Nutrition knowledge, attitudes, and self-regulation as predictors of overweight and obesity

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ABSTRACT

Background and purpose: Nutrition knowledge, attitudes, and eating self-regulation are important determinants of overweight and obesity. Eating self-regulation is the link between eating intention and behavior. However, the extent to which these factors influence overweight and obesity has not been thoroughly studied. The study examined nutrition knowledge, attitudes, and eating self-regulation as predictors of overweight and obesity among adults in a community setting.

Methods: A total of 313 adults participated in an online survey, which included the General Nutrition Knowledge Questionnaire–Revised, the Nutrition Attitudes Questionnaire, and the Self-Regulation of Eating Behavior Questionnaire. Descriptive statistics, Kendall's tau tests, and multivariate logistic regression procedures were performed.

Conclusions: More than half of the participants were either overweight or obese (56.5%). The mean nutrition knowledge score was 74.1%, and only 28.1% correctly identified the body mass index for obesity. Positive predictors of overweight and obesity included poor eating self-regulation of giving up too easily on eating intentions (odds ratio [OR] = 3.81), male gender (OR = 2.0), and age (OR = 1.03), whereas nutrition attitudes were a negative predictor (OR = 0.74).

Implications for practice: The odds of overweight or obesity were nearly four times greater for those who gave up too easily on their eating intentions. Nurse practitioners can play a critical role in establishing healthy dietary habits to maintain weight control by promoting good eating self-regulation, despite the current obesogenic environment. After assessing patient readiness and motivation, it is important to help patients make eating self-regulation as manageable as possible to promote long-term weight management.

Keywords: Obesity; overweight; eating; self-regulation; weight loss; attitudes; knowledge.

The obesity epidemic is a serious health crisis. More than two thirds of adults in the United States are either overweight or obese (Hales, Carroll, Fryar, & Ogden, 2017). This chronic disease is a root cause of other complications, such as type 2 diabetes, hypertension, myocardial infarction, stroke, and osteoarthritis, as well as certain cancers (Tsai, Remmert, Butryn, & Wadden, 2018). The estimated total cost of obesity in the United States was $342.2 billion in 2013, and it is a major contributing factor in rising healthcare costs and medical insurance premiums (Biener, Cawley, & Meyerhoefer, 2017).

Despite the high prevalence and cost of obesity, it is a preventable and treatable disease with better health outcomes upon weight loss. The Look AHEAD study (Action for Health in Diabetes) involving 5,145 overweight and obese adults with type 2 diabetes showed that a modest weight loss of 5–10% was associated with significant improvements in blood pressure, HbA1c, and HDL cholesterol (Wing et al., 2011). Similarly, in the DiRECT study of 306 overweight and obese patients diagnosed with type 2 diabetes within the past 6 years, almost half of the primary care-led intervention group achieved remission of diabetes at 12 months with a mean weight loss of 10 kg (Lean et al., 2018). Among those patients who lost 15 kg or more at 12 months, the diabetes remission rate was 86%, with HbA1c less than 6.5% and cessation of all antidiabetic drugs.

Intensive behavioral interventions involving healthy nutrition and modest exercise have shown to be highly

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effective in inducing short-term weight loss, but long-term maintenance of such weight loss is more difficult and challenging (Kahan, Wilson, & Sweeney, 2018; Tsai et al., 2018). A landmark Diabetes Prevention Program (DPP) randomized controlled trial of 3,234 overweight and obese adults showed an average weight loss of 15 lbs at 6 months with intensive lifestyle interventions involving a low-calorie, low-fat diet and at least 150 min of moderate physical activity per week (Knowler et al., 2002). However, the weight loss was poorly sustained at an average of 9 lbs at 3–4 years and only about 4 lbs at 10 years (Diabetes Prevention Program Research Group, 2004, 2009). The low-fat diet used in the DPP study consisted of less than 25% fat, without any recommendations for protein or carbohydrate. In contrast, another landmark randomized controlled trial of 773 overweight adults who had initially lost an average of 24 lbs over 2 months on a low-calorie diet showed that people on a high-protein, low-glycemic-index, low-carbohydrate diet eaten ad libitum without caloric restriction continued to maintain their original weight loss at 6 months (Larsen et al., 2010). The causes of obesity are multifactorial, including genetic makeup, individual behaviors, and psychosocial factors, as well as the current obesogenic environment in the United States (MacLean et al., 2015). Therefore, individual variability, including the development of self-regulation, plays a significant role over how one responds to obesity treatment and sustained long-term weight loss (MacLean et al., 2018).

Self-regulation refers to the psychological mechanism that links an individual's intention with behavior (Allan, Johnston, & Campbell, 2011; Gellert, Ziegelmann, Lippke, & Schwarzer, 2012). Among individuals with overweight or obesity, *eating self-regulation* refers to the ability to control eating behavior in line with their intention for healthy eating and weight control, especially within an obesogenic environment (de Vet & de Ridder, 2015). According to the cyclical model of obesity and cognitive function, obesity causes physiological changes that negatively affect cognitive function (Hawkins et al., 2018). These cognitive deficits contribute to poor self-regulation, leading to unhealthy eating behavior and low physical activity. In addition, the key attributes of eating self-regulation have been identified as goal setting, self-monitoring of dietary intake, self-regulation to resist temptations, self-evaluation of dietary performance, and autonomous motivation (Reed et al., 2016).

Previous studies have demonstrated the impact of eating self-regulation on weight loss and its long-term maintenance. An observational study of 1,601 women aged 40–50 years in New Zealand showed that self-regulation of eating behavior was positively associated with healthy eating habits and lower body mass index (BMI) (Leong, Madden, Gray, & Horwath, 2012). In this study, self-regulation of eating was assessed with a scale

that asked about various reasons for eating, including internal motivation, personal values and meaning associated with eating, and self-judgment over consequences. However, this study did not address the link between eating intention and eating behavior. Another study, a randomized controlled trial of 314 adults who had previously lost at least 10% of their body weight, showed that those who received intensive face-to-face intervention to enhance self-regulation were better able to maintain their weight loss at 18 months compared with the control group (Wing, Tate, Gorin, Raynor, & Fava, 2006). The self-regulation examined in this study was focused on self-monitoring of weight and ensuing changes in diet and exercise, but self-regulation as a link between eating intention and behavior was not fully addressed.

Self-regulation of eating usually occurs in the context of the individual's nutrition knowledge and attitudes. Previous studies have shown that positive nutrition attitudes foster healthy eating habits, which are further influenced by nutrition knowledge (Rose, Williams, Rengers, Kennel, & Gunther, 2018; Stroebele-Benschop, Dieze, & Hilzendegen, 2018). For those patients who are ready and motivated to lose weight, primary care providers can help them achieve weight loss through better nutrition knowledge and attitudes, as well as their eating self-regulation that links eating intention with behavior. Therefore, patients' nutrition knowledge, nutrition attitudes, and eating self-regulation are important factors that need to be considered in caring for those with overweight and obesity. However, the extent to which these factors influence overweight and obesity has not been thoroughly studied.

Aims

The aim of this study was to examine nutrition knowledge, nutrition attitudes, and eating self-regulation as predictors of overweight and obesity among adults in a community setting.

Methods
Design and participants

This cross-sectional study was conducted from October 2017 to November 2017 using an online survey portal, Qualtrics (Online Survey Services, Provo, UT). The eligibility criteria included male or female adults aged 18 years or above who were literate in English.

Instruments

The survey questionnaire included section 4 of the General Nutrition Knowledge Questionnaire–Revised (GNKQ–R), the Nutrition Attitudes Questionnaire, and the Self-Regulation of Eating Behavior Questionnaire (SREBQ). Demographic data, including age, gender, ethnicity, educational background, height, and weight, were also collected. Body mass index was calculated as weight

divided by height squared (kg/m^2). A BMI of 25–29.9 kg/m^2 is defined as overweight, and a BMI greater than or equal to 30 kg/m^2 is defined as obese (Jensen et al., 2014).

Section 4 of the GNKQ–R contains 20 multiple-choice items that assess four topics related to nutrition knowledge regarding diet, disease, weight management, and BMI (Kliemann, Wardle, Johnson, & Croker, 2016). The first topic, with eight items, covers the relationship between diet and various diseases. The second topic, with four items, asks about diet to maintain healthy weight. The third topic, on weight management, includes six questions assessing knowledge about weight management, such as monitoring weight/eating, reading food labels, and taking nutritional supplements. The final topic consists of two questions on BMIs of normal and obese weight status. Each item carries one point for a correct answer, and a higher summation score indicates better nutrition knowledge.

The eight-item Nutrition Attitudes Questionnaire consists of two subscales, Caring About Nutrition and Nutrition Affects Health (Byrd-Bredbenner, O'Connell, Shannon, & Eddy, 1984; Cannoosamy, Pem, Bhagwant, & Jeewon, 2016). The Caring About Nutrition subscale covers nutritional interest, whereas the Nutrition Affects Health subscale asks questions about the importance of nutrition to health. Response options on a five-point Likert scale range from 1 (strongly disagree) to 5 (strongly agree). Internal consistency reliabilities were reported as Cronbach's alphas of 0.67 and 0.53 for the Caring About Nutrition and Nutrition Affects Health subscales, respectively. In the current study, the Cronbach's alphas for the two subscales were 0.73 and 0.75, respectively.

The five-item SREBQ was developed to assess eating self-regulatory capacity in maintaining eating intentions (Kliemann, Beeken, Wardle, & Johnson, 2016). The items assess ability to control eating behavior, ability to stick to eating intentions, ability to monitor actual eating behavior, and ability to adjust when necessary to achieve eating intentions. Each item was rated on a five-point Likert scale, ranging from one (never) to five (always), with higher scores indicating better self-regulation. The Cronbach's alpha was previously reported as 0.75. In the current study, the Cronbach's alpha was 0.73.

Data collection procedures

This study was reviewed and approved by the university institutional review board. A waiver of signed informed consent was granted, since minimal risks were involved in this survey study. Recruitment emails containing a hyperlink to the web-based survey were sent to first-year students at the university and to personal contacts via social media. Respondents who agreed to participate were asked to click the link in the email directing them to a study-specific, secure Qualtrics website. The survey took approximately 10 minutes to complete.

Data analysis

Descriptive statistics were calculated using the means, standard deviations, frequencies, and percentages to summarize the sample characteristics and key variables of the study. The dependent variable in this study was overweight and obesity based on BMI categories, coded as a dichotomous variable (BMI $\geq$ 25 kg/m^2 = 1; BMI < 25 kg/m^2 = 0). For each item in the SREBQ, the participant's response was recoded as a dichotomous variable, with poor self-regulation responses of 1–2 recoded as "1" and good self-regulation responses of 3–5 recorded as "0" to allow calculation of odds ratio in multivariate logistic regression modeling to predict overweight and obesity. Instead of using the summation SREBQ score, individual SREBQ items were used in statistical analysis to identify the specific aspects of self-regulation that best predict overweight and obesity.

Bivariate correlations by Kendall's tau tests were performed to examine the correlations between overweight/obesity and other key variables, including four nutrition knowledge topics, two nutrition attitudes subscales, each item of the SREBQ, and demographic variables. The variables that had statistically significant correlations with overweight and obesity were entered into a multivariate logistic regression model to examine the predictors of overweight and obesity. The level of significance was set at $p < .05$, and SPSS, version 24 (IBM Corporation, Armonk, NY), was used for all data analyses.

Results
Sample characteristics

Of the 318 participants, 5 did not complete the survey, so 313 subjects were included in data analysis. More than half of the participants had a BMI in the overweight or obese range (n = 177; 56.5%), and about a quarter were obese (n = 72; 23.0%; Table 1). The average age was 42 years. Most of the participants were female (75.7%), non-Hispanic Caucasians (85.0%), and college graduates (71.6%). Among males, 53 subjects out of 75 were overweight or obese (70.7%).

Nutrition knowledge, attitudes, and self-regulation of eating behavior

The mean overall nutrition knowledge score was 74.1% (Table 2). Among the various nutrition knowledge topics, the subjects had the highest knowledge score on diet and diseases, with a mean score of 80.7%. Within this topic, the subjects scored lowest on the item that asked about eating less red meat to reduce cancer (37.1%). On the topic of diet and weight, the mean knowledge score was 77.4%, with only 57.5% of subjects responding correctly to the item about eating a high-protein diet to maintain a healthy weight. On the topic of weight management, the mean score was 74.5%, with only 23.5% responding correctly to the item about taking nutritional supplements to

Table 1. Sample characteristics (*N* = 313)

	Non-Overweight/Obese Group (*n* = 136)	Overweight/Obese Group (*n* = 177)	Total (*N* = 313)
Age, mean (range), year	39 (18–69)	44 (19–76)	42 (18–76)
Gender			
Male	22 (16.2)	53 (29.9)	75 (24.0)
Female	114 (84.4)	123 (69.5)	237 (75.7)
Ethnicity			
Non-Hispanic Caucasian	112 (82.4)	154 (87.0)	266 (85.0)
African American	3 (2.2)	4 (2.3)	7 (2.2)
Hispanic	14 (10.3)	14 (7.9)	28 (8.9)
Asian/Pacific Islander	3 (2.2)	1 (0.6)	4 (1.3)
Other	4 (2.9)	4 (2.3)	8 (2.6)
Education			
High school graduate or less	8 (5.9)	11 (6.2)	19 (6.1)
Some college	31 (22.8)	38 (21.5)	69 (22.0)
College graduate	96 (70.6)	128 (72.3)	224 (71.6)
Body mass index (BMI)[a]			
Underweight	1 (0.7)	NA	1 (0.3)
Normal weight (18.5–24.9 kg/m^2)	135 (99.3)	NA	135 (43.1)
Overweight (25.0–29.9 kg/m^2)	NA	105 (59.3)	105 (33.5)
Obese ($\geq$30 kg/m^2)	NA	72 (40.7)	72 (23.0)

Note: Values are expressed as n *(%) unless otherwise indicated.*
Percentages may not add up to 100% because of missing data or rounding.
[a]*Body mass index (BMI) category per CDC Adult BMI calculator.*

manage weight. The subjects' knowledge of BMIs was very poor, with only 50.2% and 28.1% correctly identifying the BMIs for normal and obese weight, respectively.

The overall mean nutrition attitudes score was 4.18 ($\pm$0.63) out of 5. The Caring About Nutrition subscale mean score was 4.00 ($\pm$0.80), while the Nutrition Affects Health subscale mean score was 4.49 ($\pm$0.77). **Figure 1** shows a comparison of poor self-regulation of eating behavior between overweight/obese and non-overweight/obese groups. A larger percentage of subjects who were overweight or obese responded as having poor self-regulation in all five self-regulation items. Among these five items, the self-regulatory statement "I often or always give up too easily on my eating intentions" showed the largest difference between the two groups (44.6% vs. 15.4%).

Predictors of overweight and obesity

Table 3 shows the results of bivariate correlation between overweight/obesity and other variables by Kendall's tau tests. Findings revealed that overweight/obesity had

significant positive correlations with age ($r = 0.16$, $p = .001$) and male gender ($r = 0.17$, $p = .003$). In contrast, it had a negative correlation with the Nutrition Affects Health subscale of nutrition attitudes ($r = -0.17$, $p = .01$). Among the SREBQ items, overweight and obesity had statistically significant positive correlations with the items, including "I often/always give up too easily on my eating intentions" ($r = 0.31$, $p < .001$), "I am never/rarely good at resisting tempting food" ($r = 0.20$, $p = .001$), and "I often/always easily get distracted from the way I intend to eat" ($r = 0.21$, $p < .001$). A multivariate logistic regression procedure showed that self-regulation of "I often/always give up too easily on my eating intentions" (odds ratio [OR] = 3.81; 95% confidence interval [CI] [2.15, 6.74]; $p < .001$), male gender (OR = 2.00; 95% CI [1.10, 3.62]; $p = .023$), and age (OR = 1.03; 95% CI [1.01, 1.05]; $p = .003$) were positive predictors of overweight/obesity (Table 4). In contrast, the Nutrition Affects Health subscale of nutrition attitudes was a negative predictor of overweight and obesity (OR = 0.74; 95% CI [0.63, 0.87]; $p < .001$).

Table 2. Correct nutrition knowledge scores (*N* = 313)

	%
Knowledge on diet and diseases	
Eating less refined foods and prevention of diabetes	94.9
Eating less trans fats and prevention of heart disease	93.9
Low fiber intake and bowel disorders	91.7
Salt intake and high blood pressure	89.1
White bread and high blood sugar	83.7
Sugar intake and tooth decay	81.8
Eating animal fats and blood cholesterol	73.2
Eating red meat and cancer	37.1
Topic mean score	80.7
Knowledge on diet and weight	
To maintain a healthy weight, cut out fat completely[a]	96.8
Eating bread always causes weight gain[a]	88.5
Fiber can decrease the chances of gaining weight	66.5
To maintain a healthy weight, eat a high-protein diet	57.5
Topic mean score	77.4
Knowledge on weight management	
Monitoring eating	99.4
Reading food labels	97.8
Monitoring weight	93.6
Not eating while watching TV	87.8
Grazing throughout the day[a]	45.0
Taking nutritional supplements[a]	23.5
Topic mean score	74.5
Knowledge on BMI categories	
BMI for normal weight	50.2
BMI for obese weight	28.1
Topic mean score	39.1

Note: Mean overall nutrition knowledge score = 74.1%.
Note: BMI = body mass index.
[a]*"Disagree" or "No" is the correct response.*

Discussion

This study indicates that one of the strongest predictors of overweight and obesity is poor eating self-regulation. The odds of overweight and obesity were nearly four

times higher for those who often or always gave up too easily on their eating intentions. Inability to follow eating intentions and failure to achieve the long-term goal of controlling eating behaviors appear to be critical determining factors for being overweight or obese. As expected, older age was a positive predictor of overweight and obesity. The odds ratio of 1.03 for age indicates a 3% yearly increase in the odds of being overweight or obese, which is equivalent to about a 30% increase per decade. This is most likely due to behavioral and physiological changes associated with aging, along with a decreasing basal metabolic rate (Nooyens et al., 2009). It is interesting that male gender doubles the odds of overweight and obesity in this population recruited through social media. In contrast to these positive obesogenic predictors, good nutrition attitudes as assessed by the Nutrition Affects Health subscale were a negative predictor for overweight and obesity, which was not surprising. The odds ratio of 0.74 indicates that the odds of overweight and obesity are reduced by 26% for every one-unit increase in the subscale score (e.g., from "somewhat agree" to "strongly agree").

Among these predictors of overweight and obesity, poor eating self-regulation is a modifiable factor. The current US environment, in which energy-dense and palatable foods are inexpensive and easily available, makes the general population particularly vulnerable to weight gain. Nonetheless, such an obesogenic environment does not necessarily affect all individuals the same way, and there is a significant individual variation in weight gain. Some of the variations do arise from unmodifiable genetics, but there is a component that may be amenable to training, such as eating self-regulation. Good eating self-regulation, practiced over time, can become ingrained as healthy dietary habits that are largely automatic and self-sustaining (Gardner, Lally, & Wardle, 2012; Johnson, Pratt, & Wardle, 2012). In the current study, we have found that poor self-regulation of eating, that is, often or always giving up too easily on eating intentions, strongly predicts overweight and obesity. This result is consistent with the previous study from New Zealand that associated high self-regulation of eating behavior with lower BMI among middle-aged women (Leong et al., 2012).

Nutrition attitudes appear to be another modifiable predictor of overweight and obesity in the current study. These findings are consistent with previous reports that personal beliefs and attitudes toward nutrition and health influence healthy eating behaviors (Cooke & Papadaki, 2014; Dissen, Policastro, Quick, & Byrd-Bredbenner, 2011). Interestingly, all three Nutrition Affects Health subscale items in the current study cover general information about eating and health: eating well prevents certain diseases; foods they eat will keep them healthy; and nutrition is important for their health. Asking these
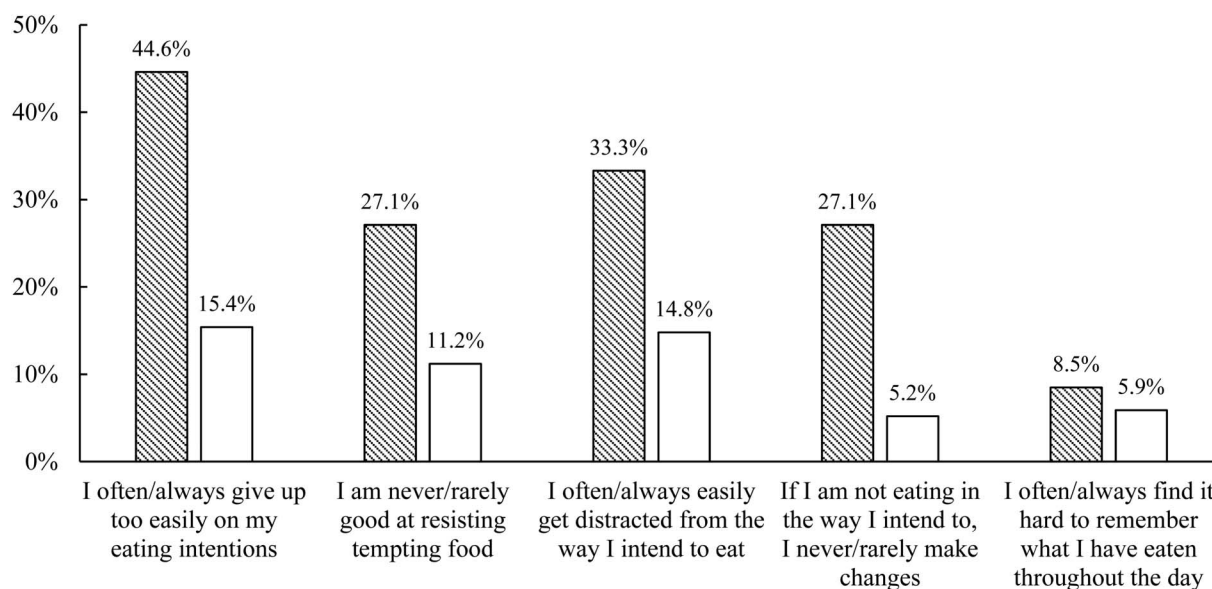
Figure 1. Comparison of poor self-regulation of eating behavior (*N* = 313). Crosshatch bars represent adults with overweight/obesity, and white bars represent adults without overweight/obesity.

three simple questions may help assess patients' basic understanding of how nutrition affects their health. If a patient has poor understanding, targeted education and counseling may be a good starting point for improving knowledge and attitudes toward nutrition and weight management in the primary care setting (Dissen et al., 2011).

Limitations

There were a few limitations to the current study. First, the findings of eating self-regulation and nutrition attitudes as predictors of overweight and obesity should not be taken as a cause-and-effect relationship in this cross-sectional study. Second, stability of weight status was not measured in this study, but reported weights are assumed to be the long-term results of eating self-regulation. Third, the subjects recruited through social media were mostly college graduates, female, and Caucasian. This may limit generalizability of the study findings to other populations. Fourth, the data were collected through a self-reported, web-based survey, which may over- or underestimate actual weight status. Finally, additional studies are needed to confirm the current study findings and to establish cause-and-effect relationships between eating self-regulation and overweight/obesity.

Implications for practice

The ongoing obesity epidemic is a major public health problem in urgent need of practical solutions. Fortunately, obesity is preventable and treatable. The US Preventive Services Task Force recommends that all adults be screened for obesity in the primary care setting and that intensive lifestyle counseling be offered to patients with a BMI of 30 kg/m² or higher (Moyer & US Preventive

Services Task Force, 2012). As frontline primary care providers, nurse practitioners are responsible for regularly monitoring their patients' BMI, as well as diagnosing and treating the chronic disease of obesity to prevent future complications. When it comes to managing obesity and its effects on patients, there are several implications for nurse practitioners in the primary care setting.

First, we need to possess a deeper understanding of the chronic disease process of obesity, as well as the current evidence for safe and effective management of obesity, which is rapidly evolving. Obesity is not simply a lifestyle problem, but rather is a complex, chronic disease involving biological, behavioral, psychosocial, and environmental factors (MacLean et al., 2015). Based on the evidence supporting high-intensity counseling therapy for weight loss, the Centers for Medicare and Medicaid (CMS) have been reimbursing 14 sessions of face-to-face intensive behavioral therapy delivered over 6 months in the primary care setting (Centers for Medicare and Medicaid Services, 2011). To be eligible for reimbursement, the therapy must be performed by qualified primary care practitioners, including nurse practitioners and clinical nurse specialists. The intensive counseling and behavioral therapy sessions include weight loss goal setting, dietary and physical activity improvements, identifying and reducing barriers to lifestyle change, and self-monitoring of progress.

Second, each patient with obesity needs to be assessed for readiness and motivation for weight loss before initiating individualized behavior therapy. Applying the 5-A framework (Ask, Advice, Assess, Assist, and Arrange) in counseling and motivational interviewing is also recommended as a useful approach (Acosta et al., 2017; DiLillo & West, 2011). Personalized reasons for

Table 3. Correlations with overweight/obesity (*N* = 313)

	Overweight/Obesity
Age	0.16**
Male gender	0.17**
Knowledge on diet and disease	0.03
Knowledge on diet and weight	−0.06
Knowledge on weight management	0.02
Knowledge on BMI	−0.05
Attitudes: Caring About Nutrition	−0.05
Attitudes: Nutrition Affects Health	−0.17*
I often/always give up too easily on my eating intentions	0.31***
I am never/rarely good at resisting tempting food	0.20**
I often/always easily get distracted from the way I intend to eat	0.21***
If I am not eating in the way I intend to, I never/rarely make changes	0.09
I often/always find it hard to remember what I have eaten throughout the day	0.05

*Note: **p < .01 ***p < .001 by Kendall's tau tests. Demographic variables of ethnicity and educational backgrounds were also entered, but none of them was significant.*
Note: BMI = body mass index.

behavioral changes should be elicited, including eating self-regulation (West et al., 2011; Wong & Cheng, 2013). To foster patient engagement, it is important to use appropriate language, such as "unhealthy weight" rather than "obesity," because the latter is associated with

Table 4. Multivariate logistic regression in predicting overweight and obesity (*N* = 313)

	OR	95% CI	*p*-Value
I often/always give up too easily on my eating intentions	3.81	2.15–6.74	<.001
Male gender	2.00	1.10–3.62	.023
Age	1.03	1.01–1.05	.003
Attitudes: Nutrition Affects Health	0.74	0.63–0.87	<.001

Note: CI = confidence interval; OR = odds ratio.

stigmatization (Kahan et al., 2018). Thus, it is critical to be respectful, nonjudgmental, and empathetic toward patients (Vansteenkiste & Sheldon, 2006). Furthermore, it is important to avoid setting unrealistic weight loss goals, such as achieving a normal BMI. Instead, the focus should be on clinical improvements in obesity-related conditions, such as hypertension or diabetes (Tsai et al., 2018). For example, a weight loss program led by primary care providers targeting overweight and obese patients with a recent diagnosis of type 2 diabetes showed significant improvements in HbA1c or even a cure of diabetes with better quality of life (Lean et al., 2018). Positive reinforcements of good effort and incremental success can further motivate patients.

Third, most patients can achieve a moderate short-term weight loss of 5–10%, but long-term weight loss maintenance is difficult. It is imperative to counsel patients about the metabolic predisposition for regaining weight after the initial weight loss and to make eating self-regulation as manageable as possible (Tsai et al., 2018). For example, a randomized clinical trial showed that high-protein, low-glycemic-index food eaten ad libitum without any caloric restriction, i.e., eating until satiety, was most effective in long-term weight loss maintenance (Larsen et al., 2010). Low-glycemic-index foods to be consumed include most vegetables, unsweetened dairy products, some fruits, and legumes (Smethers & Rolls, 2018). Another randomized clinical trial showed that consumption of less energy-dense foods, that is, foods with fewer calories by volume or weight, was also effective in maintaining long-term weight loss (Lowe, Butryn, Thomas, & Coletta, 2014). For safe weight loss, adequate intake of micronutrients and minerals should also be considered (Castiglione et al., 2018). Healthy eating strategies that incorporate manageable eating self-regulation can turn into healthy eating habits over time.

Finally, assessing each patient's basic understanding of nutrition's effects on health can prompt personalized education and counseling to improve attitudes toward nutrition and weight management. In addition, a multidisciplinary, collaborative approach, including registered dietitians, referral to community programs, other lifestyle counselors, pharmacotherapies, or surgery, may be a part of comprehensive obesity management (Acosta et al., 2017).

Conclusions

Nurse practitioners can play a critical role in establishing healthy dietary habits to maintain weight control in the current obesogenic environment. This study indicates that poor eating self-regulation is one of the strongest modifiable predictors of overweight and obesity. Based on current clinical evidence and CMS's reimbursement policy, nurse practitioners should consider high-intensity

weight loss counseling for patients who are ready and motivated to lose weight. Furthermore, adopting pragmatic strategies to make eating self-regulation as manageable as possible may be beneficial for maintaining long-term weight loss. Further studies are needed to examine the effects of such strategies.

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