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The impact of carbohydrate quality index on menopausal symptoms and quality of life in postmenopausal women

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Abstract

Introduction Menopause is a natural process that often leads to physical and emotional symptoms affecting women's quality of life. Nutrition is increasingly recognized as important in managing these symptoms, with certain dietary patterns—particularly those rich in fiber and whole grains—showing potential benefits. In many regions, including parts of Asia and countries with carbohydrate-heavy diets, carbohydrate quality may significantly influence menopausal health outcomes and related chronic conditions. This study aimed to examine the relationship between carbohydrate quality index, and menopausal symptoms and quality of life in postmenopausal women.

Methods A total of 604 postmenopausal women participated. Participants completed a demographic questionnaire, the Menopause-Specific Quality of Life Questionnaire (MENQOL) (higher scores indicate poorer quality of life), and the Menopause Rating Scale (MRS) (higher scores indicate more severe symptoms). A food frequency questionnaire was used to collect dietary intake. Carbohydrate quality was assessed using the Carbohydrate Quality Index (CQI), which considers glycemic index, fiber intake, solid carbohydrate-to-total carbohydrate ratio, and whole grain consumption. Participants were divided into five quartiles based on their CQI scores. Statistical analysis was performed using SPSS 24, with Mann-Whitney U test, Kruskal-Wallis H test, ANOVA, and regression analysis controlling for socioeconomic status, body mass index, education, and menopausal status.

Results Among the participating women, 273 were aged 30–55 years, 241 were aged 56–64 years, and 90 were aged 65 years and older. The youngest group (30–55) had the highest MENQOL (19.81 ± 9.70) and MRS (44.77 ± 30.91) scores, indicating more severe symptoms. Women postmenopausal for over 3 years reported significantly lower MENQOL scores (15.74 ± 0.42) compared to those postmenopausal for less than 3 years (17.98 ± 10.84) (Z=-1.95, $p < 0.05$). Across CQI quartiles, women in Q5 had significantly lowest MENQOL (14.35 ± 8.77) scores (Kruskal-Wallis

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χ^2=2.24, $p < 0.05$). In regression analysis, being married (β = 0.13, $p < 0.05$) and receiving menopausal treatment (β = 0.11, $p < 0.05$) were positively associated with higher CQI scores.

Conclusions Higher carbohydrate quality, is linked to fewer menopausal symptoms. Regression analysis showed that marital status and menopausal treatment were significantly associated with Carbohydrate Quality Index scores. Further research with larger samples and longitudinal studies is needed to explore the causal relationship between carbohydrate quality and menopausal outcomes.

Keywords Carbohydrate quality, Carbohydrate quality index, Menopausal symptoms, Menopause-Specific quality of life

Introduction

Menopause is defined as the permanent cessation of menstruation due to hormone deficiency and the loss of follicular activity in the ovaries [1]. The average age of menopause is between 45 and 55 years worldwide, and it is estimated that approximately 1.1 billion women will have entered menopause by 2025 [2]. During this period, women experience changes in factors such as hot flashes, sleep disorders, depression, bone and joint problems, decreased sexual function, and alterations in food consumption [1, 3, 4]. These factors contribute to changes in women's quality of life [1].

Diet plays a crucial role in the management of menopausal symptoms, and recent studies have examined the association between dietary intake and menopausal health [5–8]. A systematic review found that higher consumption of whole grains and unprocessed foods was associated with lower intensity of menopausal symptoms [9]. Higher fiber intake has been linked to a reduced prevalence of vasomotor symptoms and improved overall well-being in postmenopausal women [10]. A longitudinal study on postmenopausal women during the COVID-19 pandemic found increased sugar intake and changes in food consumption patterns, while menopausal symptom severity decreased [11]. These findings underscore the need to further investigate dietary factors, particularly carbohydrate quality, in relation to menopause.

In many Asian countries, including Turkiye, carbohydrates from sources such as cereals, rice, and potatoes are the primary components of the diet. High consumption of these carbohydrate-rich foods can negatively impact health by increasing glycemic load and energy intake [10]. While earlier studies have predominantly focused on the relationship between total carbohydrate intake and chronic diseases such as diabetes, cardiovascular disease, and obesity [12–15], recent research has begun to emphasize the importance of carbohydrate quality—considering factors such as fiber content, glycemic index, and whole grain consumption—in women's health during the menopausal transition [10, 16]. For instance, a study conducted in Iran demonstrated that better carbohydrate quality intake was associated with fewer psychological and somatic symptoms in menopausal women [17]. Similarly, the consumption of high glycemic index sugary foods [18] and liquid carbohydrate-based snacks [19] has been linked to greater menopausal symptoms and insomnia, whereas diets rich in fruits, vegetables, and whole grains have been associated with fewer menopausal symptoms [20]. A study conducted in Brazil found that postmenopausal women had higher calorie intake—especially from sugars—compared to women in the menopausal transition, and both groups reported lower quality of life and reduced functional capacity, further emphasizing the need to evaluate dietary patterns in this population [21]. Additionally, high glycemic index diets have been associated with increased depressive symptoms [22–23], whereas greater consumption of whole grains, fruits, and vegetables has been inversely related to depression in menopausal women [23, 24]. Taken together, these findings suggest that carbohydrate quality, rather than total carbohydrate quantity, may play a more pivotal role in influencing physical and psychological well-being during menopause. Therefore, the current study utilizes the Carbohydrate Quality Index (CQI), which incorporates four components—dietary glycemic index, solid carbohydrate/total carbohydrate ratio, fiber intake, and whole grains/total grains ratio—each scored from 1 to 5 and categorized into quintiles (Q1 to Q5) to represent levels of carbohydrate quality [24].

One indicator of carbohydrate quality is the glycemic index of foods. It has been shown that the risk of mortality and disease increases with the intake of simple sugars and refined grains, and with lower intake of whole grains that have a high glycemic index [25]. This is because high glycemic index foods promote inflammation and oxidative stress by causing rapid blood glucose fluctuations, leading to increased insulin secretion and activation of pro-inflammatory pathways, including increased production of pro-inflammatory cytokines such as TNF-α and IL-6 [10, 26–28]. In one study, high refined grain consumption was associated with an increased risk of type 2 diabetes [29]; in another study, consumption of high glycemic index foods in women was linked to breast cancer [30].

Adequate fibre and whole grain consumption play an important role in reducing the risk of various diseases,

including those that arise during menopause [31]. The literature suggests that high fibre intake is associated with a later age of menarche [32]. In one study, a high-fibre diet was found to be linked to a lower risk of long-term cardiovascular disease, particularly in individuals aged 40–59 years [33]. Zhou et al. reported that high-fibre food consumption was associated with increased bone mineral density in women [34], indicating that dietary fibre may help lower the risk of menopause-related diseases.

Although previous research has explored dietary intake and menopause [5, 7–9], the role of carbohydrate quality in menopausal symptoms has received limited attention in research, particularly in relation to menopausal symptoms and quality of life. Therefore, this study aims to address this gap by evaluating the association between carbohydrate quality, menopausal symptoms, and quality of life in postmenopausal women, using a cross-sectional observational approach and assessing variables such as dietary intake, symptom severity, and overall health. By integrating recent findings and adopting a comprehensive methodological approach, this research seeks to provide new insights into dietary strategies that may improve menopausal health outcomes.

Methods

This descriptive, cross-sectional study was conducted in Türkiye, between January 1 and May 1, 2023, and included 604 postmenopausal female volunteers. Women who had not menstruated for 12 consecutive months, had no intermenstrual bleeding, and volunteered to participate were included. The study excludes women with psychological diseases, cancer, gynecological conditions, as well as those using dietary supplements. The minimum sample size was calculated using GPower 3.1 software. A power analysis was conducted to ensure that the study had a statistical power of 80% with a 5% margin of error. The estimated sample size for detecting a statistically significant effect was 542 participants. This was based on a two-tailed test with a significance level of 0.05, considering the expected effect size based on previous studies. The actual sample size of 604 participants was sufficient to achieve this power, accounting for potential dropouts and missing data (Fig. 1). The study was conducted following the principles of the Declaration of Helsinki and received ethical approval from the Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee (approval date: December 08, 2022; decision number: 19-1237). All participants were informed about the purpose and procedures of the study, and written informed consent was obtained from each participant prior to data collection.

Researchers measured body weight (kg) and height (cm) with participants standing upright, maintaining a straight gaze, and ensuring the Frankfort Plane (alignment of the outer corner of the eyes and the top of the ears) was parallel to the ground [35]. Body weight, height, and Body Mass Index (BMI) values were calculated using the standard formula and categorized based on World Health Organization (WHO) criteria [36].

Data collection tools

The data were collected using the Demographic Structure Questionnaire, the Menopause-Specific Quality of Life Scale (MENQOL), the Menopause Rating Scale (MRS), and a Food Consumption Frequency Form.

Demographic structure questionnaire

Demographic Structure Questionnaire: This questionnaire was specifically developed by the researchers for this study and has not been used in previous research. It consists of 19 questions designed to gather general information about the participants, such as age, gender, body weight, height, marital status, and age at menopause.

Menopausal status verification

Participants were asked how they received their menopause diagnosis. Women who had been diagnosed by a doctor were included in the study, and the women's self-reports were used as the basis for inclusion. However, their status was not independently verified by a healthcare professional.

Menopause-Specific quality of life questionnaire

This scale is used to assess the quality of life during menopause. Its validity and reliability were confirmed by Kharbouc and Şahin, with Cronbach's Alpha values for each subscale ranging from 0.73 to 0.88. The scale consists of 29 questions across 4 subdimensions, with scores ranging from 1 to 8. As the score on this scale increases, the severity of complaints also increases [37].

Menopause rating scale

This scale was used to measure the severity and frequency of menopausal symptoms. The scale was developed by Schneider [38]. The validity and reliability of the 11-question scale were established by Gürkan, and the Cronbach's Alpha value was found to be 0.84. The scale has 3 subdimensions: psychological, somatic, and urogenital complaints. Each question has 5 response options (ranging from 0 to 4 points), with a total possible score of 44 and a minimum score of 0. Higher scores indicate a negative impact on quality of life and an increase in symptoms [39].

Carbohydrate quality index calculation

A food consumption frequency questionnaire consisting of 132 items was used to calculate carbohydrate quality.

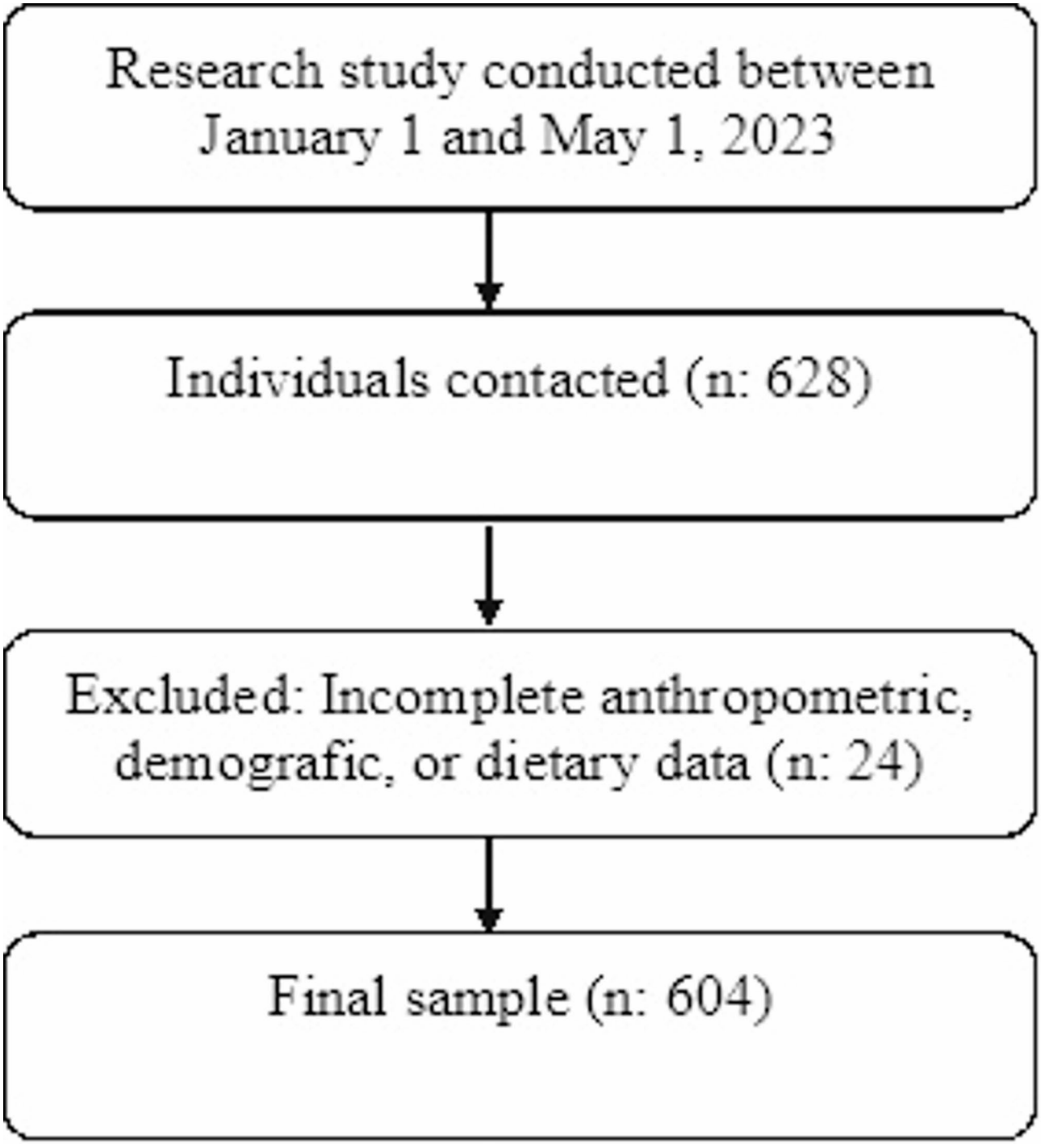

Fig. 1 Flowchart of study sample selection

Carbohydrate quality was determined based on 4 subcomponents: dietary glycemic index, solid carbohydrate/total carbohydrate ratio, fibre intake (g/day), and whole grains/total grains ratio. We aretrieved the glycemic index (GI) for certain foods from the University of Sydney's GI database [40] and BEBIS programme [41].

Each of these 4 components was scored from 1 to 5 (with glycemic index scored inversely: the highest value receives 1, the lowest receives 5, and the other components scored in the opposite direction). The total carbohydrate quality score was then recalculated into quintiles (Q1, Q2, Q3, Q4, and Q5) to form the Carbohydrate Quality Index (CQI), with Q1 representing the lowest

Table 1 Criteria used to calculate carbohydrate quality

Components of dietary index	Index range (points)*	Criteria for minimum index	Criteria for maximum index
Glycemic index	1–5	Maximum glycemic index (fifth quintile)	Minimum glycemic index (first quintile)
Dietary fibre intake (g/d)	1–5	Minimum dietary fibre intake (first quintile)	Maximum dietary fibre intake (fifth quintile)
Ratio of solid carbohydrates: (solid and liquid carbohydrates)	1–5	Minimum value of this ratio (first quintile)	Minimum value of this ratio (first quintile)
Ratio of whole grains: (whole and refined grains or their products)	1–5	Minimum value of this ratio (first quintile)	Maximum value of this ratio (fifth quintile)
Total index (range)	4–20		

* Dietary indices were calculated proportionally based on intake values falling within the defined maximum and minimum criteria

carbohydrate quality and Q5 the highest [24]. No reference cutoff was used to differentiate high versus low carbohydrate quality.

Each of the four components contributes equally to the total CQI score (minimum: 4, maximum: 20) with no additional weighting applied to any specific component. The total carbohydrate quality score is calculated by summing the individual component scores, with each component having an equal influence on the final CQI score [24].

Data evaluation

Statistical analyses were performed using IBM SPSS Statistics 24. The 'Independent Samples t-test' (t-table value) was applied to compare the measurement values between two independent groups if the data were normally distributed. The 'Mann-Whitney U' test (Z-table value) was used for non-normally distributed data. For comparisons among three or more groups, the 'ANOVA' test (F-table value) was used for normally distributed data, while the 'Kruskal-Wallis H' test (χ^2 value) was applied for non-normally distributed data. The normality of continuous variables was tested using the Kolmogorov-Smirnov test (or Shapiro-Wilk test). A p-value > 0.05 was considered to indicate a normal distribution. Linear regression analysis was performed to determine the factors affecting the CQI (Referent category: BMI (under – normal weight), chronic disease (no), marital status (single), Menopausal Treatment Status (No), education (high school and lower)). (no), marital status (single), Menopausal Treatment Status (No), education (high school and lower)). Multicollinearity was assessed using the Variance Inflation Factor (VIF), with values > 10 considered indicative of high collinearity. Homoscedasticity was evaluated using the Breusch-Pagan test. A p-value < 0.05 was considered statistically significant.

Results

The MENQOL scale score of women whose years in menopause was less than 3 years (17.98 ± 10.84) was statistically higher than that of women whose years in menopause was 3 years or more (15.74 ± 0.42) (Z: -1,95; $p < 0.05$). The MRS total score of women aged 30–55 years was statistically higher than that of women aged 56–64 years (χ^2: 7,58; $p < 0.05$), while the MENQOL total score was statistically higher in women aged 30–55 compared to those aged 56–64 and 65 years and older (χ^2: 5,29; $p < 0.05$). The MRS score was 48.85 ± 37.13 in women under 45 years of age, compared to 39.07 ± 26.62 in women aged 45 years and above (Z: -2,01; $p < 0.05$). The MENQOL score of single women (13,03 ± 11,12) was found to be statistically lower than that of married women (17,10 ± 8,91) (Z: -4,11, $p < 0.05$) (Table 2) (Mann-Whitney U test; Kruskal-Wallis H test).

Among women with years in menopause of less than 3 years, 38.1% were in Q3, and 23.4% were in Q1, while 27.3% of women with years in menopause of 3 years or more were in Q3 and 26.3% in Q1. According to BMI values, 32.8% of those who were underweight/normal were in Q3, 24.2% in Q1, and 19.5% in Q5; 27.3% of those who were slightly overweight/obese were in Q3, 27.3% in Q1, and 19.3% in Q2 (Table 3).

The BMI of women in the Q1 group (28.32 ± 5.51 kg/m^2) was statistically lower than that of those in Q2 (30.24 ± 5.99 kg/m^2) and Q4 (30.59 ± 4.42 kg/m^2) (χ^2: 12,32, $p < 0.05$). The MENQOL scale score was statistically higher in the Q3 group compared to the Q5 group (χ^2: 2,24; $p < 0.05$). The lowest age at menopause was observed in the Q4 group (43.91 ± 5.68 years). The highest number of main meals was found in the Q5 group, while the lowest number of snacks was found in the Q1 group (χ^2: 3,29; $p < 0.05$) (Table 4).

The energy and carbohydrate intake of the Q3 group (E: 2318 ± 826.90 kcal, CHO: 265.18 ± 112.54 g) was statistically higher than that of the Q1 group (E: 2036.65 ± 603.15 kcal, CHO: 225.26 ± 69.52 g) (F: 3,58; $p < 0.05$). The highest dietary fiber and lowest glycemic index were found in the Q5 group (respectively χ^2: 13,15; $p < 0.05$ for fiber, χ^2: 7,61; $p < 0.05$ for GI) (Table 4).

The regression analysis showed that the model explained 73% of the variation in the Carbohydrate Quality Index (CQI) score ($R^2 = 0.68$). According to the results

Table 2 Scale scores based on general characteristics of women

	MRS score	MENQOL score
Years in Menopause		
< 3 years (n:197)	42,50 ± 33,48	17,98 ± 10,84
≥ 3 years (n:407)	41,09 ± 28,05	15,74 ± 0,42
p^{γ}	0,608	**0,050**
Z	-1,36	-1,95
Age (years)		
30–55[1] (n:273)	44,77 ± 30,91	19,81 ± 9,70
56–64[2] (n:241)	35,78 ± 27,46	13.75 ± 8,47
≥ 65[3] (n:90)	37,02 ± 17,85	13,63 ± 7,36
p^{β}	**0,002** [1–2]	**< 0,001** [1–2, 3]
χ^2	7,58	5,29
The average age of menopause		
< 45 y (n:153)	48,85 ± 37,13	16,9 ± 10,26
≥ 45 y (n:451)	39,07 ± 26,62	16,33 ± 9,08
p^{γ}	**0,003**	0,997
Z	-2,01	-0,004
BMI kg/m²		
Under – Normal weight (n:384)	40,27 ± 32,30	16,61 ± 9,74
Overweight/Obese (n:220)	43,77 ± 25,14	16,23 ± 8,76
p^{γ}	0,140	0,808
Z	-1,88	-0,24
Marital status		
Single (n:93)	36,98 ± 33,34	13,03 ± 11,12
Married (n:511)	42,38 ± 29,20	17,10 ± 8,91
p^{γ}	0,110	**0,001**
Z	-1,47	-4,11

BMI: Body mass index; MENQOL: Menopause specific quality of life questionnaire, MRS: Menopause rating scale

γ: Mann-Whitney U test (Z value), β: Kruskal-Wallis H test (χ^2 value)

Table 3 Demographic distribution of women by CQI ranges

	Q1 (*n*:153)	Q2 (*n*:102)	Q3 (*n*:186)	Q4 (*n*:61)	Q5 (*n*:102)
	n **(%)**	***n*** **(%)**	***n*** **(%)**	***n*** **(%)**	***n*** **(%)**
Years in Menopause					
< 3 years	46(23,4)	24(12,2)	75(38,1)	22(11,2)	30(15,2)
≥ 3 years	107(26,3)	78(19,2)	111(27,3)	39(9,6)	72(17,7)
Age (Years)					
30–55	65(23,8)	42(15,4)	96(35,2)	38(10,3)	42(15,4)
56–64	64(26,6)	51(21,2)	60(24,9)	27(11,2)	39(16,2)
≥ 65	24(26,7)	9(10)	30(33,3)	6(6,7)	21(23,3)
Mean age at menopause (y)					
< 45 y	42(27,5)	15(9,8)	33(21,6)	30(19,6)	33(21,6)
≥ 45 y	111(24,6)	87(19,3)	153(33,9)	31(6,9)	69(15,3)
BMI kg/m²					
Under – Normal weight	93(24,2)	60(15,6)	126(32,8)	30(7,8)	75(19,5)
Overweight/Obese	60(27,3)	42(19,1)	60(27,3)	31(14,1)	27(12,3)
Marital status					
Single	36(38,7)	15(16,1)	15(16,1)	9(9,7)	18(19,4)
Married	117(22,9)	87(17,0)	171(33,5)	52(10,2)	84(16,4)

BMI: Body mass index

of the linear regression analysis, the CQI score was significantly higher in married individuals compared to those who were not married (B = 0.094, $p = 0.002$). Additionally, the CQI score was significantly higher in those who had received menopausal treatment compared to those who had not. Age, average age of menopause, BMI, and education were not found to be associated with the CQI score (Table 5).

Discussion

This study investigated the impact of carbohydrate quality on menopausal symptoms and quality of life. The main findings indicate that carbohydrate quality is associated with the severity of menopausal symptoms and overall quality of life among postmenopausal women. Women with higher Carbohydrate Quality Index (CQI) scores exhibited lower symptom severity and improved quality of life, particularly in the Q5 group, which had the highest dietary fiber intake and the lowest glycemic index. Demographic factors such as marital status and menopausal treatment were also associated with carbohydrate quality. Additionally, women in earlier stages of menopause and younger age groups reported higher symptom severity, while single women reported better quality of life compared to married women. These findings emphasize the crucial role of carbohydrate quality and dietary patterns in managing menopausal symptoms and improving overall well-being in postmenopausal women. They also underscore the need for targeted nutritional strategies and further interventional research in this population.

Age appears to play a significant role in the severity of menopausal symptoms and quality of life. William et al. [42] found that women aged 60–65 years reported a better quality of life during menopause compared to younger age groups. However, a separate study conducted among women aged 50–59 years reported no significant relationship between age and quality of life [1]. In the present study, the highest MENQOL and MRS scores—indicating lower quality of life and more severe menopausal symptoms—were observed among participants aged 30–55 years. Furthermore, individuals who experienced menopause before the age of 45 had significantly higher scores than those who entered menopause at age 45 or older ($p < 0.05$) (Table 2). This finding may be attributed to the average age of menopause in Türkiye being 45 years; thus, women experiencing menopause before this age may face a greater burden of symptoms and reduced quality of life due to the challenges associated with early menopause.

Marital status plays a significant role in the symptoms experienced during menopause. A study conducted in Turkey found that the severity of menopause symptoms in married women was higher than that in single women

Table 4 Demographic characteristics, scale scores, and nutrient intake of women by CQI ranges

	Q1[1] (*n*:153)	**Q2[2] (*n*:102)**	**Q3[3] (*n*:186)**	**Q4[4] (*n*:61)**	**Q5[5] (*n*:102)**	***p***
	X ± SS	**X ± SS**	**X ± SS**	**X ± SS**	**X ± SS**	
Age (y)	57,18 ± 7,47	57,55 ± 7,28	55,95 ± 8,59	56,34 ± 7,60	58,26 ± 7,18	0,113 [β] χ^2: 7,48
BMI (kg/m^2)	28,32 ± 5,51	30,24 ± 5,99	28,56 ± 4,23	30,59 ± 4,42	28,87 ± 5,17	**0,015[β][1–2,4]** χ^2: 12,32
MRS score	45,6 ± 34,35	44,7 ± 37,34	41,8 ± 26,57	40,4 ± 27,46	38,0 ± 28,73	0,299 [β] χ^2: 10,55
MENQOL score	16,58 ± 8,79	14,24 ± 9,46	18,24 ± 9,46	17,35 ± 8,58	14,35 ± 8,77	**< 0,001[β][3–5]** χ^2: 2,24
Mean age at menopause (y)	45,88 ± 4,83	47,11 ± 5,16	47,37 ± 4,29	43,91 ± 5,68	46,85 ± 5,39	**< 0,001[β][4 – 2,3,5]** χ^2: 7,65
Number of main meals	2,33 ± 0,47	2,35 ± 0,48	2,22 ± 0,45	2,14 ± 0,35	2,5 ± 0,50	**< 0,001[β][5 – 3,4]** χ^2: 3,29
Number of snacks	1,26 ± 0,76	1,50 ± 0,64	1,54 ± 0,73	1,49 ± 0,74	1,29 ± 0,89	**0,002[#][1–3]** F: 1,57
Glycemic index	49,01 ± 30,46	52,86 ± 28,15	37,04 ± 17,16	35,09 ± 22,54	25,60 ± 8,30	**0,001[β][1–3,4,5]** **[2–3,4,5] [5 – 3,4]** χ^2: 13,15
Energy (kcal)	2036,65 ± 603,15	2160,63 ± 516,16	2318 ± 826,90	2175,41 ± 668,09	2268,76 ± 847,44	**0,041[#][1–3]** F: 3,58
CH (g)	225,26 ± 69,52	252,09 ± 55,60	265,18 ± 112,54	234,99 ± 98,36	249,73 ± 112,80	**0,002[β][1–3]** χ^2: 17,34
Protein (g)	67,60 ± 17,68	67,65 ± 16,30	76,09 ± 27,00	78,58 ± 30,83	78,49 ± 31,84	**0,017[β][1–3,4,5], [2–5]** χ^2: 12,09
Fat (g)	95,61 ± 41,5	97,01 ± 33,8	105,62 ± 41,2	101,67 ± 32,7	105,83 ± 36,5	0,082 [β] χ^2: 11,14
Fibre (g)	23,70 ± 6,64	26,07 ± 7,63	31,71 ± 17,73	33,60 ± 15,53	37,97 ± 18,47	**< 0,001[β][1–3,4,5], [2–3,4,5], [3–5]** χ^2: 7,61

CH: Carbohydrate, BMI: Body mass index; MENQOL: Menopause specific quality of life questionnaire, MRS: Menopause rating scale

β: Kruskal-Wallis H test (χ^2 value), #: One-Way ANOVA (F value)

Table 5 Linear regression analysis of variables affecting the CQI index

	Univariable					95% confidence interval for B	
	B	SH	β	t	*p*	Lower	Upper
Age (y)	0,02	0,02	0,07	1,39	0,167	-0,01	0,05
The average age of menopause (y)	0,01	0,02	0,02	0,58	0,563	-0,03	0,06
Marital status (Married)	0,094	0,3	0,13	3,15	**0,002**	0,35	1,54
Menopausal treatment status (Yes)	0,79	0,3	0,11	2,62	**0,009**	0,2	1,39
BMI (Overweight/Obese)	-0,36	0,23	-0,07	-1,56	0,120	-0,83	0,1
Education (Bachelor's degree and above)	0,35	0,24	0,07	1,47	0,143	-0,12	0,82

Referent category: Marital status (single), Menopausal Treatment Status (No), BMI (under – normal weight), Education (high school and lower)

[43]. In another study, the quality of life of married women was reported to be lower than that of never-married women [44]. In this study, the MRS score was found to be higher in married women than in single women (Table 2). This is thought to be due to the influence of sexual life on married individuals. Moreover, regression analysis indicated that carbohydrate quality (CQI) was not significantly associated with BMI, education level, or menopausal age. Instead, the strongest associations were found with marital status and menopausal treatment. These findings suggest that while CQI may contribute to menopausal well-being, its influence should be interpreted within a broader context that includes social and treatment-related factors.

Considering the increasing prevalence of obesity among postmenopausal women, the relationship between menopause and obesity appears to be closely intertwined [45, 46]. Hormonal changes during menopause are associated with a shift from gynoid to android fat distribution, which contributes to central obesity and metabolic complications [45–47]. Obesity during menopause has been linked to exacerbated menopausal symptoms such as sleep disturbances, joint pain, and hot flushes [48]. In a study conducted on 5027 postmenopausal women, approximately 30% were found to be obese, and high BMI values were associated with cardiovascular risk factors such as elevated blood glucose, systemic arterial hypertension, and low HDL-C levels [49]. Similarly, another study reported that obese and overweight women had lower physical and mental HRQoL scores compared to normal or underweight women [50]. In the present study, 220 women (approximately 36%) were classified as overweight or obese. However, no statistically significant difference was found between BMI categories (under/normal weight vs. overweight/obese) in terms of MENQOL and MRS scores (Table 2). Several factors may account for this unexpected finding. Firstly, the cross-sectional nature of the study restricts conclusions about causality or the long-term influence of obesity on the progression of menopausal symptoms. Secondly, unmeasured lifestyle variables—such as physical activity, dietary patterns, and psychological well-being—may have acted as confounding or moderating factors in the relationship between BMI and symptom severity.

Dietary factors also influence the severity of menopausal symptoms such as stress and hot flashes [51–52]. In a study by Lee et al. [53], it was shown that women consuming a diet with higher carbohydrate quality experienced fewer menopausal symptoms. In this study, the lowest MRS score was in the Q5 group ($p > 0.05$) (Table 4). This indicates that women in the Q5 group have fewer menopause-specific complaints than those in the other groups. Additionally, other dietary components such as healthy fats (e.g., omega-3 fatty acids) and proteins (particularly plant-based proteins) may also play a role in modulating menopausal symptoms [54–56]. Studies suggest that omega-3 fatty acids, commonly found in fish and flaxseeds, may help reduce the frequency and intensity of hot flashes, while adequate protein intake may play a role in supporting muscle mass and overall well-being during menopause [54–56]. Future studies should explore the combined effects of these macronutrients, including omega-3 fatty acids and plant-based proteins, on menopausal symptoms and quality of life in a more comprehensively.

The consumption of foods that enhance carbohydrate quality, such as whole grains and fiber, plays a crucial role in preventing chronic diseases. Conversely, the consumption of refined grains and beverages containing added sugar contributes to the development of these diseases [57]. The lowest intake of dietary fiber and whole grains was observed in the Q1 group, while the highest intake was found in the Q5 group. Additionally, the highest intake of refined grains and carbohydrates from liquids was seen in the Q1 group and the lowest in the Q5 group. A study by Yüksel [58] indicated that carbohydrate quality improved with increased intake of whole grains and dietary fiber. In this study, the highest fiber intake was observed in the Q5 group and the lowest in the Q1 group (Table 4).

The glycemic index is among the factors affecting carbohydrate quality in the diet; a high glycemic index decreases carbohydrate quality, while a low glycemic index increases it. One study found the highest glycemic

index in the Q1 group and the lowest in the Q5 group [58]. In other studies, groups with low carbohydrate quality had higher glycemic index values [16, 24, 59]. In this study, the lowest glycemic index value was observed in the Q5 group, while the highest glycemic index values were found in the Q1 and Q2 groups ($p < 0.05$) (Table 4).

Healthy nutrition and the presence of chronic diseases are among the factors affecting the quality of life in menopausal women. A study conducted on postmenopausal women in the USA found that low dietary fiber intake increased the risk of some chronic diseases [60]. Mengna et al. [61] found that carbohydrate quality (low GI, high fiber) positively affected Sex Hormone Binding Globulin levels in the body, rather than carbohydrate quantity. In another study, carbohydrate quality was shown to affect bone mass density in postmenopausal women and reduce the risk of osteoporosis [62]. Additionally, refined grain consumption, which reduces carbohydrate quality, has been linked to decreased potential for healthy aging and negatively impacts general well-being [63]. In this study, the lowest MENQOL scale score was observed in the Q5 group ($p < 0.05$) (Table 4). It is believed that this may be due to the improvement in the quality of life among women with a high carbohydrate quality diet, resulting from a decrease in some menopause-specific symptoms. Additionally, micronutrients such as vitamins and minerals also play a key role in maintaining health during menopause. Certain micronutrients, including calcium, vitamin D, and magnesium, are known to support bone health and help alleviate some menopausal symptoms [64–65]. Future research should investigate the combined effects of both macronutrients and micronutrients, particularly in the context of menopause. Understanding how vitamins, and minerals interact in relation to menopausal symptoms could provide valuable insights for dietary interventions aimed at improving health outcomes in postmenopausal women.

This study has some limitations. Due to the cross-sectional design, this study can only establish associations and cannot determine cause-and-effect relationships or evaluate temporal relationships. Data collection relied on self-reported information from participants, who were observed only once. This may have led to issues such as social desirability bias and response errors. In addition, the analyses examining the relationship between carbohydrate quality, life quality, and menopause symptoms may have been influenced by confounding factors such as the participants' demographic characteristics. A potential limitation of this study is the exclusion of individuals with psychological diseases, cancer, gynecological conditions, and those using dietary supplements. However, other confounding factors, such as physical activity and medication use, were not specifically considered. Also, while marital status and menopausal treatment were found to be significant predictors of CQI, other potential confounding factors, such as physical activity, socioeconomic status, and chronic disease status, were not included in the regression model. Since all these limitations may affect the generalizability of the study's findings, future research should focus on using longitudinal and intervention studies to examine the long-term effects of dietary changes, particularly carbohydrate quality, on menopausal symptoms. Additionally, exploring the role of other macronutrients and micronutrients, as well as investigating dietary patterns such as the Mediterranean diet, could help develop comprehensive strategies to improve health outcomes in postmenopausal women.

A notable strength of this study is its use of validated tools, such as the Menopause-Specific Quality of Life Scale (MENQOL) and the Menopause Rating Scale (MRS), which ensure accurate assessment of menopausal symptoms and quality of life. The Carbohydrate Quality Index (CQI) employed in this study provides a comprehensive measure of dietary intake, allowing for a detailed analysis of how carbohydrate quality relates to menopausal health outcomes. Additionally, this study addresses an important gap in the literature, as limited research has been conducted on the relationship between carbohydrate quality and menopausal symptoms. The findings of this study contribute valuable insights to a relatively underexplored area and highlight the need for further investigation to better understand the role of dietary factors in managing menopausal health.

In conclusion, this study found that higher carbohydrate quality was associated with fewer menopausal symptoms. Regression analysis showed significant associations between marital status, menopausal treatment, and Carbohydrate Quality Index scores. Specifically, women in the highest carbohydrate quality group (Q5) reported fewer symptoms compared to those in the lowest group (Q1). These findings suggest a potential link between dietary carbohydrate quality and menopausal symptom management. However, given the limited research in this area, larger-scale longitudinal and intervention studies are needed to explore the long-term effects and underlying mechanisms.

Abbreviations

BMI	Body Mass Index
CQI	Carbohydrate Quality Index
BeBiS	Beslenme Bilgi Sistemi/ Nutrition Information System
GI	Glycemic index
MENQOL	Menopause-Specific Quality of Life Scale
MRS	Menopause Symptoms Assessment Scale
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions
EE designed the experiment and drafted the manuscript. SE, EG and GÇ collected the data. EE participated in the experiment and helped analyze the data. All authors have read and approved the final manuscript.

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Data availability
The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted following the principles of the Declaration of Helsinki and received ethical approval from the Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee (approval date: December 08, 2022; decision number: 19-1237). All participants were informed about the purpose and procedures of the study, and written informed consent was obtained from each participant prior to data collection.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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