

Dietary Fibre Consumption in a Sample of Italian Adults: Relationship Between Dietary Habits and Gender, Ponderal Status and Physical Activity

Myriam Galfo, M.Sc., Fabrizia Maccati, M.Sc., Francesca Melini, M.Sc.,
Valentina Melini, Ph.D.¹

Council for Agricultural Research and Economics–Research Center on Food and Nutrition (CREA), Via Ardeatina 546,
Rome 00178, Italy.

Received 19 April 2023 • Revised 12 June 2023 • Accepted 26 July 2023 • Published online 7 November 2023

Abstract:

Objective: The aim of this study was to investigate the consumption frequency of foods rich in dietary fibre; in relation to gender, ponderal status and physical activity, in a sample of Italian adults.

Material and Methods: A cross-sectional online survey was conducted; from November 2021 to June 2022, on 300 subjects by a questionnaire on sociodemographic characteristics, lifestyle behaviours and consumption frequency of dietary fibre-rich foods.

Results: The consumption frequency of dietary fibre is higher in females than in males. A higher percentage of obese people never or rarely consumed foods rich in dietary fibre. In regards to the consumption of whole-meal biscuits/whole-meal rusks/whole grains, it was observed that a higher percentage of overweight subjects ate them every day, more so than those who were obese, of normal-underweight and in overweight females; with the difference being significant (52.6% vs 16.7% and 32.6%; p -value=0.0366). The same trend was observed for fruit and vegetable consumption; wherein, 11.1% of overweight participants consumed 5 or more servings per day of fruit and vegetables. In contrast, only 7.9% of normal-underweight and 3.6% of obese behave according to WHO recommendations. In overweight females, this difference was significant (12.8% vs 8.3% and 8.3%; p -value=0.0103). A significant (p -value<0.05) higher consumption of dietary fibre was observed in physically active people than in physical inactive people, while no significant differences existed between those who exercise for at least 150 minutes/week and those who exercise less than 150minutes.

Contact: Myriam Galfo, M.Sc.
Council for Agricultural Research and Economics (CREA) Research Center for Food
and Nutrition Via Ardeatina 546, Rome 00178, Italy.
E-mail: myriam.galfo@crea.gov.it

J Health Sci Med Res
doi: 10.31584/jhsmr.20231011
www.jhsmr.org

© 2023 JHSMR. Hosted by Prince of Songkla University. All rights reserved.
This is an open access article under the CC BY-NC-ND license
(<http://www.jhsmr.org/index.php/jhsmr/about/editorialPolicies#openAccessPolicy>).

Conclusion: Dietary fibre consumption was moderately associated with gender and weight status and significantly associated with physical activity.

Keywords: dietary fibre consumption, gender, physical activity, ponderal status

Introduction

Dietary fibers are non-digestible plant polysaccharides found in high amounts in fruit and vegetables, wholegrain cereals, legumes, nuts and seeds¹. They are generally classified, based on their solubility in water, into two major classes: soluble dietary fiber and insoluble dietary fiber. Soluble dietary fiber comprises viscous or fermentable fibers; such as pectin, β -glucan, gums, and inulin, which are fermented in the colon; whereas, insoluble fibers; such as cellulose, hemicellulose, lignin, chitosan and resistant starch, can be only fermented to a limited extent in the colon². Not all types of fibers are present in the same food categories. Resistant starch, for instance, can only be found in starchy foods; such as cereals, legumes and tubers. In contrast, pectins are more available in fruits and some vegetables: β -glucans and arabinoxylans are present in cereals³. The health benefits of dietary fiber have long been recognized, as a diet rich in fiber has been found to significantly minimize the risk of diet-related diseases; such as cardiovascular diseases, obesity, type 2 diabetes and of certain cancers⁴⁻⁷. Conversely, a low fiber intake can have negative effects on the gut microbiota composition that can lead to a higher predisposition to chronic inflammatory diseases as well as other health complications⁸. Although, fibers are present in a wide range of plant-based foods and the daily fiber intake has been recommended by dietary guidelines worldwide for many years, diets in Western countries are still characterized by processed and preserved foods, which are high in fat and refined sugars; but low in fiber⁹.

The European Food Safety Authority recommends an intake of 25 g per day for adults. This recommendation is based on the role of dietary fibre in bowel function¹⁰.

Additionally, as to the benefits that diets, rich in foods containing fibre and providing a daily intake higher than 25g per day, can have on health. Dietary fiber is, in fact, known to help regulate appetite and body weight. The effect is related to the dose and the chemical structure of fibre; for instance, inulin plays a key role in the mechanism affecting the release of gut peptides, or dextrins that improve satiety in the short term^{11,12}. Findings from various studies also support the beneficial role of total dietary fiber intake in maintaining a healthy body weight, promoting weight loss and preventing weight gain¹³.

National dietary recommendations for fiber vary from country to country, with most of them generally recommending a daily intake of 25–35g for adults¹⁴. In Italy, a daily reference intake of 12.6–16.7 g fibre/1,000 kcal is recommended (8.4 g/1,000 kcal on childhood), with a suggested dietary target of at least 25 g/day for the prevention of chronic diseases¹⁵.

To the best of our knowledge, no studies are currently available on surveys of the habits of consuming daily foods rich in dietary fiber, among samples of the adult Italian population. Hence, the aim of this research was to investigate the consumption frequency of foods rich in dietary fibre in a sample of Italian adults, and then to correlate it to: gender, ponderal status and physical activity.

Material and Methods

Study design and data collection

The survey was carried out from November 2021 to June 2022, via an online platform, accessible through any device with an Internet connection, and disseminated through the most popular social networks; including

WhatsApp, Twitter, Facebook and Instagram. The study was carried out among a sample of Italian adults, and a total of 300 participants completed the questionnaire in agreement with the Declaration of Helsinki (2000); in accordance to national and international regulations.

As in many online surveys, a Non-Probability sampling method was used, which has the advantage of being cheap, quick, widely accessible and possible during the quarantine period of COVID-19¹⁶. All participants were informed as to the study, the fact that data would be analysed for research purposes only, for possible publication, in accordance with current privacy regulations and that they agreed to participate in the data collection. Participants' personal information was anonymous to maintain and protect confidentiality. Given the anonymous nature of the survey carried out, via the internet, without any tracking of sensitive or personal data, the study did not require the approval of the ethics committee. The final database was downloaded as a Microsoft Excel sheet.

Questionnaire

The questionnaire, created with the Google Forms tool and distributed electronically, consisted of 36 questions; divided into four sections. The first section focused on participants' personal data (i.e., age, gender, weight and height, place of residence and education level). The second section contained questions concerning lifestyle factors (i.e., alcohol consumption, sleep time, physical activity, breakfast habits and type of dietary regime). The third section comprised of questions regarding the frequency of consumption of foods rich in dietary fibre; such as fruits, vegetables, legumes, wholemeal pasta, wholemeal bread, wholemeal biscuits/whole meal rusks/whole grains, brown/red/black rice or mixture's of rice, cereals/quinoa/legumes, and nuts; such as walnuts, hazelnuts, almonds and so forth. The fourth section focused on knowledge of the importance of including foods rich in dietary fibre for a healthy diet.

Anthropometric data

Height and weight information retrieved by the questionnaire was all self-reported by the respondents. Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). Weight status was classified according to WHO¹⁷ categories as follows: underweight (BMI<18.5), normal weight (BMI between 18.5 and 24.9), overweight (BMI between 25 and 29.9) and obese (BMI \geq 30).

Statistical analysis

Descriptive analyses were presented as means \pm standard deviations for quantitative variables, and as percentages for categorical variables. Chi-square test and T-tests were used to test for significant proportion and mean differences.

For all the tests, p-values<0.05 were considered statistically significant. All statistical analyses were performed using MedCalc[®] Statistical Software version 20.111 (MedCalc Software Ltd, Ostend, Belgium; <https://www.medcalc.org>; 2022).

Results

Socio-demographic, anthropometric and lifestyle characteristics of the study participants are presented in Table 1. The percentage of females in the sample exceeded that of males (61.3% vs 38.7%, respectively). Participants age was 43.9 ± 13.5 , weight was 70.8 ± 15.4 kg; height was 170.1 ± 9.0 cm, and BMI was 24.3 ± 4.2 kg/m^2 . The prevalence of overweight/obesity was 36.3%, with higher and significant values in males than in females (50.0% vs 27.8%; p-value=0.0003). Also, the percentage of the sample subjects who held a university degree was higher than the total amount of subjects who attended either high or secondary schools (respectively: 59.7% vs 36.7% and 3.7%), with significant differences between females and males. In fact, the percentage of females holding a university degree was significantly higher than males.

Conversely, among people having attended high school, the female percentage was significantly lower than their male counterparts (respectively: 68.5% vs 45.7% and 29.3% vs 48.3%; p -value=0.0003).

In regards to alcohol consumption, 67.7% of the sample declared that they consumed alcohol daily, with higher and significant percentages in males than in females (81.9% vs 58.7%; p -value<0.0001). As to physical activity, half of the participants exercised for at least 150 minutes a week, again with significantly higher values in males than in females (61.5% vs 42.9%; p -value=0.0051). Regarding dietary regimes, the female subjects of the sample followed the Mediterranean diet at significantly higher percentages (50.0% vs 36.5%; p -value=0.0017), while the male participants followed an omnivorous alimentation with significantly higher percentages compared to the sampled females (56.5 vs 36.4; p -value=0.0017).

In regards to the frequency of dietary fibre consumption, within the total sample and by gender, approximately half of the participants do not consume whole-meal pasta, with slightly higher percentages in males than females (56.9% vs 54.3%), while 12% of the sample consumed whole-meal bread, with significantly higher values of females compared to males (15.2% vs 6.9; p -value=0.0141). Also, 30.8% ate everyday whole-meal biscuits /whole-meal rusks and whole grains at breakfast, with a higher percentage of females (35.8% vs 22.7%). In addition, more than half of the sample consumed 1–2 servings a day of fruit and vegetables, of which 60.9% were females. Only 8.3% followed the WHO recommendations of 5 or more servings per day, with a higher percentage of females compared to males (9.2% vs 6.9%, respectively). Regarding legumes, 31.0% of participants consumed them 2–3 times a week, with higher values in males than females (33.6% vs 29.3%) (Table 2).

The summary of consumption frequency of foods rich in dietary fibre, depending on the ponderal status, is shown in Table 3. As for whole-meal bread and pasta, there was

a higher, although non-significant, percentage of obese people whom rarely or never consumed them compared to overweight and normal-underweight people (67.8% vs 50.6% and 55.5% for pasta and 50.0% vs 35.8% and 42.8% for bread). This was a similar trend in both obese males and females.

In regards to the consumption of whole-meal biscuits /whole-meal rusks/whole grains, on the other hand, it was observed that a higher percentage of overweight subjects consumed them every day compared to obese and normal-underweight people (42.1% vs 22.3% and 27.3%, respectively). The same trend was observed in overweight males (31.5% vs 26.7% and 15.8%) and in overweight females; wherein, the difference was significant (52.6% vs 16.7% and 32.6%; p -value=0.0366). Table 3 also shows that a quarter of the obese subjects consumed nuts daily, both in the total sample and in males and females. In addition, all three weight ponderal statuses consumed mainly 1 or 2 servings a day of fruit and vegetables, both in the total sample and in males and females. In contrast 11.1% of overweight consumed fruit and vegetables of 5 or more servings per day, according to WHO recommendations, compared to 7.9% of normal-underweight and 3.6% of obese. In the female subjects, significant differences in fruit and vegetable consumption were observed depending on the weight status: a quarter of obese females never consumed fruit nor vegetables compared to normal, overweight and underweight people (25.0% vs 2.6% and 2.3%, respectively; p -value=0.0103), while more overweight females consumed 5 or more servings per day than those who were obese or underweight (12.8% vs 8.3% and 8.3%, respectively; p -value=0.0103).

Finally, a high percentage of obese people that eat legumes were rarely or never compared to overweight and normal weight people (respectively 42.9% vs 19.7% and 24.6%), with the same trend in both males (43.7% vs 19.0% and 31.0%) and females (41.7% vs 20.5% and 21.8%) (Table 3).

Concerning the frequency of consumption of foods rich in dietary fibre in relationship to physical activity of the total sample the results highlight many significant differences between those who are used to doing physical activity and those who are not. In fact, the daily consumption of whole-meal bread, whole-meal biscuits/whole meal rusks/whole grains, dried fruit, legumes and fruit and vegetables was significantly higher in physically active people than physically inactive people. (14.0% vs 7.0% $p=0.0458$ for whole-meal bread; 33.7% vs 23.5% $p=0.0373$ for whole-meal biscuits/whole meal rusks/whole grains; 21.5% vs 8.1% $p=0.0019$ for dried fruit; 9.3% vs 5.8% $p=0.0731$ for

fruit and vegetables; 36.4% vs 17.4% $p=0.0056$ for legumes). Conversely, physically inactive people have higher percentages in non-consumption of these (53.5% vs 36.9% $p=0.0458$ for bread; 32.1% vs 20.2% $p=0.0373$ for whole-meal biscuits/whole-meal rusks/whole grains; 48.8% vs 31.8% $p=0.0218$ for brown/red/black rice or a mixture of rice with cereals/quinoa/legumes; 18.7% vs 11.2% $p=0.0019$ for dried fruit; 5.8% vs 2.3% $p=0.0731$ for fruit and vegetable; 30.2% vs 22.9% $p=0.0056$ for legumes). There were no significant differences between those who exercise for at least 150 minutes a week and those who do less than 150 minutes (Table 4).

Table 1 Characteristics of the study participants (means±standard deviation, n and %)

Characteristics	All sample n=300	Males n=116 (38.7%)	Females n=184 (61.3%)	p-value
Age (years)	43.9±13.5	43.6±15.1	44.1±12.5	0.7789 ^a
Weight (kg)	70.8±15.4	82.6±13.7	63.4±11.2	<0.0001 ^a
Height (cm)	170.1±9.0	178.3±6.5	164.9±6.0	<0.0001 ^a
BMI	24.3±4.2	26.1±4.3	23.3±3.9	<0.0001 ^a
Ponderal status				
Underweight	11 (3.7)	1 (0.9)	10 (5.4)	0.0005 ^b
Normal weight	180 (60.0)	57 (49.1)	123 (66.8)	
Overweight	81 (27.0)	42 (36.2)	39 (21.3)	
Obese	28 (9.3)	16 (13.8)	12 (6.5)	
Education				
Less than middle school	11 (3.7)	7 (6.0)	4 (2.2)	0.0003 ^b
High school	110 (36.7)	56 (48.3)	54 (29.3)	
University degree	179 (59.7)	53 (45.7)	126 (68.5)	
Alcohol consumption				
Yes	203 (67.7)	95 (81.9)	108 (58.7)	<0.0001 ^b
No	97 (32.3)	21 (18.1)	76 (41.3)	
Physical activity				
Yes	214 (71.3)	86 (74.1)	128 (69.6)	0.3945
No	86 (28.7)	30 (25.9)	56 (30.4)	
≥150 min/week	119 (50.4)	59 (61.5)	60 (42.9)	0.0051 ^b
<150 min/week	117 (49.6)	37 (38.5)	80 (57.1)	
Sleep time				
≥7h/night	187 (62.3)	70 (60.3)	117 (63.6)	0.5731
<7h/night	113 (37.7)	46 (39.7)	67 (36.4)	
Breakfast habits				
Yes	268 (89.3)	100 (86.2)	168 (91.3)	0.1644
No	32 (10.7)	16 (13.8)	16 (8.7)	
Dietary regime				
Omnivorous	132 (44.1)	65 (56.5)	67 (36.4)	0.0017 ^b
Mediterranean	134 (44.8)	42 (36.5)	92 (50.0)	
Vegetarian/vegan	14 (4.7)	1 (0.9)	13 (7.1)	
Other	19 (6.4)	7 (6.1)	12 (6.5)	

^aComparison between males and females based on t-test; ^bComparison between males and females based on chi-square test
BMI=body mass index

Table 2 Consumption frequency dietary fibre among total sample and by gender (n and %)

Variables	Total sample n=300	p-value	Males n=116 (38.7%)	Females n=184 (61.3%)	p-value
Consumption of whole-meal pasta					
Every day	9 (3.0)	<0.0001*	2 (1.7)	7 (3.8)	0.7123
4-6 times/week	14 (4.7)		7 (6.0)	7 (3.8)	
2-3 times/week	41 (13.7)		16 (13.8)	25 (13.6)	
1 time week	70 (23.3)		25 (21.6)	45 (24.5)	
Rarely/never	166 (55.3)		66 (56.9)	100 (54.3)	
Consumption of wholemeal bread					
Every day	36 (12.0)	<0.0001*	8 (6.9)	28 (15.2)	0.0141*
4-6 times/week	23 (7.7)		8 (6.9)	15 (8.2)	
2-3 times/week	53 (17.6)		21 (18.1)	32 (17.4)	
1 time week	63 (21.0)		35 (30.2)	28 (15.2)	
Rarely/never	125 (41.7)		44 (37.9)	81 (44.0)	
Consumption of whole-meal biscuits/ whole-meal rusks/whole grains¹					
Every day	89 (30.8)	<0.0001*	25 (22.7)	64 (35.8)	0.0726
4-6 times/week	35 (12.1)		12 (10.9)	23 (12.8)	
2-3 times/week	63 (21.8)		32 (29.1)	31 (17.3)	
1 time week	34 (11.8)		13 (11.8)	21 (11.7)	
Rarely/never	68 (23.5)		28 (25.5)	40 (22.4)	
Consumption of brown/red/black rice or a mixture of rice with cereals/quinoa/ legumes					
Every day	3 (1.0)	<0.0001*	2 (1.7)	1 (0.5)	0.3969
4-6 times/week	13 (4.3)		4 (3.4)	9 (4.9)	
2-3 times/week	58 (19.3)		17 (14.7)	41 (22.3)	
1 time week	116 (38.7)		48 (41.4)	68 (37.0)	
Rarely/never	110 (36.7)		45 (38.8)	65 (35.3)	
Consumption of dried fruit (walnuts, hazelnuts, almonds, etc.)					
Every day	53 (17.7)	<0.0001*	23 (19.8)	30 (16.3)	0.5686
4-6 times/week	35 (11.7)		10 (8.6)	25 (13.6)	
2-3 times/week	77 (25.7)		33 (28.4)	44 (23.9)	
1 time week	95 (31.7)		34 (29.3)	61 (33.2)	
Rarely/never	40 (13.3)		16 (13.8)	24 (13.0)	
Consumption of fruit and vegetables					
≥5 servings/day	25 (8.3)	<0.0001*	8 (6.9)	17 (9.2)	0.2911
3-4 servings/day	90 (30.0)		42 (36.2)	48 (26.1)	
1-2 servings/day	175 (58.4)		63 (54.3)	112 (60.9)	
Nothing	10 (3.3)		3 (2.6)	7 (3.8)	
Consumption of legumes					
2-3 times/week	93 (31.0)	0.0002*	39 (33.6)	54 (29.3)	0.2344
1 time/week	132 (44.0)		44 (37.9)	88 (47.8)	
Rarely/never	75 (25.0)		33 (28.4)	42 (22.8)	

p-values according to chi-square test, *statistical significance is expressed as p-value<0.05¹, consumption only among those having breakfast habits

Table 3 Consumption frequency of foods rich in dietary fibre in correlation with gender and ponderal status (n and %)

Variables	Total sample				Males				Females			
	Normal-underweight	Overweight	Obese	p-value	Normal-underweight	Overweight	Obese	p-value	Normal-underweight	Overweight	Obese	p-value
Consumption of whole-meal pasta	191(63.7)	81 (27.0)	28 (9.3)		58 (50.0)	42 (36.2)	16 (13.8)		133 (72.3)	39 (21.2)	12 (6.5)	
Every day	7 (3.7)	1 (1.2)	1 (3.6)	0.7298	2 (3.4)	0 (0.0)	0 (0.0)	0.8569	5 (3.8)	1 (2.6)	1 (8.3)	0.4723
4-6 times/week	10 (5.2)	3 (3.7)	1 (3.6)		4 (6.9)	2 (4.8)	1 (6.2)		6 (4.5)	1 (2.6)	0 (0.0)	
2-3 times/week	25 (13.1)	14 (17.3)	2 (7.1)		9 (15.5)	5 (11.9)	2 (12.5)		16 (12.0)	9 (23.1)	0 (0.0)	
1 time/week	43 (22.5)	22 (27.2)	5 (17.9)		12 (20.7)	11 (26.2)	2 (12.5)		31 (23.3)	11 (28.2)	3 (25.0)	
Rarely/never	106 (55.5)	41 (50.6)	19 (67.8)		31 (53.5)	24 (57.1)	11 (68.8)		75 (56.4)	17 (43.5)	8 (66.7)	
Consumption of whole-meal bread												
Every day	24 (12.6)	10 (12.9)	2 (7.1)	0.3789	4 (6.9)	3 (7.1)	1 (6.2)	0.8265	20 (15.0)	7 (17.9)	1 (8.3)	0.2993
4-6 times/week	12 (6.3)	6 (7.5)	5 (17.9)		4 (6.9)	2 (4.8)	2 (12.5)		8 (6.0)	4 (10.4)	3 (25.0)	
2-3 times/week	32 (16.8)	18 (22.2)	3 (10.7)		8 (13.8)	11 (26.2)	2 (12.5)		24 (18.0)	7 (17.9)	1 (8.3)	
1 time/week	41 (21.5)	18 (22.2)	4 (14.3)		20 (34.5)	11 (26.2)	4 (25.0)		21 (15.8)	7 (17.9)	0 (0.0)	
Rarely/never	82 (42.8)	29 (35.8)	14 (50.0)		22 (37.9)	15 (35.7)	7 (43.8)		60 (45.2)	14 (35.9)	7 (58.4)	
Consumption of whole-meal biscuits/whole-meal rusks/whole grains¹												
Every day	51 (27.3)	32 (42.1)	6 (22.3)	0.1969	9 (15.8)	12 (31.5)	4 (26.7)	0.1604	42 (32.6)	20 (52.6)	2 (16.7)	0.0366*
4-6 times/week	23 (12.4)	8 (10.5)	4 (14.8)		6 (10.5)	2 (5.3)	4 (26.7)		17 (13.2)	6 (15.8)	0 (0.0)	
2-3 times/week	47 (25.3)	13 (17.1)	3 (11.1)		22 (38.6)	8 (21.1)	2 (13.3)		25 (19.4)	5 (13.2)	1 (8.3)	
1 time/week	23 (12.4)	7 (9.2)	4 (14.8)		7 (12.3)	5 (13.2)	1 (6.7)		16 (12.4)	2 (5.3)	3 (25.0)	
Rarely/never	42 (22.6)	16 (21.1)	10 (37.0)		13 (22.8)	11 (28.9)	4 (26.6)		29 (22.4)	5 (13.1)	6 (50.0)	
Consumption of brown/red/black rice or a mixture of rice with cereals/quinua/legumes												
Every day	1 (0.5)	2 (2.5)	0 (0.0)	0.3824	0 (0.0)	2 (4.8)	0 (0.0)	0.2182	1 (0.8)	0 (0.0)	0 (0.0)	0.5848
4-6 times/week	9 (4.7)	4 (4.9)	0 (0.0)		4 (6.9)	0 (0.0)	0 (0.0)		5 (3.8)	4 (10.3)	0 (0.0)	
2-3 times/week	41 (21.5)	15 (18.5)	2 (7.1)		9 (15.5)	7 (16.7)	1 (6.2)		32 (24.1)	8 (20.5)	1 (8.3)	
1 time/week	69 (36.1)	32 (39.5)	15 (53.6)		22 (37.9)	16 (38.0)	10 (62.6)		47 (35.2)	16 (41.0)	5 (41.7)	
Rarely/never	71 (37.2)	28 (34.6)	11 (39.3)		23 (39.7)	17 (40.5)	5 (31.2)		48 (36.1)	11 (28.2)	6 (50.0)	

Variables	Total sample			Males			Females					
	Normal- underweight	Overweight	Obese	p-value	Normal- underweight	Overweight	Obese	p-value	Normal- underweight	Overweight	Obese	p-value
Consumption of dried fruit (walnuts, hazelnuts, almonds, etc.)												
Every day	38 (19.9)	8 (9.9)	7 (25.0)	0.1770	14 (24.1)	5 (11.9)	4 (25.0)	0.1058	24 (18.0)	3 (7.7)	3 (25.0)	0.2476
4-6 times/week	27 (14.1)	8 (9.9)	0 (0.0)		8 (13.8)	2 (4.8)	0 (0.0)		19 (14.3)	6 (15.4)	0 (0.0)	
2-3 times/week	46 (24.1)	24 (29.6)	7 (25.0)		19 (32.8)	11 (26.2)	3 (18.8)		27 (20.3)	13 (33.3)	4 (33.3)	
1 time/week	55 (28.8)	31 (38.3)	9 (32.1)		10 (17.2)	17 (40.5)	7 (43.7)		45 (33.9)	14 (35.9)	2 (16.7)	
Rarely/never	25 (13.1)	10 (12.3)	5 (17.9)		7 (12.1)	7 (16.6)	2 (12.5)		18 (13.5)	3 (7.7)	3 (25.0)	
Consumption of fruits and vegetables												
≥5 servings/day	15 (7.9)	9 (11.1)	1 (3.6)	0.1756	4 (6.9)	4 (9.5)	0 (0.0)	0.2211	11 (8.3)	5 (12.8)	1 (8.3)	0.0103*
3-4 servings/day	61 (31.9)	19 (23.5)	10 (35.7)		26 (44.8)	9 (21.4)	7 (43.7)		35 (26.2)	10 (25.6)	3 (25.0)	
1-2 servings/day	110 (57.6)	51 (63.0)	14 (50.0)		26 (44.8)	28 (66.7)	9 (56.3)		84 (63.2)	23 (59.0)	5 (41.7)	
Nothing	5 (2.6)	2 (2.4)	3 (10.7)		2 (3.5)	1 (2.4)	0 (0.0)		3 (2.3)	1 (2.6)	3 (25.0)	
Consumption of legumes												
2-3 times/week	62 (32.5)	22 (27.2)	9 (32.1)	0.0644	22 (38.0)	12 (28.6)	5 (31.3)	0.1273	40 (30.1)	10 (25.6)	4 (33.3)	0.4204
1 time/week	82 (42.9)	43 (53.1)	7 (25.0)		18 (31.0)	22 (52.4)	4 (25.0)		64 (48.1)	21 (53.8)	3 (25.0)	
Rarely/never	47 (24.6)	16 (19.7)	12 (42.9)		18 (31.0)	8 (19.0)	7 (43.7)		29 (21.8)	8 (20.5)	5 (41.7)	

p-values according to chi-square test; *statistical significance is expressed as p-value<0.05; consumption only among those having breakfast habits

Table 4 Consumption frequency dietary fibre associated to physical activity (n and %)

Variables	Physical activity (n=214)	Physical inactivity (n=86)	p-value	PA ≥150 min/ week (n=119)	PA<150 min/ week (n=117)	p-value
Consumption of wholemeal pasta						
Every day	8 (3.7)	1 (1.2)	0.1612	3 (2.5)	5 (4.3)	0.4483
4-6 times/week	13 (6.1)	1 (1.2)		7 (6.0)	6 (5.1)	
2-3 times/week	32 (15.0)	9 (10.5)		21 (17.6)	13 (11.1)	
1 time/week	48 (22.4)	22 (25.6)		23 (19.3)	31 (26.5)	
Rarely/never	113 (52.8)	53 (61.5)		65 (54.6)	62 (53.0)	
Consumption of wholemeal bread						
Every day	30 (14.0)	6 (7.0)	0.0458*	18 (15.1)	14 (12.0)	0.5243
4-6 times/week	19 (8.9)	4 (4.7)		13 (10.9)	8 (6.8)	
2-3 times/week	42 (19.6)	11 (12.8)		23 (19.3)	21 (17.9)	
1 time/week	44 (20.6)	19 (22.0)		26 (21.9)	24 (20.5)	
Rarely/never	79 (36.9)	46 (53.5)		39 (32.8)	50 (42.8)	
Consumption of wholemeal biscuits/wholemeal rusks/whole grains¹						
Every day	70 (33.7)	19 (23.5)	0.0373*	37 (31.6)	39 (34.2)	0.5591
4-6 times/week	26 (12.5)	9 (11.1)		17 (14.5)	13 (11.4)	
2-3 times/week	50 (24.0)	13 (16.0)		31 (26.6)	22 (19.3)	
1 time/week	20 (9.6)	14 (17.3)		11 (9.4)	13 (11.4)	
Rarely/never	42 (20.2)	26 (32.1)		21 (17.9)	27 (23.7)	
Consumption of brown/red/black rice or a mix of rice with cereals/quinoa/legumes						
Every day	2 (0.9)	1 (1.2)	0.0218*	2 (1.7)	0 (0.0)	0.1617
4-6 times/week	12 (5.6)	1 (1.2)		8 (6.7)	4 (3.4)	
2-3 times/week	48 (22.4)	10 (11.6)		30 (25.2)	20 (17.1)	
1 time week	84 (39.3)	32 (37.2)		46 (38.7)	52 (44.4)	
Rarely/never	68 (31.8)	42 (48.8)		33 (27.7)	41 (35.1)	
Consumption of dried fruit (walnuts, hazelnuts, almonds, etc.)						
Every day	46 (21.5)	7 (8.1)	0.0019*	25 (21.0)	22 (18.8)	0.0747
4-6 times/week	28 (13.1)	7 (8.1)		22 (18.5)	8 (6.8)	
2-3 times/week	59 (27.6)	18 (20.9)		31 (26.1)	34 (29.1)	
1 time/week	57 (26.6)	38 (44.2)		28 (23.5)	38 (32.5)	
Rarely/never	24 (11.2)	16 (18.7)		13 (10.9)	15 (12.8)	
Consumption of fruit and vegetable						
≥5 servings/day	20 (9.3)	5 (5.8)	0.0731*	14 (11.8)	9 (7.7)	0.2734
3-4 servings/day	71 (33.2)	19 (22.1)		41 (34.5)	34 (29.1)	
1-2 servings/day	118 (55.2)	57 (66.3)		63 (52.9)	70 (59.8)	
Nothing	5 (2.3)	5 (5.8)		1 (0.8)	4 (3.4)	
Consumption of legumes						
2-3 times/week	78 (36.4)	15 (17.4)	0.0056*	48 (40.3)	33 (28.2)	0.1139
1 time/week	87 (40.7)	45 (52.4)		47 (39.5)	51 (43.6)	
Rarely/never	49 (22.9)	26 (30.2)		24 (20.2)	33 (28.2)	

p-values* according to chi-square test, *statistical significance is expressed as p-value<0.05, 1consumption only among those reporting breakfast habits

PA=physical activity

Discussion

This cross-sectional study examined the consumption frequency of foods rich in dietary fibre related to gender, ponderal status and physical activity in a sample of an Italian, adult population.

The findings from this present research showed that women consumed more fibre than men. Similar results were reported in a previous study, wherein females (children, adolescents, and adults) were more inclined to consume foods rich in dietary fibre than males. This could be attributed to the more health-conscious nature of women and their tendency to comply with dietary recommendations more so than men¹⁸.

Also, Alharbi and Alarifi observed a significantly higher intake of dietary fibre in women compared to men (p -value <0.05), due to in particular a higher consumption of vegetables, nuts and seeds and total fibre per day in women. On the contrary, men showed a higher intake of bread, whole grains, and cereals than women; however, there was a high consumption of legumes by both genders. In addition, there was a similar consumption of fruit by both genders¹⁹. Riediger and colleagues also demonstrated that females are likely more consistent in consuming recommended amounts of fruit and vegetables when compared to males²⁰. On the other hand, the study of Alfawaz et al. observed that the consumption of fruit juice, fresh peeled fruits, and cereals was higher for males than females²¹. This result is also supported by a study performed by Bagordo and colleagues that showed bread, fresh fruit, and raw vegetables as the most frequently consumed foods among males when compared to females²². In addition, research by Bennett et al. showed that men tend to have a higher fibre intake than women in the United Kingdom²³.

In our survey, a higher percentage of obese people than overweight and normal-underweight subjects either did not consume, or rarely consumed foods rich in dietary fibre; however, there was a greater consumption of whole-meal biscuits /whole-meal rusks/ whole grains and fruit and

vegetables by the overweight individuals than the other two groups. Several other studies also associated insufficient dietary fibre intake with obesity; however, these results were not always conclusive²⁴⁻²⁶.

Hadrévi et al. reported obese individuals having a significantly lower dietary fiber intake compared to those of normal-weight²⁷. Previous cross-sectional studies and prospective cohort studies have indicated a strong, negative association between fiber intake and obesity. In particular, cross-sectional studies indicated that adults with the highest level of fiber intake have a relative risk of obesity than those with the lowest level of fiber level of recruitment. Prospective cohort studies reported that people with the highest level of fiber consumption had lower rates of weight gain and obesity compared to those with the lowest level of fiber intake²⁸. Also, a European study suggested that total fiber intake was negatively associated with increased body weight and waist circumference²⁹. Moreover, Davis and colleagues reported that dietary fiber was inversely related to weight, BMI, and most strongly to percent body fat³⁰.

Regarding physical activity, this study showed a statistically significantly higher consumption of foods rich in dietary fibre by physically active people than physical inactive people. However, there were no significant differences between those who exercise for at least 150 minutes a week and those who do less than 150 minutes. Similar findings were reported by the study of Da Silva et al.; wherein, inadequate consumption of dietary fibers was higher among physically inactive subjects³¹. It is known that people having more information about health, or being more concerned with disease prevention, tend to maintain healthier habits; such as physical activity in addition to having more adequate food consumption³². In concerns to the desire to change body weight, an increase in fiber consumption is generally recommended, because of the lower energetic level of foods rich in this nutrient³³.

Despite these interesting findings, this research has, nevertheless, some limitations. First, it was not possible to

assess whether the associations found would have a cause-and-effect relationship, due to the cross-sectional nature of the survey. Secondly, a non-representative sample of the adult population agreed to complete the questionnaire, and finally, data are based on self-reported questionnaires wherein errors in reporting are possible.

Conclusion

In this cross-sectional study, the consumption frequency of foods rich in dietary fibre was moderately associated with gender and weight status, and was significantly associated with physical activity. Further studies are, nevertheless, necessary on a larger number of participants.

However, preliminary results showed the need to increase dietary fiber intake in the general population, by encouraging among consumers the consumption of whole-meal options in bread, cereal products and plant-based foods; such as fruit and vegetables. In this way, nutritional education programs can contribute to fostering health benefits for both individuals and communities.

Acknowledgement

The authors gratefully thank the people and their families who participated in this study.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Conflict of interest

The authors have no conflicts of interest to declare.

References

- Fuller S, Beck E, Salman H, Tapsell L. New horizons for the study of dietary fiber and health: a review. *Plant Foods Hum Nutr* 2016;71:1–12.
- Anderson JW, Baird P, Davis RH, Ferreri S, Knudtson M, Koraym A, et al. Health benefits of dietary fiber. *Nutr Rev* 2009;67:188–205.
- Lovegrove A, Edwards CH, De Noni I, Patel H, El SN, Grassby T, et al. Role of polysaccharides in food, digestion, and health. *Crit. Rev. Food Sci Nutr* 2017;57:237–53.
- Van de Vijver LP, van den Bosch LM, van den Brandt PA, Goldbohm RA. Whole grain consumption, dietary fibre intake and body mass index in the Netherlands cohort study. *Eur J Clin Nutr* 2009;63:31–8.
- Threapleton DE, Greenwood DC, Evans C, Cleghorn CL, Nykjaer C, Woodhead C, et al. Dietary fiber intake and risk of cardiovascular disease: systematic review and meta-analysis. *BMJ* 2013;347:f6879.
- Bradbury KE, Appleby PN, Key TJ. Fruit, vegetable, and fiber intake in relation to cancer risk: findings from the European Prospective Investigation into Cancer and Nutrition (EPIC). *Am J Clin Nutr* 2014;100:S394–8.
- Wannamethee SG, Whincup PH, Thomas MC, Sattar N. Associations between dietary fiber and inflammation, hepatic function, and risk of type 2 diabetes in older men: potential mechanisms for the benefits of fiber on diabetes risk. *Diabetes Care* 2009;32:1823–5.
- Maslowski KM, Mackay CR, Eswaran S. Diet, gut microbiota and immune responses. *Nat Commun. Nature Publishing Group*. 2014;5:5–9.
- Thorburn AN, Macia L, Mackay CR. Diet, metabolites, and “western-lifestyle” inflammatory diseases. *Immunity* 2014;40:833–842.
- European Food Safety Authority. EFSA sets European dietary reference values for nutrient intakes. [homepage on Internet]. Parma: European Union; 2010 [cited 2010 Mar 26]. Available from: <https://www.efsa.europa.eu/en/press/news/nda100326>
- Guérin-Deremaux L, Pochat M, Reifer C, Wils D, Cho S, Miller LE. The soluble fiber NUTRIOSE induces a dose-dependent beneficial impact on satiety over time in humans. *Nutr Res* 2011;31:665–72.
- Russo F, Clemente C, Linsalata M, Chiloiro M, Orlando A, Marconi E, et al. Effects of a diet with inulin-enriched pasta on gut peptides and gastric emptying rates in healthy young volunteers. *Eur J Nutr* 2011;50:271–7.
- Du H, Van der A DL, Boshuizen HC, Forouhi NG, Wareham

- NJ, Halkjær J, Tjønneland A, et al. Dietary fiber and subsequent changes in body weight and waist circumference in European men and women. *Am J Clin Nutr* 2010;91:329–36. doi: 10.3945/ajcn.2009.28191
14. Stephen AM, Champ MM, Cloran SJ, Fleith M, van Lieshout L, Mejbörn H, Burley VJ. Dietary fibre in Europe: current state of knowledge on definitions, sources, recommendations, intakes and relationships to health. *Nutr Res Rev* 2017;30:149–90.
 15. Italian Society of Human Nutrition (SINU). Livelli di Assunzione di Riferimento di Nutrienti ed Energia per la Popolazione Italiana; Milan: SICS; 2014.
 16. Lehdonvirta V, Oksanen A, Rasanen P, Blank G. Social media, web, and panel surveys: using non-probability samples in social and policy research. *Policy Internet* 2021;13:134–55.
 17. World Health Organization. Obesity: preventing and managing the global epidemic. *World Health Organ Tech Rep Ser* 2000;894:i–253.
 18. Kiefer I, Rathmanner T, Kunze M. Eating and dieting differences in men and women. *J Men's Health Gend* 2005; 2:194–201.
 19. Alharbi MH, Alarifi SN. Gender-based differences in the consumption of food rich in fibre and its relationship with perceived mood status: a cross-sectional study. *Healthcare (Basel)* 2022;10:730. doi: 10.3390/healthcare10040730.
 20. Riediger ND, Moghadasian MH. Patterns of fruit and vegetable consumption and the influence of sex, age and socio-demographic factors among canadian elderly. *J Am Coll Nutr* 2008;27:306–13.
 21. Alfawaz H, Khan N, Alhuthayli H, Wani K, Aljumah MA, Khattak MNK, et al. Awareness and knowledge regarding the consumption of dietary fiber and its relation to self-reported health status in an adult arab population: a cross-sectional study. *Int J Environ Res Public Health* 2020;17:4226. doi: 10.3390/ijerph17124226.
 22. Bagordo F, Grassi T, Serio F, Idolo A, De Donno A. Dietary habits and health among university students living at or away from home in southern italy. *J Food Nutr Res* 2013;52.
 23. Bennett E, Peters SAE, Woodward M. Sex differences in macronutrient intake and adherence to dietary recommendations: Findings from the UK Biobank. *BMJ Open* 2018;8:e020017.
 24. Gonzalez-Rodriguez LG, Perea-Sanchez JM, Aranceta-Bartrina J, Gil A, Gonzalez-Gross M, Serra-Majem L, et al. Intake and dietary food sources of fibre in Spain: differences with regard to the prevalence of excess bodyweight and abdominal obesity in adults of the anibes study. *Nutrients* 2017;9:326.
 25. Bozzetto L, Costabile G, Della Pepa G, Ciciola, P, Vetrani C, Vitale M, et al. Dietary fibre as a unifying remedy for the whole spectrum of obesity-associated cardiovascular risk. *Nutrients* 2018;10:943.
 26. Kendall CW, Esfahani A, Jenkins DJ. The link between dietary fibre and human health. *Food Hydrocoll* 2010;24:42–8.
 27. Hadrévi J, Søggaard K, Christensen JR. Dietary fiber intake among normal-weight and overweight female health care workers: an exploratory nested case-control study within FINALE-Health. *J Nutr Metab* 2017;7:1–7.
 28. Anderson JW. Dietary fiber and associated phytochemicals in prevention and reversal of diabetes. In: Pasupuleti VK, Anderson JW, eds. *Nutraceuticals, Glycemic Health and Type 2 Diabetes*. Ames, Iowa: Blackwell Publishing Professional; 2008;111–42.
 29. Du H, van der A DL, Boshuizen HC, Forouhi NG, Wareham NJ, Halkjaer J, et al. Dietary fiber and subsequent changes in body weight and waist circumference in European men and women. *Am J Clin Nutr* 2010;91:329–36.
 30. Davis JN, Hodges VA, Gillham MB. Normal-weight adults consume more fiber and fruit than their age- and height-matched overweight/obese counterparts. *J Am Diet Assoc* 2006;106:833–40.
 31. Silva GMD, Durante ÉB, Assumpção D, Barros MBA, Corona LP. High prevalence of inadequate dietary fiber consumption and associated factors in older adults: a population-based study. *Rev Bras Epidemiol* 2019;22:e190044.
 32. Venturini CD, Engroff P, Sgnaolin V, Kik RME, Morrone FB, Silva Filho IG, et al. Consumo de nutrientes em idosos residentes em Porto Alegre (RS), Brasil: um estudo de base populacional. *Ciênc Saúde Coletiva* 2015;20:3701–11.
 33. Moreira P, Romualdo MCS, Amparo FC, Paiva C, Alves R, Magnoni D, et al. A educação nutricional em grupo e sua efetividade no tratamento de pacientes obesos. *Rev Bras Obesid Nutr Emagrecim* 2012;6:216–24.