) effects of lifestyle interventions on weight loss (findings from previous studies are summarized in eAppendix M in the Supplement). Given that the exact design of lifestyle interventions varies from one to another, it is possible that more intensive programs—such as the one implemented in Japan—may be more effective than other programs. Our findings differed from a study by Nakao et al that compared individuals who attended the health guidance intervention (compliers) vs those who did not (noncompliers) and reported dramatic improvements in both weight and cardiovascular risk factors. However, compliers and noncompliers differed in ways that could not be accounted for by adjusting for only observed variables (compliers might be more motivated to improve lifestyle than noncompliers); therefore, their findings might overestimate the impact of the guidance. To address this issue, as secondary analyses, they also used the facility-level proportion of participants who underwent the health guidance intervention as an instrument in the instrumental variable method. However, facilities that attracted more health-conscious participants are likely to experience a larger improvement in health outcomes, and such violation of the exclusion restriction of the instrumental variable method leads to biased estimates. Our choice of the RD method, which is often used in situations that do not permit randomized clinical trials, leverages the fact that individuals just above and below the threshold value of the assignment variable are likely similar and that treatment assignment above the arbitrary cutoff simulates randomization. This design is another, potentially more robust, method to evaluate the association of the health guidance intervention with health outcomes.

Limitations

Our study has limitations. First, the lack of data on more detailed information about the health guidance intervention each participant received (eg, whether participants underwent individual vs group interviews) precluded us from evaluating whether the association of the health guidance intervention varied by how it was delivered. Second, we could not identify the exact reason as to why the observed association attenuated over time. We could not disentangle 2 potential mechanisms: the guidance had only a short-term impact, as is the case with many lifestyle interventions, or it was due to treatment contamination of the study population (ie, more individuals who were just below the threshold at the initial screening gained weight and became eligible for the guidance over time). Finally, given that our study focused on corporate employees in Japan, the findings may not be generalizable to individuals who are unemployed or to populations of other countries.

Conclusions

In summary, among working-age men in Japan, we found that the government-led national health guidance intervention was not associated with clinically meaningful or sustained weight loss. We found no evidence that health guidance intervention was associated with improvements in cardiovascular risk factors. Given the high cost of national program implementation, the intervention deployed in this intensive risk reduction program needs to be reevaluated and retooled to more effectively improve population health outcomes.
National Health Guidance Intervention for Obesity and Cardiovascular Risks and Health Outcomes

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