A brief educational intervention on the consumption of fruits and vegetables and physical activity improves healthy habits in university students

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Abstract

Background The aim of this study was to determine the nutritional status and physical activity of 70 university students before and after an educational intervention consisting of World Health Organization (WHO) recommendations on fruit and vegetable consumption and physical activity.

Methods The nutritional diagnosis was carried out by measuring body composition using anthropometric measurements. A survey was also carried out on the consumption of fruit and vegetables and the time involved in regular physical activity per week. The physical condition of participants was evaluated using the Harvard step test. One year after the intervention, the participants were invited back for a second assessment using the same tools as previously.

Results The results showed that the intervention had a positive effect on healthy lifestyle habits since they increased the percentage of compliance with the recommendations of physical activity, by 16% in men and 9% in women. In addition, the intake of fruits and vegetables increased by 14% and 12% respectively.

Conclusions It was concluded that these improvements, although discrete and far from reaching the recommendations proposed by WHO, provide a basis for designing and implementing strategies that increase the percentage of adherence to healthy living habits through low-cost and easy to adopt interventions.

Background

It is estimated that 80% of deaths from non- communicable chronic diseases (NCDs) occur in low- and middle-income countries. Chronic diseases include heart disease, strokes, cancer, chronic respiratory diseases and diabetes mellitus [1]. These diseases are, in large part, the result of an inadequate diet, physical inactivity, tobacco consumption and excess of alcohol [2]. The WHO has estimated that up to 2.7 million lives could be saved annually if people had sufficient consumption of fruits and vegetables. On the other hand, a low consumption of these foods has been linked as one of the 10 most important risk factors for contracting diseases that cause the highest mortality worldwide [3]. These facts generate a high economic burden, as well as social dependence and physical disability. This generates a high economic burden, as well as social dependence and physical disability in people of these countries [4].

It has been shown that regular physical activity reduces the risk of coronary heart disease and stroke, type II diabetes, hypertension, colon cancer, breast cancer and depression, and helps to achieve energy balance and weight control [5]. On the other hand, adequate consumption of fruit and vegetables can prevent micronutrient deficiency and reduce the risk of heart disease, obesity, diabetes and cancer, specifically gastrointestinal cancer. In order to encourage the incorporation of physical activity and fruit and vegetable consumption as part of a healthy lifestyle, in May 2004, the WHO adopted the global strategy on diet, physical activity and health for the prevention and control of NCDs [6]. The goal for physical activity in adults aged between18 and 64 was estimated at a minimum of 150 minutes of moderate aerobic physical activity, or 75 minutes of vigorous aerobic physical activity each week or an equivalent combination of moderate and vigorous activities [5]. As for the consumption of fruit and vegetables, the goal for the population over 2 years old is an intake of at least 400 g of these foods each day, which equals five servings, for example three of fruit and two of vegetables [6].

Adopting healthy habits is essential in order to maintain good health and avoid the risk of those diseases [7]. For university students, many of whom come from different cities in the country with diverse eating habits, it is complex to follow healthy guidelines. According to them, the lack of time to cook, eat or prepare healthy foods. In addition, the change from a regular routine of physical activity at school level to a routine of physical inactivity and full-time academic commitments, make it difficult to comply with the recommendations [8].

The objective of this study was to determine the nutritional status and physical activity of students benefiting from the food subsidy from the University of Caldas and carry out an educational intervention in compliance with the WHO recommendations related to physical activity and consumption of fruit and vegetables [2].

Methods

From 2014 to 2015 a prospective longitudinal study was conducted, with volunteers from different faculties of the University of Caldas in Manizales, Colombia. In the first assessment, 103 students were examined. The criteria to be included in the study were being an active student in this institution, being between 18 and 40 years old and receiving nutritional support with a lunch from Monday to Friday. The exclusion criteria were being pregnant or having any physical condition that prevented the potential participants from undergoing the tests. The procedures were approved by the ethics committee of the Faculty of Health. The intervention was carried out with 30 female and 40 male students who completed the second assessments.

The measurements were taken in the nutritional assessment laboratory under previously standardized environmental procedures and conditions. Anthropometry was carried out according to the protocol from the American Society of Hand Therapists [9, 10] and physical condition using the Harvard step test. Waist and hip circumferences, weight, height, bicipital, tricipital, subescapular and suprailiac skinfolds, hand grip strength and physical condition were measured. From these data, Body Mass Index (BMI) (kg/m^2), waist/hip ratio (WHR), body fat percentage (% body fat), Hand Grip Strength Test (HGST) (kg/f) and Brohua Index (BI) were calculated [11]. After taking the measurements, individuals reported their daily or weekly consumption of fruits and vegetables in terms of servings after the meaning of a serving of fruit or vegetables was explained to them. Each person received their results in a pre-coded format, and they were interpreted according to the WHO reference values for the BMI [12], % body fat [13] WHR by Colombian government, [14] HGST [15] and BI according to the correspondent equation (BI= Duration of exercise in seconds x 100/2 x sum of pulse counts in recovery) and the following table (Table 1) for interpretation [11]:

Table 1. Interpretation of the BI results.

Rating	Fitness Index
Excellent	> 90
Good	80-89
High Average	65-79
Low Average	55-64
Poor	< 55

Intervention

The intervention was an individualized face to face individual educational talk for 20-30 minutes. It consisted on explaining each person's results to emphasize their own deficits and needs. Their results were interpreted according to reference values described in methods section.

Everyone was instructed on the basic recommendations of a healthy lifestyle according to WHO [3] and five very detailed reasons why it is important to consume at least 5 daily servings of fruits and vegetables: water soluble vitamins, minerals, water, fiber and polyphenols content [16]. They were also instructed on the need to diversify their consumption taking into account the meaning of the different colors and the antioxidant, anti-inflammatory and anti-neoplastic power that they represent. In addition, they were informed about the positive effects related to a higher intake of fruits and vegetables. Because so many students argued that fruits were expensive, a comparison was made between the price of a fruit such as banana or guava and a package of potato chips which can be up to 5 to 6 times more expensive in this low-to-middle income country.

Based on the physical activity guidelines for Americans, 2nd edition, the participants were also instructed to get a minimum of 150 minutes per week of moderate aerobic activity or 75 minutes per week of vigorous aerobic activity for two days a week [17]. Additionally, each student was explained the need to combine the above with a resistance muscle strengthening activity with weights twice a week. Emphasis was placed on the scientific evidence that shows a very close relationship between physical activity and immunological, physical, and mental well-being. They were also asked how they were transported to the university and encouraged to go to the university on foot. They were also encouraged to go down a few blocks before arriving at their destination so that if they used public transportation, they would walk at least a couple of blocks, and use every opportunity to walk.

Those who had their measurements in normal ranges and complied with the recommendations were congratulated and invited to continue their good habits. People with one or more of the examined parameters altered, were explained the long-term consequences especially related to NCDs, academic performance and cognitive impairment.

Participants follow-up

After one year, the same above measurements were made and a survey was performed to establish the effect of the intervention performed the previous year. The questionnaire included questions about consumption of fruit and vegetables, amount of physical activity performed before and after the intervention and perceived changes when they had a variation in their habits.

Statistical analysis

The data were analyzed using the statistical software XLSTAT version 2014.3.07 licensed for the University of Caldas. Data were expressed as means and standard deviations. For the comparison of means, before and after the educational intervention, the student's t-test was applied for paired samples. For computing the statistical significance of the hypotheses, a two-tailed test was developed. A significance of 5% was used. In addition, the data were analyzed by principal component analysis (PCA) for men and women independently.

Results

70 people finally participated in the study (30 female / 40 male), with an average age of 21(3) and 22(4) and a BMI of 22.05(3.5) and 21.9(2.6) kg/m^2 for women and men respectively. During the second evaluation of fitness test, four women and one man had constraints which prevented them from being involved. The characteristics of the participants at the

beginning and at the end of the study are reported in Table 2. Significant favorable changes were observed in all variables except the BI for both sexes, % body fat in women and WHR in men.

Table 2. Anthropometric parameters, fruit and vegetables consumption and exercise time before and after the intervention.

	Women n= 30			Men n= 40		
	Before	**After**	**p-value**	**Before**	**After**	**p-value**
FVC (# of portions)	1.3 (1.1)	2.0 (0.9)	0.011	1.3 (0.9)	1.8 (1.0)	0.017
Exercise time (min)	40.4 (50.6)	146.0 (65.4)	0.000	75.8 (71.0)	162.3 (58.8)	0.000
Weight (kg)	54.4 (8.8)	57.4 (8.5)	0.000	63.2 (8.2)	68.5 (8.6)	0.000
BMI (Kg/m2)	22.1(3.5)	23.1(3.2)	0.001	22.0 (2.7)	23.7 (2.8)	0.000
Body fat (%)	31.3 (3.6)	30.6(2.1)	0.217	18.9 (4.4)	20.0 (3.7)	0.016
WHR	0.7 (0.1)	0.8 (0.1)	0.047	0.8 (0.1)	0.8 (0.1)	0.502
HGST (Kg/f)	23.9 (3.9)	25.8 (4.6)	0.001	35.2 (6.0)	41.7 (6.3)	0.000
BI	78.0 (21.0)	73.2 (32.7)	0.381	73.9 (30.7)	71.0 (23.6)	0.241

For the comparison of means, before and after the educational intervention, the student's t-test was applied for paired samples. A significance of 5% was used.

FVC, Fruits and vegetables consumption.

Data are mean and Standard Deviation (SD).

The results obtained show that, on average, both men and women had a normal BMI. However, women showed high values (>30%) for % body fat, while men had acceptable values (≤20%). Both, men and women did not reach the percentage of strength (>85%) referenced for their age and sex and the WHR showed that women were at the upper limit of reference, while men were below it.

Regarding physical condition, the BI showed that women had a physical status classified as "good" while men were classified in the "average" category. Exercise time increased after the intervention in both women and men; however, only 26% of men complied with the recommendations of physical activity of the WHO. The average for all men was of 68 minutes per week (45.3% of the recommended level). After the intervention, 42% of participants already fulfilled the recommendation, raising the average physical activity to 98 minutes per week (65.3% of the recommended level). Likewise, before the intervention, only 20% of women complied with the physical activity recommendations and the average for this group was of 54 minutes per week (36% of the recommended level). After the intervention, 29% of them already fulfilled the recommendation, raising the average physical activity to 77 minutes per week (51.3% of the recommended level) (Fig. 1).

Regarding the consumption of fruit and vegetables, the average consumption at the beginning of the study for all participants was 1.3 portions and at the end, 2.0 and 1.8 for men and women, respectively. This reflects an increase in consumption of 53% and 38.4% respectively. Despite this, after the intervention, only 12% of women and 14% of men consumed the 5 servings recommended by WHO (Fig. 1).

Fig. 1 Changes in exercise time per week and in the consumption of fruit in men and women.

* p<0.01 *** p<0.0001.

Students who followed at least one of the WHO recommendations noted some physical and emotional changes. In women there was improvement in the perception of physical and mood well-being. 28% of female respondents said they felt an increase in energy, 16% an improvement in their physical condition, 15% noticed some loss of weight, 14% improved digestion, 7% the appearance of the skin, 4% increased concentration and 3% in the quality of sleep. Additionally, 5% reported a decrease in stress. The men reported improvement in the perception of physical and mood well-being. 30% of male respondents said they felt an increase in energy and 22% an improvement in their physical condition, 8% in their digestion, 9% in their strength, 4% in their concentration, 3% in sleep quality, 10% noticed an increase in muscle mass, 5% in weight increase and 4% reported a decrease in stress.

The data were subjected to a PCA by sex. Bartlett's sphericity test showed that there were differences between the variables (p<0.001 for women and men), which allowed the PCA to be performed.

Three main components had eigen values greater than 1.0, which were used for subsequent analysis. These components explained 66.9% and 64.4% of the variance for women and men respectively (Table 3). Variables with a factor load >0.4 were considered a good contribution to the component.

Table 3. Total variance explained by the components

	Women			Men		
	EXC	FV	FV and EXC	BC	FV and EXC	HGST
Eigen value	2.326	1.251	1.107	1.883	1.608	1.019
Variability (%)	33.233	17.874	15.809	26.907	22.971	14.551
% accumulated	33.233	51.107	66.916	26.907	49.878	64.430

Data are mean and SD.

FVC, Fruits and vegetables consumption; EXC, exercise time; BC, Body Composition.

For women, the first component explains the greater variance (33.23%), where BMI (34.78%), % body fat (23.6%) and exercise (15%) contributed positively to the component. In the second component, those who contributed the most in a positive way were fruit consumption (24.8%) and BI (36%), HWR contribution was (22.3%) in a negative way. For women, the first component was related to exercise time, the second with fruit consumption and the third with both. As for men, the first component was related to body composition, the second with fruit consumption and exercise time, and the third with HGST. In the third component, fruit consumption and exercise time (49.6% and 20.4% respectively) contributed positively (Table 4).

Table 4. Correlation matrix between variables and components obtained

	Women			Men		
	EXC	FV	FV and EXC	BC	FV and EXC	HGST
FVC	-0.004	0.557	0.741	-0.080	0.459	-0.212
EXC (min)	0.599	0.092	0.476	-0.014	0.600	0.142
BMI (Kg/m^2)	0.900	-0.161	-0.235	0.872	0.208	-0.212
Body fat (%)	0.742	0.340	-0.177	0.856	-0.214	-0.340
HWR	0.552	-0.529	0.307	0.605	0.193	0.628
HGST (Kg/f)	0.550	0.245	-0.200	-0.134	0.606	-0.566
BI	-0.004	0.672	-0.331	0.015	0.738	0.278

Data are mean and SD.

FVC, Fruits and vegetables consumption; EXC, exercise time.

For men, the first component contributed to 26.9% of the total variance explained, with the variables that most contributed to the component in a positive way being the BMI (40.4%), the fat % (19.8%) and the HWR (19.5%). In the second component were BI (33.8%), HGST (22.9%) and year (22.4%). In the third component, those that contributed the most were HWR (38.7%) in a positive way and HGST (31.5%) in a negative way. The first component was related to body composition, the second to exercise and fruit consumption and the third to HGST.

In the factorial plans constituted by components 1 and 2 for women and men, it was observed that in women there was a direct relationship between the consumption of fruit and vegetables and the BI after the intervention (the higher the consumption of fruit the more the BI improves), independent of body composition (BMI, HWR, % body fat) and HGST (Fig. 2).

For men, fruit and vegetables consumption and exercise showed a direct relationship with the BI and the HGST (higher consumption of fruit and exercise time improves HGST and BI), independent of body composition (BMI, HWR, % body fat) (Fig. 2).

Fig. 2 Factorial drawings of axes 1 and 2. A Women, B Men. F, fruit; V, vegetables.

Discussion

Various strategies have been used to promote healthy eating and physical activity habits in university students such as taking advantage of public university restaurants, teaching courses to improve culinary skills, using a food pantry, or even offering a monetary incentive [18-21]. The effects are still unsatisfactory, and more alternatives are required to improve them [22, 23].

This study wanted to take advantage of those obtained by the university students during an evaluation of the nutritional status of students who received a food subsidy to try to sensitize them to a greater consumption of fruits and vegetables and the performance of regular physical activity according to the recommendations of the health authorities at the world.

The results showed that indeed, the majority indeed most of the students (74.5%) did not comply with the WHO recommendation since they only consumed between one and two servings of fruits and vegetables per day. This is consistent with studies [24, 25] in Chilenian university students where they found that only 5% of their students reached the goal of 5 daily servings, while in the present study 2% did.

On the contrary, a study conducted at Universidad del Valle and Universidad ICESI in Colombia, found that 15% of the students surveyed followed the recommendations [26].

In addition to contributing to the prevention of NCDs, the consumption of fruit and vegetables exerts beneficial effects by providing micronutrients such as vitamins A, C, folic acid and minerals, as well as the presence of dietary fiber and some photochemical that contribute to the maintenance of good health [27]. The low intake of these foods has been associated with a decrease in manual prehensile force [28]. This is could be the reason why 90% of men and 84% of women did not reach the level of strength required at the start of the study.

In general, Colombian population has a low consumption of fruits and vegetables and a high consumption of refined cereals, fats and sweets with the risk of gaining weight and generating vitamin and mineral deficiencies. Thus, in this country, the highest prevalence of low vitamin A intake occurs in the university community, reaching 80% [29]. Therefore, it is necessary to break down barriers that students mention and prevent them from fully complying with the proposed recommendations. Socioeconomic factors, influence of the eating behaviors from family and friends, lack of information regarding following a healthy diet and lack of time are the main reasons they argue [21].

Despite the poor compliance with the recommendations for fruit and vegetables consumption by students from the University of Caldas, there was a positive effect of the intervention with a change in the percentage from 2% to 13% of students who reached the goal in this aspect. However, this figure is much lower than in United States where 40% of the population manages to meet the proposed goals [30].

Twenty-six % of men and 20% of women said they were doing physical activity for at least 30 minutes, 5 times or more per week and this value is similar to that found by Olivares and Lera [24] who report 25% in men and 16% in women. The data also resemble those of a study conducted in Colombia at Universities in Cali, Bogotá, Manizales and Tuluá, in which the authors concluded that only 22.2% of students perform physical activity [22]. It was evidenced that men carried out a higher percentage of physical activity than women. This pattern is repeated in Chile where men performed 15% more physical activity than women [8]. This behavior could be caused by the fact that, culturally, women have been assigned to care of family members, reducing the chances of having enough time for themselves [31].

Students who complied with the recommendations of physical activity perceived a physical and mental well-being, possibly associated with the release of neurotransmitters such as serotonin, dopamine and norepinephrine that have been associated with memory recovery and a better mood [32].

The results obtained in this study suggest that an educational intervention constitutes an effective action to achieve a better adherence of university students to the recommendations of a healthy lifestyle. It is probable that the individualized intervention, together with the interpretation of its results immediately after obtaining them, evidencing in many cases that the students had deficits in their muscular strength, excess fat or poor physical condition, was moderately effective in sensitizing the students towards healthier habits.

A study carried out with individuals aged between 18 and 24 through a course to promote fruit and vegetables consumption in 2006 produced a significant increase in the consumption of fruit and vegetables ($p<0.005$**) and a reduction ($p<0.05$**) of the consumption of chips [33].

On the other hand, another study with university students determined that after 2 years, an educational intervention was not effective in promoting long-term physical in men, although in women there was an improvement in behavior related to

physical activity. The intervention consisted of offering a general health course to the students as well as a guidance through emails and phone calls [34]. A systematic review published in 2002, with the aim of evaluating the effectiveness of a variety of approaches to increase physical activity (informative, behavioral, social, environmental and political) concluded that there is sufficient evidence that physical education in school is effective in increasing physical activity levels and improving physical condition [35].

The study has some limitations. There was no control group to compare the results. This was due to the fact that the students belonged to a university subgroup that received support from the University for belonging to low socioeconomic strata and all of them underwent the same intervention. This is also why the results can only be applied to this subgroup of people. However, these circumstances are similar in the country's state universities and the results could be a reference for taking similar actions to those in this study.

Conclusion

Although the improvements in fruits and vegetables consumption and physical activity carried out in this study were discrete and are still far from complying with the recommendations proposed by WHO [2], the results provide a basis for designing and carrying out strategies that increase the percentage of adherence to healthy lifestyle habits through low cost interventions and easy application.

Abbreviations

WHO: World Health Organization

NCDs: Non- communicable Chronic Diseases

BMI: Body Mass Index

WHR: waist/hip ratio

% body fat: Body fat percentage

HGST: Hand Grip Strength Test

BI: Brohua Index

PCA: Principal Component Analysis

Declarations

Ethics approval and consent to participate. The procedures were approved by the ethics committee of the Faculty of Health of the University of Caldas.

Consent for publication. Not applicable.

Availability of data and materials. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions

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Author disclosure statement

"The authors declare no conflict of interest for all potential sources of bias, including affiliations funding sources, and financial or management relationships".

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Figures

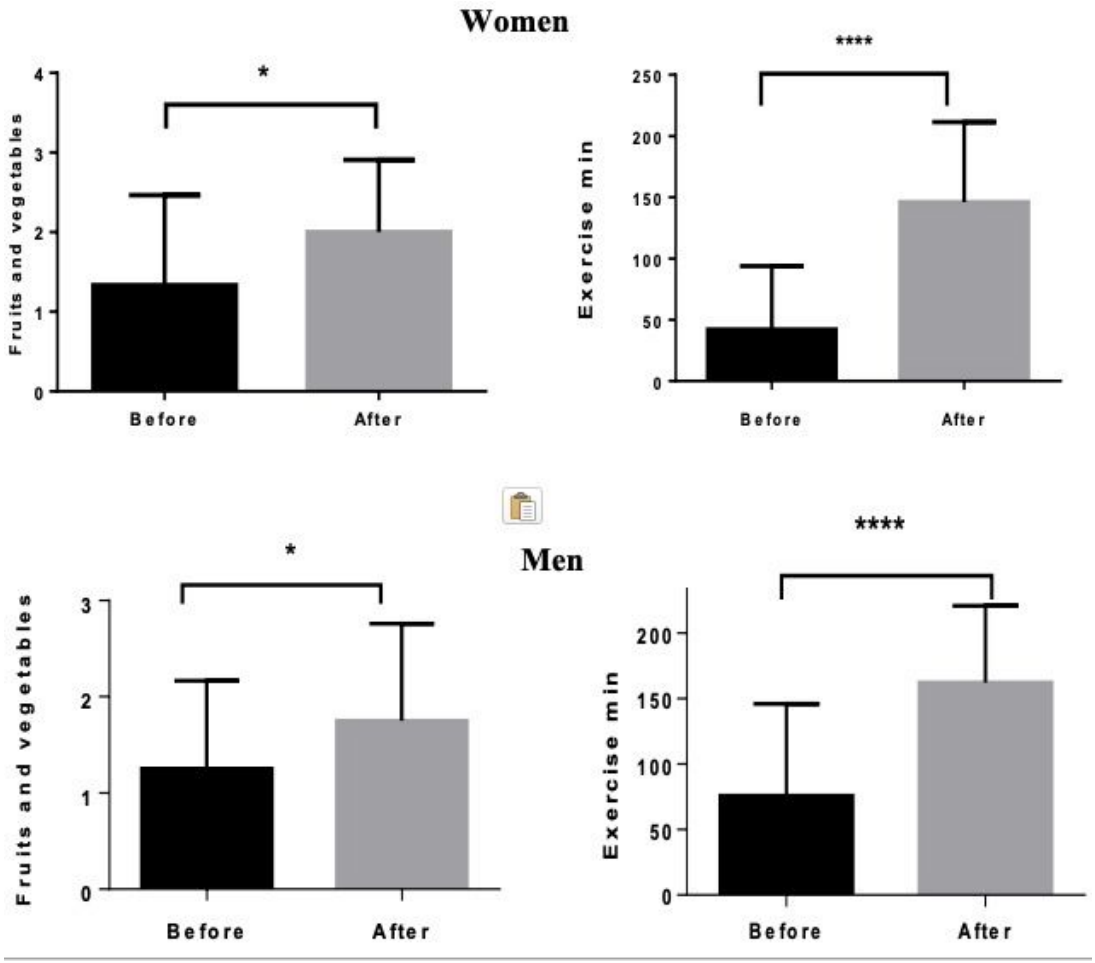

Figure 1

Changes in exercise time per week and in the consumption of fruit in men and women. * p<0.01 *** p<0.0001.

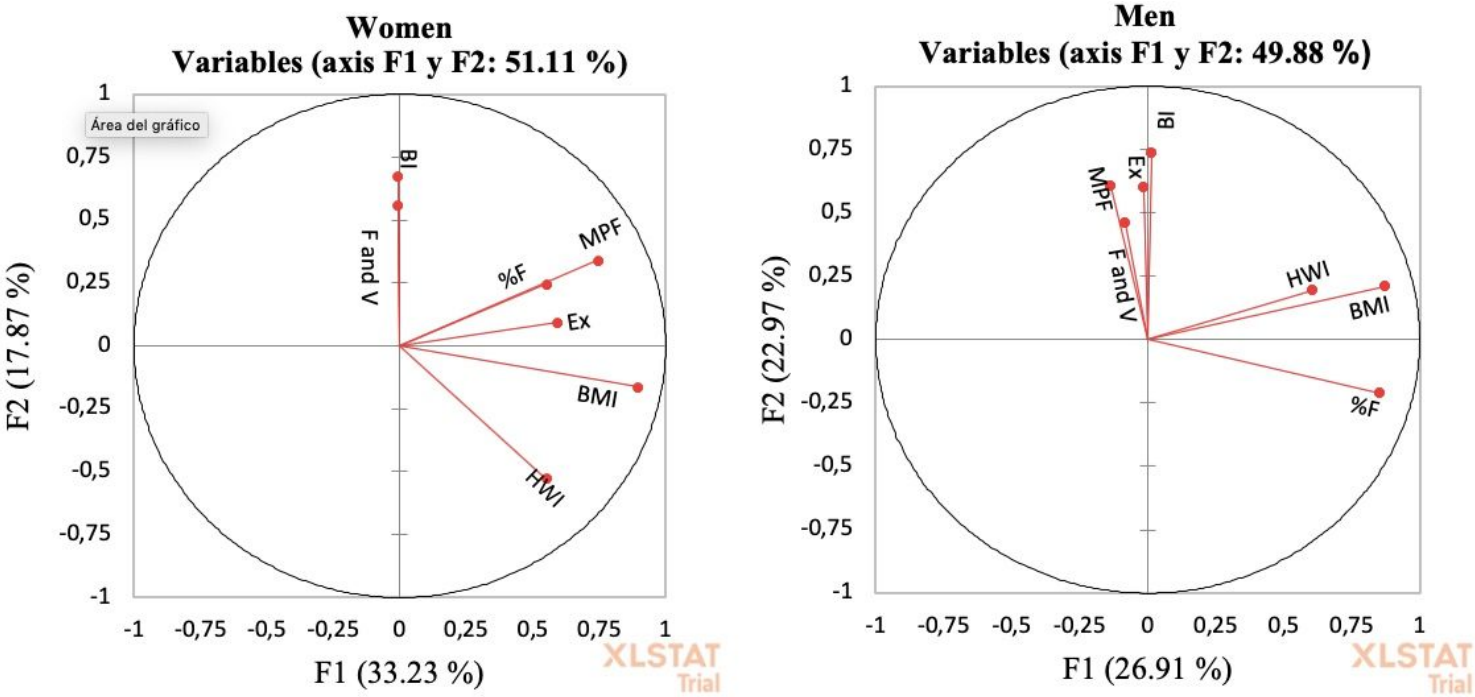

Figure 2

Factorial drawings of axes 1 and 2. A Women, B Men. F, fruit; V, vegetables.