ORIGINAL RESEARCH

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The Role of Hedonic Hunger As a Moderator and Mediator in Older Adults Obesity

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Abstract

Objective: In the modern age, the pursuit of food is now a means of pleasure and of satisfying hunger. This study examined the role of hedonic hunger and eating behaviors on obesity in older adults.

Materials and Methods: This cross-sectional study was conducted on 400 older adults. The nutrition information system (BeBiS), bioelectrical impedance analysis, power of food scale-Turkish version (PFS-Tr), and Dutch eating behaviour questionnaire (DEBQ) were used to evaluate the subjects.

Results: The mean age of 400 people included in the study was 67.82±2.77 years. It was found that the moderator effect of the interaction of daily energy intake and hedonic hunger behaviour (PFS-Tr) on the waist-to-hip ratio was significant. In particular, the regulatory effect of low hedonic hunger scores (PFS-Tr) was significant (p=0.019) and the waist-to-hip ratio decreased as the scores obtained from the scale decreased. The mediator effect of the restrained eating (ResE) sub-dimension (DEBQ) between the average daily energy intake and body fat mass was significant (estimate =0.221, p=0.021), and an increase in ResE behavior scores resulted in an increase in body fat mass. It was found that 89.4% of the effect of ResE behaviour on body fat mass was direct and large. There was a weak positive correlation between the average daily energy intake and food available subscale of PFS-Tr (r=0.157) and food present subscale (r=0.017). Total daily energy intake had a direct effect on body fat mass (estimate =0.008, p=0.005).

Conclusion: The results of our study support a positive relationship between hedonic hunger and abdominal obesity in older adults. Decreased ResE behaviour increases the whole-body fat mass. Evaluation of hunger and implementation of programmes that support ResE behaviour may be useful in controlling obesity and its negative consequences in older adults.

Keywords: Hedonism, obesity, hunger aging, geriatrics

Introduction

To a great extent, the history of humanity witnessed man's pursuit of food to maintain energy balance and to survive by preventing hunger. However, in societies of today that have easy access to food, food consumption may occur for reasons other than energy deficiency (1). Hedonic hunger can be defined as a person's interest in food for pleasure and the desire to consume it, although there is no physical hunger (2). The global dimension of obesity is gradually increasing, and food consumption shows an increasing trend toward pleasure and not only because of calorie need (3). There is evidence that obese individuals prefer and consume more tasteful foods than normal-weight individuals (3).

The combination of the obesity epidemic and aging raises concerns. Because there is no consensus on age-related physiological changes, there are uncertainties in the

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intervention. It has been shown that calorie restriction and/or dietary modification may have favorable effects on obese older adults (4). Adequate and balanced dietary content is of great importance in combating obesity by reducing the risk of diseases that increase with aging (4). Frequent and excessive consumption of tasteful foods because of hedonic hunger may lead to many diseases such as eating disorders, obesity, hypertension, diabetes mellitus, cardiovascular diseases, non-alcoholic fatty liver disease, obstructive sleep apnea, and some types of cancer (5). Our study investigated the relationship between dietary content, hedonic hunger behavior, and obesity in older adults.

Materials and Methods

Type, Location, and Time of the Study

This cross-sectional study was conducted on individuals over 65 years of age and older who applied to the endocrinology outpatient clinic of Malatya Training and Research Hospital in 2023. Permission for this study was obtained from the Malatya Clinical Research Ethics Committee (approval number: E-23536505-619-221990829, date: 11.08.2023).

Sample Size

The sample size analysis with a power of 95%, a confidence interval of 1%, and an effect size of 0.1 yielded 391 as the minimum number of participants to be reached, rounded to 400. Consent forms were obtained for individuals who accepted to participate in the study among those fulfilling the inclusion criteria.

Study Exclusion Criteria

People under 65 years of age, those who have any organic eating disorder, recent surgery, psychiatric illness, dementia, chronic kidney disease, heart failure, and those who follow a certain diet were excluded from the study.

Dietary Content Analysis

A sociodemographic questionnaire form was applied to the individuals who applied to the outpatient clinic, and they were then asked to record the nutrition information form for two weekdays and one weekend day in a period of one week. A 3-day, 24-hour reminder method was used to assess food intake at home. How to keep the records and which days to fill in the forms were explained in detail. Completed nutrition record forms were obtained directly from the patient. Nutritional values for three days were calculated using the nutrition information system (BeBiS) software (6), which is coded for analyzing the nutritional content of foods and meals based on the data provided in the dietary record forms. The average amounts of carbohydrate, fat, protein (in grams and %), and daily energy (kilocalories) were calculated.

Bioelectrical Impedance Analysis

Body composition analyses were performed using the body composition analyzer BC-420MA device with metabolic measurements when the participants submitted their nutrition forms. The working principle of the device is bio-impedance measurement, consisting of comparing the input and output values of 50 kHz electric current sent to the body through foot electrodes and received by hand electrodes.

Power of Food Scale-Turkish Version (PFS-Tr)

The power of food scale was developed by Lowe et al. (7) to assess the psychological impact of living in food-abundant environments, in other words, the evaluation of hedonic hunger status. It measures appetite for, rather than consumption of, palatable foods at three levels of food proximity [food available (FA), food present (FP), and food tasted (FT)]. The Turkish validity and reliability of the scale, i.e., PFS-Tr scale were determined by Ulker et al. (8). The scale consists of 13 items categorized into three subscales. The first one is the FA subscale, which assesses general thoughts about palatable food that is available but not physically present (items 1,2,9,10). The second subscale, the FP subscale, consists of items assessing the attractiveness of food that the individual has direct access to; i.e., palatable food is physically present but not tasted yet (items 3,4,5 and 6). The third subscale, the FT subscale, includes items that assess the desire/pleasure obtained from food when it is first tasted but not consumed yet (items 7,8,11,12 and 13). At the end of the evaluation, four scores were obtained as three subscale scores and one total scale score. Total and subscale scores were obtained by summing the related item scores and dividing by the number of related items. An increase in the score indicates a higher predisposition to hedonic hunger (8). PFS-Tr is not only a measure of the food environment but also measures individual differences in appetite-related thoughts, feelings, and desires in environments where palatable foods are abundant and continuously available. Beyond physiological needs, this approach defines an appetite model that shows individual differences in motivation to eat, and the presence of palatable food would further increase food consumption (9).

Dutch Eating Behaviour Questionnaire (DEBQ)

DEBQ, a hedonic hunger scale, was first developed to evaluate eating behaviour by Van Strien et al. (10) in 1986. The Turkish validity and reliability of the scale were determined by Bozan et al. (11). The scale consists of three subscales evaluating emotional eating (EmoE) behaviour (e.g., do you eat sweets when you are unhappy?), externally induced eating (ExtE) behaviour (if the smell of what you eat is very good, do you eat more than you normally eat?) and restrained eating (ResE) behaviour (do you eat less than you want to eat to avoid getting fat?). The first 10 questions in the questionnaire are in the ResE subscale, questions 11-23 are in the EmoE subscale, and questions 24-33 are in the ExtE subscale. The total score of the questionnaire

is not calculated, whereas the total scores of the subscales are calculated. In the calculation, question 31 affects the total score in the ExtE subscale as a reverse question. Although there is no cut-off point for the subscales, an increase in the score is associated with negative eating behavior (11).

Statistics

IBM SPSS Statistics 22 (SPSS, Inc., Chicago, IL, USA) and Jamovi ver.2.3.28 (12) software were used for data analysis. The Kolmogorov-Smirnov test was used to test the normality of the distribution test. Parametric tests were used in the analysis of normally distributed data, whereas non-parametric tests were used in the analysis of data that did not fit the normal distribution. The data were analyzed using the t-test, Mann-Whitney U test, Spearman and Pearson correlation analysis, chi-square test, binary logistic regression, moderation effect, and mediation effect analysis. The effect size was evaluated using the rank biserial correlation coefficient (with 0.10 indicating a small, 0.30 a medium, and 0.50 or greater a large effect size). Mediation analyses were performed using structural equation modeling path analysis in Jamovi. Direct and indirect effect coefficients (estimates) were accepted as low effect if close to 0.01, medium effect if close to 0.09, and high effect if close to 0.25 (13). P<0.05 was considered statistically significant.

Results

The mean age of 400 older adults included in the study was 67.82±2.77 (min: 65-max: 80). The male-to-female ratio was 58:42, and 50% of the participants were obese. Participants with a value of body mass index (BMI) >18.5 kg/m^2 and <30 kg/m^2 were accepted as "normal BMI", while those with BMI ≥30 kg/m^2 were accepted as "obese BMI" or shortly "obese" (14). No significant difference was found between the age and comorbidity distributions of the patients according to the BMI categories. Obese patients were more common in women (Table 1).

The total daily dietary energy intake was significantly higher in obese individuals than in individuals with normal BMI, and the effect size was moderate. It was found that fat consumption was significantly higher in obese individuals, and the effect size was low (Table 2).

Table 1. Characteristics of participants according to age, sex, and comorbidities

Characteristics	BMI groups (Mean ± SD or n)		p
	Obese* (n=200)	Normal* (n=200)	
Age	67.77±2.57	67.50±4.42	0.657
Sex (male/female)	62/138	106/94	0.002**
Chronic disease (yes/no)	196/4	194/6	0.844
Hypertension (yes/no)	138/62	118/82	0.141
Diabetes mellitus (yes/no)	154/46	126/74	0.061
Cardiovascular diseases (yes/no)	16/184	32/168	0.082
COPD or asthma (yes/no)	28/172	14/186	0.166
Cancer (yes/no)	1/199	8/192	0.369
Rheumatological disease (yes/no)	14/186	12/188	1.000

*Normal BMI: 18.5 kg/m^2 < BMI <30 kg/m^2, obese BMI: BMI ≥30 kg/m^2, **Statistically significant difference
BMI: Body mass index, SD: Standard deviation of the mean, COPD: Chronic obstructive pulmonary disease

Table 2. Comparison of the dietary content according to the presence of obesity

Nutrient content	Obesity		p	Effect size
	Obese BMI	Normal BMI		
	Median (IQR)	Median (IQR)		
Energy (kcal)	1330 (374.5)	1131 (348.3)	<0.001*	0.385
Protein (g)	45 (17.8)	48.9 (17)	0.406	0.067
Percent protein (%)	15 (6)	16 (7)	0.070	0.147
Fat (g)	58.4 (25.5)	53.5 (27)	0.006*	0.206
Percent fat (%)	43 (12.8)	42.5 (13.8)	0.789	0.039
Carbohydrate (g)	119 (55.9)	115 (36.8)	0.334	0.093
Percent carbohydrate (%)	43 (13)	42 (14)	0.315	0.002
Fibre (g)	17.8 (8.1)	16.35 (11.2)	0.133	0.255

*Statistically significant difference
IQR: Interquartile range, g: Gram, kcal: Kilocalories, BMI: Body mass index

When the correlations between hedonic hunger behaviour, eating behaviour and the main food groups in the diet were examined, no correlation was found between behaviours and the amount of carbohydrates or fat taken daily. EmoE subscale scores of DEBQ showed a positive correlation with daily protein intake but a weak negative correlation with fibre intake; i.e., conditions with emotional effects led to higher protein intake but lower fibre-rich food intake. Regarding PFS-Tr, average daily energy intake showed a weak positive correlation with the FA and FP subscale scores of PFS-Tr, whereas fat intake showed a weak positive correlation with only the FP subscale scores (Table 3).

When the correlations between hedonic hunger behavior, eating behavior, and body composition were examined, the ResE subscale score of DEBQ was found to show a weak positive correlation with both body fat mass and body fat percentage; i.e., ResE behavior led to an increase in body fat. The FA subscale score of PFS-Tr showed a weak positive correlation with muscle mass; i.e., when palatable food was available but not physically present, muscle mass increased. The waist-to-hip ratios showed a weak negative correlation with EmoE and ExtE subscale scores of the DEBQ scale; i.e., conditions with emotional effects and external factors such as attractive smell of the food etc. led to a decrease in the waist-to-hip ratio (Table 4).

When the mediator effect of the DEBQ subscales between average daily energy intake and body fat mass was analyzed, it was found that only ResE behaviour had a significant direct effect (path a) on body fat mass, comprising 89.4% of the total effect of ResE on body fat mass increase (p=0.021), i.e., an increase in ResE subscale scores of the DEBQ scale resulted in an increase in body fat mass, and this effect was found to be large (Figure 1, Table 5).

The total score of the PFS-Tr had a significant regulatory effect on the relationship between daily energy intake and waist-to-hip ratio, and the effect of the interaction of daily energy intake and PFS-Tr on the waist-to-hip ratio was significant (Figure 2, Table 6).

While the regulatory effect of high scores obtained from the scale was not significant (p=0.996), the regulatory effect of low scores was significant (p=0.019) and the waist-to-hip ratio was observed to decrease as the scores obtained from the scale decreased (Figure 3).

Table 3. Correlations between dietary content and subscale scores of DEBQ and PFS-Tr scales

Subscales (scale)	Energy (kcal)	Protein (g)	Protein (%)	Fat (g)	Fat (%)	Carbohydrate (g)	Carbohydrate (%)	Fibre (g)
ResE (DEBQ)	-0.069	-0.087	0.029	-0.010	0.044	-0.054	-0.060	0.080
EmoE (DEBQ)	-0.028	0.177*	0.155*	0.033	0.021	0.083	-0.080	-0.186*
ExtE (DEBQ)	0.12	0.115	-0.018	0.117	0.079	0.056	-0.037	-0.011
FA (PFS-Tr)	0.157*	0.007	-0.117	0.077	0.010	0.041	0.032	0.067
FP (PFS-Tr)	0.017*	0.410	0.054	0.012*	0.011	0.020	0.036	-0.113
FT (PFS-Tr)	0.115	-0.009	-0.057	0.038	-0.023	0.079	0.049	0.105
Total score (PFS-Tr)	0.117	-0.026	-0.106	0.047	-0.008	0.077	0.058	0.042

*p<0.05, **p<0.01, ***p<0.001
DEBQ: Dutch eating behaviour questionnaire, PFS-Tr: Power of food scale-Turkish version, ResE: Restrained eating subscale score of DEBQ, EmoE: Emotional eating subscale score of DEBQ, ExtE: Externally induced eating subscale score of DEBQ, FA: Food available subscale score of PFS-Tr, FP: Food present subscale score of PFS-Tr, FT: Food tasted subscale score of PFS-Tr, g: Gram, kcal: Kilocalories

Table 4. Correlations between body composition and subscale scores of the DEBQ and PFS-Tr scales

	ResE (DEBQ)	EmoE (DEBQ)	ExtE (DEBQ)	FA (PFS-Tr)	FP (PFS-Tr)	FT (PFS-Tr)	Total score (PFS-Tr)
Body mass index (BMI)	0.103	-0.104	-0.081	0.038	0.014	-0.022	0.021
Waist-to-hip ratio	0.092	-0.154*	-0.160*	0.012	0.060	-0.063	-0.006
Body fat (%)	0.174*	-0.078	-0.069	0.047	0.056	0.030	0.055
Body fat mass (kg)	0.141*	-0.097	-0.051	0.070	0.050	-0.053	0.023
Lean body (%)	0.109	-0.056	0.028	0.023	-0.010	0.012	0.010
Muscle mass (kg)	-0.094	-0.060	0.067	0.151*	0.012	-0.025	0.051
Internal organ adiposity	0.013	-0.010	0.014	0.074	0.108	-0.058	0.046

*p<0.05,**p<0.01,***p<0.001
DEBQ: Dutch eating behaviour questionnaire, PFS-Tr: Power of food scale-Turkish version, ResE: Restrained eating subscale score of DEBQ, EmoE: Emotional eating subscale score of DEBQ, ExtE: Externally induced eating subscale score of DEBQ, FA: Food available subscale score of PFS-Tr, FP: Food present subscale score of PFS-Tr, FT: Food tasted subscale score of PFS-Tr, kg: Kilogram, BMI: Body mass index

Table 5. Mediation estimates of restrained eating on body fat mass

Mediation effect	Paths in Figure 1	Mediation estimates*	SE	95% CI	Z	p	Mediation %
Indirect	a×b	-0.0263	0.0211	0.06763-0.0150	-1.25	0.212	10.6
Direct	c	0.2214	0.0956	0.03390-0.4088	2.31	0.021	89.4
Total	c+a×b	0.1951	0.0970	0.00486-0.3853	2.01	0.044	100.0

*Estimates: 0.01: Small, 0.01-0.09: Medium, 0.09-0.025: Large effect
SE: Standard error of mediates, CI: Confidence interval

Table 6. Moderation estimates of energy intake and power of food scale on waist-to-hip ratio

	Estimate	SE	95% CI		Z	p
			Lower	Upper		
Energy intake	-7.66e-5	3.83e-5	-1.52e-4	-1.46e-6	-1.998	0.046*
PFS-Tr	0.00394	0.00484	-0.00555	0.0134	0.814	0.416
Energy x PFS-Tr	3.79e-5	1.89e-5	8.90e-7	7.49e-5	2.007	0.045*

*Statistically significant difference
CI: Confidence interval, PFS-Tr: Power of food scale-Turkish version, SE: Standard error of mediates

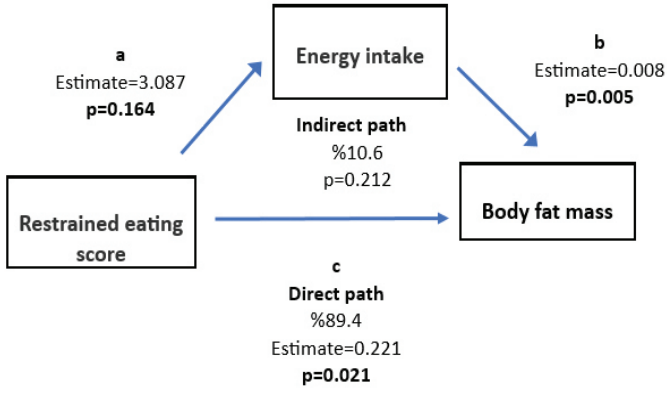

Figure 1. Path estimates of the mediation between restricted eating and body fat mass

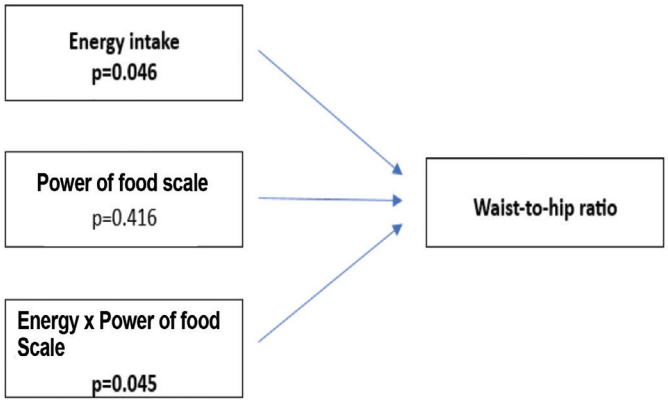

Figure 2. Moderation estimates of energy intake and power of food scale on waist-to-hip ratio

Discussion

Obesity is a condition mediated by complex neuronal and hormonal systems resulting from gene-environment interactions (15). Overeating behavior is important in the emergence of obesity, and food sensitivity among individuals may affect this condition. These may lead to the emergence of different tendencies toward obesity (16). Frequent consumption of high-energy and tasty foods in the absence of energy needs may trigger overeating behavior (17). Although hedonic differences associated with obesity have been reported, a strong relationship between BMI and hedonic hunger has not been shown (18). In our study, the relationship between hedonic hunger behavior

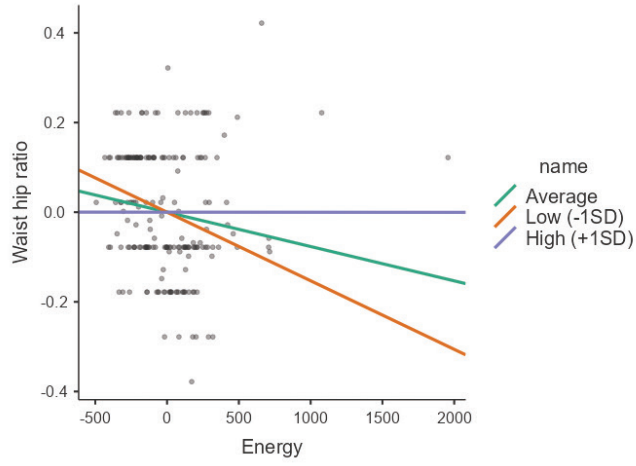

Figure 3. Simple slope plot of the regulatory effect of the power of the food scale on the waist-to-hip ratio

Name: Power of food scale scores, Low estimate: p=0.019, High estimate: p=0.996, Average: p=0.048, SD: Standard deviation of the mean. The graphic shows the effect of the predictor (energy intake) on the dependent variable (waist-to-hip ratio) at different levels of the moderator (power of food scale-Tr)

and obesity in older adults was examined. There was a weak positive correlation between "EmoE" behavior (DEBQ) and daily protein intake, a weak positive correlation between "FA" subscale (PFS-Tr) and average daily energy intake, and a weak positive correlation between "FP" subscale (PFS-Tr) and energy and fat intake. There was a weak positive correlation between "ResE" behaviour (DEBQ) and body fat percentage and fat mass and a weak positive correlation between the FA subscale (PFS-Tr) and muscle mass. There was a mediating effect of ResE behaviour (DEBQ) between average daily energy intake and body fat mass, with impaired ResE resulting in an increase in body fat mass. When the relationship between daily energy consumption and waist-to-hip ratio was examined, it was found that the regulatory effect of low scores obtained from the PFS-Tr scale was significant, and as the scores obtained from the scale decreased (as hedonic hunger behaviour decreased), the waist-to-hip ratio decreased.

In the study by Ribeiro et al. (18), a weak positive relationship was found between the hedonic hunger score and BMI. A relationship was found between the FP subscale and obesity, and each unit increase in FP scores increased the risk of obesity approximately 2-fold (odds ratio: 2.1). In a study conducted on young adults in the United States of America, the relationship between hedonic hunger and weight and dieting behaviors was examined. No relationship was found between weight and hedonic hunger, whereas a positive relationship was found between frequency of dieting, FP and FA sub-dimensions of the hedonic hunger scale and total score. High scores obtained from the hedonic hunger scale were found to be associated with more dieting cross-sectionally, but it was reported that it was not a good indicator of weight gain and dieting in the long term (19). In the study conducted by Dikyol et al. (20), it was found that the risk of being overweight/obese was higher in women who showed eating behavior even when full. The relationship between high food sensitivity and obesity is associated with unfavorable physical, social, and psychological outcomes. In the study conducted by Cappelleri et al. (9), a weak positive relationship was found between BMI and hedonic hunger sub-dimensions, and it was reported that the risk of obesity increased between 1.6 and 2.3 times as the scores obtained from the hedonic hunger scale increased. In the study conducted by Vainik et al. (21), the relationship between eating behaviors and obesity in women was examined, and the findings reflected the same basic feature: that uncontrolled eating behavior was related to weight. It was emphasised that the neuro-behavioural characteristics associated with obesity should be better understood. In the study conducted by Schultes et al. (22), it was found that obese patients had a significant increase in appetite for palatable foods and that patients who underwent gastric bypass surgery had lower scores in the sub-dimension of "FT" of PFS. The occurrence of this difference in patients after surgery shows the importance of excessive appetite in the pathophysiology of obesity.

Appelhans et al. (23) tested the interaction between palatable food, reward sensitivity, and inhibition control in overweight and obese women. They found that high palatable food reward sensitivity predicted greater consumption of palatable food at low levels of inhibition control but was not associated with food intake at high levels of inhibition control. The findings support a model between palatable food reward sensitivity and overeating, and it was emphasised that overeating was triggered when there was insufficient inhibition in the control. Burger et al. (24) reported that hedonic hunger was not a significant predictor of weight gain, but individuals reporting high hedonic hunger showed increased neuronal and perceptual responses to palatable foods, were more motivated to consume such foods, and were more likely to overeat. In the study by Witt et al. (25), the effect of hunger and exposure to palatable foods on hedonic appetite was evaluated. It was found that "ExtE" and "ResE" behaviours had no effect on hedonic hunger under hunger and food exposure conditions. Hedonic hunger represented a relatively constant structure that was not significantly affected by daily hunger changes. In our study, it was found that the mediator effect between ResE behavior and average daily energy intake and body fat mass was significant, and impairment in ResE resulted in an increase in body fat mass. In the literature, the relationships between hedonic hunger and weight were not consistent in studies conducted in different sexes, ages, and populations. A strong and positive relationship between hedonic hunger and obesity was not clearly demonstrated. The difference between our study and other studies was that it was one of the rare studies examining the relationship between hedonic hunger and obesity among older adults. The results of our study indicated a relationship between hedonic hunger and abdominal obesity. In particular, low hedonic hunger scale scores had a strong regulatory effect on abdominal obesity. ResE had a direct effect on body fat mass as a mediator and resulted in an impairment in ResE scores with an increase in fat mass.

Study Limitations

The strength of our study was that it was one of the rare studies investigating the relationship between hedonic hunger and obesity in older adults, while its limitations were that it was a single-center, hospital-based study.

Conclusion

The results of our study support a positive relationship between hedonic hunger and abdominal obesity in older adults. A decrease in restrictive eating behavior increased whole-body fat mass. There was a positive correlation between average daily energy intake and FA and a positive correlation between FP and energy and daily fat intake. Total daily energy intake had a

direct effect on the amount of body fat. In older adults, after a good clinical evaluation, assessment of hyperhedonic hunger and implementation of programs that support restrictive eating behaviour may be useful in controlling obesity and its negative consequences.

Ethics

Ethics Committee Approval: Permission for this study was obtained from the Malatya Clinical Research Ethics Committee (approval number: E-23536505-619-221990829, date: 11.08.2023).

Informed Consent: Consent forms were obtained for individuals who accepted to participate in the study among those fulfilling the inclusion criteria.

Authorship Contributions

Concept: B.M., L.K., H.D., C.K.Ş., E.D.M., E.B., Design: B.M., L.K., H.D., C.K.Ş., E.D.M., E.B., Data Collection or Processing: L.K., Analysis or Interpretation: B.M., H.D., Literature Search: B.M., L.K., H.D., C.K.Ş., Writing: B.M., L.K., H.D., C.K.Ş., E.D.M., E.B.

Conflict of Interest: No conflicts of interest were declared by the authors.

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