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Fruits and Vegetables Intake Lowers the Risk of Hypertension: Does It Really Work?

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ABSTRACT

The association between fruit and vegetables (FVs) consumption and hypertension risk remains controversial. This study aims to validate a short screener of FVs intake on the Lebanese population. Based on the data collected, FVs consumption was analyzed accordingly to compare the intake between hypertensive and normotensive subjects. Cross-sectional study conducted in the greater area of Beirut. Subjects recruited were Lebanese citizens (N=300) aging 35 years old and above adjusted for age (N=150 participants < 65 years old and N= 150 participants ≥65 years old) and gender (equally distributed between men and women). Descriptive Statistics, Chi Square test, Alpha Cronbach test, and Binary Logistic tests were conducted. FV consumption was high in subjects with hypertension compared to normotensive subjects who have low adherence to the 5 servings/day of FV recommendations. Also, there was no difference observed between genders concerning FV intake. The internal consistency test shows that the questions used in this questionnaire were not consistent thus; some modifications should be implemented to adjust this questionnaire appropriately to the population studied. High fruits and vegetables intake was associated with an increased risk of hypertension. While the mechanism of blood pressure variation via fruit and vegetable consumption is not yet clear, selective consumption of healthy foods and nutrients, maintaining a healthy body weight, and staying physically active may lead to prevention and treatment of hypertension. As for the questionnaire's validity, more culturally adapted options should be added to the screener in a way that satisfies FV consumption of the Arabian world in general, and that of the Lebanese population specifically.

Introduction

High blood pressure (BP) is a major independent risk factor for cardiovascular diseases [1]. According to the WHO (World Health Organization) report, worldwide raised blood pressure is estimated to cause 7.5 million deaths, which is equivalent to about 12.8% of the total deaths. This accounts for 57 million disability adjusted life years (DALYs) or 3.7% of total DALYs [2]. Globally, around 22% of adults aged 18 and over had raised blood pressure in 2014. In Lebanon, and based on the Non-communicable disease (NCD) report of the WHO, the prevalence of hypertension was reported to be high which is equivalent to 28.8% [3]. Several risk factors for hypertension were reported including obesity, genetic factors, physical inactivity, and dietary factors (salt, fat, and alcohol) [4, 5, 6, 7]. Among the preventive factors, it is well acknowledged that dietary factors play a prominent role in the modulation of BP in hypertensive or normotensive individuals [8, 9, 10, 11, 12, 13, 14, 15,16]. Fruits and vegetables consumption has been shown to have a powerful association with lower levels of blood pressure and a lower risk of hypertension. The intake of potassium, calcium, magnesium, fiber, and protein, derived from plants, has also been shown to be associated with lower levels of BP [17, 18, 19]. Evidence is limited, however, on the associations between FVs consumption and BP. While some studies showed an inverse association between FV consumption and a reduced risk of hypertension [20, 21, 22, 23, 24, 25], Lin et al found a significant relationship between FV consumption and an increased risk of hypertension [26] and a neutral relationship was found between FV consumption and the risk of hypertension in many other studies [27, 28, 29, 30]. In the current study, we aimed to validate a translated short screener of FVs intake "Fruit and Vegetables in your Diet" for estimating servings and habitual intake of FVs. The data collected was further utilized to investigate the cross-sectional consumption of FVs among Lebanese hypertensive and normotensive participants.

Materials and Methods

Participants

Data collection started in February 2016 and ended in June 2016. A total of 300 Lebanese subjects aged ≥35 years old were randomly recruited from the Greater Area of Beirut region. Of those recruited, 150 subjects were normotensive defined as having undiagnosed hypertension with no previous or current medical treatment for hypertension or Systolic Blood Pressure (SBP) ≥140 mmHg and/or Diastolic Blood Pressure (DBP) ≥90 mmHg along with another 150 subjects diagnosed with hypertension or treated with antihypertensive treatment [31]. The participants were matched by age and gender in both groups: 75 persons, of both genders, aging below 65 years old were grouped into normotensive and hypertensive categories and 75 persons of both genders aging above 65 years old were grouped into normotensive and

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hypertensive categories. The allocations of recruitment, within Beirut, were: Mar Antonios Dispensary in Jdeideh, Borj El-Barajneh Dispensary, Al-Sahel General Hospital, Al-Hara PHC, Lebanese University, and other regions in Beirut's Suburb.

Assessment of fruit and vegetable intake

On the baseline questionnaire entitled "Fruit and Vegetables in your Diet" [32], participants had to respond to the questions embedded in two major parts. The instrument was translated to the Arabic Language but not cross-culturally adapted to the Lebanese population. The first part of the screener estimated the servings consumed of FV. The participants had to respond to four questions. Fruits' (including juice) and vegetables' (raw and cooked) intake was assessed through a score that computed the number of servings (or cups) consumed daily/weekly. Options ranged between As, Bs, Cs, and Ds. As for interpreting the score, the following was considered: Mostly As: eating 5 or more servings of fruits and vegetables per day; Mostly Bs: Just about meeting the recommendations of a minimum of 5 servings of fruits and vegetables per day; Mostly Cs: Not eating enough fruits and vegetables per day; Mostly Ds: Not eating enough fruits and vegetables per week. The response to the four questions was then added qualitatively. But in order to analyze the results numerically, we developed a subjective "**Servings score**" characterized by two options: <5 servings, when responses are mostly Bs, Cs, and Ds, and ≥5 servings for those having mostly As. The second part of the questionnaire estimated the habitual intake of FV. Options for fruits questions (4) include: consuming a fruit as a snack, with breakfast, as a part of lunch or dinner, or in a dessert; while options for vegetables questions (4) include: consumption as a snack, portions with the main meal, a side salad with the main meal, or as a vegetable-based meal.

Assessment of Hypertension

Participants recruited were proved to be hypertensive if they had one of the following criteria: a physician diagnosis of hypertension, initiated anti-hypertensive treatment, self-reported SBP elevated to ≥140 mmHg or DBP elevated to ≥90 mmHg. The participants had to respond for both questionnaires: the Hypertension-related questionnaire and the Fruits and Vegetables consumption-related questionnaire. The Hypertension-related questionnaire was developed and validated by the WHO and is entitled "Questionnaire for hypertensive patients" [33]. It contains 5 titles (diagnosis of hypertension, management, complications and hospitalization, Medications and adherence, and knowledge and self-care) and 23 questions embedded in the titles.

Both questionnaires were administered by the interviewer/researcher. Descriptive statistics were performed to analyze the responses for each questionnaire.

Ethical Standards Disclosure

The study received an approval from the "Ethical committee of the Lebanese University". The response to the initial questionnaire was considered as an informed consent to participate voluntarily in the study.

Statistical Analysis

Means and standard deviations for continuous variables and the frequencies and percentages for categorical variables were analyzed.

To examine the association between the consumption of fruits and vegetables in hypertensive and normotensive, we conducted the chi square test.

Binary logistic regression was used to test the association between the FV consumption and habitual intake using OR and 95% CI.

To validate the translated FV screener in the Arabic Language and on the Lebanese population, we conducted the α-Cronbach test to evaluate the screener's degree of internal consistency. Statistical analyses were performed by IBM SPSS (Statistical Package for the Social Sciences) version 23.

Results

Descriptive Statistics

Among 150 normotensive subjects, the mean age of men was 64.85 ± 11.33 years compared to 62.73 ± 11.15 years in women (p =0.25). More than 60% of men and women consume <5 servings/day of FV (Table 1). As for the habitual intake of FV, most of the normotensive subjects (49%) reported eating fruits "often as a snack", 43% eat "sometimes" fruits as breakfast, 49% eat "sometimes fruits on lunch and dinner" and 62.7% never eat "fruits with sweets". As for the vegetable intake, only 2% consume "regularly vegetables as a snack", 8.7% consume "regularly vegetables with meals", around 50% eat "often salads" and only 8.7% consume "regularly vegetables as soup".

Table 1. FV Consumption Screener for Normotensive Participants.

FV Consumption Scores	Normotensive Participants		
	Women (n=75)	Men (n=75)	
N	150		p-value*
Age (years old)	Mean (μ) ± SD 62.73 ± 11.150	Mean (μ) ± SD 64.85 ± 11.326	0.25
FV consumed Servings: <5 servings ≥5 servings	N (%) 45 (60) 30 (40)	N (%) 47 (63) 28 (37)	0.737

All values were expressed as mean ± Standard Deviation for continuous variables or subject number and percentage in the parenthesis for categorical variables.

* p-value was obtained using Chi2 test

Among 150 hypertensive persons, the mean age of men was 63.39 years ± 11.93 years compared to 63.63 ± 11.52 years in women (p =0.9). 70% to 75% of men and women consume ≥5 servings/day (Table 2). As for the habitual intake of FV, the majority (47%) reported eating fruits " often as a snack", 63% never consume "fruits on breakfast", 47% eat fruits "sometimes on Lunch and Dinner" and 78% reported no intake of "fruits with sweets". As for the vegetable intake, 18.7% consume "regularly vegetables as a snack", 43.3% consume "regularly vegetables with meals", 46.7% also consume "regularly salads" and 12% consume "vegetables as a soup" on a regular basis.

Table 2. FV Consumption Screener for Hypertensive Participants.

FV Consumption Scores	Hypertensive Participants		
	Women (n=75)	Men (n=75)	
N	150		p- value*
Age (years old)	Mean (μ) ± SD 63.63 ± 11.524	Mean (μ) ± SD 63.39 ± 11.934	0.9
FV consumed Servings: <5 servings ≥5 servings	N (%) 19 (25) 56 (75)	N (%) 22 (29) 53 (71)	0.583

All values were expressed as mean ± Standard Deviation for continuous variables or subject number and percentage in the parenthesis for categorical variables.

* p-value was obtained using Chi2 test

Associations of FV consumption with Blood Pressure

Table 3 describes FV consumption between both groups: Normotensive (N=150) and hypertensive (N=150) participants. Mean age is adjusted between both groups. The analyses of the FV consumption, in terms of servings, show that 61.3% of normotensive subjects consume <5 servings/day compared to 27.3% in hypertensive subjects (p<0.001). Moreover, 38.7% of normotensive subjects consume ≥5 servings/day compared to 72.7% of hypertensive subjects (p<0.001). In terms of the habitual intake, the differences between hypertensive and normotensive were investigated. There was no difference between subjects with hypertension and normotensive in terms of eating "fruits as a snack" (p=0.270). However, most subjects with hypertension do not consume "fruits on breakfast", which it is not the case for the majority of normotensive who consumed fruits "sometimes" on breakfast (p=0.001). Also, among those who never consumed "fruits on lunch and dinner", the percentage of normotensive subjects was the highest (p=0.004). Small number of subjects with hypertension consumes "sometimes fruits with sweets" compared to a greater number in those without hypertension (p<0.001). Most of normotensive subjects "never" consume vegetables (p<0.001) as a snack but "sometimes" with meals (p<0.001) compared to hypertensive subjects who did the contrary. Concerning salads and soup, both groups of subjects consumed it similarly (p>0.05).

Table 3. Comparison of FV Consumption between Normotensive and Hypertensive Participants.

FV Consumption Scores	Participants		
	Normotensive (n=150) Hypertensive (n=150)		
N	300		
Age (years old)	Mean (µ) ± SD 63.79 ± 11.251	Mean (µ) ± SD 63.51 ± 11.692	
FV consumed Servings:	N (%)	N (%)	p-value*
<5 servings	92 61)	41 (27)	<0.001
≥5 servings	55 (39)	109 (73)	<0.001

All values were expressed as mean ± Standard Deviation for continuous variables or subject number and percentage in the parenthesis for categorical variables.

* p-value was obtained using Chi2 test

To evaluate the FV intake between normotensive men and women, Chi-Square test was performed. Results show no statistically significant difference, between men and women, in servings consumed (p=0.737) and habitual intake of FV (p=0.116). Similar results were obtained for hypertensive subjects concerning the servings consumed (p=0.583) and habitual intake of FV (p=0.099).

An unadjusted binary logistic regression showed that normotensive subjects have 0.23 times low adherence to the recommendations of 5 servings of FV/day compared to hypertensive subjects [OR=0.23- 95% CI (0.14-0.38)]. The adjusted backward binary logistic regression by gender shows that gender do not control the differences in FV intake between hypertensive and normotensive [(OR=1.16-95% CI (0.71-1.89)].

Table 4. Unadjusted odds ratios (OR) and 95% confidence intervals (CI) for the consumption of FV between Hypertensive and Normotensive participants.

	Level	Odds Ratio (OR)†	95% Confidence Interval†	p-value*
FV Servings	<5 servings ≥5 servings	1.0 0.237	0.146 – 0.386	0.000

* p-value was obtained using Chi2 test

† OR and 95% CI were obtained using Binary Logistic Regression

Questionnaire validation

To assess the internal consistency of the FV consumption questionnaire, Cronbach α test defined as poor ≤0.50, moderate 0.51-0.69, and high ≥0.7, was established. The internal consistency of the screener showed an α coefficient = 0.453.

Discussion

FV consumption screener

Our results show that FV consumption was high in subjects with hypertension compared to normotensive subjects who have low adherence to the 5 servings/day of FV recommendations. Also, there was no difference observed between genders concerning FV intake. The internal consistency test shows that the questions used in this questionnaire were not consistent thus; some modifications should be implemented to adjust this questionnaire appropriately to the population studied.

It has been well recognized that high FV consumption is associated with a reduction of blood pressure in Western countries; however, there is little evidence about these associations in other regions. Dietary intervention trials [9, 16, 34, 35] including the Dietary Approaches to Stop Hypertension, DASH trial [9], have demonstrated a short-term BP-lowering effect of increased fruit and vegetables consumption. Of prospective observational studies, the Health Professionals Follow-up Study [36] and the Nurses' Health Study [10] previously reported that high baseline intake of FV was associated with lower BP as well as lower risk of hypertension after 4 years of follow-up. The "Coronary Artery Risk Development In Young Adults" - CARDIA - study found that baseline FV intake was inversely correlated to 15 years incidence of elevated BP among young adults [37]. In the Chicago Western Electric Study, baseline FV intake was inversely related to 7-year BP change among middle-aged men [12]. Among Spanish participants in the Seguimiento University of Navarra (SUN) project, an inverse association between FV intake and risk of hypertension was found particularly for those who consumed low levels of olive oil [29]. In a recent Japanese study, high intake of fruit, but not vegetable, was associated with a lower risk of future hypertension among subjects without baseline hypertension [38]. A cross-sectional study (The INTERMAP Study) among American participants showed that higher intakes of fiber, especially insoluble, may contribute to lower BP, independent of nutrients associated with higher intakes of fiber-rich foods.

On the other hand, different studies found either a negative or a neutral association between FVs consumption and blood pressure. In the cohort study "Fruit and Vegetable intake and the risk of hypertension in middle-aged and older women", Wang L. et al found that a higher intake of FV, as part of a healthy dietary pattern, may only contribute to a modest

beneficial effect of hypertension prevention, possibly through improvement in body weight regulation [27].

Another study was conducted by Fan et al. who found out that compared to normotensive subjects, hypertensive participants on medical treatment were less likely to consume five or more servings of fruit and vegetables per day, be current smokers, and binge drinkers [28]. Lin LP et al found that the factors of older age, being overweight or obese, the waist circumference, and FV intake were variables that could significantly predict the hypertension condition of the subjects and that FVs consumption was significantly associated with an increased risk of hypertension [26]. The findings of this study came hand in hand with our results.

In line with these findings, our results strengthen evidence for a negative association between total fruit and vegetable intake and hypertension, in which hypertensive participants were consuming more FV servings/day and have incorporated this consumption as a habitual intake compared to the normotensive subjects. This association was supported by the logistic regression test in which subjects who consumed more than 5 servings of fruits and vegetables/day are 0.23 times more exposed to be hypertensive than those consuming <5servings/day.

Questionnaire's validity

As for the questionnaire's validity, Chronbach Alpha test showed that more culturally adapted options should be added to the screener in a way that satisfies FV consumption of the Arabian world in general, and that of the Lebanese population specifically. Some suggestions to improve the questionnaire are adding the following options: Body Mass Index, BMI (underweight, normal, overweight, obese) based on reported weight and height, Socio-demographic information: Residency (living with family, living alone), planning of a typical day food menu (family member/chef/peer, myself), Activity level (not exercising, irregularly exercising, and regularly exercising), current smoker (Yes, No), Alcohol drinker (No, Yes: specify quantity), and more options related to FVs consumption that has been proved to have an effect on blood pressure [27]: fruits intake (apples, bananas, oranges, raisins, strawberries, blueberries: none/rarely – 1-3 servings/month – 1 serving/week – 2-4 servings/week - >4 servings/week) and vegetables intake (green-leafy vegetables, cruciferous vegetables, dark-yellow vegetables, legumes, onions, and tomatoes: <0.2 servings/day – 0.2-0.4 servings/day – 0.4-0.6 servings/day – 0.6-1.0 servings/day - ≥1.0 serving/day).

To our knowledge, this is the first national study correlating the fruits and vegetables consumption with the risk of an elevated blood pressure, and for validating a translated questionnaire in the Arabic language on the Lebanese population.

Several limitations merit discussion: First, its cross-sectional design makes causal inferences not possible. Second, the sample size was small and time frame was short and thus the results can't be generalized on the whole population. A third limitation is self-reporting, where reliability and validity of self-reported information commonly depend on participants' honesty. Finally, the findings were based on a short form of dietary assessment. Details about the type and variety of fruits and vegetables typically consumed by this population are therefore unknown.

Conclusion

In conclusion, results from this cross-sectional study showed that a high fruits and vegetables intake was associated with an increased risk of hypertension. While the mechanism of blood pressure variation via fruit and vegetable consumption is not yet clear, selective consumption of healthy foods and nutrients, maintaining a healthy body weight, and staying physically active may lead to prevention and treatment of hypertension.

What was already known before the study	What information this study adds to the existing knowledge
DASH Diet (≥5 servings/day fruits and vegetables) helps in decreasing blood pressure.	Non-hypertensive people are at an increased risk of being hypertensive upon Increased fruits and vegetables consumption (≥5 servings/day)

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Contributors

i) Authors' Contribution: All authors have contributed to the design, conduct of the study/data collection, interpretation of data and writing of the manuscript.

ii)Conflict of interest: The authors declare no conflict of interest.

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