RESEARCH

THE RELATIONSHIP BETWEEN GLYCAEMIC INDEX, DAILY ENERGY INTAKE, METABOLIC PARAMETERS, AND BODY COMPOSITION IN THE ELDERLY: A CROSS-SECTIONAL STUDY

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Abstract

Introduction: This study aimed to evaluate the relationship between dietary glycaemic index, daily energy intake, metabolic parameters and body composition in elderly individuals.

Materials and Methods: This is a cross-sectional study that included 198 elderly individuals who applied to the endocrinology outpatient clinic. Participants were asked to record the foods they consumed on three-day diet forms, which would be collected the following week at the time when also the metabolic parameters would be measured and body composition analyses performed at the polyclinic. Nutrient content was recorded with the BeBIS software. The body composition was analysed by using the bioelectrical impedance method.

Results: The mean age of 198 people included in the study was 67.78±2.76 (65–78). HbA_{1c}, insulin and HOMA-IR, visceral adiposity rates, body fat mass and metabolic age were found to be higher in participants with a dietary glycaemic index ≥70, and the effect of the glycaemic index on these parameters was statistically small. The daily energy intake showed a positive correlation with fasting blood glucose, triglyceride and triglyceride-glucose (TyG) index. Both the daily energy intake and glycaemic index showed a weakly positive correlation with visceral adiposity, metabolic age, body fat mass and body mass index. A dietary glycaemic index ≥70 was observed to increase the risk of obesity OR=3.7 times (95% CI=1.72 – 7.94), and the risk of HbA_1C higher than 8 to increase OR=3.13 times (95% CI=1.0 – 9.74).

Conclusion: An increase in the dietary glycaemic index and the daily energy intake in the elderly results in poor glycaemic control.

Keywords: Aged; Glycaemic Index; Obesity.

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INTRODUCTION

Nutrition is a complex issue involving many factors and variables that affect health. Adverse health effects of low-quality, carbohydrate-containing foods and beverages have resulted in an increase in the scientific popularity of so-called low-carb diets (1). The glycemic index (GI) is a rating system for foods that contain carbohydrates. It indicates how quickly each food alters blood sugar level when eaten on its own and ranks carbohydrate-containing foods by the amount of increase in blood glucose levels after consumption, compared to reference foods with a GI ≤ 55 (pure glucose or white bread). The values between 56 and 69 are classified as "moderate GI" and those ≥ 70 as "high GI" on the glucose scale (1). Clinical practice guidelines recommend dietary and lifestyle changes as the basis of treatment strategies to prevent and manage diseases. Approaches that target postprandial glycaemic changes through changes in dietary carbohydrate quality and quantity may have some advantages (2). In addition to the glycemic index of foods, the amount of energy consumed daily can also have an impact on health and disease. An adequate caloric intake is an important determinant of health status, especially when degenerative conditions and difficult-to-treat diseases become dominant with age (3). In general, large variations in daily energy intake may be associated with poor diet quality (4). Since the risk of disease increases with age, adequate caloric intake and low glycaemic index diets are important to maintain a balanced health status, especially during older ages. Maintaining adequate nutritional balance is the best preventative measure to eliminate nutritional risk. This study aimed to examine the relationship between dietary content, glycaemic index, and daily energy intake with metabolic parameters and body composition in a group of elderly individuals.

MATERIALS AND METHODS

This cross-sectional study included individuals aged ≥ 65 years who applied to the endocrinology outpatient clinic at Turgut Özal University Training and Research Hospital, Malatya, Türkiye in 2022. The permission to conduct the study was obtained from the ethics committee of Turgut Özal University's Non-interventional Clinical Research Ethics Committee. The sample size calculation (with 99% of power, 1% of confidence interval, and r = 0.381) revealed a minimum sample size of 152 (5), and 198 people were included in the study. From those who wanted to participate, individuals who met the inclusion criteria were included in the study, after obtaining written consent. The study exclusion criteria were individuals younger than 65 years of age, having any organic eating disorder, recent surgery, psychiatric illness, dementia, chronic kidney disease, heart failure, and those with a specific diet.

Measurements

Dietary content analysis

After a sociodemographic questionnaire was administered to people who applied to the outpatient clinic, they were asked to record a nutrition information form (NIF) for three days (two weekdays and one day over the weekend). NIFs were provided using the 3-day, 24-hour recall method to assess nutrient intake at home. The method of keeping the records and the days on which they should be filled out were explained in detail. The completed food registration forms were directly received. The 3-day nutritional values were calculated using the BeBIS (Nutritional Information System), which is a software designed to analyse nutrient content. BeBIS calculates the average carbohydrate, fat, and protein amounts (in %), glycaemic index, and the daily energy amount (in kcal) of the diet content. In the glycaemic index classification, GI ≤ 55 was accepted as "low GI", GI = 56 – 69 as "moderate

GI", and GI ≥ 70 as "high GI" (6). Measurement of metabolic parameters and the analysis of body composition were performed at the time of submission of NIFs at the clinic.

Metabolic parameters

Blood samples (for detecting the metabolic parameters) were collected from the participants when they came to submit the filled NIFs. Fasting blood glucose (FBG), HbA_{1c}, total cholesterol, triglyceride, low-density lipoprotein (LDL), high-density lipoprotein (HDL), insulin, and homeostatic model assessment of insulin resistance (HOMA-IR) were measured. The triglyceride and glucose index (TyG index) was calculated as follows:

Ln (Fasting triglyceride(mg/dl) x Fasting glucose(mg/dl)/2)

Bioelectrical impedance analysis

Body composition analyses of the participants were performed using the Body Composition Analyser BC-420MA device along with the metabolic measurements at the time of submission of the filled NIFs. The device works by measuring bioimpedance after the administration of an electric current of 50 kHz into the body through the feet (via electrodes). The analysis included visceral fat rating, basal metabolic rate, metabolic age, bone mass, skeletal muscle mass, free fat mass, body fat mass, body fat, and body mass index (BMI) measurements.

Statistical analysis

The SPSS 22 software was used for data analysis. Student's t-test, Mann-Whitney U test, Spearman and Pearson correlation analyses, chi-square test, and binary logistic regression analysis were used. Statistical significance was set at $p < 0.05$.

RESULTS

The mean age of 198 elderly participants included in the study was 67.78 ± 2.76 years (range, 65–78). Among patients with GI ≥ 70, the proportion of obese patients and those with HbA_{1c}>8 was significantly higher. The sociodemographic characteristics of patients according to the GI group are shown in Table 1.

HbA_{1c}, insulin, HOMA-IR, visceral adiposity rates, body fat mass, and metabolic age were significantly higher in patients with a dietary mean GI ≥ 70, while the effect size of the GI on these parameters was small (Table 2).

The average daily energy intake showed a weak positive correlation with diet, fasting blood glucose, triglyceride, and TyG index. The average daily energy intake showed a weak positive correlation between diet, glycaemic index, visceral adiposity, metabolic age, body fat mass, and BMI (Table 3).

Logistic regression models created to predict the risk of obesity (BMI ≥ 30) and high HbA1C levels (> 8) were found to be significant. Every 0.003 unit (kcal) increase in daily energy intake increased the risk of obesity 1.003 times (3 per thousand), and every 0.001 unit rise, increased the risk of high HbA1C 1.001 times (1 per thousand). A mean dietary glycaemic index > 70 increased the risk of obesity 3.7 times and the risk of HbA1C (>8) 3.13 times (Table 4).

DISCUSSION

An appropriate dietary intake is essential for the elderly population. Although proper dietary intake can increase longevity, ageing itself can increase the risk of malnutrition. Adequate and balanced nutritional intake throughout life helps maintain health by protecting tissues or providing defence against infections. Maintaining proper nutrition (especially high in protein and calorie balance) may improve the degeneration processes accompanying ageing and the development and control of diseases (7).

In this study, the effects of dietary content, glycaemic index, and daily energy intake on metabolic and anthropometric parameters in the elderly were

Table 1. Sociodemographic characteristics

Characteristics	Glysemic Index (mean±SD) or n(%)		p
	<70 (n=55)	≥70 (n=141)	
Age	68.00±2.94	67.69±2.70	0.480
Sex (Male/Female)	23 (41.8)/32(58.2)	60(42.6)/81(57.4)	0.925
Chronic disease (Yes/No)	55(100.0) / 0(0.0)	139(98.6) / 2(1.4)	1.000
Hypertension (Yes/No)	36(65.5)/19(34.5)	91(64.5)/50(35.5)	1.000
Diabetes mellitus (Yes/No)	35(63.6)/20(36.4)	103(73.0)/38(27.0)	0.261
Cardiovascular disease (Yes/No)	9(16.4)/46(83.6)	15(10.6)/126(89.4)	0.392
Chronic obstructive pulmonary disease or asthma (Yes/No)	3(5.5)/52(94.5)	17(12.1)/124(87.9)	0.267
Cancer (Yes/No)	2(3.6)/53(96.4)	2(1.4)/139(98.6)	0.314
Rheumatological disease (Yes/No)	3(5.5)/52(94.5)	10(7.1)/131(92.9)	1.000
Obesity (Yes/No)	18(32.7)/37(67.3)	80(56.7)/61(43.3)	**0.003**
HbA_{1c} (<8/≥8)	51(92.7)/4(7.3)	113(80.1)/28(19.9)	**0.027**

Table 2. Comparison of metabolic and anthropometric parameters

	Glycemic index					
	<70		≥70			
Metabolic parameters	Mean±SD	Median	Mean±SD	Median	p	Effect Size
FBG (mg/dl)	132.80±45.86	120	135.94±52.11	118	0.445	0.012
HbA_{1c}	6.73±1.00	6.60	7.09±1.35	6.70	**0.039**	**0.130**
Total cholesterol	188.91±35.14	191.00	187.38±42.787	185.00	0.642	0.033
Triglyceride	156.60±62.20	142.00	167.50±107.34	145.00	0.469	0.007
LDL	118.78±48.453	112.00	113.41±33.45	111.00	0.627	0.029
HDL	52.21±10.93	50.00	53.84±12.85	53.00	0.219	0.071
Insulin	10.33±6.14	10.00	13.05±18.06	10.00	**0.034**	**0.168**
HOMA-IR	3.15±2.04	2.90	3.74±2.31	3.10	**0.039**	**0.162**
TyG index	9.12±0.581	9.14	9.15±0.641	9.12	0.450	0.010
Body composition analyse						
Viceral fat rating (%)	12.95±4.03	12.0	14.57±4.90	14.0	**0.007**	**0.227**
Basal metabolic rate	1606.69±287.73	1523.0	1651.46±282.45	1623.0	0.113	0.111
Metabolic age	61.44±11.13	60.00	66.86±11.57	69.00	**0.001**	**0.281**
Bone mass (kg)	3.00±0.52	3.00	3.30±2.57	3.10	0.145	0.097
Skeletal muscle mass (kg)	49.10±11.72	50.00	51.94±9.44	51.00	0.083	0.127
Free fat mass (kg)	53.10±9.58	52.80	58.51±44.64	53.90	0.099	0.118
Body fat mass (kg)	26.96±12.00	26.00	32.82±12.14	31.80	**<0.001**	**0.294**
Body fat (%)	32.80±10.56	33.00	36.31±9.56	36.00	**0.016**	**0.198**
BMI (kg/m^2)	29.77±6.84	28.00	33.11±7.00	32.00	<0.001	0.316

Table 3. Correlations between daily energy intake, glycaemic index, and metabolic and anthropometric measurements

Metabolic parameters	Energy (kcal)	Glycemic index	Body composition analysis	Energy (kcal)	Glycemic index
FBG	0.154*	-0.053	Viceral fat rating (kg)	0.140*	0.170*
HbA_{1c}	0.105	0.079	Basal metabolic rate	0.125	0.143*
Total cholesterol	0.106	-0.049	Metabolic age	0.229**	0.192**
HDL	-0.051	0.028	Bone mass (kg)	0.111	0.030
LDL	0.130	-0.083	Skeletal muscle mass (kg)	0.043	0.132
Triglyceride	0.164*	-0.022	Free fat mass	0.027	0.120
Insulin	0.032	0.094	Body fat mass (kg)	0.192**	0.213**
HOMA-IR	0.117	0.118	Body fat (%)	0.159*	0.138
TyG index	0.175*	-0.051	BMI (kg/m^2)	0.220**	0.235***

***p<0.05, **p<0.01, ***p<0.001**

Table 4. Logistic regression model

Obesity risk model	β	p	OR (CI 95%)
Daily Energy Intake (kcal)	0.003	**<0.001**	**1.003** (1.002-1005)
Protein (%)	-0.042	0.306	0.958(0.883-1.040)
Fat (%)	0.003	0.885	1.003(0.957-1.052)
Carbohydrate (%)	0.005	0.756	1.005(0.973-1.038)
Glycemic Index (≥70-<70)	1.309	**<0.001**	**3.702** (1.725-7.946)
HbA_{1c} elevation model			
Daily Energy Intake (kcal)	0.001	**0.022**	**1.001** (1.00011-1.00015)
Protein (%)	-0.019	0.710	0.981(0.887-1.090)
Fat (%)	-0.012	0.651	0.987(0.987-0.936)
Carbohydrate (%)	-0.007	0.677	0.992(0.959-1.030)
Glycemic Index (≥70-<70)	1.143	0.048	**1.010-9.740**)

investigated. There was no significant relationship between fat, carbohydrate, and protein proportions in the diet, and obesity and glycaemic control. The daily energy intake and glycaemic index were correlated with obesity (body fat ratio, visceral fat ratio, and BMI) and poor glycaemic control (HbA_{1C}, HOMA-IR, and insulin).

A meta-analysis by Chiavaroli et al. revealed that low GI diet ingredients reduced HbA_{1C} more than high GI diets in 1617 participants with type 1 and 2 diabetes, who were predominantly middle-aged, overweighted or obese, with moderately controlled type 2 diabetes. In addition, a low GI diet was found to reduce fasting glucose, LDL-C, non-HDL-C, apoB,

triglycerides, body weight, and BMI (8). In a systematic review by Ojo et al., a low GI diet was shown to be more effective in controlling HbA_{1C} and fasting blood sugar levels in patients with type 2 diabetes than a high GI diet (9). Another meta-analysis by Livesey et al., found that the risk of type 2 diabetes mellitus increased 1.27 times for every 10 units increase of GI in the diet, and 1.26 times for every 80 units of GI in a 2000 kcal diet (10). Sacks et al. compared a low glycaemic index - low carbohydrate diet with a high glycaemic index - high carbohydrate diet and found that insulin sensitivity, systolic blood pressure, LDL cholesterol, and HDL cholesterol were not affected, but triglycerides were reduced by 23% (11). Argiana et al. reported that consumption of a dessert with a low glycaemic index or low glycaemic load improved glucose and insulin responses in patients with type 2 diabetes compared to a conventional dessert with similar carbohydrate content, but with different sugar and fibre contents (12). In our study, it was found that a high glycaemic index was associated with poor glycaemic control; the risk of elevated HbA_{1C} increased 3.13 times, and insulin and HOMA-IR values were higher in patients consuming a high GI diet (i.e. GI ≥ 70). A low GI diet appears to have a positive effect on glycaemic control. TyG index, a new marker, is an important predictor of insulin resistance. In our study, a weak positive correlation was found between daily energy intake and the TyG index. Selvi et al. found that TyG index showed a significant positive correlation with HbA_{1C} and HOMA-IR (13). The TyG index is a potential risk factor for diabetes mellitus (DM) and cardiovascular diseases (CVD) (13). The increase in daily energy intake contributes to an increase in this index. A higher GI diet causes a higher glucose response and increases the risk of CVD and DM. Sieri et al. reported that a high glucose load (GL) was associated with a higher risk of CVD (Hazard ratio (HR) = 1.16). Every 50 g/day GL was found to increase CVD risk (HR = 1.18) (14). It would not be wrong to say that increased daily energy intake and a high dietary glycaemic index are potential risk factors for DM and CVD. Vega et al. found a relationship between GI and disease outcomes such as DM and CVD in their analysis of intervention studies on diet content (15). Another finding of our study was that a high glycaemic index and daily energy intake increased the risk of obesity, body fat ratio, and visceral adiposity. Being overweight and obese are risk factors for CVDs, such as heart diseases, stroke, DM, and various cancers, which are the leading causes of death worldwide. The International Carbohydrate Quality Consortium agreed that diets low in GI are relevant for the prevention of diabetes, coronary heart disease, and possibly obesity. It is accepted that low GI diets are especially important in individuals with insulin resistance (16). In a study by Hameed et al., a high visceral adiposity index was found to be associated with poor glycaemic control, dyslipidaemia, and an increased TyG index, and it was reported that as visceral adiposity quartile increased, the rates of poor glycaemic control also increased (17). An increase in the dietary glycaemic index and daily energy intake will lead to negative consequences for both metabolic parameters (insulin, HOMA-IR, and fasting blood glucose) and body composition (fat ratio and visceral adiposity ratio), especially increasing the risk factors for DM and cardiovascular diseases. Dietary interventions may reduce the risk of complications or the development of diseases associated with poor glycaemic control (prediabetic, insulin resistant, atherosclerotic, and overweight) in the elderly.

The study included elderly individuals and this is the strength of the study; while being limited to a hospital is a limitation.

The results of this study indicated that a high dietary glycaemic indexed intake and increased daily energy intake in the elderly led to poor glycaemic control, increased the risk of obesity, and were asso-

ciated with visceral adiposity and body fat ratio. Diets with a low glycaemic index as well as controlled energy consumption in prediabetic elderly people with CVD risk factors would protect them from possible negative consequences.

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