Clin Nutr Res. 2022 Oct;11(4):289-301
https://doi.org/10.7762/cnr.2022.11.4.289
pISSN 2287-3732·eISSN 2287-3740

cnr
CLINICAL NUTRITION RESEARCH

Original Article

Check for updates

The Association Between Dietary Diversity Score and Cardiovascular Risk Factors Among Patients With Pemphigus Vulgaris: A Cross Sectional Study

Atefeh Seifollahi,[1] **Mahboubeh Rezaei Fazl**,[2] **Leila Setayesh**,[2] **Mohammad Hassan Javanbakht**,[1] **Maryam Daneshpazhooh**,[3] **Sakineh Shab-Bidar**,[2] **Mehdi Yaseri** [4]

[1]Department of Cellular, Molecular Nutrition School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences (TUMS), Tehran 14155-6117, Iran
[2]Department of Community Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences (TUMS), Tehran 14155-6117, Iran
[3]Autoimmune Bullous Diseases Research Center, Tehran University of Medical Sciences (TUMS), Tehran 14155-6117, Iran
[4]Department of Biostatistics, Tehran University of Medical Sciences (TUMS), Tehran 14155-6117, Iran

Received: Apr 17, 2022
Revised: Jul 25, 2022
Accepted: Aug 8, 2022
Published online: Oct 24, 2022

Correspondence to
Mohammad Hassan Javanbakht
Department of Cellular, Molecular Nutrition School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences (TUMS), Tehran 14155-6117, Iran.
Email: mhjavan@sina.tums.ac.ir

ORCID iDs
Atefeh Seifollahi
https://orcid.org/0000-0002-7784-8953
Mahboubeh Rezaei Fazl
https://orcid.org/0000-0003-4850-1720
Leila Setayesh
https://orcid.org/0000-0002-5617-7310
Mohammad Hassan Javanbakht
https://orcid.org/0000-0001-7646-6657
Maryam Daneshpazhooh
https://orcid.org/0000-0003-1020-8895
Sakineh Shab-Bidar
https://orcid.org/0000-0002-0167-7174
Mehdi Yaseri
https://orcid.org/0000-0002-4066-873X

ABSTRACT

This study was conducted to evaluate the associations between dietary diversity score (DDS) and cardiovascular risk factors in this population. In this cross-sectional study, 187 patients, aged 18–65 years with pemphigus vulgaris were included. DDS was assessed by a 24-hour dietary recall method. Anthropometric measures and biochemical parameters assessed according to standard protocols. Multivariate linear regression analyses used for detecting any associations between DDS and cardiovascular risk factors. The mean ± standard deviation age and body mass index of studied participants were (46.71 ± 11.49 years) and (27.83 ± 4.39 kg/m^2) respectively. Our findings showed that a higher DDS intake was related with higher consumption of vegetables ($p = 0.001$), dairy products ($p < 0.001$), cereals ($p = 0.002$), red and processed meat ($p < 0.001$), sweets and desserts ($p < 0.001$). After controlling for confounding variables, the results showed positive associations between DDS and high-density lipoprotein cholesterol (HDL-C, $\beta = 1.87$, 95% confidence interval [CI], 0.30–3.45, $p = 0.02$) and total cholesterol (TC) levels ($\beta = 6.41$, 95% CI, 1.62–11.03, $p = 0.02$) ($\beta = 1.75$, 95% CI, 0.20–3.30, $p = 0.02$). However, there were no associations between DDS and prevalence of obesity and glucose homeostasis. The results of this cross-sectional study showed that DDS might be associated with increased HDL-C and TC. However, further prospective studies are needed to prove these findings.

Keywords: Diet; Pemphigus vulgaris; Cardiovascular risk factors

INTRODUCTION

Pemphigus vulgaris (PV) as the most common form of pemphigus, is a rare life-threating autoimmune disorder that usually affects skin and mucous membranes [1,2]. It was

Funding

The study was supported by the Tehran University of Medical Sciences and by grants from Tehran University of Medical Sciences (grant number: 97-01-101-37923).

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Conceptualization: Javanbakht MH; Data curation: Seifollahi A, Rezaei Fazl M; Formal analysis: Yaseri M; Investigation: Daneshpazhooh M; Supervision: Shab-Bidar S; Writing - original draft: Seifollahi A; Writing - review & editing: Setayesh L.

estimated that the incidence rate of PV varies from 0.07–3.2 cases per 100,000 people per year and is about one case per 100,000 population in Iran [3]. Some potential genetic and environmental risk factors for the development of pemphigus disease are certain drugs, viral exposures, physical factors, allergic agents, vaccinations, dietary habits, and psychological stresses [4]. Treatment with corticosteroids and immunosuppressive drugs is the main strategy in the management of pemphigus disease [5]. However, previous evidence showed that long-term treatment with these drugs might increase the risk for diseases such as infections, diabetes mellitus, and osteoporosis [6]. It also suggested that use of corticosteroid drugs in pemphigus patients may detrimentally increases the risk of hypertension, obesity, hyperlipidemia, and insulin resistance—side effects that constitute the criteria for the diagnosis of cardiovascular disease (CVD) [7,8]. Therefore, finding new approaches to overcome the complications of corticosteroids is necessary.

As a modifiable environmental factor, dietary factors play an important role in the development of PV [9-12]. However, there is little evidence about the associations between diet and PV related complications. Accordingly, previous research showed that patients with PV had lower serum selenium, zinc, and copper compared to the healthy people [13]. Other studies also have provided evidence showing an association of PV with low levels of vitamin D compared to healthy subjects which might contribute to worsen the disease [14,15]. Besides, the results of a randomized, double blind, placebo-controlled trial showed that L-carnitine supplementation might have beneficial effects on oxidative markers and lipid profiles in patients with PV [16]. On the other hand, recent nutritional epidemiology shifts toward dietary patterns and dietary indexes are more comprehensive than individual foods and nutrients in the detection of the relationship between dietary intakes and risk of skin and chronic diseases [17,18]. Among these indices, the dietary diversity score (DDS) is of great interest because this priori defined indices assesses the overall quality of diet and the adequacy of nutrient [19,20]. This tool evaluates the diversity within food groups which are usually chosen according to dietary guidelines [21,22]. Previous research has been linked the DDS to several chronic diseases such as cancer and metabolic syndrome [23,24]. However, the latest systematic review and meta-analysis did not show any significant association between the DDS and body mass index (BMI) [25]. Besides, a number of studies have indicated that decreased insulin resistance and abnormal glucose homeostasis [23,26,27], reduced serum triglyceride (TG) level [22,23,26-29], and increased high-density lipoprotein cholesterol (HDL-C) [22,27] are associated with higher dietary diversity. In contrast, other study showed that greater adherence to the DDS was associated with increased total cholesterol (TC) and low-density lipoprotein (LDL) and decreased HDL-C and TG [22].

As mentioned above, there is no sound evidence regarding the associations between the DDS and cardiovascular risk factors. In addition, there is no study investigating the association between the DDS and drug-related corticosteroids complications among patients with PV. Therefore, the present study was conducted to investigate the association between the DDS and some cardiovascular risk factors among PV patients in Iranian populations.

MATERIALS AND METHODS

Study population and design

This cross-sectional study performed on 187 patients with PV referring to Razi skin Hospital of the Tehran University of Medical Sciences)TUMS). After explaining the goals of the study,

https://doi.org/10.7762/cnr.2022.11.4.289

if the patients were willing to participate in the research, they signed written consent forms and were asked to refer to Razi Hospital in the next visit after 12–14 hours of fasting. Inclusion criteria were patient's satisfaction, age 18–65 years old, diagnosis of PV by a dermatologist based on the European Dermatology Forum Iranian guidelines for rituximab therapy in pemphigus patients (at least one-year disease duration) [30], intake of corticosteroid drugs alone or combine with other drugs (methotrexate, azathioprine, and cellcept). They did not include in the study if they were on dietary regiment and who had total daily energy intakes outside the range of 800–4,200 kcal/d, had cardiovascular or diabetes diseases before PV diagnosis. All steps were performed in accordance with ethical criteria of Tehran University of Medical Sciences (TUMS, ethics code:IR.TUMS.VCR.REC.1397.301). Written informed consent was obtained from all participants.

Demographic assessment

Patients completed a questionnaire regarding information about the age, medical condition, disease duration, type and quantity of drugs.

Anthropometric measurements

Weight and height were measured according to standardized methods to the nearest 100 g in minimally clothed condition using digital scales and standing position by a tape stadiometer to the nearest 1 mm, respectively. Waist circumference (WC) was assessed to the nearest 0.1 cm at the umbilical level, and hip circumference at the maximal level over light clothing using a non-stretch tape measure. BMI calculated as weight (kg) divided by height in meters squared.

Biochemical measurements

All blood tests were done in the morning after 10-hour overnight fasting. Serum glucose level, TG, TC, and HDL-C were measured using commercial kits routinely used in Iran (Pars Azmoon Co., Tehran, Iran). LDL cholesterol (LDL-C) was also calculated by Friedewald formula [31] and serum insulin was measured by electrochemiluminescence immunoassay method (Diagnostic Biochem Canada, Inc., Montreal, Canada). We subtracted the concentration of HDL-C from that TC to determine the non-HDL-C level. Moreover, insulin sensitivity was calculated by the following formulas according to quantitative insulin sensitivity check index (QUICKI = 1/(log(fasting insulin, μU/mL) + log(fasting glucose, mg/dL)) [32], and homeostatic model assessment for insulin resistance (HOMA-IR = (fasting insulin, μm/mL) + (fasting glucose, mg/dL)/405) [33].

Dietary assessment and DDSs calculation

Usual dietary intakes of subjects were collected using 24-hour dietary recalls on 2 non-consecutive days (1 workday and one day off). Dietary intakes were gathered with the help of experienced nutritionists. The subjects asked to report all the foods and beverages they consumed during the previous 24 hours. After this, reported dietary intakes converted to grams using Home Scale Guide. Finally, Nutritionist IV software (First Databank, San Bruno, CA, USA) was used to assess the amount of energy and nutrients intake. DDS determined based on the previous research and followed the local and cultural aspects of food grouping [34-36]. Accordingly, the 5 main food groups mentioned in food pyramid including cereals, vegetables, fruits, meats and dairy products were used, which were divided into 23 subgroups. Cereals and their products were classified into 5 subgroups (breads, biscuits, pasta, rice, and barley/bulgur/corn [breakfast cereal]), vegetables into 7 subgroups (tomatoes and their products, starchy vegetables and legumes, yellow and orange vegetables, green leafy vegetables and other vegetables such as eggplant and squash), fruits into 2 subgroups

https://doi.org/10.7762/cnr.2022.11.4.289

including citrus, summer vegetables, berries, other fruits and their juices such as apples, bananas, grapes, raisins, etc., dairy products into 3 subgroups (milk, cheese, yogurt, etc.) and meats into 4 subgroups (red meat, chicken, poultry, eggs, fish, etc.). These subgroups were selected in such a way to include diversity of all food items and were adjusted for energy intake. To be considered as a consumer of each food subgroup, one should eat at least a half serving of that item in accordance with the definitions of quantitative food guide pyramid indicators during the 2 days of recall. The final score of dietary diversity is 10, and each of the 5 main groups has a maximum score of 2 out of 10 total score of food diversity. The calculation method of the main groups' scores shows the percentage of maximum possible score. For example, a person who has consumed at least half of the 4 main subgroups of cereals has a score of (4:5 × 2 = 1.6) in the cereal group. This means that the individual has scored only 1.14 out of 2 points assigned to the main group of cereals. The scores of other main groups is similarly calculated and the total score will be the sum of 5 main groups (5 × 2 = 10).

Statistical analysis

After collecting all the samples, the data of the questionnaires were entered into a computer and final analysis was performed on the information related to 187 subjects. Kolmogorov-Smirnov test was used to check the normal of distribution data. Chi-square test were used for comparison of qualitative variables. We used one-way analysis of variance for quantitative variables and Mann-Whitney tests were used if they were not normal. To describe quantitative and qualitative variables, mean (standard deviation or standard error) and frequency report (percentage) were used, respectively. We classified DDS based on mean to 2 groups. Cardiovascular risk factors (dietary intakes of participants across the medians of DDS was assessed using the analysis of covariance (adjusted for age, gender, BMI, energy intake, and anti-diabetic drugs and Lipid-lowering drugs usage). Linear regression was used to investigate the relationship between the DDS and CVD risk factors in crude and adjusted models (adjusted for age, gender, BMI, energy intake, anti-diabetic drugs and Lipid-lowering drugs usage). Spearman was performed to evaluate the correlation between the DDS and cardiovascular biomarkers. Statistical analysis performed using SPSS software version 22 (IBM Corp., Armonk, NY, USA) and $p < 0.05$ was considered as statistically significant.

RESULTS

Sociodemographic characteristics, anthropometric measures, biochemical markers and energy intakes among participants are presented in **Table 1**. It was showed that the mean of BMI and LDL was higher in female than male ($p < 0.05$). It also revealed that male participants have higher mean of energy intake ($p = 0.005$). In addition, these individuals had mean blood glucose (102.70 ± 37.32 mg/dL), TC (185.35 ± 42.72 mg/dL), TG (138.10 ± 102.30 mg/dL), HDL-C and LDL-C, insulin level, HOMA-IR, and QUICKI were 58.68 ± 12.34, 112.63 ± 35.92 mg/dL, 93.17 ± 61.16, 4.79 ± 5.46 and 0.03 ± 0.32, respectively. Moreover, the participants had an average insulin level of 93.17 ± 61.16 microns/mL. The frequency of use of hypoglycemic drugs is 40 (21.4%) and the frequency of fat-lowering drugs is 23 (12.3%). These numbers are different in terms of gender.

General characteristics of participants across the 2 categories of DDS (based on median) presented in **Table 2**. Statistically significant difference between DDS and total energy intake was seen across the medians of DDS ($p \leq 0.001$).

https://doi.org/10.7762/cnr.2022.11.4.289

Table 1. Sociodemographic characteristics, anthropometric measures, biochemical markers, and energy intakes among target population

Variables	Total (n = 187)	Male (n = 62)	Female (n = 125)	p value
Age (yr)	46.71 ± 11.49	46.30 ± 11.42	46.91 ± 11.56	0.730
WC (cm)	94.98 ± 11.71	93.03 ± 10.36	95.95 ± 12.26	0.100
BMI (kg/m^2)	27.83 ± 4.39	26.86 ± 3.67	28.31 ± 4.62	0.030
Total energy intake (kcal/d)	1,945.60 ± 196.27	2,002.43 ± 213.98	1,917.41 ± 181.23	0.005
FBS (mg/dL)	102.70 ± 37.35	100.19 ± 25.20	103.95 ± 42.15	0.520
TG (mg/dL)	138.10 ± 102.30	153.20 ± 157.98	130.60 ± 57.01	0.150
TC (mg/dL)	185.35 ± 42.72	181.28 ± 37.87	187.39 ± 44.39	0.350
HDL-C (mg/dL)	58.68 ± 12.34	57.45 ± 11.50	59.29 ± 12.74	0.330
LDL-C (mg/dL)	112.63 ± 35.92	102.91 ± 39.80	117.44 ± 32.95	0.009
Insulin (mIU/L)	17.93 ± 16.61	20.12 ± 19.40	16.85 ± 15.01	0.200
HOMA-IR (mg/dL)	4.79 ± 5.46	5.22 ± 6.53	4.57 ± 4.85	0.440
QUICKI	0.32 ± 0.03	0.31 ± 0.02	0.32 ± 0.03	0.210
Lipid-lowering drug usage				0.440
Yes	23 (12.3)	6 (9.7)	17 (13.6)	
No	164 (87.7)	56 (90.3)	108 (86.4)	
Anti-diabetic drug usage				0.870
Yes	40 (21.4)	14 (22.6)	26 (20.8)	
No	147 (78.6)	48 (77.4)	99 (79.2)	

Data are presented as mean ± standard deviation and number (%). Independent sample t-test or Mann-Whitney U-test were used for comparison of quantitative variables. χ^2 test or were used for comparison of qualitative variables.
WC, waist circumference; BMI, body mass index; FBS, fasting blood sugar; TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; HOMA-IR, homeostatic model assessment-insulin resistance; QUICKI, quantitative insulin sensitivity check index.

Table 3 shows participants' anthropometric measurements and cardiovascular markers across the medians of the DDS in the crude model. We also evaluated the association in 3 model, in the way that model one was adjusted for age and gender, model 2 was adjusted for model 1 plus energy intake (BMI and WC) or energy intake and BMI (fasting blood sugar [FBS], TG, TC, HDL-C, LDL-C, insulin, HOMA-IR, and QUICKI), and model 3 was adjusted for model 2 plus anti-diabetic drugs and lipid-lowering drugs usage. No statistically significant differences were seen in relation of DDS and cardiovascular risk factors ($p > 0.05$).

Dietary intakes of patients across medians of DDS are displayed in **Table 4**. It was found that higher DDS was associated with higher consumption of dairy ($p < 0.001$), grains ($p = 0.002$), red/processed meats ($p < 0.001$), and sweets and desserts ($p < 0.001$).

Table 2. Participants' characteristics according to different categories of DDS

Variables	DDS		
	Category 1 (n = 94)	Category 2 (n = 93)	p value
Age (yr)	46.40 ± 10.25	47.02 ± 12.67	0.710
BMI (kg/m^2)	27.54 ± 4.07	28.13 ± 4.70	0.360
WC (cm)	93.84 ± 12.12	96.13 ± 11.23	0.180
Total energy (kcal/d)	1,856.95 ± 136.13	2,035.20 ± 207.37	< 0.001
Sex			0.320
Male	28 (29.8)	34 (36.6)	
Female	66 (70.2)	59 (63.4)	
Lipid-lowering drug usage			0.840
Yes	12 (12.8)	11 (11.8)	
No	82 (87.2)	82 (88.2)	
Anti-diabetic drugs usage			0.300
Yes	23 (24.5)	17 (18.3)	
No	71 (75.5)	75 (81.7)	

Dietary pattern scores are categorized according to the median. Data are presented as mean ± standard deviation or number (%). Independent sample t-test or Mann-Whitney U test were used for comparison of quantitative variables. χ^2 test were used for comparison of qualitative variables.
DDS, dietary diversity score; BMI, body mass index; WC, waist circumference.

https://doi.org/10.7762/cnr.2022.11.4.289

Table 3. The association of anthropometric measurements and cardiovascular markers across the medians of the DDS

Variables	DDS		p value*
	Low category (n = 94)	High category (n = 93)	
BMI (kg/m^2)			
Crude	27.54 ± 4.07	28.13 ± 4.70	0.36
Model 1	27.49 ± 0.45	28.17 ± 0.45	0.29
Model 2	27.27 ± 0.47	28.39 ± 0.48	0.11
Model 3	27.25 ± 0.48	28.42 ± 0.48	0.10
WC (cm)			
Crude	93.84 ± 12.12	96.13 ± 11.23	0.18
Model 1	93.78 ± 1.19	96.19 ± 1.19	0.15
Model 2	93.83 ± 1.26	96.14 ± 1.27	0.22
Model 3	93.99 ± 1.27	95.98 ± 1.27	0.29
FBS (mg/dL)			
Crude	100.26 ± 30.53	105.17 ± 43.20	0.37
Model 1	100.24 ± 3.85	105.19 ± 3.87	0.36
Model 2	101.19 ± 3.93	104.23 ± 3.95	0.60
Model 3	100.44 ± 3.88	105.00 ± 3.91	0.43
TG (mg/dL)			
Crude	149.08 ± 132.91	127.00 ± 55.26	0.14
Model 1	149.84 ± 10.52	126.23 ± 10.57	0.11
Model 2	149.62 ± 11.17	126.45 ± 11.24	0.17
Model 3	150.34 ± 11.24	125.72 ± 11.30	0.14
TC (mg/dL)			
Crude	186.96 ± 46.52	183.73 ± 38.68	0.60
Model 1	186.80 ± 4.43	183.89 ± 4.45	0.64
Model 2	180.76 ± 4.58	189.99 ± 4.61	0.18
Model 3	180.97 ± 4.61	189.79 ± 4.64	0.20
HDL-C (mg/dL)			
Crude	58.56 ± 9.96	58.80 ± 14.41	0.89
Model 1	58.52 ± 1.28	58.85 ± 1.28	0.85
Model 2	57.26 ± 1.34	60.11 ± 1.35	0.16
Model 3	57.12 ± 1.35	60.25 ± 1.35	0.12
LDL-C (mg/dL)			
Crude	110.21 ± 37.31	115.07 ± 34.48	0.35
Model 1	109.67 ± 3.65	115.62 ± 3.67	0.25
Model 2	107.51 ± 3.88	117.80 ± 3.90	0.08
Model 3	107.66 ± 3.91	117.65 ± 3.93	0.09
Non-HDL-C			
Crude	128.43 ± 43.55	124.92 ± 36.00	0.55
Model 1	128.40 ± 4.14	124.92 ± 4.16	0.58
Model 2	128.40 ± 4.33	124.92 ± 4.35	0.32
Model 3	128.40 ± 4.35	124.92 ± 4.38	0.38
TC/HDL-C			
Crude	3.23 ± 0.83	3.25 ± 0.89	0.88
Model 1	3.23 ± 0.09	3.25 ± 0.09	0.88
Model 2	3.23 ± 0.09	3.25 ± 0.09	0.41
Model 3	3.23 ± 0.09	3.25 ± 0.09	0.48
Insulin (μIU/mL)			
Crude	16.75 ± 16.81	19.13 ± 16.41	0.33
Model 1	16.86 ± 1.71	19.02 ± 1.72	0.37
Model 2	17.93 ± 1.75	17.94 ± 1.76	0.99
Model 3	18.11 ± 1.74	17.75 ± 1.75	0.89
HOMA-IR			
Crude	4.19 ± 4.25	5.39 ± 6.42	0.13
Model 1	4.22 ± 0.56	5.36 ± 0.56	0.15
Model 2	4.61 ± 0.55	4.96 ± 0.56	0.68
Model 3	4.62 ± 0.55	4.96 ± 0.56	0.68

(continued to the next page)

https://doi.org/10.7762/cnr.2022.11.4.289

Table 3. (Continued) The association of anthropometric measurements and cardiovascular markers across the medians of the DDS

Variables	DDS		p value*
	Low category (n = 94)	High category (n = 93)	
QUICKI			
Crude	0.32 ± 0.03	0.31 ± 0.02	0.02
Model 1	0.32 ± 0.00	0.31 ± 0.00	0.03
Model 2	0.32 ± 0.00	0.31 ± 0.00	0.15
Model 3	0.32 ± 0.00	0.31 ± 0.00	0.17

Data are presented as mean ± standard deviation for crude model and mean ± standard error for adjusted models. ANCOVA was applied to assess the relationship among variables.
Crude: Not adjusted for any variables.
Model 1: This model was adjusted for age and gender.
Model 2: This model was adjusted for model 1 plus energy intake (BMI and WC) or energy intake and BMI (FBS, TG, TC, HDL-C, LDL-C, insulin, HOMA-IR, and QUICKI).
Model 3: This model was adjusted for model 2 plus anti-diabetic drugs and Lipid-lowering drugs usage.
DDS, dietary diversity score; BMI, body mass index; WC, waist circumference; FBS, fasting blood sugar; HOMA-IR, homeostasis model assessment-insulin resistance; QUICKI, quantitative insulin sensitivity check index; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol; ANCOVA, analysis of covariance.
*Calculated using t-test for the crude model and ANCOVA in the adjusted models.

Table 4. Dietary intakes of participants across medians of DDS

Variables	DDS		
	Category 1 (n = 89)	Category 2 (n = 90)	p value*
Carbohydrate (g/day)	267.33 ± 4.18	274.80 ± 4.16	0.230
Protein (g/day)	65.05 ± 1.36	64.02 ± 1.35	0.610
Total fat (g/day)	72.70 ± 1.95	69.45 ± 1.94	0.270
Cholesterol (mg/day)	188.83 ± 8.67	189.06 ± 8.61	0.980
Saturated fatty acids (g/day)	17.19 ± 0.51	17.54 ± 0.51	0.620
Dietary fiber (g/day)	16.80 ± 0.39	15.90 ± 0.39	0.130
Vitamin			
A (RAE/day)	1,066.00 ± 91.22	1,121.10 ± 90.66	0.680
E (mg/day)	20.06 ± 1.02	18.72 ± 1.01	0.380
K (μg/day)	96.86 ± 4.75	99.93 ± 4.72	0.660
D (μg/day)	0.56 ± 0.03	0.58 ± 0.03	0.670
C (mg/day)	104.51 ± 4.93	92.70 ± 4.90	0.100
B1 (mg/day)	1.56 ± 0.03	1.63 ± 0.03	0.210
B2 (mg/day)	1.43 ± 0.06	1.41 ± 0.06	0.790
B3 (mg/day)	17.72 ± 0.38	18.26 ± 0.38	0.350
B5 (mg/day)	4.82 ± 0.12	4.79 ± 0.12	0.870
B6 (mg/day)	1.50 ± 0.04	1.48 ± 0.04	0.750
B9 (μg/day)	341.86 ± 9.57	345.23 ± 9.52	0.810
B12 (μg/day)	5.20 ± 0.61	5.11 ± 0.60	0.920
Minerals			
Potassium (mg/day)	2,544.84 ± 84.69	2,526.67 ± 84.17	0.880
Calcium (mg/day)	668.71 ± 28.24	651.19 ± 28.06	0.670
Iron (mg/day)	13.40 ± 0.37	13.60 ± 0.37	0.720
Magnesium (mg/day)	267.41 ± 5.48	262.125 ± 5.44	0.510
Zinc (mg/day)	8.24 ± 0.16	8.20 ± 0.15	0.860
Phosphorous (mg/day)	1,084.25 ± 25.36	1,076.58 ± 25.21	0.830
Sodium (mg/day)	1,563.51 ± 102.58	1,566.03 ± 101.94	0.980
Food groups			
Fruits (g/day)	387.42 ± 31.06	464.44 ± 31.24	0.100
Vegetables (g/day)	404.49 ± 28.18	520.83 ± 28.35	0.006
Dairy (g/day)	218.67 ± 19.19	345.04 ± 19.31	< 0.001
Nut/Legumes (g/day)	40.41 ± 5.09	44.94 ± 5.12	0.550
Grains (g/day)	416.73 ± 12.16	472.70 ± 12.24	0.002
Fish/Poultry (g/day)	36.82 ± 4.10	43.69 ± 4.12	0.260
Red/Processed meats (g/day)	34.20 ± 3.10	56.07 ± 3.12	< 0.001
Sweets and desserts (g/day)	51.24 ± 7.15	100.10 ± 7.19	< 0.001

Data are presented as mean ± standard error.
DDS, dietary diversity score.
*Analysis of covariance test was used (dietary intakes were adjusted for energy intake).

https://doi.org/10.7762/cnr.2022.11.4.289

Crude and adjusted associations between the DDS and cardiovascular risk factors are summarized in **Table 5**. The results showed that the DDS was positively associated with higher HDL-C (β = 1.87, 95% confidence interval [CI], 0.30–3.45, p = 0.02) and TC (β = 6.41, 95% CI, 1.62–11.03, p = 0.02) after adjusting for potential confounders including age, gender, energy intake and BMI, respectively.

Table 6 shows the possible correlation between the DDS and cardiovascular risk factors in patients with PV. Accordingly, the results showed no significant correlations between the DDS and the risk factors of CVD (p > 0.05).

Table 5. Crude and adjusted associations between dietary diversity score and cardiovascular risk factors

Variables	Beta	Confidence interval	p value*
BMI (kg/m^2)			
Crude	0.09	−0.38–0.58	0.69
Model 1	0.15	−0.33–0.63	0.53
Model 2	0.31	−0.23–0.87	0.26
Model 3	0.34	−0.22–0.90	0.23
WC (cm)			
Crude	90.81	−0.47–2.10	0.21
Model 1	0.90	−0.37–2.10	0.16
Model 2	0.88	−0.59–2.35	0.23
Model 3	0.69	−0.80–2.18	0.36
FBS (mg/dL)			
Crude	−0.03	−4.16–4.09	0.98
Model 1	0.03	−4.11–4.18	0.98
Model 2	−0.91	−5.48–3.65	0.69
Model 3	0.16	−4.42–4.75	0.94
TG (mg/dL)			
Crude	−4.29	−15.59–6.99	0.45
Model 1	−5.19	−16.54–6.15	0.36
Model 2	−3.38	−16.42–9.66	0.60
Model 3	−4.67	−17.97–8.62	0.48
TC (mg/dL)			
Crude	0.45	−4.27–5.17	0.85
Model 1	0.67	−4.08–5.44	0.77
Model 2	6.42	1.62–11.69	0.01
Model 3	6.41	1.03–11.79	0.02
HDL-C (mg/dL)			
Crude	0.49	−0.86–1.85	0.47
Model 1	0.56	−0.81–1.93	0.42
Model 2	1.75	0.20–3.30	0.02
Model 3	1.87	0.30–3.45	0.02
LDL-C (mg/dL)			
Crude	0.49	−3.47–4.45	0.80
Model 1	1.09	−2.84–5.03	0.58
Model 2	2.72	−1.80–7.25	0.23
Model 3	2.55	−2.07–7.18	0.27
Non-HDL-C			
Crude	−0.04	−4.45–4.37	0.98
Model 1	0.11	−4.33–4.57	0.95
Model 2	4.67	−0.32–9.67	0.06
Model 3	4.54	−0.55–9.63	0.08
TC/HDL-C			
Crude	0.00	−0.09–0.09	0.95
Model 1	0.00	−0.09–0.09	0.95
Model 2	0.04	−0.06–0.15	0.42
Model 3	0.04	−0.06–0.15	0.44

(continued to the next page)

https://doi.org/10.7762/cnr.2022.11.4.289

Table 5. (Continued) Crude and adjusted associations between dietary diversity score and cardiovascular risk factors

Variables	Beta	Confidence interval	p value*
Insulin (μIU/mL)			
Crude	1.39	−0.43–3.22	0.13
Model 1	1.28	−0.56–3.12	0.17
Model 2	0.71	−1.31–2.75	0.48
Model 3	0.73	−1.31–2.79	0.47
HOMA-IR			
Crude	0.45	−0.14–1.05	0.13
Model 1	0.42	−0.17–1.03	0.16
Model 2	0.16	−0.48–0.81	0.60
Model 3	0.25	−0.40–0.90	0.44
QUICKI			
Crude	−0.030	−0.007–0.000	0.08
Model 1	−0.003	−0.007–0.000	0.10
Model 2	−0.002	−0.006–0.002	0.32
Model 3	−0.002	−0.006–0.002	0.26

Crude: Not adjusted for any variables. Model 1: This model was adjusted for age and gender. Model 2: This model was adjusted for model 1 plus energy intake (BMI and WC outcomes) or energy intake and BMI (FBS, TG, TC, HDL-C, LDL-C, insulin, HOMA-IR, and QUICKI outcomes). Model 3: This model was adjusted for model 2 plus anti-diabetic drugs and Lipid-lowering drugs usage.
BMI, body mass index; WC, waist circumference; FBS, fasting blood sugar; HOMA-IR, homeostasis model assessment-insulin resistance; QUICKI, quantitative insulin sensitivity check index; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol.
*Calculated using linear regression.

Table 6. Pearson correlation between dietary diversity score and cardio metabolic risk factors among study participant

Variables	Correlation coefficient	p value
BMI (kg/m^2)	0.020	0.69
WC (cm)	0.090	0.21
TG (mg/dL)	−0.050	0.45
TC (mg/dL)	0.010	0.85
HDL-C (mg/dL)	0.050	0.47
LDL-C (mg/dL)	0.010	0.80
Non-HDL-C	−0.001	0.98
TC/HDL-C	0.004	0.95
FBS (mg/dL)	−0.001	0.98
Insulin (μIU/mL)	−0.110	0.13
HOMA-IR	0.100	0.13
QUICKI	−0.120	0.08

Controlled for age and gender. energy intake (BMI and WC) or energy intake and BMI (FBS, TG, TC, HDL-C, LDL-C, insulin, HOMA-IR, and QUICKI), anti-diabetic drugs and lipid-lowering drugs usage.
BMI, body mass index; WC, waist circumference; FBS, fasting blood sugar; HOMA-IR, homeostasis model assessment-insulin resistance; QUICKI, quantitative insulin sensitivity check index; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol.

DISCUSSION

We investigated the relation of DDS and HDL-C and TC levels. However, there was no significant association between DDS and other risk factors of CVD. To the best of our knowledge, this is the first study investigating the association of DDS and CVD risk factors in patients with PV and highlighting the roles of diet in the management of such complications that are resulted mostly from corticosteroid and immunosuppressive drugs consumption.

The results of our study revealed that DDS was significantly associated with higher HDL-C and TC. It is noteworthy that this score was not associated with LDL-C, non-HDL-C, and TC to HDL-C ratio, so it seems that the significant positive association between DDS and TC levels is a function of increased HDL-C and is not related to non-HDL-C cholesterol. In line with our

https://doi.org/10.7762/cnr.2022.11.4.289

study, a number of researchers have revealed that DDS has a positive association with HDL-C. Accordingly, in a cross-sectional study performed on Australian frail elderly people higher DDS was significantly associated with higher HDL-C and lower LDL-C and TG levels. In this study, dietary intakes were collected using weighed 3-day food records and the results were controlled for confounder such as age, BMI, and energy intake [29]. In other cross-sectional study, pre-diabetes subjects in the fourth quartile of DDS had higher HDL-C and lower TG levels compared to the subjects in the first quartile. Of course, dietary data were collected using food frequency questionnaire and the results were not controlled for potential confounders [27]. In contrast to our results, in a cross-sectional study performed on South African women, being in the third compared to first category of dietary diversity was associated with higher TC and LDL-C and lower HDL-C [22]. Besides, the results of other studies showed no associations between the dietary variety and HDL-C levels [23,26,28]. Altogether, it seems the various results on the association between the DDS and HDL-C levels in the studies should be due to different methods for dietary intake collection, different populations, and controlling the analyses for various confounders. Accordingly, our results showed be used with cautious since we did not control the results for physical activity, a key factor related to the HDL-C levels [28].

In the present research, the DDS was not significantly associated with obesity (both abdominal and general). In accordance with our results, in a meta-analysis on observational studies, Salehi-Abargouei et al. [25] reported that there is no association between the DDS and the chance of overweight/obesity. In fact, the association between the DDS and obesity and obesity indices are based on the case-control and cross-sectional studies and there is no prospective in this context. In addition, the methods for dietary intake assessment were different between the studies. As another limitation for the previous research, it should be noted that the adjustment for potential confounders were varied between the studies. Besides, most of the previous research have used only 5 food groups (grains, fruits, vegetables, dairy products, and meats) for the calculation of the DDS and did not consider dietary fat intake. Based on the recent research, healthy fats (especially plants fats) are of great interest due to their health benefit properties [23,37-39] and considering this food group in the scoring of the DDS can be helpful in the final decision about the association between the DDS and cardiovascular risk factors.

Finally, our results showed that there is no association between the DDS and the indices of glucose homeostasis (FBS, HOMA-IR, QUICKI, and serum insulin) in patients with PV. In contrast, in a cross-sectional study being in the highest quartile of the DDS was associated with higher QUICKI and lower HOMA-IR and serum insulin among subjects with metabolic syndrome. However, the results of this study were based on the crude analysis of the data and it seems this results should be used with cautious [26]. In a case-control study among patients with pre-diabetes, Gholizadeh et al. [27] showed inverse association between the DDS and FBG levels. This finding was also based on a crude analysis without adjusting for potential confounders. Moreover, in a cross-sectional study the risk of abnormal glucose homeostasis decreased with increasing the score of dietary diversity [23]. Alike other cardiovascular risk factors, it seems that there is no sound evidence regarding the associations between the DDS and the indices of glucose homeostasis due to low sample size of the studies, differences in dietary intake assessment and calculation of the DDS. Therefore, further comprehensive prospective and clinical studies are needed to confirm or reject this evidence.

In general, the main mechanisms of the effects of the DDS in improving CVD risk factors is unclear. However, the results of previous studies suggest that DDS is associated with

https://doi.org/10.7762/cnr.2022.11.4.289

increased calcium and vitamin intake as well as decreased intake of fatty acids and cholesterol that may improve the risk factors for chronic diseases [22]. Moreover, the components of dietary diversity, including dairy products [38], fruits and vegetables [40], and whole grains [41] are effective in preventing metabolic syndrome. In addition, fruits and vegetables are important components of dietary diversity and are rich sources of antioxidants, indicating their positive and direct relationship with increasing skeletal muscle strength [42,43].

This study was the first one that investigated the association between the DDS and CVD risk factors in patients with PV. However, our study had some limitations. First, this was a cross-sectional study and we cannot find the causality of the obtained results. Second, our study included low number of participants. Third, although we controlled the results for some potential confounders, however, other confounders (especially physical activity) levels were not taken into account. Forth, it seems that dietary recall could not estimate the overall dietary intakes of the participants because no fish intake reported in our study.

In conclusion, the results of the present study showed that the DDS might be associated with increased HDL-C and TC. However, due to the limitations of the study and inconsistent results of the previous studies more comprehensive prospective studies with larger sample sizes and longer durations taking into account different population is warranted.

ACKNOWLEDGEMENTS

We thank all of the women who participated in the survey. We also thank all of the health centers to their cooperation and assistance.

REFERENCES

1. Grando SA. Pemphigus autoimmunity: hypotheses and realities. Autoimmunity 2012;45:7-35.
PUBMED | CROSSREF
2. Sticherling M, Erfurt-Berge C. Autoimmune blistering diseases of the skin. Autoimmun Rev 2012;11:226-30.
PUBMED | CROSSREF
3. Chams-Davatchi C, Valikhani M, Daneshpazhooh M, Esmaili N, Balighi K, Hallaji Z, Barzegari M, Akhiani M, Ghodsi Z, Mortazavi H, Naraghi Z. Pemphigus: analysis of 1209 cases. Int J Dermatol 2005;44:470-6.
PUBMED | CROSSREF
4. Brenner S, Goldberg I. Drug-induced pemphigus. Clin Dermatol 2011;29:455-7.
PUBMED | CROSSREF
5. Esmaili N, Chams-Davatchi C, Valikhani M, Daneshpazhooh M, Toosi S, Karimi A, Mortazavi H. Assessment of the therapeutic benefit of oral prednisolone and common adjuvant therapy in stage II of randomized controlled trial study for management of pemphigus vulgaris. Arch Iran Med 2014;17:626-8.
PUBMED
6. Yeh SW, Sami N, Ahmed RA. Treatment of pemphigus vulgaris: current and emerging options. Am J Clin Dermatol 2005;6:327-42.
PUBMED | CROSSREF
7. Pozzilli C, Marinelli F, Romano S, Bagnato F. Corticosteroids treatment. J Neurol Sci 2004;223:47-51.
PUBMED | CROSSREF
8. Stanbury RM, Graham EM. Systemic corticosteroid therapy--side effects and their management. Br J Ophthalmol 1998;82:704-8.
PUBMED | CROSSREF
9. van Dam RM, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. Ann Intern Med 2002;136:201-9.
PUBMED | CROSSREF

10. Feskens EJ, Virtanen SM, Räsänen L, Tuomilehto J, Stengård J, Pekkanen J, Nissinen A, Kromhout D. Dietary factors determining diabetes and impaired glucose tolerance. A 20-year follow-up of the Finnish and Dutch cohorts of the Seven Countries Study. Diabetes Care 1995;18:1104-12.
PUBMED | CROSSREF
11. Cani PD, Neyrinck AM, Fava F, Knauf C, Burcelin RG, Tuohy KM, Gibson GR, Delzenne NM. Selective increases of bifidobacteria in gut microflora improve high-fat-diet-induced diabetes in mice through a mechanism associated with endotoxaemia. Diabetologia 2007;50:2374-83.
PUBMED | CROSSREF
12. Dahlquist GG, Blom LG, Persson LA, Sandström AI, Wall SG. Dietary factors and the risk of developing insulin dependent diabetes in childhood. BMJ 1990;300:1302-6.
PUBMED | CROSSREF
13. Javanbakht M, Daneshpazhooh M, Chams-Davatchi C, Eshraghian M, Zarei M, Chamari M, M D. Serum selenium, zinc, and copper in early diagnosed patients with pemphigus vulgaris. Iran J Public Health 2012;41:105-9.
PUBMED
14. El-Komy MH, Samir N, Shaker OG. Estimation of vitamin D levels in patients with pemphigus vulgaris. J Eur Acad Dermatol Venereol 2014;28:859-63.
PUBMED | CROSSREF
15. Marzano AV, Trevisan V, Eller-Vainicher C, Cairoli E, Marchese L, Morelli V, Beck-Peccoz P, Crosti C, Chiodini I. Evidence for vitamin D deficiency and increased prevalence of fractures in autoimmune bullous skin diseases. Br J Dermatol 2012;167:688-91.
PUBMED | CROSSREF
16. Mohammadi H, Djalali M, Daneshpazhooh M, Honarvar NM, Chams-Davatchi C, Sepandar F, Fakhri Z, Yaghubi E, Zarei M, Javanbakht MH. Effects of L-carnitine supplementation on biomarkers of oxidative stress, antioxidant capacity and lipid profile, in patients with pemphigus vulgaris: a randomized, double-blind, placebo-controlled trial. Eur J Clin Nutr 2018;72:99-104.
PUBMED | CROSSREF
17. Tresserra-Rimbau A, Rimm EB, Medina-Remón A, Martínez-González MA, de la Torre R, Corella D, Salas-Salvadó J, Gómez-Gracia E, Lapetra J, Arós F, Fiol M, Ros E, Serra-Majem L, Pintó X, Saez GT, Basora J, Sorlí JV, Martínez JA, Vinyoles E, Ruiz-Gutiérrez V, Estruch R, Lamuela-Raventós RM; PREDIMED Study Investigators. Inverse association between habitual polyphenol intake and incidence of cardiovascular events in the PREDIMED study. Nutr Metab Cardiovasc Dis 2014;24:639-47.
PUBMED | CROSSREF
18. Pischon T, Hankinson SE, Hotamisligil GS, Rifai N, Willett WC, Rimm EB. Habitual dietary intake of n-3 and n-6 fatty acids in relation to inflammatory markers among US men and women. Circulation 2003;108:155-60.
PUBMED | CROSSREF
19. Steyn NP, Nel JH, Nantel G, Kennedy G, Labadarios D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? Public Health Nutr 2006;9:644-50.
PUBMED | CROSSREF
20. Turner-McGrievy GM, Barnard ND, Cohen J, Jenkins DJ, Gloede L, Green AA. Changes in nutrient intake and dietary quality among participants with type 2 diabetes following a low-fat vegan diet or a conventional diabetes diet for 22 weeks. J Am Diet Assoc 2008;108:1636-45.
PUBMED | CROSSREF
21. Kant AK, Graubard BI. A comparison of three dietary pattern indexes for predicting biomarkers of diet and disease. J Am Coll Nutr 2005;24:294-303.
PUBMED | CROSSREF
22. Oldewage-Theron WH, Egal AA. A cross-sectional baseline survey investigating the relationship between dietary diversity and cardiovascular risk factors in women from the Vaal Region, South Africa. J Nurs Educ Pract 2014;4:50-61.
CROSSREF
23. Azadbakht L, Mirmiran P, Azizi F. Dietary diversity score is favorably associated with the metabolic syndrome in Tehranian adults. Int J Obes 2005;29:1361-7.
PUBMED | CROSSREF
24. Kant AK, Schatzkin A, Ziegler RG. Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. J Am Coll Nutr 1995;14:233-8.
PUBMED | CROSSREF
25. Salehi-Abargouei A, Akbari F, Bellissimo N, Azadbakht L. Dietary diversity score and obesity: a systematic review and meta-analysis of observational studies. Eur J Clin Nutr 2016;70:1-9.
PUBMED | CROSSREF

26. Abbasalizad Farhangi M, Vajdi M, Nikniaz L, Nikniaz Z. Interaction between vascular endothelial growth factor-A (rs2010963) gene polymorphisms and dietary diversity score on cardiovascular risk factors in patients with metabolic syndrome. Lifestyle Genom 2020;13:1-10.
PUBMED | CROSSREF
27. Gholizadeh F, Moludi J, Lotfi Yagin N, Alizadeh M, Mostafa Nachvak S, Abdollahzad H, Mirzaei K, Mostafazadeh M. The relation of dietary diversity score and food insecurity to metabolic syndrome features and glucose level among pre-diabetes subjects. Prim Care Diabetes 2018;12:338-44.
PUBMED | CROSSREF
28. Toft U, Kristoffersen LH, Lau C, Borch-Johnsen K, Jørgensen T. The dietary quality score: validation and association with cardiovascular risk factors: the Inter99 study. Eur J Clin Nutr 2007;61:270-8.
PUBMED | CROSSREF
29. Bernstein MA, Tucker KL, Ryan ND, O'Neill EF, Clements KM, Nelson ME, Evans WJ, Fiatarone Singh MA. Higher dietary variety is associated with better nutritional status in frail elderly people. J Am Diet Assoc 2002;102:1096-104.
PUBMED | CROSSREF
30. Daneshpazhooh M, Balighi K, Mahmoudi H, Tavakolpour S, Abedini R, Soori T, Ehsani AH, Ghiasi M, Noormohammadpour P, Ghandi N, Lajevardi V, Sadeghinia A, Nasimi M, Azizpour A, Chams-Davatchi C. Iranian guideline for rituximab therapy in pemphigus patients. Dermatol Ther 2019;32:e13016.
PUBMED | CROSSREF
31. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972;18:499-502.
PUBMED | CROSSREF
32. Katz A, Nambi SS, Mather K, Baron AD, Follmann DA, Sullivan G, Quon MJ. Quantitative insulin sensitivity check index: a simple, accurate method for assessing insulin sensitivity in humans. J Clin Endocrinol Metab 2000;85:2402-10.
PUBMED | CROSSREF
33. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: insulin resistance and β-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia 1985;28:412-9.
PUBMED | CROSSREF
34. Kennedy G, Ballard T, Dop MC. Guidelines for measuring household and individual dietary diversity. Rome: Food and Agriculture Organization of the United Nations; 2011.
35. Kant AK, Block G, Schatzkin A, Ziegler RG, Nestle M. Dietary diversity in the US population, NHANES II, 1976-1980. J Am Diet Assoc 1991;91:1526-31.
PUBMED | CROSSREF
36. Sadeghi O, Shayanfar M, Mohammad-Shirazi M, Sharifi G, Esmaillzadeh A. A case-control study on dietary quality indices and glioma. Br J Nutr 2019;122:103-10.
PUBMED | CROSSREF
37. Azadbakht L, Esmaillzadeh A. Dietary diversity score is related to obesity and abdominal adiposity among Iranian female youth. Public Health Nutr 2011;14:62-9.
PUBMED | CROSSREF
38. Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi F. Dairy consumption is inversely associated with the prevalence of the metabolic syndrome in Tehranian adults. Am J Clin Nutr 2005;82:523-30.
PUBMED | CROSSREF
39. Hasan-Ghomi M, Mirmiran P, Amiri Z, Asghari G, Sadeghian S, Sarbazi N, Azizi F. The association of food security and dietary variety in subjects aged over 40 in district 13 of Tehran. Iran J Endocrinol Metab 2012;14:Pe360-7.
40. Esmaillzadeh A, Kimiagar M, Mehrabi Y, Azadbakht L, Hu FB, Willett WC. Fruit and vegetable intakes, C-reactive protein, and the metabolic syndrome. Am J Clin Nutr 2006;84:1489-97.
PUBMED | CROSSREF
41. Esmaillzadeh A, Mirmiran P, Azizi F. Whole-grain consumption and the metabolic syndrome: a favorable association in Tehranian adults. Eur J Clin Nutr 2005;59:353-62.
PUBMED | CROSSREF
42. Robinson SM, Jameson KA, Batelaan SF, Martin HJ, Syddall HE, Dennison EM, Cooper C, Sayer AA; Hertfordshire Cohort Study Group. Diet and its relationship with grip strength in community-dwelling older men and women: the Hertfordshire cohort study. J Am Geriatr Soc 2008;56:84-90.
PUBMED | CROSSREF
43. Cesari M, Pahor M, Bartali B, Cherubini A, Penninx BW, Williams GR, Atkinson H, Martin A, Guralnik JM, Ferrucci L. Antioxidants and physical performance in elderly persons: the Invecchiare in Chianti (InCHIANTI) study. Am J Clin Nutr 2004;79:289-94.
PUBMED | CROSSREF