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Adherence to Nordic Nutrition Recommendations and Abdominal Obesity and Anthropometric Indices among Women: A Cross-Sectional Study in Tehran, Iran

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ABSTRACT

Background: Abdominal obesity (AO) is a global health problem. Although few studies indicated that Nordic diet (ND) was associated with AO, no evidence exists for the association between ND and AO outside the Nordic countries. In this study, we aimed to determine the relationship of ND with AO and anthropometric indices among Iranian women. **Methods:** In this cross-sectional study, we evaluated anthropometric indices and usual dietary intakes of 294 Iranian women aged 20-50 years. We defined AO as waist circumference (WC) ≥ 88 cm and WC ≥ 90 (according to Iranian criteria). Association between qualitative variables and health eating index-nordic nutrition recommendation (HEI-NNR) score was determined using Chi-square and Mann–Whitney tests. The relationship of HEI-NNR score with AO was analyzed by a logistic regression model after adjusting the effect of confounders. **Results:** The mean of HEI-NNR score was significantly higher in overweight and obese participants than participants without overweight (P = 0.04). No linear trend was found for body mass index, WC, and waist to hip ratio (WHR) through the HEI-NNR score even after adjustment for confounders. A significant positive association was found among HEI-NNR score, overweight, and obesity (OR = 1.85, 95%CI = 1.15-2.96, P = 0.01). However, the association did not remain significant after adjusting for the confounders. **Conclusion:** Adherence to the ND was not associated with AO and anthropometric measurement among Iranian women. Future evidences from RCT and prospective cohort studies are needed to confirm these findings.

Keywords: *Nordic diet recommendation; Abdominal obesity; Anthropometric indices*

Introduction

Abdominal obesity (AO) is a rapidly growing global health problem (Lee *et al.*, 2017),which plays an important role in increasing the risk of chronic illnesses (Mohan and Deepa, 2006).

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The prevalence of AO has increased from 44.4% to 66.1% among Iranian women from 1999 to 2011 (Barzin *et al.*, 2015). The rising rate of AO, reflects the impact of lifestyle factors, including diet on the etiology of obesity (Azadbakht and Esmaillzadeh, 2008). Nowadays, researchers try to investigate at the relationship of AO with different dietary patterns. Dietary patterns might have a greater effect on health than individual food items; so, they might be more useful regarding public recommendation (Hu, 2002).

Recently, Nordic dietary pattern has gained interest (Mithril *et al.*, 2012). According to the previous studies, an inverse relationship exists between dietary scores of Nordic countries and their mortality rates (Olsen *et al.*, 2011), colorectal cancer (women only) (Kyrø *et al.*, 2013) , high sensitivity C-reactive protein (HSCRP) (Kanerva *et al.*, 2014), preeclampsia (Hillesund *et al.*, 2014b), and excessive weight gain during pregnancy (Hillesund *et al.*, 2014a).

An observational study showed that Nordic dietary score was inversely associated with AO (Kanerva *et al.*, 2013).The Nordic diet (ND) is based on 3 recommendations: (i) more calories from plant foods (and less from meat); (ii) more consumption of seafood; and (iii) more foods from the wild countryside (Hedren *et al.*, 2002). However, the latest Nordic Nutrition Recommendations (NNR), i.e., fifth edition (released in 2012), suggests Daily Recommended Value (DRV) for macronutrients (Hedren *et al.*, 2002).

So far, two studies examined the relationship between Nordic food patterns based on the NNR version of 2004 and AO (Darwiche *et al.*, 2016, Kanerva *et al.*, 2013), but no study has ever examined the association between AO and NNR version 2012 (current version).

Considering the high prevalence of AO in women, this study was designed to evaluate the role of NNR on AO in Iranian women aged 20-50 years in Tehran (capital of Iran). To our knowledge, only 2 studies examined the relations of ND with AO (Darwiche *et al.*, 2016, Kanerva *et al.*, 2013) and no study has ever investigated ND outside the Nordic countries.

Materials & Methods

Participants: This cross-sectional study was conducted among women aged 20 - 50 years living in Tehran selected by random cluster sampling. The participants (n = 306) were randomly recruited from four health centers affiliated to Shahid Beheshti University of Medical Science). Women who were pregnant or lactating were not included because of their altered diet and body weight. Furthermore, participants with an incomplete FFQ (n = 8) or those whose total daily energy intake (EI) was out of the range of mean±3 SD of energy intake were excluded (n = 4). Thus, the final sample for statistical analysis included 294 cases. To reduce errors and biases in completing the questionnaires and measurements, a pilot study was carried out on 30 women (aged 20-50) at one of the health centers not included in the study (as a pilot center).

Assessment of dietary intake: Dietary intake was measured using a valid semi-quantitative food-frequency questionnaire (FFQ) including 168 food items (Asghari *et al.*, 2012). Women were asked to report their consumption frequency on a daily, weekly, or monthly basis. Later, the energy consumption mean was calculated for each participant per month; i.e., 30 days. The average daily intake of each food item was estimated by multiplying the consumption frequency of each food by its standard portion size. Since Iranian food composition table (FCT) is incomplete and provides data only on a few nutrients (Azar and Sarkisian, 1980), analyses of energy and nutrients were carried out using the USDA FCT (Jessri *et al.*, 2011). However, for some dairy products such as whey, wild plum, vetch, mint, sweet canned cherry, and sour cherry that are not included in the USDA FCT, Iranian FCT was used instead (Azar and Sarkisian, 1980).

Assessment of anthropometric measures: Height was measured to the nearest 0.1 cm and body weight to the nearest 0.1 kg using a Seca (Clara 803 electronic scale; Hamburg, Germany) electronic scale while the participants were wearing minimal clothes without shoes. The body

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mass index (BMI) was calculated by dividing the weight in kilograms by square of height in meters (kg/m^2) for each participant. Waist circumference (WC) was measured by an inelastic tape without any compression in the middle part of region between the lowest rib and the highest iliac crest at the end of the natural expiration. Furthermore, AO was defined both as WC ≥ 88 cm (National Cholesterol Education Program (US, 2002) and WC ≥ 90 according to the Iranian criteria (Azizi *et al.*, 2010).

Assessment of demographic information: In this study, the required data on demographic and socio-economic variables were collected through a general information questionnaire. The participants were asked about their age, marital status (single/ married, divorced/widow), family size, number of children, ethnicity, center of residence, university degree (yes/no), total family income/month (USD), and occupation. Occupation was categorized into five levels: (i) unemployed and/or housewife; (ii) job category 1 (laborer, farmer and rancher); (iii) job category 2 (self-employed, shopkeeper); (iv) job category 3 (teacher, service man, government employee and trooper); and (v) job category 4 (employer, industrialist, business owner, manager, doctor, lawyer, pilot, and university professor). For women's occupations, another classification was added as category 0 (household keeper).

The status of current smoking, supplements and medicine use, diagnosis of chronic illnesses by a doctor, and a family history of obesity (in the first-degree relatives) were obtained through interviews.

In order to study the participants' physical activity, the validated International Physical Activity Questionnaire (IPAQ) (Vasheghani-Farahani *et al.*, 2011) was completed by face to face interview. The questionnaire assesses the physical activity of respondents across a comprehensive set of domains within 7 days before the interview. These domains include: 1- work-related physical activity (7 items), 2- transport-related physical activity (6 items), 3- domestic, gardening (yard) and care family physical activity (6 items), 4- physical activity related to leisure, sports and entertainment (6 items); and 5- sitting time (2 items). The activity levels were expressed as metabolic equivalent task in minute per week (METs-min/week).

Health eating index-nordic nutrition recommendation (HEI-NNR) score: The HEI-NNR score was estimated based on the ratio of measured and recommended intake of the selected nutrients (von Ruesten *et al.*, 2014) (**Table 1**). In other words, nutrients with the minimum recommended intake (fiber), within the recommended intake range [monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), total fat and total protein], or with the maximum recommended intake values [saturated fatty acid (SFA) + trans fatty acid (TFA), added sugar] were computed differently (**Table 1**). For total sugar and fiber added protein, the potential score may range between 0 and 10. Due to the large association between total fat and fat components, the scores given in the following equations were multiplied by 0.5 in order to prevent overestimation of fat components in the total HEI-NNR score. Hence, for SFA + TFA, MUFA, PUFA, and total fat, a maximum score of 5 was applied (**Table 1**). Consequently, the total score could range between 0 and 50.

For fiber, an increasing intake was evaluated with a proportionally increasing score from 0 to 10 according to **Equation 1**. Intakes above the recommended minimum level were hence scored with the maximum score of 10.

Equation 1:

$$score = \frac{\text{reported intake}}{\text{recommended intake}} \times 10$$

The results of SFA + TFA and added sugar represent nutrients that should not be consumed more than the maximum level. Consequently, intakes lower than the recommended maximum level were scored with the maximum of 5 (for SFA + TFA) or 10 points (for added sugar) while excess of the recommended intake was estimated using the proportional score deduction based on **Equation 2**.

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Equation 2:

$$score = \frac{\text{recommended intake}}{\text{reported intake}} \times 10$$

For MUFA, PUFA, total fat and total protein, as nutrients within the range of recommended intake, **Equation 1** was applied to score intakes below the recommendations. However, for intakes above the recommended range, **Equation 2** was used. For intakes within the recommended range, maximum score (5 for MUFA, PUFA, total fat, and 10 for total protein) was considered.

The HEI-NNR score was computed based on the ratios of measured and recommended intake of the selected nutrients including: SFA + TFA, MUFA, PUFA, total fat, added sugar, fiber, and total protein (**Table 1**).

Ethical considerations: Shahid Beheshti University of Medical Sciences in Iran reviewed and approved all study and ethical procedures. Moreover, informed written consent forms were obtained from all participants (Approval of the Ethics Committee to No. 708/0450 and the Code of Ethics IR.SBMU.Rec.1396.132).

Data analysis: Statistical analyses were conducted using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to evaluate the normal distribution of quantitative variables. Frequency distribution tables were used to describe the qualitative variables. The quantitative variables were also described using the mean values and standard deviations. Analysis of the relationship among qualitative variables was carried out using the Chi-square and Mann–Whitney tests. The association of NNR scores with AO was analyzed by a logistic regression model after adjusting the effect of confounders.

Results

Table 2 represents the baseline characteristics of women according to NNR score. In the present study, the mean age of women was 33.94 ± 8.47 years (range = 20-50 years) and 56.8% of them were overweight and obese. Furthermore, 36.7% and 28.6% of the participants had AO based on NIH and Iranian cut-off, respectively. A very small proportion of women were current smokers (7.5%). The mean of HEI-NNR score was equal to 46.44 ± 2.30. The mean of Nordic score in overweight and obese participants was significantly higher than the individuals without overweight (P = 0.04). The NNR scores increased significantly with increasing age and energy intake.

Table 3 shows the mean dietary intakes and percentage of adherence to each component of the NNR. The mean consumption of each component is within the range of the recommendation for nearly all macronutrients, except of SFA + TFA and MUFA.

As you see in **Table 4**, no linear trend was found for BMI, WC and waist to hip ratio (WHR) through the HEI-NNR score, even after additional adjustment.

The odds ratios for AO, overweight, and obesity across NNR scores are shown in **Table 5**. In model 1, NNR score had a significant association with overweight and obesity (OR = 1.85, 95% CI = 1.15-2.96, P = 0.01). However, the association was not significant after adjusting for confounders.

We assessed the associations of BMI, WC and WHR, with NNR components to find out the effective factors (**Table 6**). Among the single HEI-NNR score components, higher consumption of fiber was associated with higher BMI and WC, but the association was not significant after adjusting for energy intake (data not shown).

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Table 1. Overview of Nordic nutrition recommendations

	Nordic nutrition recommendation (NNR)	
Macronutrients	**Recommended intake**	**Maximum score**
Total fat	25-35% of energy	5
Saturated + trans fat	Not more than 10% of energy	5
Monounsaturated fat	10-20% of energy	5
Polyunsaturated fat	5-10% of energy	5
Fiber	At least 25-35 g/day	10
Added sugar	Not more than 10% of energy	10
Total protein	10-20% of energy	10

Table 2. General characteristics of participants

Variables	**N**	**%**	**NNR-score**	**P-value[b]**
Age (y)				
≤ 33	147	50	46.07 ± 2.56[a]	0.007
> 33	147	50	46.85 ± 1.90	
Physical activity met.min/week)				
≤ 1651	147	50	46.20 ± 2.40	0.058
> 1651	147	50	46.69 ± 2.18	
Energy intake (kcal)				
≤ 2561	147	50	45.73 ± 2.67	0.0001
> 2561	147	50	47.16 ± 1.58	
Marital status				
Single	74	25.2	46.36 ± 2.58	0.38
Married	206	70.1	46.55 ± 2.11	
Widow/ divorced	14	4.8	45.29 ± 3.22	
Income (USD)				
≤ 1000	197	67	46.43 ± 2.33	0.69
> 1000	97	33	46.48 ± 2.25	
Health centers				
Torab and Sabaroo	51	17.3	47.14 ± 1.70	0.006
Nader and Saheb-zaman	135	45.9	46.48 ± 2.43	
Ahmadi, Khaje nezam-ol-molk and Zahra	48	16.3	45.57 ± 2.33	
Homayoun	60	29.4	46.47 ± 2.25	
Dogmechi Homayoun				
University education				
Yes	174	59.2	46.36 ± 2.42	0.63
No	120	40.8	46.56 ± 2.13	
Workout				
Never	60	20.4	46.53 ± 2.49	0.31
1 day/week	74	25.2	46.31 ± 2.18	
2 day/week	100	34.0	46.26 ± 2.38	
More than 2 day/week	60	20.4	46.83 ± 2.13	
Supplement				
Yes	113	38.4	46.29 ± 2.56	0.75
No	181	61.6	46.54 ± 2.13	
Current Smoking				
Yes	22	7.5	46.46 ± 1.91	0.72
No	272	92.5	46.44 ± 2.33	
Family history obesity				
Yes	94	32	46.42 ± 2.13	0.57
No	200	68	46.46 ± 2.38	
Body mass index (kg/m^2)				
< 18.5	5	1.7	46.72 ± 1.20	0.12
18.5 - 24.9	122	41.5	46.06 ± 2.62	

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Table 2. General characteristics of participants

Variables	N	%	NNR-score	P-value[b]
25 - 29.9	120	40.8	46.83 ± 2.04	
≥ 30	47	16	46.41 ± 2.02	
Abdominal obesity[c]				
Yes	108	36.7	46.50 ± 2.27	0.77
no	186	63.3	46.41 ± 2.33	
Abdominal obesity[d]				
Yes	84	28.6	46.50 ± 2.31	0.86
no	210	71.4	46.42 ± 2.31	
Overweight and obesity				
Yes	167	56.8	46.71 ± 2.03	0.04
no	127	43.2	46.09 ± 2.58	

[a]: mean±SD; [b]: Kruskal-Wallis Test; [c]: according to National Institutes of Health criteria; [d]: according to Iranian criteria

Table 3. Dietary intake and adherence to Nordic nutrition recommendation (adherence scores and % of adherence)

Macronutrients	Intake	Adherence score	Adherence (%)
Total fat (% of energy)	35.49 ± 6.11	4.67 ± 0.42 [a]	44.6
Saturated + trans fat ((% of energy)	11.73 ± 3.17	4.27 ± 0.76 [a]	32.3
Monounsaturated fat ((% of energy)	7.85 ± 2.84	3.72 ± 1.01 [a]	17.3
Polyunsaturated fat ((% of energy)	8.75 ± 3.10	4.65 ± 0.57 [a]	61.2
Fiber (g/day)	40.73 ± 27.94	9.30 ± 1.45	74.1
Added sugar ((% of energy)	2.86 ± 2.56	9.95 ± 0.35	98.3
Total protein ((% of energy)	16.13 ± 3.60	9.85 ± 0.49	85.4
Total energy intake (kcal/day)	2818.60 ± 1188.60	-	-

[a]: maximum score was 5 whereas for the rest of the components the maximum score was 10.

Table 4. Adherence to Nordic nutrition recommendation (measured by the HEI) and anthropometric indices

Anthropometric indices	Body mass index (kg/m^2)		Waist circumference (cm)		Waist to hip circumference	
	B	95% CI	B	95% CI	B	95% CI
Nordic nutrition recommendation score						
Model 1[a]	0.12	-0.11-0.36	0.20	-0.38-0.79	9.21	-0.005-0.005
Model 2[b]	-0.05[c]	-0.28-0.18 [c]	-0.28	-0.70-0.13	-0.003	-0.007-0.002

[a]: model 1: Linear regression Crude model; [b]: model 2: Linear regression model adjusted for age, Energy intake, Body mass index, total physical activity, health center, marital status, income, university education; [c]: Linear regression model 2 without adjusted for Body mass index.

Table 5. Odds ratios (95% confidence intervals) for abdominal obesity, overweight and obesity across Nordic nutrition recommendation scores

Weight status	Overweight and obesity (n=167)		Abdominal obesity[a] (n=108)		Abdominal obesity[b] (n=84)	
	Odds	95% CI	Odds	95% CI	Odds	95% CI
Nordic nutrition recommendation score						
Model 1[c]	1.85	1.15-2.96	1.13	0.70-1.82	1.18	0.71-1.97
Model 2[d]	1.43	0.92-1.17	0.89	0.46-1.73	0.91	0.46-1.80

[a]: according to National Institutes of Health criteria; [b]: according to Iranian criteria; [c]: model 1: binary logistic crude model; [d]: model 2: binary logistic model adjusted for age, Energy intake, Body mass index, total physical activity, center, marital status, income, university education

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Table 6. Association of single NNR component scores with anthropometric indices

Anthropometric indices	Body mass index (kg/m^2)		Waist circumference (cm)		Waist to hip circumference	
	Odds	95% CI	Odds	95% CI	Odds	95% CI
Total fat	-0.96	-2.27-0.34	-3.15	-6.33-0.02	-0.008	-0.03-0.01
Saturated + Trans fats	-0.20	-0.94-0.53	-1.13	-2.91-0.64	-0.006	-0.02-0.008
Monounsaturated fats	-0.31	-0.87-0.23	-1.12	-2.46-0.21		
Polyunsaturated fats	-0.55	-1.53-0.42	-1.39	-3.77-0.98	-0.01	-0.03-0.007
Fiber	0.62	0.24-1.00	1.70	0.78-2.61	0.007	-0.001-0.01
Added sugar	-0.46	-2.06-1.12	-1.53	-5.41-2.35	0.007	-0.02-0.03
Total Protein	0.81	-0.32-1.94	2.07	-0.68-4.83	0.01	-0.008-003

Discussion

To the best of our knowledge, this is the first study to investigate the association of NNR with anthropometric indices in the Middle East. The mean of Nordic score in overweight/obese subjects was significantly higher than subject without overweight. A significant positive association was found between NNR score and overweight/ obesity, but the association was not significant after adjustment for age, BMI, and energy intake. Furthermore, we could not determine any association between NNR and AO.

Several randomized controlled trials (RCT) showed an inverse association between the ND and changes in anthropometric measures (Adamsson *et al.*, 2011, Poulsen *et al.*, 2015, Poulsen *et al.*, 2013).

In two large cohort studies (Li *et al.*, 2015, Roswall *et al.*, 2014), adherence to NDS was not associated with changes in body weight or WC, which is in line with our findings. In some previous studies, adherence to NNR had a beneficial effect on AO (Kanerva *et al.*, 2013) and weight loss (Darwiche *et al.*, 2016). These findings could be caused by intake of modifying carbohydrate, unsaturated fatty acids, and dietary fiber, which are important modifiers for lipid-related disorders, including obesity and pathological changes in the gastrointestinal tract (Mooradian *et al.*, 2008). In NNR, the recommended amount of total fat is up to 30%. A report showed that those who succeeded in weight loss and survival had the principle of reducing fat intake to 30% daily (Foreyt and Goodrick, 1991). Another recommendation for NNR 2012 is fatty acids. In studies over the role of unsaturated fatty acids on health, an inverse relationship was observed between PUFA and obesity, especially abdominal obesity (Ghosh *et al.*, 2003, Hosseinpour-Niazi *et al.*, 2012, Summers *et al.*, 2002). Generally, intake of omega-3 increases adiponectin and leptin hormones that suppress appetite (Krebs *et al.*, 2006, Pérez-Matute *et al.*, 2007) and reduce energy intake consequently. Furthermore, MUFA prevents abdominal obesity by stimulating the accumulation of fat in the peripheral regions and inhibition of fat accumulation in the abdominal areas, while consumption of saturated fatty acids is associated with fatty accumulation in the abdominal areas (Due *et al.*, 2008).

Moreover, dietary fiber and whole grain; lead to weight loss or weight control and WC maintenance (Bes-Rastrollo *et al.*, 2006). Dietary fibers reduce calorie intake (Bes-Rastrollo *et al.*, 2006), decrease nutrient absorption (Koopman and van Loon, 2009), aid in early signals of satiation (Buijsse *et al.*, 2009), and reduce transit time (Cuthbertson *et al.*, 2005).

However, NNR had no relationship with anthropometric and abdominal obesity in the present study. One of the effective factors in overweight and obesity is energy intake, which is not considered in NNR score. The other limitation of NNR score is not considering the non-essential micronutrients and nutrients. The other possible reasons include the relatively low proportion of NNR components (MUFA, SFA + trance and total fat) in women of this study. Another reason is that dietary patterns are only evaluated based on dietary intake in the present study.

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The FFQ administered in this study measures the habitual diet over the last 12 months, while obesity is generated over several years. In general, obese people may resort to the healthy foods and eating patterns to lose weight or prevent obesity. Therefore, they pursue NNR components more than the individuals with normal weight and low weight.

Another explanation can indicate that assessment of the diet by FFQ may have bias. In other words, overestimating consumption of healthy food and under-reporting intake of "unhealthy" foods are likely more common among overweighting women (Nielsen *et al.*, 2009, Olafsdottir *et al.*, 2006).

This research has several strengths; initially, this is the first study over the association of NNR with AO outside the Nordic region. Second, all demographic and lifestyle confounders were considered and all analyses for these factors were adjusted, which reduced the probability of residual confounding bias. Third, the participation rate was high (> 90%), which reduces the probability of selection bias in the present study.

However, several limitations are also inherent in the present study. Given the cross-sectional design of this study, no causal relationship can be inferred. Other limitations include the small sample size and possibility of recall bias, including under/over reporting of specific foods.

Conclusions

This cross-sectional study shows that adherence to the NNR was not significantly associated with BMI, WC, or WHR. Future evidences are required from RCT and prospective cohort studies to confirm these findings.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' contribution

Latifi A, Rezazadeh A and Rashidkhani B developed the theoretical formalism, performed the analytic calculations and performed the numerical simulations. Latifi A, Rezazadeh A, Rashidkhani B and Shahvegharasl Z contributed to the final version of the manuscript. Rashidkhani B supervised the project.

Conflict of interest

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