Weight Loss Strategies Associated With BMI in Overweight Adults With Type 2 Diabetes at Entry Into the Look AHEAD (Action for Health in Diabetes) Trial

HOLLIE A. RAYNOR, PHD, RD[1]
ROBERT W. JEFFERY, PHD[2]
ANDREA M. RUGGIERO, MS[3]
JEANNE M. CLARK, MD, MPH[4]
LINDA M. DELAHANTY, MS, RD[5]
FOR THE LOOK AHEAD (ACTION FOR HEALTH IN DIABETES) RESEARCH GROUP

OBJECTIVE — Intentional weight loss is recommended for those with type 2 diabetes, but the strategies patients attempt and their effectiveness for weight management are unknown. In this investigation we describe intentional weight loss strategies used and those related to BMI in a diverse sample of overweight participants with type 2 diabetes at enrollment in the Look AHEAD (Action for Health in Diabetes) clinical trial.

RESEARCH DESIGN AND METHODS — This was a cross-sectional study of baseline weight loss strategies, including self-weighing frequency, eating patterns, and weight control practices, reported in 3,063 women and 2,082 men aged 45–74 years with BMI ≥25 kg/m^2.

RESULTS — Less than half (41.4%) of participants self-weighed ≥1/week. Participants ate breakfast 6.0 ± 1.8 days/week, ate 5.0 ± 3.1 meals/snacks per day, and ate 1.9 ± 2.7 fast food meals/week. The three most common weight control practices (increasing fruits and vegetables, cutting out sweets, and eating less high-carbohydrate foods) were reported by ~60% of participants for ≥20 weeks over the previous year. Adjusted models showed that self-weighing less than once per week ($B = 0.83$), more fast food meals consumed per week ($B = 0.14$), and fewer breakfast meals consumed per week ($B = -0.19$) were associated ($P < 0.05$) with a higher BMI ($R^2 = 0.24$).

CONCLUSIONS — Regular self-weighing and breakfast consumption, along with infrequent consumption of fast food, were related to lower BMI in the Look AHEAD study population.

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As the prevalence of obesity has increased in the U.S., so has that of type 2 diabetes (1). Because of the relationship between body weight and insulin resistance (2), intentional weight loss is an essential component of treatment for type 2 diabetes (3).

Changing eating, physical activity, and other weight-related behaviors is critical for weight management (4). One behavioral technique believed to be key for successful weight management is frequent self-weighing (5). Regular self-weighing provides objective information on weight and on the success of specific eating and activity behaviors in reducing weight (6).

Different eating patterns may also be important for weight control. Regular consumption of meals, especially breakfast, may aid in weight control by preventing overconsumption later in the day caused by excessive hunger (7). However, regular intake of fast food may negatively impact weight control, as fast food is high in energy and fat (8).

National surveys have consistently found that the most prevalent weight control practice used by adults self-reporting an attempt to lose/maintain body weight is eating less, followed by being active (9,10). In adults without type 2 diabetes who have actually lost or maintained weight over time, specific weight control strategies associated with successful weight control include those that target reducing energy intake and use of these strategies consistently over time (11,12).

Because little is known about intentional weight loss strategies used by individuals with type 2 diabetes, one aim of this investigation was to describe the occurrence of these strategies in a racially/ethnically diverse sample of overweight individuals with type 2 diabetes participating in the Look AHEAD (Action for Health in Diabetes) clinical trial. A second aim was to identify specific weight loss strategies related to baseline BMI. As medical nutrition therapy is an integral part of the self-management of diabetes (13), it was hypothesized that the use of more dietary-focused compared with activity-focused strategies would be significantly related to a lower baseline BMI. Thus, we hypothesized that frequent self-weighing; regular consumption of meals, particularly breakfast; and infrequent consumption of fast food would be associated with lower BMI. In addition, as persistent use of weight control practices that reduce energy intake has been related to actual weight loss and/or weight maintenance (11,12), we also hypothesized that a longer duration of practices that reduce energy intake would be related to lower BMI.

RESEARCH DESIGN AND METHODS

— Look AHEAD is a multicenter, randomized clinical trial being

From the [1]Department of Psychiatry and Human Behavior, Brown Medical School/The Miriam Hospital, Providence, Rhode Island; the [2]Division of Epidemiology and Community Health, University of Minnesota, Minneapolis, Minnesota; the [3]Department of Biostatistical Sciences, Wake Forest University School of Medicine, Winston-Salem, North Carolina; the [4]Department of Medicine and Epidemiology, The John Hopkins University, Baltimore, Maryland; and the [5]Diabetes Center, Massachusetts General Hospital, Boston, Massachusetts.
Corresponding author: Hollie Raynor, PhD, RD, hraynor@utk.edu.
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H.A.R. is currently affiliated with the University of Tennessee, Knoxville, Tennessee.

conducted in overweight/obese adults with type 2 diabetes at 16 centers across the U.S. This trial compares the long-term effects of an intensive lifestyle intervention for weight loss on incidence of serious cardiovascular events with those of a diabetes support and education control condition (14). Participants will be followed for up to 11.5 years.

Look AHEAD recruited 5,145 participants with type 2 diabetes aged 45–74 years with a BMI ≥25 kg/m^2 (≥27 kg/m^2 if taking insulin) and no upper limit for BMI. The goal of recruitment was to achieve equal numbers of men and women and a minimum of 33% of participants from racial/ethnic minority groups and to have ≤30% of participants taking insulin. Exclusion criteria included inadequate control of diabetes (i.e., A1C >11%), factors affecting a participant's ability to adhere to interventions, and underlying diseases likely to limit life span and/or affect the safety of the interventions (15).

All participants gave informed consent, consistent with the Helsinki Declaration and approved by the institutional review board of each center. Eligibility for Look AHEAD was determined using a series of screening visits.

Measures

Sociodemographic and anthropometric characteristics. Self-reported information on sex, race/ethnicity, marital status, highest level of education, employment status, and annual household income was collected from participants. Marital status was coded as either married/living in a marriage-type relationship or not, and education was coded as high school or less, vocational, some college, college degree, or graduate/professional education. Annual household income was split into four categories: <$30,000, $30,000–$59,999, $60,000–$79,999, or ≥$80,000. BMI was calculated as body weight in kilograms divided by the square of height in meters, with height measured by a wall-mounted stadiometer and weight measured by electronic scale.

Intentional weight loss history. Participants reported on lifetime frequency of intentional weight loss of 5–9, 10–19, 20–49, 50–79, 80–99, and ≥100 lb (16,17). Response categories were 0, 1–2, 3–4, 5–6, and ≥7 times. Variables derived from these categories were *1*) percentage of participants with at least one intentional weight loss of ≥5 lb, *2*) minimum number of intentional weight losses of ≥5 lb, and *3*) minimum total amount of intentional weight loss (defined as frequency multiplied by amount, using the lower end of the frequency and amount intervals and summing across categories) (17).

Self-weighing. Frequency of self-weighing was determined by the question, "How often do you weigh yourself?" Response categories were never, about once a year or less, every couple of months, every month, every week, every day, and more than once per day (4). For analyses examining sex and race/ethnicity, all response categories were included. For regression analyses, the categories were dichotomized at least once per week versus less than once per week, and the former was used as the reference in analyses as this is the recommendation given in behavioral weight control interventions (4).

Eating patterns. Participants reported the number of days per week they ate breakfast and the typical number of eating occasions, both meals and snacks, per day (18). Participants also reported how many days per week they ate any meal at fast food restaurants (8).

Weight control practices. Weight control practices were assessed using a list of 23 specific behaviors for weight control (12,17,19). Participants indicated whether they had engaged in any of the specific behaviors for weight control during the previous year. Previous research indicates the best method for assessing successful weight control in adults is to ask duration of use of each strategy (12); thus, participants indicated the weekly duration of each strategy used during the previous year. Results were expressed as percentage of participants using each practice and duration of use of each practice, up to 52 weeks (1 year). Participants not using a specific weight control practice received a value of zero for the duration variable (12). As the importance of each specific behavior was of interest for its impact on BMI, each of the items were considered individually in analyses (12,17,19).

Statistical analyses

To describe weight loss strategies used by this sample, *t* tests, ANOVAs, and χ^2 tests were used to assess for differences between sex and/or race/ethnicities in all variables. To identify weight loss strategies associated with BMI, several steps were taken. As BMI has been related to intentional weight loss history variables (17), the relationships between BMI and minimum number of intentional weight losses of >5 lb and minimum total amount of intentional weight loss were examined in univariate regression models to establish their need to be included in the larger multivariate model for BMI. To determine which weight loss strategies should be included in the larger multivariable model for BMI, associations between frequency of self-weighing, number of days per week in which breakfast was consumed, total number of meals and snacks per day, number of fast food meals consumed per week, and duration of all 23 specific weight control practices and BMI were examined in univariate regression models. Those variables significantly related to BMI were identified and a correlation matrix was conducted to look for relationships between variables with $P > 0.80$ (indicating problems with multicollinearity) (20), but no variables were associated at this level. Thus, all intentional weight loss history variables and weight loss strategies significantly associated with BMI in univariate models were included in the multivariable model of BMI. As the purpose of the multivariate model of BMI was to determine intentional weight loss history variables and weight loss strategies associated with BMI in the whole sample, age, sex, race/ethnicity, and socioeconomic status were controlled in the final model.

RESULTS — Participants had a mean ± SD age of 58.7 ± 6.8 years and a BMI of 35.9 ± 5.9 kg/m^2 and were 59.5% women. Table 1 reports the sociodemographic and anthropometric characteristics. Men were older than women (59.9 ± 6.7 vs. 57.9 ± 6.8 years; $P < 0.0001$), Native Americans were younger (55.4 ± 7.3 years; $P < 0.01$), and non-Hispanic whites were older (59.4 ± 6.8 years; $P < 0.001$) than participants from all other race/ethnicity. Women had a higher BMI than men (36.5 ± 6.1 vs. 35.2 ± 5.5 kg/m^2; $P < 0.0001$), and Hispanics had a lower BMI than non-Hispanic blacks and non-Hispanic whites (35.3 ± 5.6 vs. 36.5 ± 5.9 kg/m^2 [non-Hispanic black] and 36.0 ± 5.9 kg/m^2 [non-Hispanic white]; $P < 0.05$). Significantly fewer ($P < 0.0001$) Hispanics and Native Americans were highly educated, and fewer men were not married or living in a marriage-type relationship compared with women (16.8% vs. 43.4%; $P < 0.0001$). In addition, more ($P < 0.0001$) men were employed compared with women, and more women reported an annual household income

<$30,000 compared with men (30.2 vs. 13.0%; $P < 0.0001$).

Intentional weight loss history

A history of intentional weight loss was very common, with 88.9% of women and 86.2% of men reporting at least one intentional weight loss of ≥5 lb. Native American women had the lowest prevalence of prior intentional weight loss (66.5%), whereas non-Hispanic white women had the highest prevalence (96.2%). Non-Hispanic white women also reported a greater number of intentional weight losses ≥5 lb (7.9 ± 6.1; $P <$ 0.0001) than all other groups except for women of other race/ethnicity (6.4 ± 6.1) (60.8% of participants of other race/ethnicity indicated mixed race/ethnicity), with Native American women (2.9 ± 4.3) and men (2.9 ± 4.2) reporting the least number of intentional weight losses ≥5 lb. Non-Hispanic white women also had a greater ($P < 0.0001$) amount of overall intentional weight loss (135 ± 139 lb) than all other groups except for women of other race/ethnicity (97 ± 93 lb), again with Native American women reporting the lowest amount of overall intentional weight loss (53 ± 96 lb).

Self-weighing

Overall, 41.4% of participants reported self-weighing at least weekly, and non-Hispanic white men (48.5%), followed closely by non-Hispanic white women (47.0%), reported the highest prevalence of this, whereas Native American women had the lowest prevalence of self-weighing at least weekly (19.2%). Non-Hispanic black and Native American women, as well as Native American men, had the highest prevalence of never weighing themselves (11.3, 14.8, and 16.4%, respectively). When participants were classified by frequency of self-weighing, those that self-weighed on a weekly basis had a lower BMI (35.3 ± 5.6 kg/m^2; $P < 0.001$) than those who weighed themselves less than once per month.

Eating patterns

Breakfast was consumed on 6.0 ± 1.8 days/week and 5.0 ± 3.1 meals/snacks were eaten per day. There were no differences in breakfast consumption between sexes. Native Americans consumed breakfast fewer days per week (5.2 ± 2.2; $P < 0.001$) than participants of all other race/ethnicity. Participants who consumed breakfast 7 days/week had a lower

Table 1—*Baseline characteristics of Look AHEAD participants*

	Women					Men				
	Non-Hispanic white	Non-Hispanic black	Hispanic	Native American	Other*	Non-Hispanic white	Non-Hispanic black	Hispanic	Native American	Other*
n (%)	1,665 (54.4)	614 (20.1)	483 (15.8)	203 (6.6)	98 (3.2)	1,581 (75.9)	189 (9.1)	194 (9.3)	55 (2.6)	63 (3.0)
Age (years)	58.6 ± 6.9	57.7 ± 6.4	56.9 ± 6.1	55.0 ± 7.3	57.2 ± 6.7	60.3 ± 6.6	58.6 ± 7.3	58.7 ± 6.5	56.7 ± 7.2	59.7 ± 7.0
BMI (kg/m^2)	36.7 ± 6.2	36.8 ± 6.0	35.5 ± 5.7	36.3 ± 6.5	35.7 ± 6.3	35.3 ± 5.5	35.5 ± 5.5	34.7 ± 5.2	33.4 ± 5.2	33.5 ± 5.1
Education										
≤High school	18.9	17.9	55.1	40.0	7.6	9.0	18.0	33.0	39.2	6.6
Vocational	4.6	7.6	4.6	7.7	5.4	2.7	5.8	4.7	3.9	1.6
Some college	26.5	28.7	19.8	31.3	26.1	22.3	28.0	23.0	25.5	27.9
College degree	22.5	22.8	11.9	17.4	33.7	26.0	20.6	23.0	21.6	23.0
Graduate/professional education	27.4	22.9	8.6	3.6	27.2	39.9	27.5	16.2	9.8	41.0
Married/live-in	61.7	39.6	61.8	52.2	59.2	85.9	72.5	78.9	70.9	71.4
Employed	67.4	68.3	54.0	63.8	75.8	82.2	78.6	74.5	69.8	75.5
Family income										
<$30,000	19.6	32.3	53.5	53.1	23.9	7.7	22.5	42.5	31.5	3.4
$30,000–$59,000	35.3	39.4	30.4	33.0	36.4	26.1	20.7	24.2	42.6	27.1
$60,000–$79,000	17.7	15.6	9.1	7.3	20.5	18.1	20.1	12.4	14.8	17.0
>$80,000	27.4	12.8	7.0	6.7	19.3	48.1	36.7	21.0	11.1	52.5

Data are means ± SD or % unless otherwise indicated. Total number of women was 3,063 and total number of men was 2,082. *Of "other" participants, 60.8% indicated their race/ethnicity was "mixed."

Table 2—*Prevalence (in rank order) and duration of weight control practices used over the previous year by Look AHEAD participants*

	Prevalence	Duration in weeks
Increase fruits and vegetables	65.0	26.5 ± 19.3
Cut out sweets and junk food	61.7	22.9 ± 19.2
Eat less high-carbohydrate foods	57.5	20.3 ± 19.1
Increase exercise levels	55.1	21.1 ± 17.3
Decrease fat intake	55.0	18.0 ± 17.5
Reduce number of calories eaten	51.8	18.7 ± 17.5
Record food intake daily	37.5	9.1 ± 11.2
Eat less meat	34.9	22.8 ± 19.4
Cut out between-meal snacking	34.3	14.6 ± 15.9
Use home exercise equipment	30.2	18.9 ± 17.5
Eat special low-calorie diet foods	21.0	22.3 ± 19.0
Drink fewer alcoholic beverages	18.5	25.6 ± 20.6
Use a very-low-calorie diet	17.6	16.1 ± 16.9
Count fat grams	16.4	18.0 ± 18.3
Eat meal replacements	15.8	10.4 ± 13.6
Record exercise daily	14.7	17.4 ± 17.5
Count calories	14.6	12.2 ± 15.0
Go to a weight loss group	11.9	13.3 ± 13.2
Keep a graph of exercise	7.8	15.4 ± 17.3
Keep a graph of weight	6.7	18.8 ± 18.0
Fast or go without food entirely	5.3	5.7 ± 11.8
Take diet pills	4.3	9.3 ± 12.0
Smoke cigarettes	3.5	20.2 ± 23.6

Data are % or means ± SD.

BMI (35.6 ± 5.7 kg/m^2; $P < 0.0001$) than participants who consumed breakfast 3–6 days/week (BMI = 36.7 ± 6.3 kg/m^2) and ≤2 days/week (BMI = 37.3 ± 6.1 kg/m^2). Women consumed more meals and snacks per day than men (5.1 ± 3.2 vs. 4.8 ± 2.9; $P < 0.001$), with no differences in race/ethnicity for meals/snacks consumed per day. There was no difference in BMI by the number of meals/snacks per day.

Overall, participants consumed 1.9 ± 2.7 fast food meals/week. Hispanic men and Native American women reported consumption of the greatest number of fast food meals per week (2.6 ± 3.6 and 2.6 ± 2.8, respectively), which was greater ($P < 0.05$) than the number consumed per week reported by Hispanic (1.9 ± 3.0), non-Hispanic white (1.5 ± 2.3), and other race/ethnicity women (1.4 ± 2.0), as well as non-Hispanic white men (1.8 ± 2.4). BMI differed ($P < 0.001$) between individuals reporting no fast food meals per week (BMI = 35.2 ± 5.6 kg/m^2), 1 or 2 fast food meals/week (BMI = 36.0 ± 5.8 kg/m^2), or ≥3 fast food meals/week (BMI = 36.9 ± 6.3 kg/m^2).

Weight control practices

Prevalence rates and duration of use of the practices over the previous year are presented in Table 2. Ranking and duration of use of the weight control practices were similar across sex and race/ethnicity and thus were collapsed across these categories. The three most prevalent practices, used by ~60% of participants, were increase fruit and vegetable intake, cut out sweets and junk food, and eat less high-carbohydrate foods. Duration of these practices ranged from 20.3 ± 19.1 to 26.5 ± 19.3 weeks. Besides the top three most prevalent practices, at least 50% of participants reported increasing exercise levels, decreasing fat intake, and reducing the number of calories eaten to aid in weight control.

Relationship between weight loss strategies and BMI

Table 3 shows univariate and multivariate relationships between intentional weight loss history, weight loss strategies, and BMI. More intentional weight loss attempts and greater total amount of intentional weight loss were associated ($P > 0.0001$) with a higher BMI. Weighing less than once per week and less frequent breakfast and more frequent fast food consumption were related ($P < 0.0001$) to higher BMI. In those weight control practices in which a significant ($P < 0.05$) relationship was found with BMI, typically a shorter duration of weight control practice was related to higher BMI. However, longer duration of three weight control practices (decrease fat intake, reduce number of calories eaten, and go to a weight loss group) was associated ($P < 0.05$) with higher BMI.

In the multivariate model, a larger amount of overall intentional weight loss ($B = 0.01$), self-weighing less than once per week ($B = 0.83$), and more fast food meals consumed per week ($B = 0.15$) were associated ($P < 0.05$) with higher BMI, whereas a greater number of days per week in which breakfast was consumed ($B = -0.18$) was associated ($P < 0.05$) with lower BMI. R^2 for the adjusted model was 0.24. After adjustment, the durations of individual weight control practices were no longer related to BMI.

CONCLUSIONS — Ideally, weight management recommendations for overweight patients with type 2 diabetes should lower BMI. Thus, the purpose of this investigation was to describe intentional weight loss strategies occurring in a diverse sample of overweight individuals with type 2 diabetes and identify strategies associated with lower BMI in the general sample.

When taken as a whole, in this study we found rates of intentional weight loss strategies similar to those in previous investigations examining participants without type 2 diabetes. For example, in this study, as with previous research, prior intentional weight loss was very common, particularly in non-Hispanic white women (12). However, less than half of participants weighed themselves weekly or more often, a rate described previously (4). Although a regular eating pattern was reported (five meals/snacks consumed per day), breakfast was skipped ~1 day/week. Fast food intake was fairly high, two meals per week, which is similar to what has been shown in adult women (21). However, when examined by race/ethnicity, it becomes clear that Native American participants, particularly women, appeared to have the least healthy profile for weight loss strategies (they monitored their weight less frequently, skipped breakfast more often, and consumed more fast food meals).

The top three weight control practices reported consistently by participants of all race/ethnicity and both sexes focused on dietary changes and were practiced persistently, similar to previous reports (11). Although these practices were not related

Table 3—*Parameter estimates of weight control behaviors in relation to BMI in Look AHEAD participants*

Independent variable	Univariate unadjusted model*	Adjusted multivariate model*†
Number of intentional weight losses ≥5 lb	0.2766‡	0.0877
Amount of intentional weight lost	0.0146‡	0.0138‡
Regular self-weighing		
<weekly	1.5191‡	0.8339‡
≥weekly	Referent	Referent
Breakfast eaten days per week	−0.3072‡	−0.1786‡
Number of meals/snacks eaten per day	0.0418	
Number of fast food meals eaten per week	0.2597‡	0.1499‡
Number of weeks duration of		
Increase fruits and vegetables	−0.0063	
Cut out sweets and junk food	−0.0260‡	0.0048
Eat less high-carbohydrate foods	−0.0233‡	−0.0098
Increase exercise levels	−0.0350‡	−0.0447
Decrease fat intake	0.0378‡	0.0110
Reduce number of calories eaten	0.0210‡	−0.0072
Record food intake daily	0.0104	
Eat less meat	0.0094	
Cut out between-meal snacking	−0.0070	
Use home exercise equipment	−0.0477‡	−0.0299
Eat special low-calorie diet foods	−0.0009	
Drink fewer alcoholic beverages	−0.0614‡	0.7297
Use a very-low-calorie diet	−0.0209‡	−0.0347
Count fat grams	−0.0149	
Eat meal replacements	0.0554	
Record exercise daily	−0.0058	
Count calories	−0.0099	
Go to a weight loss group	0.0643‡	0.0666
Keep a graph of exercise	−0.0472‡	−0.0442
Keep a graph of weight	−0.0230	
Fast or go without food entirely	0.0236	
Take diet pills	0.0707	
Smoke cigarettes	0.0050	

*Reported estimates are β-coefficients (linear regression). †The model is controlled for age, sex, race/ethnicity, household income, and education. ‡Significant at $P < 0.05$.

to lower BMI in the adjusted model, they could reflect an attempt to influence carbohydrate consumption. Contrary to this result, prior studies examining the prevalence of specific weight control practices in adults without type 2 diabetes using similar measures showed that the most prevalent diet-related practice targets reducing energy consumed or decreasing fat intake (11,12,17,19). This study suggests that patients with type 2 diabetes use weight control practices that help meet dietary recommendations for type 2 diabetes (13). Indeed, similar to findings from this study, in a national representative sample of adults with type 2 diabetes, making healthy food choices was a health-related behavior reported by almost 80% of the participants (22).

Most importantly, this study identified a few strategies related to lower BMI in overweight individuals with type 2 diabetes. As predicted, weekly self-weighing, regularly consuming breakfast, and eating less fast food were related to lower BMI.

Randomized trials that have promoted regular self-weighing have also shown better weight control (5,23) than conditions with less emphasis on self-weighing. Although frequent self-weighing itself most likely does not reduce weight, it may play an important role in self-regulation, providing objective feedback on energy balance (4).

This study supports previous findings that consuming less fast food (8,21) and regular breakfast consumption (7) are related to lower BMI. Greater consumption of fast food may contribute to increased BMI through excessive energy intake via passive overconsumption because of the high energy density of fast food, large portion sizes, and greater palatability (24). Eating breakfast may improve weight control by preventing excessive consumption that might occur with irregular eating patterns (25).

This study showed that duration of the most commonly used weight control practice, increasing fruit and vegetable intake, was not related to BMI in the adjusted model. Supporting this finding, a randomized trial in which fruit and vegetable intake was increased with no prescription to reduce energy intake produced an initial small weight loss that was not maintained (26), suggesting that this strategy alone may be an ineffective method for weight control.

The strengths of this study include a large, ethnically and socioeconomically diverse sample with objectively measured height and weight. Limitations include the inability to conduct multivariate analyses for BMI specific to sex and race/ethnicity because of the smaller sample size in some of the different subgroups, the retrospective nature of self-reported measures, a potential bias associated with self-report of eating patterns and weight control practices, the limited range of BMI in participants (to be eligible to participate in the trial, a BMI ≥25 kg/m^2 was required), and the observational, cross-sectional study design, which precludes any conclusions regarding the temporal ordering of relationships.

In summary, several weight loss strategies (weekly self-weighing, regular consumption of breakfast, and reduced intake of fast food) were associated with lower BMI in overweight individuals with type 2 diabetes. These strategies are specific and may be easier to implement, monitor, and adhere to than global weight loss strategies (reducing calories consumed). Future research should test interventions that encourage the persistent use of these specific strategies to help with weight control in adults with type 2 diabetes.

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