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Investigating the Effect of an Educational Intervention on Fruit and Vegetable Consumption and its Effect on Blood Lipid Levels in Government Employees: A Clustered Randomized Trial

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ABSTRACT

Aims The consumption of fruits and vegetables has a protective effect on cardiovascular disease and its associated risk factors. The present study aimed to assess the effect of educational intervention on fruit and vegetable consumption, as well as its effect on blood lipid parameters, in government employees.

Materials & Methods This quasi-experimental cluster-randomized controlled trial was conducted in two offices in Qaem Shahr. The data collection tool included a 31-item questionnaire on the frequency of fruit and vegetable consumption and a laboratory test to measure blood lipid parameters. The Chi-square test, t-test, paired sample t-test, and ANCOVA were used for data analysis.

Findings The study groups significantly differed in mean fruit and vegetable consumption after the six-month intervention (p<0.001). The mean total cholesterol (p<0.001) and low-density lipoprotein-cholesterol (LDL-C; p=0.005) levels were significantly different between the groups after the intervention. The mean difference of high-density lipoprotein (HDL)-cholesterol levels showed a significant relationship with the study groups and the interaction of gender and group (p<0.001). The mean difference of total cholesterol (p=0.008) and LDL-C had a significant relationship with the study groups (p=0.03).

Conclusion Increased consumption of fruits and vegetables is only effective in improving the levels of total cholesterol and LDL-C, but not in lowering triglyceride and HDL-C levels. Therefore, influencing factors, such as the duration of fruit and vegetable consumption, as well as the time required to monitor their effect on these parameters, should be more closely examined.

Keywords Cardiovascular diseases; Fruits; Vegetables; Lipids

CITATION LINKS

[1] Effect of Momordica charantia fruit extract ... [2] Low- density lipoproteins cause atherosclerotic ... [3] Dyslipidemia and cardiovascular disease risk ... [4] The vulnerable ...[5] Secular trends in serumlipid levels of a Middle Eastern adult ... [6] Prevalence of dyslipidemia in urban and rural areas of the northwest of Iran ... [7] Association of anthropometric indices with cardiovascular disease risk ... [8] The impact of health behaviours on incident cardiovascular ... [9] Fruit and vegetable intake and the risk of cardiovascular disease, ... [10] Fruit and vegetable consumption and risk of ... [11] Fruit and vegetable ... [12] Fruit and vegetable consumption and risk of lung cancer: a dose-response ... [13] Effect of fruits and vegetables on metabolic ... [14] Global Health Risks. Mortality ... [15] Health benefits of fruits ... [16] Antioxidant capacities and total phenolic ... [17] Total phenolic contents and antioxidant ... [18] Antioxidant capacities and total phenolic contents ... [19] Dietary natural products for prevention ... [20] Resources and biological activities ... [21] Fruit and vegetable consumption and risk factors ... [22] Association of fruit and vegetable intake with ... [23] Biological effects of fruit ... [24] Habitual flavonoid intake from fruit and ... [25] Influence of vitamin C supplementation on oxidative and ... [26] Vitamin C and heart health: A review ... [27] Identifying practical solutions to meet America'sfiber ... [28] Cardiovascular risk and fruit and vegetable ... [29] Ways of prevention and control ... [30] Effects of environmental intervention in workplace ... [31] Increasing employees' fruit consumption ... [32] A healthier workplace? Implementation ... [33] Exploring the dynamics of a free fruit ... [34] Environmental interventions for altering ... [35] An overview on the role of nutrition and food ... [36] Interactions between weight change ... [37] Combined effect of antioxidant supplementation and resistance ... [38] The combined effect of vitamins E and C ...[39] Effect of antioxidant vitamins on lipid profile and ... [40] Investigating the predictive power of constructs ....

Introduction

According to the report of the World Health Organization, 17.9 million people died in 2019 due to cardiovascular diseases [1]. Dyslipidemia is an important risk factor for cardiovascular diseases in more than 50% of adults [2, 3]. Blood lipid disorder is one of the major and modifiable risk factors for cardiovascular diseases [4]. Therefore, lipid disorders have predicted the incidence of cardiovascular disease among Iranians over 50 years old in recent years [5]. In the studies conducted in Iran, 80.5% of the urban population aged 15-64 years in West Azarbaijan province and 85.6% of the population aged 20-65 years in Khuzestan province had dyslipidemia [6, 7]. The results of multiple studies, including systematic reviews and meta-analyses, confirmed the relationship between fruit and vegetable consumption and reduced risk of cardiovascular disease, but some other studies found only fruit intake to be effective in reducing the risk of metabolic syndrome [8-13]. About 1% of Disability Adjusted Life Years (DALYS) and 2.8% of deaths worldwide are caused by insufficient consumption of fruits and vegetables [14]. A minimum daily intake of fruits and vegetables has been recommended for the prevention of chronic diseases. For instance, the intake of a minimum of 800 g of fruits and vegetables per day has been suggested for the prevention of coronary heart disease, stroke, and cardiovascular disease [9]. Since fruits and vegetables are a rich source of vitamins, minerals, fiber, and antioxidants, they have a protective effect on cardiovascular disease and its associated risk factors [15]. Fruits and vegetables due to their high antioxidant activity, can exert a preventive effect on some chronic diseases, including cardiovascular diseases [16-20]. Numerous studies have pointed to the inverse relationship between fruit and vegetable consumption and a decrease in low-density lipoprotein-cholesterol (LDL-C) concentration [21-23]. The intake of fruits and vegetables rich in flavonoids, which are powerful antioxidant agents, can be independently associated with a decreased level of LDL-C [24]. The results of a systematic review indicated that vitamin C, which is another type of antioxidant [25], can affect lipid profiles in some groups, especially those with low levels of plasma vitamin C [26]. Fruits and vegetables contain fiber in two forms, soluble and insoluble, and while the insoluble fiber causes people to feel full, it causes a decrease in food intake and weight loss, and finally it is excreted from the body, but its soluble type is useful in reducing blood fats, while only less than 5% of people receive the recommended amount of this type of fiber daily [27]. Therefore, these results can provide considerable support for public health recommendations and interventions to increase the consumption of fruits and vegetables to prevent cardiovascular disease, cancer, and premature deaths [9]. Increased consumption of fruits and vegetables is vital not only to maintain life but also to improve the welfare of society [28]. Considering the importance of preventive interventions and their lower cost compared to treatment, it is necessary to carry out primary prevention programs at the community level by targeting cardiovascular disease risk factors to reduce deaths caused by this disease through environmental modification and lifestyle changes [29]. The workplace is one of the suitable places, in which we can implement nutritional interventions. The workplace provides an opportunity to have access to large numbers of people who would otherwise be less likely to engage in preventive health behaviors [30-33]. In addition, these workplace interventions can successfully improve the health of different socio-economic and cultural sectors by targeting people who work at different levels of the same environment [34]. In light of the aforementioned issues, the present study aimed to assess the effect of educational intervention on fruit and vegetable consumption, as well as its effect on blood lipid parameters, in government employees working in Qaem Shahr City.

Materials and Methods

This study was registered at the Iranian Registry of Clinical Trials (IRCT20191127045527N1).

Study design

This quasi-experimental cluster-randomized controlled trial (CRCT) was conducted in two offices in Qaem Shahr (with at least 70 employees in the office) in 2021. Therefore, firstly, two offices were randomly selected as clusters for the intervention and control groups. Thereafter, participants were selected via the available sampling method from each selected department. The inclusion criteria were as follows: Being employed in the selected offices, completing the consent form to participate in all stages, not taking antioxidant tablets, such as vitamin C, E, and beta-carotene, as well as other supplements, for three months before the study, not being on a vegetarian diet, the absence of diseases, such as cancer and cardiovascular disease, kidney disease, liver disease, diabetes, infectious and metabolic diseases, and digestive diseases (based on medical documents). On the other hand, the exclusion criteria entailed unwillingness to continue participating in the study, being absent during the implementation of the intervention (for subjects in the intervention group), being absent for blood sampling, any medical requirement to use supplements or other antioxidant compounds during the interventions or suffering from diseases, such as cardiovascular, digestive, diabetes, liver, kidney, infectious, and metabolic diseases, and cancer. Employees from each office were registered in the study through notification using administrative automation. After being informed of the study objectives and assessing the inclusion criteria, 70 subjects were entered into the study by simple random. The data collection tools included a 31-item questionnaire on the frequency of fruit and vegetable consumption that was developed based on available fruits and vegetables in the region with the help of nutrition experts. Data regarding the mean consumption of fruits and vegetables per day, week, month, six months, or non-consumption were collected using this tool according to the recommended amount of each unit stated in the questionnaire. Moreover, considering the seasonal changes in the availability of fruits and vegetables, the average unit consumption of fruits and vegetables for six months before and after the intervention was extracted. The validity of this questionnaire was checked by experts from the nutrition department, and the reliability of the questionnaire was obtained at 0.71 using a test-retest method. A laboratory test was used to measure the blood lipid parameters of the subjects. In order to measure the amount of serum lipid parameters, the target groups were referred to the medical diagnostic laboratory in the first stage, before the intervention (baseline), and in the second stage (four months after the end of the intervention), observing at least 10-12 hours of fasting. In order to measure the investigated factors, 2 ml of fasting blood was taken from the target groups (intervention and control groups) using a syringe (2.5cc).

Blood samples were placed in a centrifuge for 0.5-1 hour to separate at least 0.5-1ml of serum at 2800rpm. Serum-separating tubes were from the activator type (tube clot activator red), which are used as clot activator tubes as one of the advantages of the work. Thereafter, the isolated sera were kept at -20°C until the test. The measurement of HDL-cholesterol and LDL-C was performed using a kit provided by Pishtaz Teb Company. This kit can measure HDL-cholesterol in the range of 2-150mg/dl and LDL-C in the range of 1-450mg/dl. Cholesterol and triglyceride were measured in the range of 5-500 and 5-700mg/dl by the photochromic method using the cholesterol (CHOD) and triglycerides (GPO-PAP) kit provided by Pars Azmoon Company. The intervention group was administered an eight-week face-to-face educational intervention and six online sessions (via WhatsApp and Telegram for one month) using educational materials, such as posters and pamphlets, on the importance of fruit and vegetable consumption and ways to overcome major obstacles in this regard.

No educational and environmental intervention was performed in the control group.

Data analysis

The collected data were analyzed by SPSS 22. The Chi-square and t-test were used to investigate the relationship between the underlying variables of two intervention and control groups; a t-test was employed to compare the mean blood serum lipid parameters and the mean six-month consumption of fruits and vegetables between the two interventions and control groups before and after the intervention. A sample t-test was used to compare the mean score of blood serum lipid parameters and the mean six-month consumption of fruits and vegetables in the intervention and control groups separately before and after the intervention. Also, the analysis of covariance (ANCOVA) was employed to compare the mean levels of blood lipids in the study groups, gender, and the interaction effect of the group and gender by controlling the impact of age as a confounding variable.

Findings

The mean age of participants in the intervention and control groups was 42.11±6.82 and 38.41±5.29, respectively. Other demographic characteristics are presented in Table 1. There was a significant difference between the intervention and control groups in terms of age (p=0.01; Table 1). Before the intervention, the mean six-month scores of consumption of fruits and vegetables in the intervention group and in the control group were not significant (p>0.05), Nonetheless, after the intervention, these mean values were significantly different (p<0.001; Table 2).

Table 1) Baseline characteristics of participants in the intervention and control groups

Variable		Intervention group			Control group			p-value*
		Number	Percentage	Total	Number	Percentage	Total	
Gender	Male	39	59.10	66	47	74.60	63	0.06
	Female	27	40.90		14	25.40		
Marital status	Single	9	13.60	66	12	19.00	63	0.40
	Married	57	86.40		51	81.00		
Residence	Urban	62	93.90	66	57	90.50	63	0.40
	Rural	4	6.10		6	9.50		
	10,000,000 to 20,000,000	5	7.60		5	7.90		
Monthly income[1]	More than 20,000,000 to 30,000,000	30	45.50	66	35	55.60	63	0.20
	More than 30,000,000 to 40,000,000	15	22.70		16	25.40		
	More than 40,000,000	16	24.20		7	11.10		
Age (Mean±SD)		42.11±6.82			38.41±5.29			0.01**

* Chi-square test;
** Independent t-test;
[1]. Rials

Table 2) Comparison of the mean levels of blood lipid parameters and fruit and vegetable consumption before and after intervention in two groups

Parameters		Before Intervention		After intervention		Paired t-test	
		Mean	SD	Mean	SD	p-value	t-value
Triglyceride (mg/dl)	Intervention group	131.19	70.22	139.5	69.39	0.19	-1.32
	Control group	161.73	109.4	167.15	100.87	0.6	-0.52
	t-value	-1.87		-1.8			
	p-value (independent t-test)	0.06		0.07			
Total cholesterol (mg/dl)	Intervention group	166.69	34.45	153.3	39.35	0.002	3.77
	Control group	174.28	38.23	179.25	41.84	0.1	-0.52
	t-value	-1.18		-3.63			
	p-value (independent t-test)	0.23		0.001<			
High-density lipoprotein (HDL) (mg/dl)	Intervention group	41.86	9.96	32.55	8.81	0.001<	7.98
	Control group	42.15	10.94	37.8	9.27	0.001<	14/4
	t-value	-0.15		-3.29			
	p-value (independent t-test)	0.8		0.001			
Low-density lipoprotein (LDL) (mg/dl)	Intervention group	98.76	26.43	92.85	28.57	0.06	1.9
	Control group	99.77	29.89	108.02	31.98	0.005	-2.9
	t-value	-0.2		-2.84			
	p-value (independent t-test)	0.8		0.005			
Fruit consumption	Intervention group	451.25	199.41	595.5	292.22	P<0.001	-4.39
	Control group	486.93	254.26	395.42	181.42	0.003	-3.13
	t-value	-0.88		5.11			
	p-value (independent t-test)	0.3		P<0.001			
Vegetable consumption	Intervention group	273.33	143.57	435.84	161.66	P<0.001	-6.55
	Control group	301.49	218.68	339.9	142.33	0.11	-1.62
	t-value	-0.86		3.9			
	p-value (independent t-test)	0.3		P<0.001			

Table 3) Relationship between the mean blood lipid levels according to group and gender by controlling the confounding effect of age using analysis of covariance

Dependent variable	Parameter	B	Std. Error	t	p-value	Partial Eta Square	Observed Power
Triglyceride	Age	0.43	0.99	0.43	0.66	0.002	0.07
	Intervention Group	4.58	22.53	0.2	0.83	<0.001	0.05
	Male Gender	-3.81	20.05	-0.19	0.84	<0.001	0.05
	Male Gender * Intervention Group	-6.53	26.51	-0.24	0.8	<0.001	0.05
Total Cholesterol	Age	-0.15	0.42	-0.36	0.71	0.001	0.06
	Intervention Group	-26.06	9.7	-2.68	0.008	0.05	0.75
	Male Gender	0.19	8.64	0.02	0.98	<0.001	0.05
	Male Gender * Intervention Group	14.02	11.42	1.22	0.22	0.01	0.23
High-density lipoprotein (HDL)- cholesterol	Age	0.03	0.12	0.3	0.76	0.001	0.06
	Intervention Group	-10.59	2.86	-3.69	<0.001	0.09	0.95
	Male Gender	-2.08	2.54	-0.81	0.41	0.005	0.12
	Male Gender * Intervention Group	8.76	3.37	2.6	0.01	0.05	0.73
Low-density lipoprotein (LDL)- Cholesterol	Age	-0.26	0.34	-0.76	0.44	0.005	0.11
	Intervention Group	-16.93	7.85	-2.15	0.03	0.03	0.57
	Male Gender	2.99	6.99	0.42	0.66	0.001	0.07
	Male Gender * Intervention Group	7.06	9.23	0.76	0.44	0.005	0.11

The difference in the mean serum levels of triglyceride, total cholesterol, HDL-C, and LDL-C between the intervention and control groups was not significant before the intervention (p=0.06, p=0.23, p=0.80, and p=0.80, respectively). Nevertheless, after the intervention, these mean values were significant regarding total cholesterol (p<0.001), HDL-C (p= 0.001), and LDL-C (p=0.005).

The mean total cholesterol (p=0.002) and HDL-C (p<0.001) levels in the intervention group before and after the intervention, as well as HDL (p<0.001) and LDL-C (p=0.005) levels in the control group before and after the intervention were significantly different (Table 2). The intervention and control groups did not differ significantly in the mean score of six-month consumption of fruits and vegetables before the intervention (p>0.05). Nonetheless, after the intervention, the intervention and control groups were significantly different in this regard (p<0.001). The mean score of six-month consumption of fruits and vegetables before and after the intervention in the intervention group was significantly different (p>0.05).

The mean score of consumption of fruit before and after the intervention in the control group showed a statistically significant difference and decreased compared to before the intervention (p=0.003). However, the mean score of consumption of vegetables before and after the intervention in the control group was not significantly different (p=0.11; Table 2). The covariance results showed that the mean difference in triglyceride levels considering the group, gender, and the interaction effect of group and gender was not significant (p>0.05). The mean difference in total cholesterol levels had a significant relationship with the intervention group (p=0.008). The mean difference in HDL-C levels had a significant relationship with the study groups and the interaction effect of gender and the group (p<0.001). The mean difference in total cholesterol (p=0.008) and LDL-C levels had a significant relationship with the study groups (p=0.03; Table 3).

Discussion

According to the results of a review study by Karkhah *et al.*, fiber and various vitamins, which are known as antioxidants and found in fruits and vegetables, can effectively lower the level of blood lipids and subsequently prevent cardiovascular disease [35]. This study attempted to investigate the effect of educational interventions on increasing the consumption of fruits and vegetables and, in turn, lowering the level of blood lipid parameters. The results of the present study pointed out that the educational interventions were effective in increasing the consumption of fruits and vegetables in the intervention group after the intervention and also compared to the control group. The present study proposed the hypothesis that an increase in fruit and vegetable consumption can effectively reduce blood lipid parameters. Nonetheless, a significant decrease was observed only in cholesterol and LDL-C levels in the intervention group compared to the control group after the intervention. This level of reduction in the intervention group was not significant before and after the intervention; however, in the control group, the level of the mentioned parameter showed a significant increase compared to before.

There was no significant change in triglyceride levels; nonetheless, there was a significant decrease in HDL-C levels between the two groups, as well as before and after the intervention in the same group. However, the study by Hosseinpour Niazi *et al.* on adults for 8-9 years demonstrated that fruit and vegetable intake had an inverse relationship with the risk of metabolic syndrome, which consists of elevated blood pressure, blood sugar, and triglyceride levels, as well as decreased HDL-C levels. In other words, apart from improving other metabolic factors, fruit consumption was effective in reducing triglyceride and increasing HDL levels [36]. These findings are not in line with those obtained in the present study. This discrepancy can be ascribed to differences in follow-up time to measure changes in lipid parameters; a longer period of time is probably needed to reduce the levels of triglyceride and elevate the HDL-C levels.

Nevertheless, studies on the effect of vitamin C and E supplements have reported contradictory results. For example, Bobeuf *et al.* (2011) in Canada showed a significant effect of vitamin C and E supplementation on the reduction of lipid levels in the blood after six months [37]. Malekahmadi *et al.* assessed the effect of vitamin C and E supplementation on blood parameters in the elderly, and 6 and 12 months after the intervention, no significant effect was observed between the two groups of control and intervention, as well as before and after the intervention in the same group [38].

In the study by Montazerifar *et al.*, an administration of vitamins C and E for two months in dialysis patients was effective and significant only in improving HDL-C levels [39]. Therefore, considering the different results obtained in various studies, it is seemingly better to include homogeneous participants in the study. For example, subjects should be matched in terms of age groups, presence or absence of certain underlying or chronic diseases, presence or absence of disorders in blood lipid parameters, as well as other issues that can have an impact on obtaining different results. For example, Khatti-Dizabadi *et al.* showed that gender was an effective factor in fruit and vegetable consumption in their study groups; the consumption of fruits and vegetables was higher in women than in men [40].

In this study, the mean age of the participants in the two groups was not the same; therefore, age was included as a confounding factor, and based on the results, it was revealed that the difference in the mean total cholesterol was not associated with age and gender. However, it was correlated with the participating groups. The mean difference in HDL cholesterol was not related to the age and gender of the participants in the study; nonetheless, it was associated with the study groups and the interaction effect of gender with the group. In other words, the mean level of HDL was lower in the intervention group and higher in males. In other words, in the intervention group, it was 10.59 units less than in the control group. The correlation coefficient in this model was 0.09. In other words, it explained 0.09 of the variance of the model with a test power of 0.95. Moreover, the mean difference in HDL-C levels in male participants in the intervention group was 8.76 units higher than that of females in the intervention group, as well as females and males in the control group. The correlation coefficient in this model was also 0.05; it explained 0.05 of the variance of the model with the test power of 0.73. On the other hand, the mean difference in LDL-C levels was not related to age, gender, and the interaction effect of gender and group; nonetheless, it was related to study groups. In other words, the mean difference in the intervention group was 16.93 units less than that in the control group. The correlation coefficient in this model was 0.03; it explained 0.03 of the variance of the model with the test power of 0.57. It is suggested to investigate some other factors, such as the duration of fruit and vegetable consumption, as well as the time required to monitor their effect to uncover the reasons behind its ineffectiveness in improving the level of triglyceride and HDL-C.

Strengths and limitations

One of the limitations of this study is the lack of recall of fruit and vegetable consumption during the last six months until the time of data collection, which might have affected the accurate calculation of the mean consumption of fruits and vegetables in the two groups of participants. Furthermore, strict adherence to the inclusion and exclusion criteria made it difficult to select the target group. Moreover, keeping the study groups together during the study to comply with the inclusion criteria required high accuracy, leading to the withdrawal of the participants in the second stage of the study. One of the strengths of the current study was the variety of direct and indirect educational interventions, which provided an opportunity for all participants to benefit from educational materials according to their working conditions.

Conclusion

Based on the results of this study, the consumption of fruits and vegetables is only effective in improving the levels of total cholesterol and LDL-C, but not in lowering triglyceride and HDL-C levels. Therefore, influencing factors, such as the duration of fruit and vegetable consumption, as well as the time required to monitor their effect, should be more closely examined.

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