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Original article

Association of Healthy Eating Index and the Alternative Healthy Eating Index with the cell blood count indices

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Abstract. *Objectives:* There is an association between diet quality and markers of inflammation. We aimed to investigate the relationship between diet quality with complete blood count (CBC) and inflammatory indices such as red cell distribution width (RDW) and white blood cell count (WBC). *Study Design:* A total of 367 male subjects aged 20-69 yrs, who were employees of Shahid Hasheminejad Gas Processing Company (SGPC) completed the study. *Methods:* All participants completed a questionnaire that contained questions about demographic factors. Standard protocols were used for measuring anthropometric indices in all subjects. Blood samples were collected after a 12 hrs fast from all participants. Biochemical parameters were determined in all participants using an auto-analyzer (Eppendorf, Germany). Systolic and diastolic blood pressure were measured using a standard mercury sphygmomanometer. CBC was measured using the Sysmex auto analyser system (KX-21 N). The HEI/AHEI scores extracted from a validated food frequency questionnaire (FFQ) to evaluate the diet quality. Data analyses were performed using SPSS 16 (SPSS Inc., IL, and USA). *Results:* A total of 367 men (aged 43.68±9.09 yrs) completed the study. The CBC indices were not significantly different between the HEI/AHEI classifications among the Iranian men (p-value >0.05 for all variables). Moreover, there was no association between HEI/ AHEI with the CBC indices in our population (p-value >0.05 for all variables). *Conclusions:* In summary, there was no association between the diet quality with the cell blood count parameters among Iranian men.

Key words: Cell blood count, diet quality, healthy eating index, inflammation, CBC

Introduction

The Healthy Eating Index (HEI) and Alternative Healthy Eating Index (AHEI) are known as dietary indices which can be used to assess dietary patterns. HEI has been constructed to reflect the evidence-based recommendations of the Dietary Guidelines for Americans (DGA) and to evaluate conformance to these recommendations (1). The AHEI is an alternative to the US Department of Agriculture's (USDA's) of HEI. It assesses the compliance of participants with consuming selected foods and nutrients that are associated with a low risk of chronic disease in clinical and epidemiological studies. AHEI includes some aspects of the HEI, but also provides a score for the USDA qualitative recommendations. For example, the AHEI

contains a certain number of privileges for consuming more fish, poultry, and whole grains (2).

Cell blood count (CBC) assesses several hematological parameters, that include some indicators of a pro-inflammatory state (3). This assessment includes counting some morphological features of erythrocytes (RBC), leukocytes (white blood cell; WBC) and thrombocytes (platelets) in 1 mm^3 of blood.

There is an association between a healthy diet and biomarkers of inflammation and oxidative balance (4, 5), immune function and inflammation in obese women (6, 7). Moreover, there is a positive relationship between a healthy diet and higher levels of hemoglobin (Hb), and vice versa, people who have an inappropriate diet have a lower hemoglobin level (8, 9). Consumption of nutrient-rich foods is associated with a lower chance of moderate anemia (based on Hb) (10).

Studies have been done on diet quality and their association with blood cell count, but more research is needed. Therefore, the purpose in this study was to investigate the relationship between diet quality and CBC and inflammatory indices such as red cell distribution (RDW) and WBC count.

Methods

Ethics

Written information was provided to all participants and written consent provided by all participants recruited in the study. The study protocol was approved by National Institute for Medical Research Development (NIMAD), Iran. A total of 367 males (aged 20–69 yrs) recruited in current study, who were employees of Shahid Hasheminejad Gas Processing Company (SGPC), Sarakhs, Iran. Inclusion and exclusion criteria are explained in details, previously (11).

Demographic and Anthropometric Measurements

All participants completed a questionnaire that contained questions on medical history, socio-demographic status, employment status, smoking habits, alcohol consumption and exercise. The questionnaire was administered by experienced interviewees who had seen the required training. Standard protocols were used for measuring waist circumference, weight, body mass index (BMI), height and percentage body fat using a bio-impedance analysis (BIA) (TANITA BC-418).

Blood Sampling

Blood samples were collected in plastic tubes in the morning after subjects had fasted for 12 hours. Haemolysed samples were not included in the analysis. Serum was separated from blood samples by centrifuge with 10000 rpm for 15 min and serum was kept in the form of frozen at -80°C for using in the analysis.

Measurements

Biochemical parameters were measured for each of participants using an auto-analyzer (Eppendorf, Germany). Systolic and diastolic blood pressure was measured using a standard mercury sphygmomanometer and standard method, on the left hand in the sitting position after 15 minutes resting. CBC was measured using the Sysmex auto analyser system (KX-21 N).

Diet quality assessments

The HEI/AHEI scores were extracted from a food frequency questionnaire (FFQ), which is applied to evaluate the diet quality. This short 65-items FFQ is validated for use in Iranian adults and prepares data on dietary intakes of the participants over the past year (12). The latest HEI version, "HEI 2010", was used in current study. Its components are defined in 12 categories with the min and max scores from 0 to 10. Taking better from each dietary group, assigns the higher score to each category. Consequently, the specific useful index based on the HEI criteria scoring system can be individually attained for every participant. The higher HEI scores, which ranges from 0 to 100, indicate greater conformance to the US Federal dietary guidelines. Moreover, the AHEI as an alternative to the HEI, were established by McCullough et al., (13), which contains the food groups associated with chronic diseases. The AHEI scored from 0 (worst) to 10 (best) and the total AHEI-2010 score ranged from 0 (nonadherence) to 110 (perfe for a period of one year ago ct adherence) (13-15).

Statistical analysis

Data analyses were performed using SPSS 16 (SPSS Inc., IL, and USA). The Kolmogorov-Smirnov

test was applied to assess the normality of distribution. Descriptive statistics including mean, frequency and standard deviation (SD) were determined for all variables and were expressed as mean ± SD for normally distributed variables (or as median and IQR for not normally distributed variables). The Spearman's test was used to investigate the relationship between HEI/AHEI scores and normal quantitative variables. A p-value of less than 0.05 was considered as statistically significant.

Results

A total of 367 men (aged 43.68±9.09 yrs) completed the study. The essential features of the participants has been shown in Table 1. Table 2 summarizes the data for the CBC indices in the HEI/AHEI categories among the study population. None of the cell blood count indices were significantly different between the HEI/AHEI categories among the Iranian men (p-value >0.05 for all variables). Table 3 shows that there was no association between HEI/AHEI with the cell blood count indices in our population (p-value >0.05 for all variables).

Table 1: The characteristics of the participants

Variable	Mean±SD (N=367)
Age(yrs)	43.68±9.09
Weight(kg)	79.21±11.19
BMI(kg/m²)	26.94±3.48
Waist Circumference(cm)	95.14±9.43
FBG(mg/dl)	99.59±27.21
DBP(mmHg)	76.72±9.68
SBP(mmHg)	114.72±14.26
Serum fasted lipids	
Cholesterol(mg/dl)	181.83±34.73
TG(mg/dl)	128(93.0 to 180)
LDL-C(mg/dl)	125.88±34.25
HDL-C(mg/dl)	41.50±14.49
CBC	
WBC (10^3/μ)	6.61±1.69
RBC (10^3/μ)	5.24±0.51
Hemoglobin (g/dl)	14.83±1.12
Hematocrit (%)	45.23±2.77
MCV (fL)	86.41±6.25
MCH (Pg)	28.42±2.25
MCHC (10^3/μ)	32.75±1.25
RDW (%)	12.98±1.90
Platelets (10^3/μ)	222.76±50.01
Neutrophils (10^3/μ)	3.58±1.25
Lymphocytes (10^3/ μ)	2.36±0.65
Neutrophil/lymphocyte ratio	1.59±0.69

Values expressed as mean ± SD. BMI, body mass index; FBG, fasting blood glucose; SBP; systolic blood pressure, DBP; diastolic blood pressure, CBC; complete blood count, WBC; white blood cell, RBC; red blood cell, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration, RDW; red cell distribution width.

Discussion

To the best of our knowledge this is the first study evaluating the association HEI and the AHEI with CBC indices. We did not find any significant difference between in the CBC indices in men between groups with high or low HEI or AHEI values.

Diet quality score has five indicators that include: Healthy Eating Index, HEI; Alternate Healthy Eating Index, AHEI; MedDietScore, MDS; Dutch Healthy Diet-Index, DHDI; PREDIMED Mediterranean Diet Score, P-MDS (16) And these five indicators are inversely related to mortality rates (17-19). A study has previously reported that a HEI score correlates with levels of nutrient concentrations in plasma, including folate in RBC (20). A high AHEI is associated with a reduction in mortality in the community (21-23). Another study reported that a high quality diet is associated with reduced anemia and reduced mortality (24). In addition, Fargnoli et al. reported that higher AHEI scores were associated with a reduction in C-reactive protein (CRP) and concentration of ferritin in the plasma (25).

One of the indicators of diet quality is the Mediterranean Diet Score that Chrysohoou et al. report in their study that the higher the Mediterranean Diet Score is related to the lower the white blood cell count. Also, plasma levels of CRP and inflammation will be less (26). Some reports suggest an anti-inflammatory effect of the Mediterranean diet, which is also associated with

Table 2: The cell blood count indices in HEI/AHEI categories among study population

CBC	HEI			AHEI		
	HEI score ≤52	HEI score >52	P-Value	AHEI score ≤62.50	AHEI score >62.50	P-Value
WBC (10^3/ µ)	6.68±1.81	6.61±1.52	0.69	6.64±1.87	6.67±1.45	0.86
RBC (10^3/ µ)	5.236.61±0.41	5.306.61±0.48	0.15	5.28±0.43	5.24±0.47	0.41
Hemoglobin (g/dl)	14.94±1.21	14.96±1.12	0.92	14.94±1.20	14.95±1.14	0.96
Hematocrit (%)	45.41±2.93	45.62±2.83	0.49	45.52±2.83	45.49±2.94	0.91
MCV (fL)	86.83±6.15	86.43±6.07	0.53	86.49±5.09	86.78±7.03	0.65
MCH (Pg)	28.67±2.19	28.38±2.60	0.25	28.40±2.33	28.66±2.46	0.30
MCHC (10^3/ µ)	32.84±1.32	32.79±1.22	0.69	32.81±1.24	32.82±1.31	0.95
RDW (%)	42.27±3.41	42.47±2.58	0.54	42.34±2.67	42.39±3.39	0.86
Platelets (10^3/ µ)	220.15±51.97	219.90±45.92	0.96	224.70±47.85	215.04±50.16	0.06
Neutrophils (10^3/ µ)	3.63±1.35	3.59±1.15	0.82	3.56±1.40	3.66±1.08	0.47
Lymphocytes (10^3/ µ)	2.40±0.65	2.37±0.56	0.65	2.40±0.65	2.37±0.56	0.61
Neutrophil/lymphocyte ratio	1.59±0.81	1.57±0.56	0.76	1.56±0.81	1.60±0.56	0.59

Group comparisons were performed using Mann-Whitney test. HEI and AHEI were categorized according to Median 52 and 62.50 in studied population. Values expressed as mean ± SD. CBC; complete blood count, WBC; white blood cell, RBC; red blood cell, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration, RDW; red cell distribution width.

Table 3. Correlations between HEI/AHEI with the cell blood count indices

Characteristics	r (HEI score)	P-value	r (AHEI score)	P-value
WBC (10^3/ µ)	0.01	0.84	0.05	0.31
RBC (10^3/ µ)	0.07	0.16	-0.05	0.35
Hemoglobin (g/dl)	0.03	0.53	-0.05	0.33
Hematocrit (%)	0.06	0.21	-0.03	0.56
MCV (fL)	-0.007	0.89	0.02	0.59
MCH (Pg)	-0.34	0.51	0.21	0.69
MCHC (10^3/ µ)	-0.04	0.42	-0.05	0.26
RDW (%)	0.002	0.97	0.05	0.34
Platelets (10^3/ µ)	-0.017	0.75	-0.015	0.77
Neutrophils (10^3/ µ)	0.028	0.61	0.098	0.075
Lymphocytes (10^3/ µ)	-0.01	0.86	-0.009	0.87
Neutrophil/lymphocyte ratio	0.01	0.85	0.076	0.16

WBC; white blood cell, RBC; red blood cell, MCV; mean corpuscular volume, MCH ; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration, RDW; red cell distribution width.

a reduction in the prevalence of metabolic syndrome, a decrease in diabetes and a reduction in mortality (27-30). Bawaked et al. have reported that a high MDS is associated with a reduction in inflammation. This diet, which includes vegetables, fruits, grains, fish, etc., shows lower levels of inflammatory markers (31). A report states that a MDS is associated with a decrease in hemoglobin (32) Another study has also shown that the diet quality score is linked to hemoglobin levels (33). Mansego et al. have reported that the Mediterranean diet is associated with changes in let-7b expression and inflammation-related microRNAS (miR-155-3p) in the patients with metabolic syndrome. The Metabolic Syndrome also has inflammatory conditions (34). The

Mediterranean diet is also associated with the reduction of oxidative stress (35, 36).

CBC includes inter alia the number of platelets, WBC and RBC (37) and some indices of the CBC are associated with the inflammatory response. Some studies have suggested that increased platelet count is associated with an increase in the number of WBC, as well as an increase in the CRP, so counting these blood cells is appropriate for identifying inflammation states (38). In fact, the WBC count is an indicator of inflammation (39). Some studies have shown that WBC count and hemoglobin are important markers for inflammation (40, 41). Vergis et al. report that there is no association between healthy diet index and inflammation (42). But in some studies, there is a link between the diet quality and its effect on blood cells and Content of plasma and their associated inflammation (27, 43).

Fung et al. have expressed that various diet quality scores are associated with inflammatory biomarkers. The report explains that higher scores of AHEI are associated with lower concentrations of inflammatory biomarkers. While there was no significant relationship between HEI and diet quality scores with inflammation (44).

Having a healthy diet, rich in vegetables and fruits, is associated with low levels of hs-CRP and other inflammatory markers (45). The higher AHEI scores is related to the decrease in CRP (46). Diet quality can directly or indirectly interact with inflammation and this is done through changes in body mass (47).

In the study of Mohammadshahi et al. in obese Iranian women, it was reported that HEI score is inversely associated with serum hs-CRP levels. That is, a high-quality diet reduces inflammation in obese women. Actually obesity is associated with inflammation (48). Dias et al. have argued that participants with higher diet quality have lower WBC count, neutrophils, lymphocytes and CRP content. This study, which was carried out on 667 subjects aged 63-68, shows that High quality nutrition was carried out on 667 subjects aged 63-68, shows that High diet quality is associated with a reduction in systematic inflammation in people (49).

Conclusions

In summary, the results of current study showed there was no association between the diet quality with the cell blood count parameters among this sample of Iranian men.

Conflicts of interest: The authors have no conflict to interest to declare.

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