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Body mass index having a mediating role between diet quality & mental and physical health among women

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Abstract

Background Women experience unique dynamics in health and Quality of Life (QoL) due to biological, psychological, and social factors. These dynamics necessitate a comprehensive examination of the indirect effects of Diet Quality (DQ) on Mental and Physical well-being through Body Mass Index (BMI). This study aims to elucidate the indirect pathways through which DQ influences mental and physical well-being, with a particular focus on the mediating role of BMI.

Methods This cross-sectional study was conducted with women ($n = 985$) aged 19–64 years. Anthropometric measurements and 24-Hour Dietary Recall (24HDR) data were collected. QoL was assessed using the Short Form-36 (SF-36), which comprises two primary subdimensions: (1) Mental Well-being, represented by the Mental Component Summary (MCS), and (2) Physical Well-being, represented by the Physical Component Summary (PCS). The Nutrient-Based Diet Quality Index (NBDQ) and Carbohydrate-to-Fibre Ratio (CHO-FBR) were calculated from 24HDR data to evaluate DQ. Two mediation models were employed. Model 1 examined the indirect effects of NBDQ on Mental and Physical well-being through BMI, with age as a confounder. Model 2 assessed the indirect effects of CHO-FBR on Mental and Physical well-being through BMI, also considering age as a confounder.

Results The mean age of participants was 31.68 ± 11.95 years. No significant differences were found in educational attainment across DQ quartiles ($p = 0.228$). Younger women (19–24 years) were more prevalent in lower DQ quartiles, while older women (45–64 years) showed higher DQ scores ($p = 0.001$). Women with spouses had higher DQ ($p = 0.007$). MCS score improved with a better NBDQ ($p = 0.033$), although PCS score did not show significant difference ($p = 0.607$). Mediation analysis revealed that NBDQ was significantly associated with MCS ($\beta = 0.169$, $p = 0.004$) but not with BMI ($\beta = 0.004$, $p = 0.568$). Aditionally, NBDQ showed a non-significant relationship with PCS ($\beta = -0.022$, $p = 0.505$).

Conclusion Improving DQ can enhance mental well-being (MCS), particularly among older women and those with spouses, while no impact was found on physical well-being (PCS). Since BMI did not mediate these effects and CHO-FBR showed no significant associations, nutritional strategies should prioritize DQ alongside age and social dynamics to effectively enhance women's QoL.

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Keywords Body mass index, Diet quality, Mental health, Dietary recall, Mediation analysis

Introduction

Quality of life (QoL) is a multifaceted variable that integrates both mental and physical well-being, both of which are influenced by nutritional factors. Assessing QoL is closely linked to the overall well-being of individuals [1]. The 36-Item Short Form Survey (SF-36), developed as part of the Medical Outcomes Study, is a widely used, thoroughly researched, self-reported measure of health-related QoL [2]. This tool addresses the two fundamental dimensions of health: the physical and mental components [3].

Physical component summary (PCS) indicates physical well-being constitutes a critical domain of QoL, encompassing the ability to perform activities of daily living. Physical well-being is often assessed using patient-reported outcome measures, performance-based assessments, and evaluations of body structure and function [4]. The subdimensions of PCS include mobility, strength, and endurance, which are essential for maintaining functional independence and overall well-being. Impaired physical functioning has been linked to higher risks of disability and reduced QoL, particularly in populations with chronic conditions or musculoskeletal disorders [5].

The second domain of QoL, mental component summary (MCS), is equally vital. Poor MCS often correlates with lower QoL scores [6], whereas adequate and balanced nutrition has been shown to support cognitive function and enhance life satisfaction [7, 8]. Adequate and balanced nutrition involves the consumption of necessary energy and nutrients required for growth, regeneration, and optimal functioning, in quantities that meet established standards, coupled with effective utilization within the organism. Insufficient and unbalanced nutrition can adversely affect physiological processes, potentially impacting the overall QoL of individuals [9]. Diet quality is a critical determinant of health that encompasses the adequacy and diversity of food intake. A higher DQ is associated with better mental well-being, a core component of QoL [10].

Body mass index, a common measure of weight status, may significantly influence mental well-being and QoL. Increased BMI, particularly among overweight or obese individuals, has been associated with higher risks of depression, anxiety, and lower subjective well-being [11]. Physiological mechanisms, including inflammation, hormonal imbalances, and metabolic dysfunctions, in individuals with higher BMI can directly contribute to mental well-being, issues [12]. Higher-quality diets have been linked to a lower risk of stress and depression, and an enhanced QoL in women [13]. Women adhering to a healthier dietary pattern were less likely to experience depression or anxiety [14], and those with better quality diets reported improved health-related QoL, including better emotional well-being [15].

The rationale for this study is grounded in the established associations between BMI, DQ, and overall QoL, particularly among women. Previous research indicates that higher BMI is often associated with lower subjective well-being, suggesting that weight status could significantly influence the relationship between DQ and mental and physical well-being [16, 17]. Women's health profiles differ from men's in terms of biological, psychological and social factors, and this situation calls for women's health research [18]. In particular, women's periodic health processes, such as hormonal changes, pregnancy and menopause, may lead to different relationships between DQ and BMI and mental and physical well-being [19–21]. Research on women is therefore important for understanding gender differences in health. In addition, while women often make decisions about family health, their individual health may often take a back seat, increasing the need for strategies that target women's health [22–25]. Conducting this study specifically with women will play a critical role in better reflecting these specific health dynamics and developing effective interventions to improve women's health. Given that both mental and physical well-being are critical dimensions of QoL, understanding the mediating role of BMI could provide valuable insights into how dietary habits impact women's overall health. This study aims to investigate the indirect effects of DQ on both mental and physical well-being through BMI. By considering age as a confounder, the study seeks to provide a nuanced understanding of the interplay between dietary habits, weight status, and health outcomes.

Method

Subjects

This study was an observational, descriptive type of research. A total of 985 adult volunteer women aged between 19 and 64 years participated. Only women were enrolled in the study. Women's periodic health processes, such as hormonal changes, pregnancy, menopause, etc., may cause the relationships between DQ and BMI and mental and physical health to evolve in different ways. Feraco et al., on the other hand, have highlighted the complex differences in dietary patterns between men and women that are shaped not only by biological factors such as genetic and hormonal responses but also by societal norms and cultural environments [26]. Participation in a study of women has been a challenge, especially in developing countries with conservative cultural and religious norms for women. To overcome this challenge, we conducted our study only with women because we are a developing country. To eliminate the bias that this distinction may create and to understand nutritional issues, we made women a key focus.

Participants were enrolled through simple randomization from various locations, including universities, hospitals, markets, and public areas in İzmir, Türkiye, between February and July 2024. In universities, participants were selected based on the last digit of their school number, while in hospitals and public areas, we used the last digit of their identity card number. In markets, we selected participants according to the last digit of their receipt number. A blinded randomization process was employed by placing numbers 0–9 in a bag. We drew one number, and only women whose school number, ID card, or receipt ended with that digit were invited to participate.

We included all women who had routine blood tests within the last 6 months and had been declared disease-free (do not suffer from a disease that affects the consumption of food) by a physician. And excluded the women who had not blood tests, had any illness, under 19 years old, over 64 years old and did not give consent for participating study. And we excluded those who take under 800 kcal a day and over 4200 kcal a day. These thresholds are commonly used in nutritional epidemiology to identify implausible dietary intakes that may stem from underreporting or over reporting, ensuring the accuracy of the dietary data [27]. We excluded twenty women.

Data collection tools

As part of this study, personal information and anthropometric measurements of the participants were gathered. The SF-36 survey was employed to assess the QoL of the participants. Nutritional status was evaluated using a 24-hour retrospective individual food consumption record form. The DQ of the participants was calculated using the Nutrient-Based Diet Quality Index (NBDQ) [28]. Data were collected through surveys conducted via face-to-face interviews.

General information This section includes inquiries regarding participants' age, educational status, occupation, marital status, adherence to any nutrition or diet program, medication use (if applicable, specifying the name of the medication), supplement usage (if applicable, detailing the type of supplements), and smoking and alcohol consumption status.

Anthropometric measurements Women's body weight (kg), height (cm), and waist and hip circumference measurements were obtained by researchers. Participants' body weight (kg) was measured on an empty stomach using a digital scale calibrated to ± 0.1 kg (Tanita BC-601), with bare feet after ensuring that the individual was wearing minimal clothing. Height (cm) was measured using a stadiometer (SECA 220) while the individual was barefoot and in an upright position (ear canal aligned with eye orbit and parallel to the ground) and taking a breath while providing the Frankfurt plane [29]. Waist and hip circumference of the individuals were measured with a non-flexible tape measure (HOLWAY tape measure). The calculated values included the waist-to-hip ratio (WHR) and BMI which is calculated by dividing body weight (kg) by height squared (m^2) according to the World Health Organization (WHO) criteria. The BMI categories are as follows: BMI < 18.5 kg/m²: underweight; BMI 18.5–24.9 kg/m²: normal weight; BMI ≥ 25.0-29.9 kg/m²: overweight; and BMI ≥ 30.0 kg/m²: obesity [30, 31]. In addition, WHO has defined the risk classification for WHR as an increased risk range for women (0.81–0.84) and a high risk threshold (≥ 0.85) and an increased risk range for men (0.96–0.99) and a high risk threshold (≥ 1.0) [32].

To ensure the accuracy of measurements, each variable was measured twice. In cases where the two measurements differed significantly, a third measurement was taken, and the average of the closest two values was used. The criterion for determining the need for a third measurement was based on established research. Specifically, for height, a third measurement was required if the difference between the two initial measurements exceeded 0.5 cm. For weight, a third measurement was conducted if the difference was greater than 0.2 kg. Similarly, a third measurement was obtained for waist circumference (WC) if the discrepancy exceeded 1 cm. The same threshold was applied to hip circumference, with a third measurement taken when the difference between the two measurements was greater than 1 cm [33].

Anthropometric measurements of the participants (weight, height, waist and hip circumferences) were taken by three different researchers. The first researcher (R1) measured 350 participants, the second researcher (R2) measured 350 participants, and the third researcher measured (R3) 285 participants. To increase the accuracy and reliability of the measurements, the anthropometric measurements of the participants were taken twice, and the mean value of the measurements was recorded. However, if a significant difference was observed between the two measurements, the same measurement was taken a third time and the average value of the three measurements was recorded. Additionally, Technical Error of Measurement (TEM) values were calculated to assess measurement reliability. For body weight, the TEM values were 0.1362 in the R1 group, 0.1219 in the R2 group, and 0.1275 in the R3 group. For height, the values were 0.3503, 0.3246, and 0.3185, respectively. Waist circumference showed TEM values of 0.7751 in the R1 group, 0.7599 in the R2 group, and 0.7149 in the R3 group. Similar values were observed for hip circumference measurements. According to the literature, acceptable TEM ranges for height, body weight, WC, and hip circumference (HC) are 0.1–0.5 cm, 0.1–0.3 kg, 0.5–1.5 cm, and 0.5–1.5 cm, respectively, with proportional error limits between 0.1 and 2.0% of the measured value [34–36].

SF 36 quality of life scale (short form) The SF-36 Quality of Life Scale, initially developed by Stewart et al. in 1987, was employed to assess the QoL among participants [37]. Koçyiğit et al. confirmed the reliability and validity of the Turkish version of SF-36, making it an appropriate tool for use in research conducted in Türkiye [38]. This widely used scale includes both physical and mental health questionnaires. It consists of 36 items divided into eight subheadings: physical functioning, physical role difficulties, emotional role difficulties, body pain, social functioning, mental health, vitality, and general health.

Physical well-being, represented by the physical component summary, encompasses essential dimensions of functional health, including physical functioning (ability to perform daily physical activities), physical role (limitations in role fulfilment due to physical health), bodily pain (perception of pain and discomfort), and general health (overall health perception and vitality).

Additionally, mental well-being, represented by the mental component summary, encompasses key dimensions of psychological health, including vitality (emotional energy and life satisfaction), mental health (emotional stability and cognitive function), role emotional (emotional role limitations), and social functioning (quality of social interactions and relationships). Responses to most questions reflected the participants' conditions over the past four weeks, except for question 2, which gauges the perceived general change in health status over the last year. The fourth and fifth questions required yes/no responses, while the other items employed a Likert-type rating. Subheadings are scored between 0 and 100, with 100 indicating optimal health and 0 indicating poor health [38].

24-Hour dietary recall (24HDR) To assess dietary intake, a retrospective 24-hour dietary recall (24HDR) method was used. The dietary intake of the individuals on the day prior to the interview was asked about and recorded. Participants were asked to provide detailed information on all food and beverage consumption over the past 24 h. This method is widely used in nutritional epidemiology for estimating dietary intake and has been validated for accuracy and reliability [39, 40].

To enhance the accuracy of portion estimation, the Food and Nutrient Photo Catalogue was utilized [41] a validated tool in dietary assessment studies [42]. Whenever possible, participants were encouraged to quantify the food they consumed using tools such as measuring cups, spoons or common portion sizes (e.g. a slice of bread). They were also asked to provide specific details, including the brand of the food, type (e.g., white or wholemeal bread), additional fat used (e.g., oil or butter), and cooking methods (e.g., baking, frying, or steaming). If a food was prepared using a recipe, participants were requested to include the recipe and indicate the portion they consumed.

Since the dietary assessment was based on a single 24-hour recall, it is acknowledged that this may not fully capture habitual dietary intake. However, single-day dietary recalls have been used in large-scale population studies and are considered a practical method for estimating mean dietary intake in groups, despite inherent day-to-day variability [40].

To ensure consistency and reliability, all dietary records were rigorously evaluated by a research team consisting of qualified dietitians with expertise in nutritional assessment. The dietary intake data were analyzed using BeBiS 9 software, which has been widely recognized for its accuracy in nutritional analysis [43]. To maintain methodological consistency, the same dietitians reviewed and verified all dietary records, minimizing inter-rater variability and ensuring the validity of the dietary intake data.

Determination of diet quality In 2015, the Committee tasked with reviewing the Women, Infants, and Children (WIC) Food Packages [39] created the NBDQ. This index was developed to evaluate the average likelihood of dietary adequacy. The Committee aimed to produce a tool to assess the impact of policy changes within the Special Supplemental Nutrition Program for WIC food packages [39]. Given that WIC packages provide a variety of foods and beverages, an index focused on nutrient adequacy is needed to determine whether policy adjustments improve the nutrient intake of WIC participants. Individuals were categorized based on their nutrient adequacy, which was determined by the ratio of nutrient intake to the Estimated Average Requirement (EAR) or Adequate Intake (AI), multiplied by 100 and capped at 100%. The average nutrient adequacy across categories was used to estimate the overall percentage of nutrient adequacy, which ranged from 0 to 100. The study evaluated nine nutrients identified by the Advisory Committee on Dietary Guidelines for 2015–2020 as under consumed, including potassium, fibre, calcium, iron, vitamin C, folate, vitamin A, vitamin E, and magnesium. Specific population subgroups (e.g. 2–5 years or 19–65 years) were also examined for additional nutrients, such as zinc. The DQ of the women in this study was determined using NBDQ. This index considers the consumption levels of potassium, dietary fibre, calcium, iron, folate, magnesium, and vitamins A, C, and

E in the calculation according to the Nutrition Guide for Türkiye [40]. Based on the 24-hour dietary recalls, we calculated the participants' daily nutrient intake using the BeBiS program [41].

Carbohydrate/fibre ratio (CHO-FBR) The American Heart Association proposed a straightforward and practical metric in 2010 to identify healthier grain products. This metric is based on the ratio between total carbohydrates and dietary fibre, and aims to assess the balance in these components [42]. The recommendation was to include at least 1 g of fibre for every 10 g of carbohydrate (≤ 10:1 ratio) based on the natural ratio found in whole-wheat flour. This metric aims to reflect the balance between refined grains (starch), sugars, whole grains, and bran, ideally in their natural state. This aligns with the guidelines from the Scientific Advisory Committee on Nutrition, which suggest a carbohydrate intake of 50% of the total energy (about 288 g of carbohydrate on a 2300 kcal/day diet) and a daily dietary fibre intake of 30 g [43]. The Turkish Dietary Guidelines recommend a minimum of 130 g of carbohydrates (45–60% of total energy) and 21 g of fibre per day for women following a 2000 kcal/day diet [40]. We calculated the participants' dietary carbohydrate and fibre intake based on their 24-hour dietary recalls using the BeBiS program [41]. The ratio was determined for each participant using the following formula: dietary carbohydrate intake (g) / dietary fibre intake (g).

Statistical analyses

The collected data were analysed using SPSS (Statistical Package for Social Sciences) version 25. The normality of the numerical data was assessed using the Kolmogorov-Smirnov test. The Pearson chi-square test was used to assess the association or independence between categorical variables, and the Kruskal-Walli's test was used to compare measures between three or more independent groups. The significance level was set at $p < 0.05$. Categorical data are presented as numbers and percentages, whereas numerical data are presented as mean ± standard deviation. We divided the data into quartiles to compare characteristics across quartiles of NBDQ, which helps to identify patterns related to education, marital status, BMI, etc. across various levels of DQ. Two mediation models were used to guide the analytical procedure used in this study. In the first model, NBDQ was used as the independent variable, BMI as the mediator, and PCS (Physical Component Summary) and MCS (Mental Component Summary) as the dependent variables. Age was included as a confounding variable. In the second model, CHO-FBR was used as the independent variable, BMI as the mediator, and PCS and MCS as the dependent variables. Similar to the first model, age was considered as a confounding factor.

Mediation analysis

Model 1: mediation model of diet quality (NBDQ), body mass index (BMI), and mental and physical well-being with age as a confounder In Fig. 1, the diagram represents a mediation analysis used to examine the indirect effects of an independent variable (NBDQ) on the dependent variables (MCS and PCS) through a mediating variable (BMI). This model evaluates the effect of DQ on MCS and PCS outcomes operating through BMI and the confounding effect of age on this relationship.

Model 2: mediation model of carbohydrate-fiber ratio (CHO-FBR), BMI, and mental and physical well-being with age as a confounder In this mediation model as shown in Fig. 2, the diagram represents a mediation analysis designed to explore the indirect effects of an independent variable (CHO-FBR) on dependent MCS and PCS through a mediating variable (BMI). The model seeks to clarify how CHO-FBR influences MCS and PCS through BMI, while also accounting for the confounding effects of age.

Results

This section presents the key findings of the study, focusing on the relationship between DQ, BMI, and mental and physical well-being among the participants. The average age of the participants was 31.68 ± 11.95 years.

Table 1 presents the characteristics of women categorized by NBDQ quartiles, representing the range of DQ scores. Young women aged 19–24 years comprised 46.9% of the sample but exhibited a decreasing proportion in higher DQ quartiles, with only 35.1% achieving the highest quartile (Q4). In contrast, older women (aged 45–64 years) represented 20.3% of the sample and demonstrated a significant increase in the proportion achieving Q4, reaching 30.7%. There was a significant association between age and NBDQ, with younger women showing a lower proportion in the highest DQ quartile compared to older women ($p = 0.001$). Women with spouses were more likely to be in the highest DQ quartile, while those without spouses were more likely to be in the lower quartiles ($p = 0.007$). The distribution of BMI categories differed across the quartiles: underweight and overweight women were more common in the lower quartiles, whereas normal weight and obese women were more evenly distributed ($p = 0.022$).

Table 2 illustrates the potential link between nutritional quality and health-related QoL. Women were divided into four groups based on their NBDQ scores: Q1 (lowest), Q2, Q3, and Q4 (highest). The table compares the scores on various health-related QoL measures and DQ ratios across these groups.

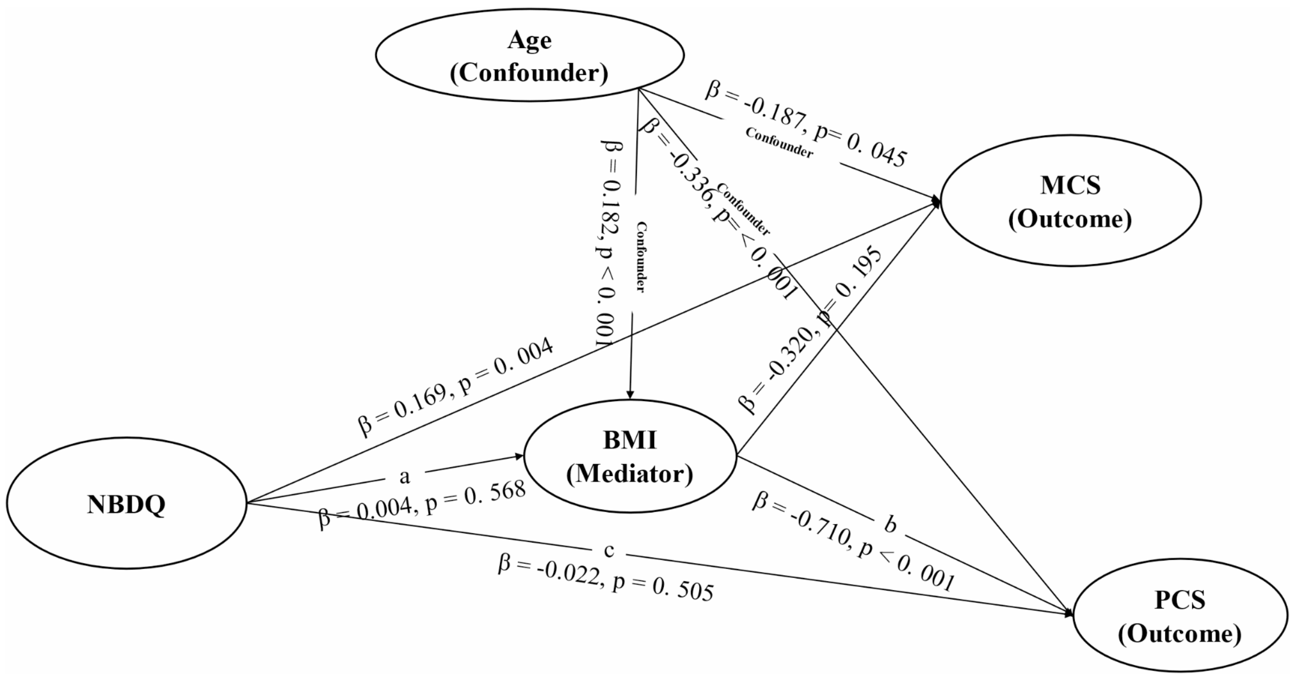

Fig. 1 Mediation analysis diagram for NBDQ, age, BMI, MCS, and PCS. Nutrition based diet quality (NBDQ); Body mass index (BMI); Mental Component Summary (MCS) evaluates mental well-being and includes subdimensions such as Role Emotional, Vitality, Mental Health, and Social Functioning. Physical Component Summary (PCS) evaluates physical well-being and comprises subdimensions like Physical Functioning, Physical Role, Bodily Pain, and General Health

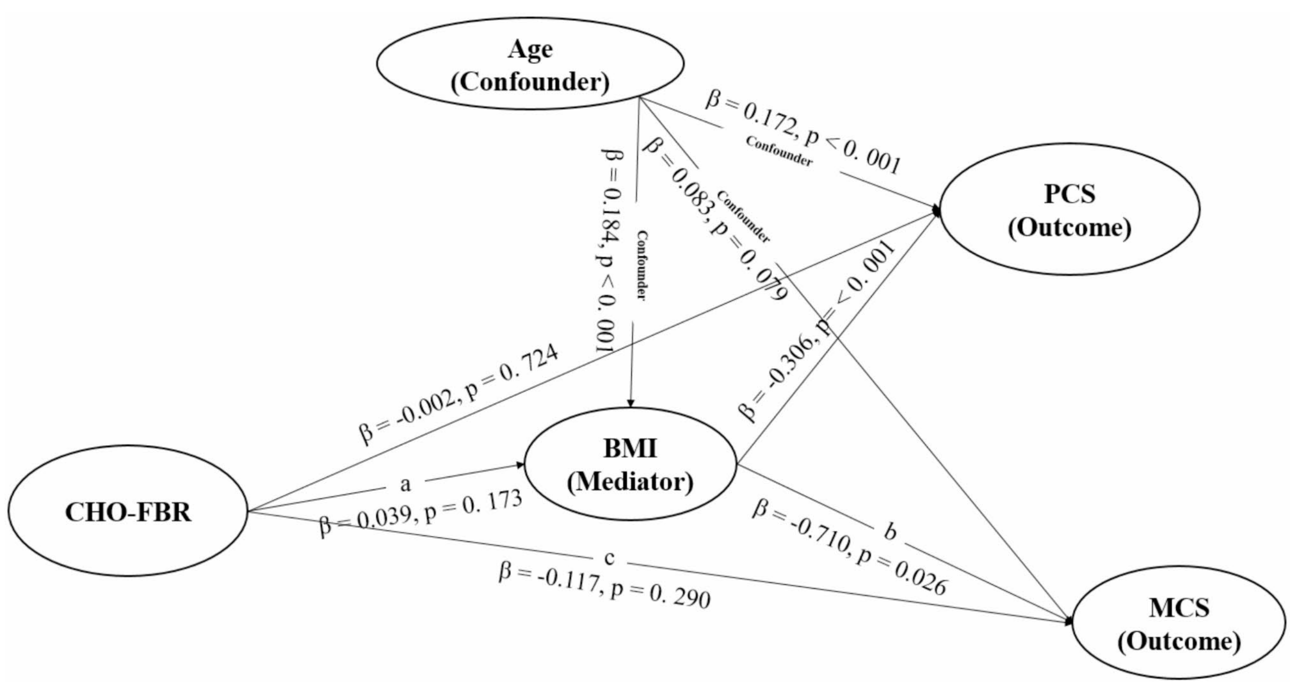

Fig. 2 Mediation analysis diagram for CHO-FBR, age, BMI, MCS, and PCS. Body mass index (BMI); Carbohydrate/fibre ratio (CHO-FBR). Mental Component Summary (MCS) evaluates mental well-being and includes subdimensions such as Role Emotional, Vitality, Mental Health, and Social Functioning. Physical Component Summary (PCS) evaluates physical well-being and comprises subdimensions like Physical Functioning, Physical Role, Bodily Pain, and General Health

Table 1 The characteristics of women

Variables	Nutrition Based Diet Quality					*p* value
	Overall (*n* = 985)	**Q1 (0-60.30) (*n* = 246)**	**Q2 (60.31–72.50) (*n* = 247)**	**Q3 (72.51–83.43) (*n* = 264)**	**Q4 (83.44–100) (*n* = 228)**	
	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**	
Age Classification						
Youthful age (19–24 years)	462 (46.9)	128 (52.0) [й]	123 (49.8) [й]	131 (49.6) [й]	80 (35.1) [£]	**0.001**
Early Adulthood (25–34 years)	176 (17.9)	48 (19.5) [ǂ]	41 (16.6) [ǂ]	47 (17.8) [ǂ]	40 (17.5) [ǂ]	
Middle Aged (35–44 years)	147 (14.9)	33 (13.4) [з]	39 (15.8) [з]	37 (14.0) [з]	38 (16.7) [з]	
Older Aged (45–64 years)	200 (20.3)	37 (15.0) [¤]	44 (17.8) [¤]	49 (18.6) [¤]	70 (30.7) [€]	
Education statutes						
≤12 years	219 (42.7)	101 (41.0)	100 (40.5)	126 (47.7)	93 (40.8)	0.228
> 12 years	565 (57.3)	145 (59.0)	147 (59.5)	138 (52,3)	135 (59.2)	
Marital status						
With spouse	362 (36.8)	78 (31.7) [§]	90 (36.4) [§, ɣ]	89.0 (33.7) [§]	105 (46.1) [ɣ]	**0.007**
Without-spouse	623 (63.2)	168 (68.3) [§]	157 (63.6) [§, ɣ]	175 (66.3) [§]	123 (53.9) [ɣ]	
Smoke						
No	659 (66.9)	168 (68.3)	154 (62.3)	183 (69.3)	162 (80.1)	0.449
Yes	318 (32.3)	78 (31.7)	93 (37.7)	81 (30.7)	66 (28.9)	
Alcohol use						
No	685 (69.5)	163 (66.3)	163 (66.0)	187 (70.8)	172 (75.4)	0.083
Yes	300 (30.5)	83 (33.7)	84 (34.0)	77 (29.2)	56 (24.6)	
Illness						
No	848 (86.1)	221 (89.9)	211 (85.4)	230 (87.1)	186 (81.6)	0.069
Yes	137 (13.9)	25 (10.2)	36 (14.6)	34 (12.9)	42 (18.4)	
BMI Classification						
Underweight	86 (8.7)	23 (9.3) [†]	25 (10.1) [a]	19 (7.2) [‡]	19 (8.3) [¥]	**0.022**
Normal	632 (64.2)	173 (70.3) [†]	151 (61.1) [a]	173 (65.5) [‡]	135 (59.2) [¥]	
Overweight	179 (18.2)	34 (13.8) [†]	49 (19.8) [a]	55 (20.8) [‡]	41 (18.0) [¥]	
Obese	88 (8.9)	16 (6.5) [†]	22 (8.9) [a, b]	17 (6.4) [‡]	33 (14.5) [ƛ]	
WHR						
Normal	838 (85.1)	219 (89.0)	213 (86.2)	221 (83.7)	185 (81.1)	0.092
Risk	147 (14.9)	27 (11.0)	34 (13.8)	43 (16.3)	43 (18.9)	

Body Mass Index (BMI), Waist-to-Hip Ratio (WHR), Pearson Chi Square Analysis ($p < 0.05$). Each subscript letter and symbol denote a subset of quartile categories whose column proportions did not differ significantly from each other at a level of 0.05. The same subscripts indicate groups that are statistically similar, while different subscripts denote distinct subsets that are also statistically similar within their respective groups

Mental component summary scores improved with better DQ, with women in Q4 having higher MCS scores than those in Q1 and Q2 ($p = 0.033$). However, physical component summary sores and subdimensions showed no significant differences ($p > 0.05$).

Carbohydrate-Fiber Ratio decreased with better DQ. Fiber intake increased in parallel with DQ (Q1: 10.7 ± 4.3; Q2: 15.0 ± 4.0; Q3: 19.2 ± 6.0; Q4: 26.7 ± 9.1) (data not shown in tables). The Q4 group had the lowest CHO-FBR ratio, indicating a higher fibre intake relative to carbohydrates. There is a potential link between increased fibre intake and better diet quality ($p < 0.001$).

In Table 3, there were no significant differences in weight, BMI, WHR or waist circumference across NBDQ quartiles (all $p > 0.05$).

In Fig. 1, the mediation analysis the relationships between DQ, BMI, and mental and physical well-being. First, the effect of DQ on BMI was positive but not statistically significant ($\beta = 0.004$, $p = 0.568$). However, DQ had a significant positive effect on mental well-being ($\beta = 0.169$, $p = 0.004$). In contrast, the relationship between DQ and physical well-being was negative but non-significant ($\beta = -0.022$, $p = 0.505$).

Body mass index, serving as a mediator, was found to significantly impact physical well-being ($\beta = -0.710$, $p < 0.001$). However, the effect of BMI on mental well-being was negative but not statistically significant ($\beta = -0.320$, $p = 0.195$). Additionally, age, a confounding variable, had a significant positive effect on BMI ($\beta = 0.182$, $p < 0.001$). Age also had a negative and significant impact

Table 2 Health-related QoL subscales and summary components and CHO-FBR according to NBDQ

Variables	Nutrition Based Diet Quality (NBDQ)					*p* value
	Overall (*n* = 985)	**Q1 (0-60.30) (*n* = 246)**	**Q2 (60.31–72.50) (*n* = 247)**	**Q3 (72.51–83.43) (*n* = 264)**	**Q4 (83.44–100) (*n* = 228)**	
SF-36 Subscales						
PCS	66.06 ± 15.44	65.56 ± 14.42	65.24 ± 16.53	67.01 ± 14.90	66.36 ± 15.82	0.607
Physical functioning	82.32 ± 18.67	83.67 ± 17.13	82.59 ± 19.31	82.42 ± 19.14	80.44 ± 18.97	0.338
Physical role	71.21 ± 34.77	71.44 ± 34.84	68.52 ± 35.47	74.52 ± 33.87	70.06 ± 34.88	0.173
Bodily pain	56.29 ± 30.65	53.35 ± 31.13	55.73 ± 29.60	55.92 ± 31.20	60.51 ± 30.37	0.076
General health	54.30 ± 15.51	53.78 ± 15.08	54.12 ± 16.22	54.87 ± 14.83	54.41 ± 16.01	0.799
MCS	58.41 ± 15.68	57.24 ± 14.90 [α]	56.58 ± 16.07 [α]	59.29 ± 14.72 [α, β]	60.10 ± 14.81 [β]	**0.033**
Vitality	49.18 ± 18.36	47.93 ± 17.31	47.97 ± 19.22	50. 00 ± 18.08	50.92 ± 18.77	0.162
Mental health	58.82 ± 16.34	56.61 ± 16.44 [ϟ]	57.45 ± 17.50 [ϟ]	58.86 ± 15.60 [ϟ, й]	62.62 ± 15.18 [й]	**< 0.001**
Role emotional	59.76 ± 30.31	59.48 ± 30.23	57.48 ± 30.89	62.62 ± 30.21	59.21 ± 29.81	0.273
Social functioning	65.29 ± 21.25	64.65 ± 20.68	63.42 ± 22.16	65.60 ± 21.74	67.66 ± 20.13	0.246
CHO-FBR	9.82 ± 4.44	11.22 ± 5.05 [a]	10.55 ± 4.81 [b]	9.31 ± 3.77 [c]	8.12 ± 3.23 [d]	**< 0.001**

Quality of Life (QoL); SF 36 Quality of Life Scale (SF-36); Physical Component Summary (PCS): [Physical functioning, Physical role, Bodily pain, General health]; Mental Component Summary (MCS) [Role emotional, Vitality, Mental Health, Social functioning]; Carbohydrate/Fibre Ratio (CHO-FBR); Kruskal Wallis analysis ($p < 0.05$). Each subscript letter and symbol denote a subset of quartile categories whose column proportions did not differ significantly from each other at a level of 0.05. The same subscripts indicate groups that are statistically similar, while different subscripts denote distinct subsets that are also statistically similar within their respective groups

Table 3 Anthropometric measurements of women according to NBDQ quartiles

Variables	Overall (0-100) (*n* = 985)	Q1 (0-60.30) (*n* = 246)	Q2 (60.31–72.50) (*n* = 247)	Q3 (72.51–83.43) (*n* = 264)	Q4 (83.44–100) (*n* = 228)	*p* value
Weight (kg)	62.73 ± 12.24	61.63 ± 11.29	62.35 ± 13.09	62.56 ± 10.63	64.55 ± 13.83	0.198
WC (cm)	75.37 ± 12.55	78.83 ± 11.61	75.01 ± 12.67	75.48 ± 11.73	77.32 ± 14.08	0.118
HC (cm)	97.94 ± 10.01	96.94 ± 10.03	98.09 ± 10.38	98.06 ± 9.10	98.70 ± 10.59	0.462
BMI (kg/m^2)	23.33 ± 4.49	22.78 ± 4.06	23.40 ± 4.93	23.24 ± 3.92	23.82 ± 5.00	0.342
WHR	0.76 ± 0.08	0.75 ± 0.08	0.76 ± 0.09	0.77 ± 0.08	0.78 ± 0.11	0.215

Nutrition Based Diet Quality (NBDQ), Waist Circumference (WC); Hip Circumference (HC); Body Mass Index (BMI), Waist-to-Hip Ratio (WHR). Kruskal Wallis analysis ($p < 0.05$).

on both mental well-being (β = -0.187, $p = 0.045$) and physical well-being (β = -0.336, $p < 0.001$).

Figure 2 presents the mediation model examining the impact of the CHO-FBR, BMI, and age on mental and physical well-being. The effect of the CHO-FBR on BMI was positive but not statistically significant (β = 0.039, $p = 0.173$). Similarly, the CHO-FBR had no significant impact on mental well-being (β = -0.117, $p = 0.290$) or physical well-being (β = -0.002, $p = 0.724$).

In contrast, BMI played a significant role in both and mental and physical well-being. Specifically, BMI was negatively associated with mental well-being (β = -0.274, $p = 0.026$). Additionally, BMI had a strong and significant negative effect on physical well-being (β = -0.306, $p < 0.001$).

Age, acting as a confounder, had a significant positive effect on BMI (β = 0.184, $p < 0.001$). While age was not significantly related to mental well-being (β = 0.083, $p = 0.079$), it had a positive and significant effect on physical well-being (β = 0.172, $p < 0.001$).

Discussion

A descriptive study was conducted with a sample of 985 participants to evaluate DQ using the NBDQ and QoL utilizing the SF-36. In addition, including demographic characteristics, anthropometric measurements, lifestyle factors, and 24HDR, were also collected. The NBDQ scores and the CHO-FBR were calculated based on the 24HDR data.

In our modelling, we evaluated the effect of DQ on mental and physical outcomes operating through BMI and the confounding effect of age on this relationship. Higher DQ was significantly associated with improved mental well-being, although it did not significantly affect BMI and physical well-being. And in this model, age is the confounder while age have a negative significant effect on mental well-being and physical well-being, it has a positive significant effect on BMI. In addition, in the second model we tried to clarify how CHO-FBR influences mental and physical well-being through BMI, while age accounting for the confounding role. The dietary CHO-FBR ratio had no directly significant impact on BMI, mental well-being, or physical well-being. However, when this relation mediating via BMI we found a negative significant effect on mental well-being and physical well-being. Moreover, age has a significant positively confounding effect on BMI and physical well-being but not on mental well-being.

A study emphasized that healthy eating patterns, such as the Mediterranean diet, are associated with better mental health outcomes compared to unhealthy eating patterns [44]. A meta-analysis of randomized controlled trials demonstrated that dietary interventions significantly reduced symptoms of depression. This supports the notion that better DQ can enhance mental outcomes, as reflected in higher MCS [45]. One study examining DQ and adherence to dietary guidelines in adults identified potential associations between DQ, dietary composition, adherence to food pyramid recommendations, and indicators of depressive symptoms, anxiety levels, and overall well-being [46]. Another research conducted in Korea demonstrated that higher DQ is correlated with a reduced risk of stress and depression, as well as improved QoL [13]. We found a significant increase in the MCS sub-dimension score of QoL as DQ increased. This finding supports studies suggesting a positive impact of healthy eating on mental well-being.

Cronin et al. (2021) discussed the modulation of gut microbiota by dietary fibre, highlighting its positive impact on gut health and, consequently, mental health. These findings reinforce dietary recommendations advocating for increased consumption of whole grains and non-starchy vegetables [47]. In this study, the CHO-FBR assessment showed significant differences across quartiles, with the highest quartile (lowest CHO-FBR) indicating potentially better QoL. Higher fibre intake, indicated by a lower CHO-FBR, is associated with enhanced gut health, which may mediate improvements in mental well-being and QoL. Elevated BMI is often associated with worse health outcomes, including impaired physical well-being and reduced mental well-being [48]. Body mass index mediates the link between DQ and mental and physical well-being. Moreover, age was included as a confounding variable, influencing DQ, BMI, and mental and physical outcomes. As people age, their DQ and BMI may change, which in turn can affect both their mental and physical well-being. Empirical studies have supported this temporal ordering, where healthier diets first improve BMI, which subsequently enhances physical and mental outcomes [49, 50]. Furthermore, longitudinal studies demonstrate that age and BMI interact with DQ to predict changes in health outcomes over time [51]. Although trends in weight, BMI, and WC within the highest NBDQ quartile were not statistically significant, they warrant further investigation into potential contributors such as muscle mass composition and physical activity levels. During a 20-year observational period, one study noted favourable age-related changes in dietary intake. Despite these changes, there was a noticeable trend toward reduced DQ over time [52]. While not statistically significant, a slight trend suggests higher weight and BMI in the highest NBDQ quartile. This might seem counterintuitive but could be due to factors like muscle mass composition, which is not directly measured in this table. Additionally, potential confounding variables like physical activity levels, which can influence both diet and weight, require consideration. Dividing participants based on NBDQ scores creates groups with varying DQ. No significant differences were observed in WC among women. However, a slight trend suggests higher WC in the highest NBDQ quartile, mirroring the weight/BMI trend. Furthermore, a study has shown that people who eat healthier tend to have a lower BMI [53]. As with weight, muscle mass composition and physical activity could play a role here, necessitating further exploration. No significant differences were found in HC and WHR, suggesting that overall body fat distribution might not be directly affected by variations in NBDQ within this study population.

Promoting balanced diets with adequate carbohydrate and fibre intake serves as an effective strategy for weight management. A prospective cohort study indicated that increased consumption of carbohydrates from whole grains, fruits, and non-starchy vegetables correlates with a reduced risk of weight gain. In contrast, higher intake of carbohydrates from refined grains and starchy vegetables is associated with greater weight gain [54]. CHO-FBR intake may lead to healthier physical and mental outcomes by mediating with BMI, which acts as a mediator affecting both mental and physical well-being. Studies have demonstrated that adherence to high-quality diets (e.g., Mediterranean or balanced diets) is associated with lower BMI [55, 56]. On the other hand, elevated BMI was often linked to poorer health outcomes, with research consistently shown that higher BMI is associated with worse MCS outcomes (e.g., higher risk of depression, anxiety) [57] and impaired physical functioning (e.g., reduced mobility, physical capacity) [58]. A study showed that dietary interventions can improve BMI and subsequently enhance mental and physical outcomes [59].

Age was included as a confounder because it can simultaneously influence DQ, BMI, MCS, and PCS. As individuals age, their dietary habits may change (e.g., due to lifestyle factors or health conditions), and age-related changes in BMI and health (both physical and mental) are well-documented [60, 61]. In our study, in aspect of NBDQ evaluation older age could be associated with higher BMI and decreased in MCS and PCS. In literature, healthier diets are shown to improve BMI, which in turn enhances both physical and mental outcomes [62]. Furthermore, longitudinal research highlights the interplay between age, BMI, and DQ in predicting health trajectories over time [63].

Strengths and limitations

The study has strengths. The inclusion of a large sample of women ($n = 985$) increases the generalizability of the findings. The use of the NBDQ to assess DQ is a validated and objective measure that considers the intake of various nutrients and food groups. There are some limitations to this study. Although we measured each anthropometric variable twice to ensure accuracy, one of the limitations of this study is that the measurements were performed by different investigators. Because dietary intake and physical activity patterns can change over time, a single 24-hour dietary recall may not accurately reflect habitual intake. The observational nature of the study means it cannot prove causation; it can only suggest associations. It is possible that people who already feel better mentally are more likely to try to eat healthy. Additionally, other potential confounders such as socioeconomic status and physical activity levels were not controlled for. More research is needed to develop specific dietary recommendations for improving mental well-being.

Conclusion

This study highlights the intricate relationships between DQ, BMI, and health outcomes, focusing on mental and physical well-being in women. High DQ, as indicated by NBDQ scores, is positively associated with improved mental well-being, emphasizing the benefits of healthy dietary habits. However, no significant relationship was found between DQ and physical well-being (PCS). Age is a significant confounder, influencing both BMI and health outcomes. BMI did not mediate the relationship between DQ and well-being, and CHO-FBR showed no significant associations with BMI, MCS, or PCS. These findings suggest that improving DQ can enhance mental well-being, particularly among older women, while no impact was observed on physical well-being. Nutritional strategies should prioritize DQ and consider age as a key factor to effectively enhance women's QoL. Future research should include additional confounders like physical activity and socio-economic status to further understand these relationships.

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Author contributions
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Data availability
All data are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval was obtained from İzmir Katip Çelebi University Non-Interventional Clinical Research Ethics Committee before the application (2024/54). Participants were provided with information about the study, and those who willingly chose to take part were requested to endorse a written consent form in compliance with the principles outlined in the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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