RESEARCH ARTICLE

The Modified Alternate Healthy Eating Index-2010 and Breast Cancer Risk among Women from Karachi, Pakistan

Uzma Shamsi[1], Tiffany Gill[2], Shaista Khan[3], Iqbal Azam[4], David Callen[5], Romaina Iqbal[6]

Abstract

Objective: To determine any relationship of diet with breast cancer risk.

Methods: The case-control study was conducted at Aga Khan University Hospital and the Karachi Institute of Radiation and Nuclear Medicine, Karachi, from February 2015 to July 2017, and comprised of cases with a confirmed diagnosis of breast cancer and healthy controls. Data was collected using the Alternate Healthy Eating Index 2010, which was modified according to the particular cultural patterns of diet in the Pakistani population. Data was analysed using SPSS 21.

Results: Of the 1124 subjects, 374(33.3%) were breast cancer cases and 750(66.7%) were controls. High intake of grains, both whole and refined including white rice, was associated with breast cancer (odds ratio: 2.53; 95% confidence interval: 1.69-3.79; $p<0.001$). There was no association of breast cancer with Alternate Healthy Eating Index 2010 score (odds ratio: 1.85; 95% confidence interval: 0.61-1.17; $p=0.291$).

Conclusions: There was found a need for awareness of a healthy diet based on more of whole grains and brown rice replacement with refined grains and white rice, respectively. Limiting refined carbohydrate intake might be a useful public health message and may reduce breast cancer incidence in the long term.

Keywords: Diet, AHEI-2010, Grains, Breast cancer. (JPMA 71: 1289; 2021) **DOI: https://doi.org/10.47391/JPMA.01276**

Introduction

Breast cancer remains the world's most prevalent cancer and although 5-year survival in high-income countries (HICs) is >90%, it is as low as 66% in India and 40% in South Africa.[1,2] Reproductive and hormonal factors are well-known causes of breast cancer, while sedentary lifestyle and unhealthy diet may also increase breast cancer risk by up to 40%.[3] Several behavioural interventions are recommended by the World Health Organisation (WHO) to reduce the risk of developing breast cancer. These include prolonged breastfeeding, regular physical activity, weight control, avoidance of harmful use of alcohol, tobacco, prolonged use of hormones and excess radiation exposure.[1,2] Several nutrition epidemiological studies have been recently published assessing the role of diet as a modifiable risk factor in breast cancer.[3] However, the role of diet in breast cancer incidence remains inconsistent in different epidemiological studies. A contributing factor to these variable findings may be the challenging nature of dietary assessments.

Eating indices assess diet quality in individuals using a structured scoring scale. Commonly used eating indices include the Healthy Eating Index-2010 (HEI-2010) and the Alternate Healthy Eating Index-2010 (AHEI-2010). The HEI-2010 was developed to measure diet quality according to the recommendations made by federal dietary guidelines for Americans. The HEI-2010 has components including fruits, vegetables, grains, dairy products, total and plant protein foods, refined grains, sodium and empty calories.[4] Each component is given a score and the score confers diet quality.

The AHEI-2010 is a standardised a priori data analysis tool originally developed to characterise overall dietary patterns associated with low chronic disease risk. It is a validated questionnaire, derived and modified from the original HEI-2010, to assess healthy diet quality and is based on servings of a particular food group per day.[5]

AHEI-2010 includes nine components and the score ranges from 2.5 (lowest) to 87.5 (highest).[5] For healthy components like fruits and legumes, the intake levels corresponding to the highest decile receive a score of +10, whereas intakes corresponding to the lowest decile receives a score of +1. Conversely, food group intakes like red meat, intakes found in the highest decile receive a score of +1 versus intakes found in the lowest decile receiving a maximum score of +10. The AHEI-2010 is about twice as strong as the HEI-2010 at predicting chronic disease.[5]

Despite the high incidence of breast cancer (age-standardised rate [ASR]: 51.7 per 100,000), literature

[1,4,6]Department of Community Health Sciences, Aga Khan University, Karachi, Pakistan; [2,5]School of Medicine, University of Adelaide, Australia; [3]Department of Surgery, Aga Khan University, Karachi, Pakistan.
Correspondence: Uzma Shamsi. e-mail: uzma.shamsi@adelaide.edu.au

regarding the role of diet in breast cancer, specifically in Pakistan, is lacking.[6] The current study was planned to assess the association of the modified AHEI-2010 and its component scores with breast cancer risk among Pakistani women.

Materials and Methods

The case-control study was conducted at Aga Khan University Hospital (AKUH) and the Karachi Institute of Radiation and Nuclear Medicine (KIRAN), Karachi, from February 2015 to July 2017. Another aspect of the study has been published previously.[7] The ethical approval or the study was obtained by the ethics review committees (ERCs) of the two institutions, but also from the ERC of the University of Adelaide, Australia. The cases were women aged 18-75 years with a biopsy-proven confirmed diagnosis of breast cancer. Controls were individually matched both to hospital and age (±5 years) and were selected from the outpatient departments (OPDs) of the two hospitals.

Dietary intake was assessed by individual interviews of the cases and the controls using the validated food frequency questionnaire (FFQ).[8] A pretest was conducted on 50 participants. Several food items were added to the study during the pretesting of the FFQ and their relevance to breast cancer risk.

For both cases and controls, dietary history was the average diet consumed in the preceding year. After informed consent was obtained, the study participants were interviewed and asked in detail about their diet.

Intake frequency was categorized into 7 groups, ranging from "never" to "5-6 times per day" for foods and for beverages, and the daily intake was calculated for each food item. Each participant was also asked about their average portion size of the food. A standard serving (SVG) size of a food item or beverage, according to FFQ is 1 plate of pulses or 1 cup of milk or one egg, or natural unit such as one apple.[8] The intake frequencies were multiplied by SVG to calculate servings per day of all food items.

The AHEI-2010 tool was modified in line with dietary behaviours particular to the adult population in Karachi. After discussion with a nutrition researcher and a biostatistician to categorise specific dietary groups, 6 components were utilised and the score ranged 0-10 points. The 6 components included were fruits, vegetables, dairy, grains, ratio between white meat and red meat, and plant proteins. Alcohol, multivitamins, sodium, and fat were excluded from the original AHEI-2010.[5] Alcohol was eliminated due to its prohibition in Pakistan. Nutrient analysis was not done in this study, and, as such, sodium and fat components were also excluded. The AHEI-2010 variables and scoring patterns were altered, as in the case of plant proteins where >2 serving per day was considered ideal instead of 1 serving per day in the original AHEI-2010.

The 6 highest intake components of AHEI-2010 were considered ideal; vegetables, fruit, grains, ratio between white and red meat, dairy, and plant proteins, including nuts and legumes. The counts were merged and summed up for all vegetables to create a total vegetable SVG per day. A higher score was given for a greater intake of vegetables; 10 points for 5+ SVG/day; 0 points for no SVG/day. Similarly, all the reported fruits were summed up to calculate total fruits per day; 10 points for 4+ SVG/day; 0 points for no SVG/day. Higher scores were assigned for consuming more white meat than red meat. The ratio of white-to-red meat was scored as 10 points for 4:1 ratio and 0 points for '0'. A separate component for non-meat protein or plant sources of proteins, like nuts, beans and pulses, was created; 10 points for 2+ SVG/day and 0 points for no SVG/day. For grains, all food items, like chappati, naan, puri, paratha, fried and boiled rice and biryani, were summed up to create total grains servings per day; 10 points for 5+ SVG/day and 0 points for no SVG/day. The difference between whole grains and refined or processed grains could not be worked out due to the lack of information on the use of whole or processed grains in the questionnaires, and, as such, captured only the total of grains. All individual component scores were summed for a total modified AHEI-2010 score, ranging from 0=lowest to 60=highest.

Height and weight were recorded from the medical files of each subject and body mass index (BMI) was calculated. Socioeconomic status (SES) was also noted and divided into three categorical variables. Factor analysis was used to calculate a composite variable from different variables and it was further categorised into three SES groups.

Data was analysed using SPSS 21. Categorical variables were reported as frequencies and percentages. Continuous variables were described as mean with standard deviation (SD). Conditional logistic regression was used to calculate matched odds ratio (OR) with 95% confidence intervals (CIs) to assess association between breast cancer and the modified AHEI-2010 total and component scores, adjusting for the potential confounders, like BMI, SES and menopausal status. Modified AHEI-2010 scores were analysed in tertiles. Trend test was carried out to assess dose-response relationships between the score tertiles and breast cancer risk. $P<0.05$ was considered statistically significant.

Results

Of the 1184 subjects enrolled, 1124(95%) completed the

Table-1: Mean intake of modified Alternate Healthy Eating Index-2010 (AEHI-2010) dietary components.

	Food items as serving per day	Controls (n= 750) Mean±SD	Breast cancer cases (n= 374) Mean±SD	*p value
1A	Components of modified AHEI Score-2010			
	Grains (whole)	2.85±1.61	3.41±1.97	<0.001
	Dairy (cup)	1.63±1.49	1.66±1.47	0.93
	Red meat (plate)	0.46±0.78	0.48±0.83	0.55
	White meat (plate)	0.58±0.86	0.58±1.03	0.97
	White Meat to Red Meat Ratio	3.39±5.60	3.23±5.18	0.43
	Plant Protein (plate)	2.86±1.14	2.89±1.15	0.77
	Fruits (whole)	1.22±1.68	1.34±1.84	0.44
	Vegetables (plate)	3.00±2.54	2.99±2.59	0.95
1B	Grains			
	Chapatti (whole)	2.20±1.35	2.63±1.65	<0.001
	Paratha (whole)	0.16±0.25	0.14±0.2	0.51
	Naan (whole)	0.32±0.72	0.47±0.91	0.01
	Puri (whole)	0.24±0.75	0.28±0.93	0.27

*t-test of independence

study; 374(33.3%) cases and 750(66.7%) controls. The mean intake of different food items for both the cases and the controls were assessed (Table 1).

The overall mean modified AHEI-2010 score was 35.1±7.64. The mean score of the cases was 35.5±7.61 and that of the controls was 34.8±7.34). Tertiles were then calculated for the AHEI-2010 score, and the association between demographic and other characteristic variables was assessed among the cases and the controls (Table 2).

There was no association of breast cancer with AHEI score (OR: 1.85; 95% CI: 0.61-1.17; p=0.291). High scores on the grains component were associated with a higher risk of breast cancer (OR: 2.53; 95% CI: 1.69-3.79; p<0.001) (Table 3).

Discussion

The findings did not show any protective association of a higher modified AHEI-2010 score against breast cancer in patients from AKUH and KIRAN hospitals in Karachi. There was a positive association between increased grain intake and breast cancer. This was contrary to the initial hypothesis as a higher AHEI-2010 score portends better diet quality and decreased risk of co-morbid conditions.

There are several possible reasons why a protective association was not observed. Firstly, the original AHEI-2010 was developed on the basis of nutritional recommendations for Americans which may not be suitable for a Pakistani population. AHEI-2010 has been

Table-3: Odds ratio (OR) and 95% confidence intervals (CIs) of breast cancer in women according to modified Alternate Healthy Eating Index-2010 (AHEI-2010) score tertiles.

Modified AHEI-2010 score tertile	OR*95 % CI	p-value
Lowest tertile	1(ref)	0.291
Middle tertile	1.08 (0.81, 1.48)	
Highest tertile	0.85 (0.61, 1.17)	

*Adjusted for BMI menopausal status and SES, OR: Odds ratio, CI: Confidence interval.

Table-2: Participant characteristics described in tertiles of modified Alternate Healthy Eating Index-2010 (AHEI-2010) score.

Category	Modified AHEI Score 2010 Lowest Tertile1 n (%)	Modified AHEI Score 2010 Middle Tertile2 n (%)	Modified AHEI Score 2010 Highest Tertile3 n (%)	p-value
Hospital				0.001
AKUH	193 (47.9)	180(49.2)	216(60.8)	
KIRAN	210(52.1)	186(50.8)	139(39.2)	
Age groups (years)				0.78
<35	64(15.9)	58(15.8)	62(17.5)	
35-44	117(29.0)	110(30.1)	110(31.0)	
45-54	128(31.8)	104(28.4)	93(26.2)	
55 & above	94(23.3)	94(25.7)	90(25.4)	
Education				0.21
< grade 8	122(30.3)	99(27.0)	81(22.9)	
grades 8-12	130(32.3)	122(33.3)	119(33.6)	
> grade 12	150(37.3)	145(39.6)	154(43.5)	
Marital status				0.15
single/widow/divorced	88(21.8)	78(21.3)	59(16.6)	
married	315(78.2)	288(78.7)	296(83.4)	
Socioeconomic Status				0.004
upper	48(12.0)	51(14.3)	44(12.5)	
middle	211(52.6)	196(54.9)	226(64.4)	
lower	142(35.4)	110(30.8)	81(23.1)	
Parity				0.65
nulliparous	54(13.4)	57(15.6)	51(14.4)	
< 3	187(46.4)	164(44.8)	176(49.6)	
> 3	162(40.2)	145(39.6)	128(36.1)	
Menopausal status				0.91
Postmenopausal	204(51.3)	181(49.9)	181(51.3)	
Premenopausal	194(48.7)	182(50.1)	172(48.7)	
Diabetes mellitus	62(15.4)	56(15.3)	44(12.4)	0.42
Any other comorbid	191(47.4)	185(50.5)	163(46)	0.46
Serum Vitamin D level				0.87
< 20 ng/mL	178(60.5)	162(59.1)	161(59.2)	
20 - 30 ng/mL	52(17.7)	50(18.2)	43(15.8)	
> 30 ng/mL	64(21.8)	62(22.6)	68(25.0)	

Modified AHEI 2010 Score Lowest tertile1 mean (SD) 27.3(4.20), Middle tertile2 mean (SD) 35.5(1.6), Highest tertile3 mean (SD) 43.5(3.7); AKUH: Aga Khan University Hospital, KIRAN: Karachi Institute of Radiation and Nuclear Medicine.

Table-4: Association of modified Alternate Healthy Eating Index02010 (AHEI-2010) dietary component score and breast cancer.

Component of modified AHEI -2010 score**	OR*	95% CI	p-value
Grains	2.53	1.69, 3.79	<0.001
Dairy	1.10	0.79, 1.52	0.63
Fruits	1.22	0.62, 2.40	0.81
Vegetables	1.41	0.95, 2.10	0.37
White red meat ratio	0.97	0.68, 1.41	0.81
Plant proteins	1.03	0.67, 1.60	0.96

*Adjusted for socioeconomic status, BMI and menopausal status; **Reference is a lower component score; OR: Odds ratio, CI: Confidence interval.

inversely associated with cancers of gastrointestinal tract (GIT) like colorectal carcinoma, pancreas, and oesophagus. However, a published meta-analysis showed that there was no association between AHEI-2010 and risk of breast cancer mortality among women with breast cancer.[9] Similarly, the Nurses' Health Study (NHS) cohort (1984 to 2006) showed no association between the AHEI-2010 and risk of breast cancer by molecular subtype.[10]

Moreover, the types of food included for some dietary components were also different from the original AHEI-2010, particularly with regard to grains, that is, based on total grains and not whole grains only. Assessment of diet by this scoring index is further limited by the location of the study population. It has been reported that the predictive ability of the score also varies widely across countries. If such scores are used, they should be modified and validated to local circumstances and recalibrated in particular populations.[11] For example, Pakistani grains and rice are commonly cooked locally using excessive oil or fat which may contribute to high-fat content. This may not be the case in other populations.

The positive association between patients with newly-diagnosed breast cancer and grains component of modified AHEI-2010 score was an unexpected finding, but can be explained by multiple factors. It has been confirmed that the Pakistani population consumes very high carbohydrate diets mainly from refined sources.[8] According to the Household Integrated Economic Survey (HIES) 2015-16, per capita monthly consumption of wheat and wheat flour was the highest (7.26kg) of carbohydrates.[12] A similar association of high starch / carbohydrate intake (>60% of energy) with total mortality was found in a large prospective cohort study from 18 countries.[13] Results of a study in Jordan also showed an association between higher consumption of refined grains and colorectal cancer (CRC) risk.[14] A systematic review of Europe and North America did not appreciate this association.[15] Whole-grain consumption, on the other hand, particularly whole-grain wheat, has been reported to be protective against oesophageal cancer[16] and several neoplasms, including GIT and breast.[17]

Additional studies have resulted in conflicting evidence with regards to grain consumption and breast cancer risk. Several studies showed that high whole grain consumption was associated with lower breast cancer risk among all women, including premenopausal women.[18,19] However, in the Nurses' Health Study II, there was no association observed between grain food intake and breast cancer.[20] Another study reported lack of any protective effect of a healthy dietary index against breast cancer in British women.[21] In summary, the role of grain intake in breast cancer risk is inconsistent in the literature.

Some studies have shown that carbohydrate quality rather than quantity of intake may be important in breast cancer risk. A plausible biological explanation in relation to breast cancer is that dietary carbohydrate quality affects serum insulin levels, and, thus, promote breast cancer growth in the presence of insulin resistance (IR).[22] Another possible explanation for the positive association between higher scores of grains and breast cancer could be the potential pollution of grains by industrial wastes, which contaminate rice and flour with certain carcinogens, like aflatoxins.[23]

The current study did not support a protective effect of intake of fruits, vegetables, and plant proteins with breast cancer which was also reported in a European study.[24] However, the effects of different fruits and vegetables may have been diluted by combining fruits and vegetables into a single dietary component.

The main strength of this study is that all the data was collected by trained clinician researchers which allowed for precision of data collection and analysis. In addition, a high proportion (95%) of participants completed the FFQ. To our knowledge, this case-control study, consisting of a representative sample of women visiting private as well as public hospitals of Karachi, is the first to investigate a potential association of diet with breast cancer in Pakistani women.

However, there are also several limitations to the study. The first is the inability to differentiate between intake of refined and whole grains and to adequately capture the dietary grains component. The modified AHEI-2010 component scores gave points for all grains whereas the original AHEI-2010 scores whole-wheat bread/grains separately. This scoring difference may explain how the category score in the current study was positively associated with breast cancer contrary to other published literature.[20,21] In addition, the AHEI-2010 is not validated in the Pakistani population, thus making comparisons difficult. Measurement error is also a limitation as patients self-reported their diet from memory. Another weakness is the inability to assess all the food items and portion sizes accurately. Like all case-control studies, there are biases related to the temporality and exposure misclassification caused by differential recall by cases. Data-collectors were trained to collect dietary information from cases and controls in a similar way in order to minimise the possibility of bias. Furthermore, the time period of exposure is also critical in breast cancer epidemiological studies with prolonged latency period. The current study only asked participants about the year preceding the diagnosis.

Further large population-based studies are recommended with respect to breast cancer to identify any modifiable risk factors. Also, nutrition studies are required to better understand the role of healthy eating habits for breast cancer prevention.

Conclusion

There was found a need for awareness of a healthy diet based on more of whole grains and brown rice replacement with refined grains and white rice, respectively. Limiting refined carbohydrate intake might be a useful public health message and may reduce breast cancer incidence in the long term.

Acknowledgement: We are grateful to Dr Ayesha Ali, Resident, Radiation Oncology, Thomas Jefferson University Hospital, Philadelphia, PA, USA, for editing and revising the manuscript.

Disclaimer: The manuscript was earlier submitted to the website of Karachi American School (KAS) for plagiarism checking on its Turnitin programme. The current overlapping of 86% in the Turnitin report is because the earlier submission has not been removed from the KAS website due to some error. The submitted manuscript at both the KAS and the JPMA is the same.

Conflict of interest: None.

Source of Funding: The Dean's Fund, Aga Khan University Hospital, Karachi.

References

1. WHO Technical Report Series. Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation. World Health Organization. Geneva: 2003
2. WHO. Breast Cancer. [Online] [Cited 2021 July 6]. Available from: URL: https://www.who.int/news-room/fact-sheets/detail/breast-cancer.
3. Ross SA. Evidence for the relationship between diet and cancer. Exp Oncol 2010; 32: 137-42.
4. Guenther PM, Reedy J, Krebs-Smith SM. Development of the Healthy Eating Index-2005. J Am Diet Assoc 2008; 108: 1896-901.
5. McCullough ML, Willett WC. Evaluating adherence to recommended diets in adults: the Alternate Healthy Eating Index. Public Health Nutr 2006; 9: 152-7.
6. Bhurgri YB, A Hassan SH, Zaidi SH, Rahim A, Sankaranarayanan R, Parkin DM. Cancer incidence in Karachi, Pakistan: first results from Karachi Cancer Registry. Int J Cancer 2000; 85: 325-9.
7. Shamsi U, Khan S, Azam I, Habib Khan A, Maqbool A, Hanif M, et al. A multicenter case control study of association of vitamin D with breast cancer among women in Karachi, Pakistan. PLoS One 2020; 15: e0225402.
8. Safdar NF, Bertone-Johnson E, Cordeiro L, Jafar TH, Cohen NL. Dietary patterns of Pakistani adults and their associations with sociodemographic, anthropometric and life-style factors. J Nutr Sci 2014; 2: e42.
9. Horn J, Opdahl S, Engstrom MJ, Romundstad PR, Tretli S, Haugen OA, et al. Reproductive history and the risk of molecular breast cancer subtypes in a prospective study of Norwegian women. Cancer Causes Control 2014; 25: 881-9.
10. Hirko KA, Willett WC, Hankinson SE, Rosner BA, Beck AH, Tamimi RM, et al. Healthy dietary patterns and risk of breast cancer by molecular subtype. Breast Cancer Res Treat 2016; 155: 579-88.
11. Lassale C, Gunter MJ, Romaguera D, Peelen LM, Van der Schouw YT, Beulens JW, et al. Diet Quality Scores and Prediction of All-Cause, Cardiovascular and Cancer Mortality in a Pan-European Cohort Study. PLoS One 2016; 11: e0159025.
12. Household integrated economic survey (HIES). Government of Pakistan Statistics Division Pakistan Bureau of Statistics Islamabad; 2015-2016.
13. Mente A, Dehghan M, Rangarajan S, McQueen M, Dagenais G, Wielgosz A, et al. Association of dietary nutrients with blood lipids and blood pressure in 18 countries: a cross-sectional analysis from the PURE study. Lancet Diabetes Endocrinol 2017; 5: 774-87.
14. Tayyem RF, Bawadi HA, Shehadah I, Agraib LM, Al-Awwad NJ, Heath DD, et al. Consumption of Whole Grains, Refined Cereals, and Legumes and Its Association With Colorectal Cancer Among Jordanians. Integr Cancer Ther 2016; 15: 318-25.
15. Makarem N, Nicholson JM, Bandera EV, McKeown NM, Parekh N. Consumption of whole grains and cereal fiber in relation to cancer risk: a systematic review of longitudinal studies. Nutr Rev 2016; 74: 353-73.
16. Skeie G, Braaten T, Olsen A, Kyro C, Tjonneland A, Landberg R, et al. Intake of whole grains and incidence of oesophageal cancer in the HELGA Cohort. Eur J Epidemiol 2016; 31: 405-14.
17. La Vecchia C, Chatenoud L, Negri E, Franceschi S. Session: whole cereal grains, fibre and human cancer wholegrain cereals and cancer in Italy. Proc Nutr Soc 2003; 62: 45-9.
18. Farvid MS, Cho E, Eliassen AH, Chen WY, Willett WC. Lifetime grain consumption and breast cancer risk. Breast Cancer Res Treat 2016; 159: 335-45.
19. Mourouti N, Meropi D, Papavagelis C, Psaltopoulou T, Kapetanstrataki MG, Plytzanopoulou P, et al. Whole Grain Consumption and Breast Cancer: A Case-Control Study in Women. J Am Coll Nutr 2015; 35: 143-9.
20. Farvid MS, Cho E, Eliassen AH, Chen WY, Willett WC. Lifetime grain consumption and breast cancer risk. Breast Cancer Res Treat 2016; 159: 335-45.
21. Cade JE, Taylor EF, Burley VJ, Greenwood DC. Does the Mediterranean dietary pattern or the Healthy Diet Index influence the risk of breast cancer in a large British cohort of women? Eur J Clin Nutr 2011; 65: 920-8.
22. Gupta K, Krishnaswamy G, Karnad A, Peiris AN. Insulin: a novel factor in carcinogenesis. Am J Med 2002; 323: 140-5.
23. Lutfullah G, Hussain A. Studies on contamination level of aflatoxins in some cereals and beans of Pakistan. Food control 2013; 23: 32-6.
24. van Gils CH, Peeters PH, Bueno-de-Mesquita HB, Boshuizen HC, Lahmann PH, Clavel-Chapelon F, et al. Consumption of vegetables and fruits and risk of breast cancer. JAMA 2005; 293: 183-93.