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Food Frequency Questionnaire to Assess Fiber Intake and Its Relationship with Health

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Abstract: The correlation between the type of food in the diet and the occurrence of intestinal pathology and other health conditions is becoming increasingly clear. The fiber intake, particularly its relationship with the maintenance of intestinal microbiota has been ascertained and is included in the concept of intestinal permeability and health. The current study investigated compliance with recommended fiber intake and individuals' clinical conditions. The study was carried out in May 2020, during the period of the first COVID lockdown in Portugal, through a MS Forms survey distributed through social media. A total of 167 out of 195 answers were considered valid, with participants being in the 18-74 age range. Most of the voluntary subjects were female. A valid food frequency questionnaire, adapted for the Portuguese population, was used to estimate dietary fiber intake and a questionnaire adapted from the Rome IV criteria and the Bristol Stool Scale was used to assess the presence of constipation. A tendency was found for individuals with some chronic disease to have a lower intake of dietary fiber. These findings indicate that an adequate dietary fiber intake and compliance with the recommended daily intake is important for the prevention of chronic diseases and that, by improving gut function, there is a general improvement of the body's functions. The study also found a higher fiber intake by females compared to males, for both groups, with and without pathology.

Keywords: Intestinal Microbiome, Intake, Fibers, Health, Chronic Diseases

1. Introduction

Food is a primary requirement for the survival and well-being of humans, not only for growth, reproduction and health, but also to modulate and support the symbiotic microbial communities that colonize the gastrointestinal tract [1]. Digestive health is a developing area of nutrition which aims to understand how some dietary components, like fiber, affect microbiota and overall health condition; in this study we want to analyze the dietary and the gastrointestinal tolerance, stool shape and frequency, transit time, gut microbial composition and metabolic activity [2]. All these aspects provide metabolic, immunological, and protective functions that play a crucial role in human health. The gastrointestinal microbiota is influenced by several factors, such as genetics, host physiology and environment [3]. The human gastrointestinal system digests and absorbs nutrients from various foods and about 90 to 97% of these foods are digested and absorbed, depending on the characteristics of the diet followed. Most of the unabsorbed material comes from plant sources since the human body lacks enzymes capable of hydrolyzing some of the chemical bonds between the molecules that constitute the plant fibers [4]. Diet is increasingly recognized as a key environmental factor that influences the composition and metabolic function of the gastrointestinal microbiota [3]. Therefore, food type, quality and origin can be used as a strategy to modulate the microbiota [1], for instance by the consumption of fiber which is metabolized by the bacterial flora of the gastrointestinal tract [3].

Dietary fibers are hard to digest and absorb in the small intestine, so they stay longer in the gastrointestinal tract and are exposed to bacterial fermentation. They can, therefore, influence metabolic and microbial activity by the production of certain end-products of fermentation (e.g., lactic acid, carbon dioxide) and by changing the composition of microbial communities [9].

Fibers can be classified according to their various characteristics, including their primary food source (e.g., cereals and grains, fruits, vegetables and legumes), their chemical structure (e.g., non-starch polysaccharides, resistant starch and resistant oligosaccharides [1], their water solubility (e.g., soluble, insoluble) and viscosity, and their fermentability, all of which are properties that can affect microbial fermentation [3].

The role of fiber in the gastrointestinal system varies depending on its solubility [4] (Figure 1). Insoluble fibers (e.g., cellulose, lignin and some hemicelluloses) are not, or are only partially, digested by bacteria in the gut, so their fermentation is limited. On the other hand, soluble fibers (e.g., gums, pectins, inulin and some hemicelluloses) form viscous gels in the presence of water and are fermented by gut bacteria, leading to metabolites such as short-chain fatty acids [1]. In general, most plant-derived foods contain 33% soluble and 67% insoluble fiber.

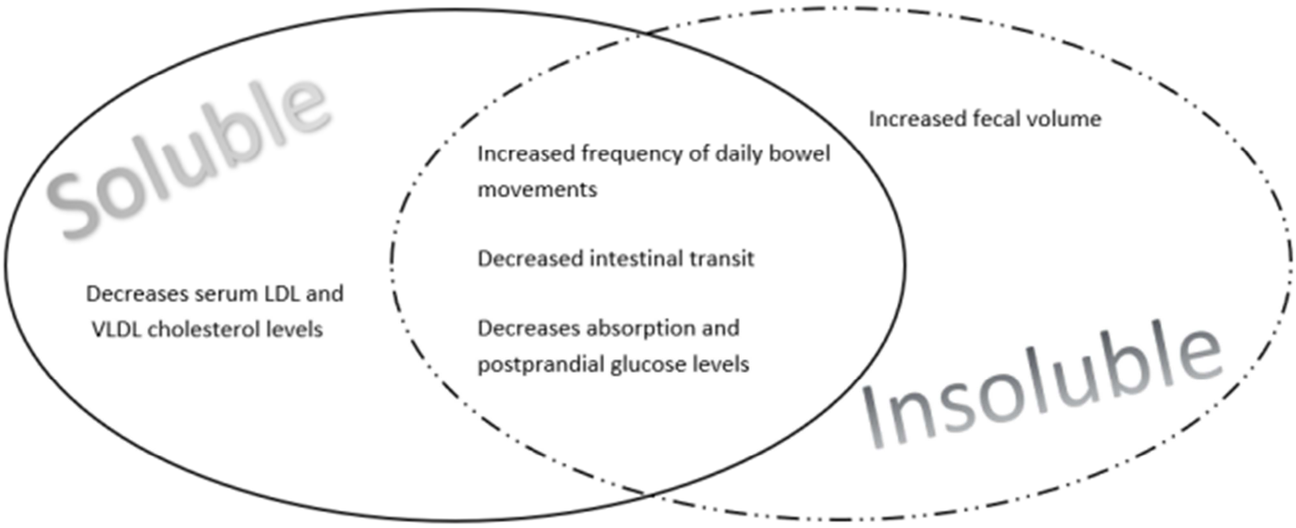

Figure 1. *Mechanical and metabolic effects of soluble and insoluble fibers. Adapted from [4].*

Diets high in plant-based foods provide many different types of dietary fiber, contributing to a more diverse composition of the microbiota [1, 5, 6]. Some of these compounds are considered prebiotics, i.e., food components that are not digestible by human enzymes and that selectively stimulate the growth and/or activity of beneficial bacterial populations in the gut (e.g., bifidobacteria and lactobacilli) [6]. These bacteria favorably modify the intestinal microbiota composition and the intestinal transit by reducing toxic metabolites and preventing diarrhea and constipation [7].

However, modern diets are low in high-fiber content plant-based foods [8]. A low intake of fibers is considered a decisive factor in the depletion of the human gastrointestinal microbiota and in their increased occurrence, probably because of chronic diseases, such as obesity, type II diabetes, cardiovascular disease, and colon cancer [9]. Furthermore, a low fiber intake together with a rich protein and sugar diet, reduces microbiota diversity and causes the loss of beneficial and protective microbes [1]. The number of identified pathologies, linked to the microbiome, have increased dramatically over the past century, and is probably a reflection of the lifestyle changes that have been occurring in society over the years [1].

According to the Portuguese Health Authority [10], an adequate fiber intake also reduces the risk of diabetes, obesity, hypertension, stroke, and coronary heart disease. In addition, it changes the absorption time of glucose, thus reducing the total glucose absorbed in the intestine, reducing cholesterol levels in the blood, and encouraging the reduction of intracolic pressure [2] Furthermore, the consequences of low fiber intake include several disorders of normal intestinal function, including increased risk of hemorrhoids and diverticulosis, increased risk of carcinoma, including colon cancer, increased risk of metabolic diseases, including diabetes, hyperglycemia, and hypercholesterolemia, all being changes that lead to increased risk of cardiovascular disease [10]. According to the American Dietetic Association (ADA), a daily fiber intake of 25 g for women and 38 g for men is recommended. In Portugal, the DGS recommends a daily fiber intake of at least 25 g per day as beneficial (age and gender not being mentioned) [11].

However, caution is also needed to avoid overdose. Intakes above 50 g of fiber per day are not recommended because of possible interactions with nutrients [4]. Symptoms of excess fiber ingestion include increased abdominal cramps, abdominal distension and even diarrhea, resulting from bacterial fermentation of fiber in the colon, with consequent release of volatile fatty acids, hydrogen, carbon dioxide and methane, and/or a local irritant effect [12].

Constipation is one of the most common gastrointestinal disorders with adverse implications on quality of life [13]. Constipation is defined as "bowel dysfunction, characterized by the presence of incomplete defecation or an increased degree of difficulty in defecating". It occurs because of one or more factors such as low caloric intake, physical inactivity, medication intake [13], and other health problems such as celiac disease or diabetes [14].

The classification of cardiovascular disease (CVD) includes diseases that can exist in isolation or coexist. Epidemiological research suggests that adequate dietary fiber intake consistently reduces the risk of CVD, especially by lowering cholesterol levels. Studies with the fibers psyllium and β-glucan have resulted in a health claim of "reduced risk of cardiovascular disease by lowering serum cholesterol" approved by the Food and Drug Administration (FDA) [15].

Hypertension (HTA) is defined by the American College of Cardiology (ACC) and the American Heart Association (AHA) as blood pressure above 130/80 mmHg [16]. Blood pressure is directly related to the risk of cardiovascular events, in addition to other risk factors that may exist. Some studies have reported that increasing dietary fiber intake decreases the risk of hypertension (Sun *et al*. 2018), especially if this increase is 7 to 15 g per day above usual levels.

According to the Portuguese National Health Service (SNS), obesity is defined as "a pathology, in which excess accumulated body fat can affect health" [17]Increased dietary fiber intake, both from naturally fiber-rich foods and fiber supplements, has been shown to be related to improved weight maintenance in adults and sustained weight reduction in overweight individuals [18].

Given the importance of fiber in health, the aim of this study is to assess the level of compliance with the recommended daily intake of fiber and its relationship with clinical conditions, with the focus on Cardiovascular Disease, Hypertension, Obesity, and Constipation in a group of Portuguese adults.

2. Materials and Methods

2.1. Design and Study Population

An observational cross-sectional analysis [19],[20], supported by a questionnaire, was used in this study to assess both compliance with the recommended daily intake of fiber assessed using a food frequency questionnaire (FFQ) and its relationship with clinical conditions. The questionnaire was previously piloted with in-person interviews to a convenient sample of ten people, to check their level of understanding of the questions. After this phase, the questionnaire was applied online through social media, namely WhatsApp and Facebook.

The questionnaire is organized into four sections: 1) sociodemographic profile; 2) presence or absence of constipation 3) clinical conditions and medication, and 4) food frequency in the last year.

The study-population included a total of 195 Portuguese adults of both genders, aged between 18 and 75 years old. The inclusion criterion was Portuguese nationality. The use of constipation medication was considered as an exclusion criterion, which led to the exclusion of 10 people. Therefore, of the initial 195, 185 were analyzed. It is therefore considered that the sample was selected by convenience and is not representative of the wider Portuguese population. Participation was voluntary, with all participants giving their informed consent at the beginning of the questionnaire, and data anonymity and confidentiality were ensured.

2.2. Assessment Tools

2.2.1. Assessment of the Presence of Constipation

Functional gastrointestinal disorders were diagnosed and classified using the Rome criteria. These are related to patient interpretation and reporting and are classified in terms of symptoms [21]. To perform this evaluation, a questionnaire adapted from the Rome IV criteria and the Bristol Stool Scale were applied. The diagnosis of functional constipation requires meeting two or more of the following criteria:

a) Defecatory straining for more than 25% of bowel movements.
b) Lumpy or grainy stools (Bristol Stool Scale 1-2) for more than 25% of bowel movements.
c) Sensation of incomplete evacuation in more than 25% of bowel movements.
d) Sensation of anorectal blockage/obstruction in more than 25% of bowel movements (digital maneuvers, manual pelvic floor support).
e) Less than 3 spontaneous bowel movements per week [22].

To assess these symptoms, the following response options regarding the percentage of criteria met were chosen: Never (0%), Rarely (25%), Sometimes (50%), Usually (75%), and Always (100%).

2.2.2. Assessment of Clinical Condition

Participants were asked about the presence or absence of pathology (constipation and cardiovascular diseases) and the intake of medication.

2.2.3. Food Frequency Questionnaire

The Food Frequency Questionnaire (FFQ) is one of the most commonly used instruments to assess food and nutrient intake in epidemiological studies. Through this survey, adults can describe their usual consumption habits during the 12 months preceding its application [23]. The direct administration FFQ used is a semi-quantitative food frequency questionnaire completed by volunteers, developed at the Department of Hygiene and Epidemiology of the Faculty of Medicine of the

University of Porto (FMUP) and adapted to Portuguese food [24]. Food and beverage intake was assessed using a semi-quantitative food frequency questionnaire, completed by the volunteers. It consists of 86 food items or beverage categories with frequencies section offering nine possible responses ranging from never to six or more times, per month, week, or day. The average food portion is the reference portion and is presented in homemade measures and in grams. The food items are organized into eight groups, namely I - Dairy Products, II - Eggs, Meat and Fish, III - Oils and Fats, IV - Bread, Cereals and Similar, V - Sweets and Pastries, VI - Vegetables and Legumes, VII - Fruits, VIII - Beverages and Miscellaneous, and - Other Foods. The last group is then used for the participants to describe other important foods that were not mentioned in the list of foods in this survey and which he/she consumed at least once a week.

2.2.4. Statistical Analysis

The collected data were stored in the Microsoft Excel program and tabulated in the statistical program SPSS® (Statistical Package for Social Sciences) - version 25, for subsequent analysis and statistical treatment. These are presented as means and standard deviation (SD) for continuous variables, or numbers and percentages for dichotomous variables. The sample was defined by frequency calculations. To query the existence of constipation, cases with two or more of the established criteria were calculated, and then cross-tabulations and frequency tables were used to characterize and identify this part of the sample. Finally, a variable was created to calculate the Body Mass Index (BMI) of the sample, in order to identify the gender distribution of all the people with a BMI $\geq$ 30 kg/m^2. To obtain the food consumption, the frequency reported for each item was multiplied by the respective standard average portion, in grams, and by a seasonal variation factor for foods consumed in specific seasons (0.25 was considered the average seasonality of three months). The conversion of foods into nutrients was done using the Food Processor Plus (ESHA Research, Salem, Oregon) computer program, with nutritional information from the food composition tables of the US Department of Agriculture, adapted to typical Portuguese foods. Outliers in the data were identified by using the interquartile range (IQR) and a total of 18 data points were then removed above the 75th and below the 25th percentile by a factor of 1.5 times the IQR [25]. To test the hypothesis that dietary fiber intake is associated with pathological conditions, an analysis of variance (ANOVA) was performed. The ANOVA assumptions were tested using the Shapiro-Wilk test [26], and since the data did not meet the normality assumptions (W=0.62, p-value < 0.001) we used a non-parametric Kruskal-Wallis analysis of variance [27] and a post-hoc comparison of the pair-wise means, using Tukey's Honest Significant Difference test [28]We started by comparing the distribution of total fiber consumption in the population presenting pathologies to that of the healthy population. Subsequently, we compared the variation of intake for total fiber, soluble fiber and insoluble fiber against the presence or absence of diseases. The population was grouped according to healthy population (no pathology; N=81), with obesity (N=8), with constipation (N=36), with obesity and constipation simultaneously (N=8), with CVD and/or hypertension (N=15), or other disease unrelated to fiber intake (N=19), e.g., kidney, neurological, gastrointestinal, osteoarticular and respiratory diseases, diabetes, and dyslipidemia. The population was then tested for statistically significant differences between the means of those groups. The test used is robust enough to consider independent sample sizes. Finally, we tested the relationship between soluble and insoluble fiber by calculating Spearman's correlation coefficient [29], a nonparametric measure of correlation since the data do not follow a normal distribution. Statistical analysis was performed in R software (R Core Team 2019) using the packages "tidyverse" [30], "Hmisc" [31], "rstatix" [32], "ggstatsplot" [33], and "ggpubr" [34], for the graphs.

3. Results

From the initial sample of 195, a total of 167 people, 34 men and 133 women, were included in the analyses, after exclusions for the reasons explained above. About half (53%) of the 167 participants were aged between 35 and 44 years old, more than half of them, 98 (58.7%), had a university degree, the vast majority, 127 (77%), were employed, and the others were either students or working students. Ten people (6%) did not fit into either of these categories. The participants had an average height of 1.66±0.07 meters and an average weight of 69±14 kilograms. However, 19 subjects had a BMI greater than or equal to 30 kg/m^2 and were in the obesity category. Of these, men presented this problem in a higher proportion relative to women. Within the sample studied, 57 individuals reported having pathologies, either CVD, HTA, or "Other", and of these, 11 participants reported taking medication for those pathologies. Out of the universe analyzed, 26 participants presented symptoms of constipation. The general characteristics of the studied population are summarized in Table 1. Regarding the participants with constipation, 20 were women and 6 were men, and 11 subjects with constipation were taking medication for other pathologies, from whom 42.3% were taking medication for constipation as well.

Table 1. *General Characteristics of the Study Population Categorized by Sex. Weight and Height Expressed as Mean ± SD and Sex Categories Expressed as Percentages.*

	Total participants		**Women**		**Men**	
	N=167		**N=133**		**N=34**	
Age	N	%	N	%	N	%
18-24	27	16,2	20	15,0	7	20,6
25-34	36	21,6	31	23,3	5	14,7

	Total participants		Women		Men	
	N=167		N=133		N=34	
35-44	53	31,7	44	33,1	9	26,5
45-54	33	19,8	29	21,8	4	11,8
55-64	13	7,8	8	6,0	5	14,7
65-74	5	3,0	1	0,8	4	11,8
>75	0	0,0	0	0,0	0	0,0
Height (m)	1,66 ± 0,07		1,64 ± 0,06		1,75 ± 0,06	
Weight ± SD (kg)	69 ± 14		67 ± 13		78 ± 14	
BMI	N	%	N	%	N	%
< 30 kg/m^2	148	88,6	119	89,5	29	85,3
≥ 30 kg/m^2	19	11,4	14	10,5	5	14,7
Education	N	%	N	%	N	%
4th grade	3	1,8	1	0,8	2	5,9
9th grade	13	7,8	9	6,8	4	11,8
12th grade	43	25,7	28	21,1	15	44,1
First Degree	65	38,9	52	39,1	13	38,2
Master's	28	16,8	28	21,1	0	0,0
PhD	5	3,0	5	3,8	0	0,0
Vocational Course	10	6,0	10	7,5	0	0,0
Occupation						
Student	22	13,2	15	11,3	7	20,6
Working-student	8	4,8	7	5,3	1	2,9
Worker	127	76,0	106	79,7	21	61,8
Other	10	6,0	5	3,8	5	14,7
Dietary prescription or supplements						
Yes	10	6,0	9	6,8	1	2,9
No	157	94,0	124	93,2	33	97,1
Pathologies						
Yes	57	34,1	45	33,8	12	35,3
No	110	65,9	88	66,2	22	64,7
Taking medication for the pathology	N=57		N=45		N=12	
Yes	11	19,3	8	17,8	3	25,0
No	46	80,7	37	82,2	9	75,0
Constipation						
Yes	26	45,6	20	44,4	6	50,0
No	31	54,4	25	55,6	6	50,0
Taking medication	N=26		N=20		N=6	
yes	11	42,3	8	40,0	3	50,0
no	15	57,7	12	60,0	3	50,0

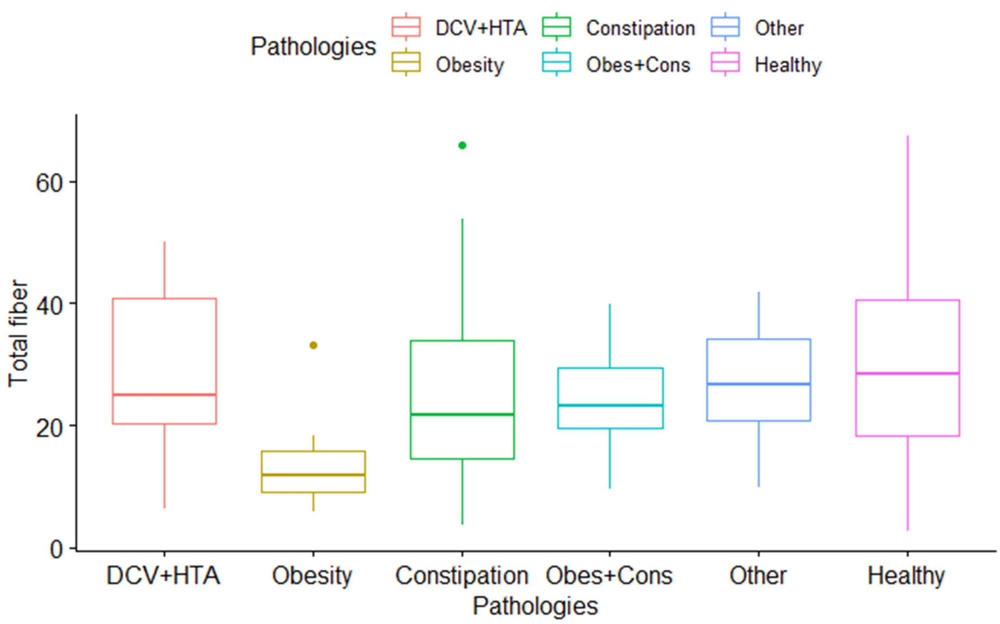

Figure 2. *Boxplot of the Average Total Fiber Intake for People with Different Pathologies (DCV+HTA=; Obes+Cons = with both Obesity and Constipation; other= other type of pathology). The Boundary of the Box Closest to zero Indicates the 25th Percentile, the Line Within the box Marks the mean, and the boundary of the box farthest from zero indicates the 75th Percentile. Whiskers Above and Below the box Indicate the 10th and 90th Percentiles. Points above and Below the Whiskers Indicate Outliers Outside the 10th and 90th Percentiles.*

When analyzing the data for the average, in grams, of the total fiber consumed by the population being studied (Figure 2), we found that the 15 participants who suffered from CVD and/or hypertension consumed 29.0±12.6 g of total fiber. As for the 8 individuals with obesity, they had a mean intake of 14.2±8.5 g and the 36 participants with constipation had 24.7±14.2 g. There were 8 participants with both obesity and constipation who reported a total fiber intake of 24.3±9.2 g and there were a further 19 individuals with other unspecified diseases who, on average, consumed 27.8±8.7 g. Finally, the 81 participants without any associated pathology were found to have an average total fiber intake of 28.8±14.6 g. Results from the Tukey's Honest Significant Difference test to evaluate the differences in total fiber intake between the different pathology groups (p= p-value; p.adj= p-value adjusted for multiple comparisons using the Bonferroni method), revealed no significant differences between the groups, with only the exception of the healthy and obese groups.

Table 2. *Mean and standard deviation (SD), in grams, of total fiber consumed by participants in general and by participants without pathologies, categorized by sex. D_f=degrees of freedom; H= statistic of the Kruskal–Wallis test) [35],).*

	Total Fiber (g)		H-statistic	D_f	p-value
	Mean	SD			
Women (n=133)	28.1	13.5	5.97	1	0.01
Men (n=34)	22.2	13.0			
Women without pathologies (n=80)	30.1	13.4	5.02	1	0.03
Men without pathologies (n=20)	22.6	13.1			

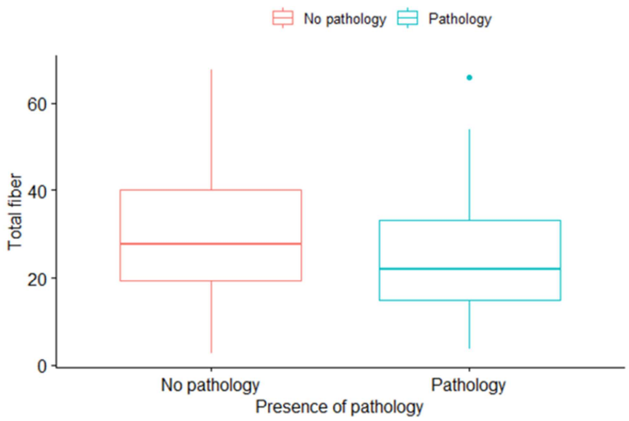

Figure 3. *Boxplot of the overall average fiber intake of the participants with no pathologies and with pathologies. The boundary of the box closest to zero indicates the 25th percentile, the line within the box marks the mean, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 10th and 90th percentiles. Points above and below the whiskers indicate outliers outside the 10th and 90th percentiles.*

We found that people with pathology consume significantly less fiber than healthy people (Figure 3). In particular obese people have a significantly reduced consumption of total fiber (Figure 2). For the intake of soluble and insoluble fiber we found no significant differences for the incidence of pathology; however, p-values very close to 0.05 were obtained.

We also found that females have a higher intake of fiber comparing to males (Figure 3). The same pattern was observed when considering only healthy people (with no pathology) which evidences the gender differences in the effect of dietary fiber intake. Regarding females, it is observed that they had an average dietary fiber intake of 28.1±13.5 g, while males consumed an average of 22.2±13.0 g, as shown in Table 2, which displays the average total fiber intake of the overall sample and of the participants without any medical condition, categorized by gender. It shows that female participants without any medical condition consumed 30.1±13.4 g of dietary fiber whereas male participants without any medical condition had a consumption of 22.6±13.1 g.

4. Discussion

The assessment of nutritional intake is important to understand the relationship between nutrition and chronic disease prevention, since, according to several authors, there is a link between gastrointestinal microbiota and health. Therefore, it was crucial to use the FFQ to assess individual dietary intake, as diet is a primary element in its composition and metabolic function [3],

Overall, the study data show that individuals without pathologies consume a higher amount of dietary fiber than individuals with pathologies, and these results are consistent with what is described in the literature, since a diet richer in fiber plays a key role in gastrointestinal health and, consequently, in reducing the risk of developing chronic diseases [3, 4], report that according to the American Dietetic Association (ADA), the daily recommendations for fiber intake are 25 g for females and 38 g for males. Other authors refer that the daily recommendations are around 30 g and the recommendations for daily fiber intake in Portugal, according to the DGS, are 25 g.

According to a review by Veronese et. al. [36],, epidemiological and cross-sectional studies indicate that lower dietary fiber intake is associated with the development of obesity and the benefits of dietary fiber consumption include its prevention and treatment. The results of this study are in line with what is described in the literature, since it was found that participants with a BMI ≥ 30 kg/m^2 had a lower mean intake of dietary fiber than participants with a BMI < 30 kg/m^2, consuming 26 g and 33.5 g of dietary fiber, respectively. The results are consistent with the fact that lower fiber intake is related to obesity, since from a nutritional perspective there is an association between dietary fiber intake and body weight control by reducing energy intake, increasing post prandial energy expenditure, and increasing satiety [37]. Interestingly, both groups of participants follow the

Portuguese daily recommendations but not those recommended by, for example, ADA which may indicate that the Portuguese recommendations should be revised.

Marques *et al*. [38] conducted a study on the high-fiber diet and the development of hypertension and found that this diet led to changes in the gut microbiota and consequently played a protective role in the development of hypertension. Gut dysbiosis has been associated with the development of hypertension and a diet rich in fibers and prebiotics ensures a healthy microbiota [7]. According to Drecher [39] the potential mechanisms of blood pressure reduction through dietary fiber intake include a reduced risk of obesity, decreased total and LDL cholesterol and high systemic inflammation with a decreased visceral fat volume, and improved vascular health. Both obesity and hypertension are risk factors associated with cardiovascular events, and according to Stephen *et al*. [5], there is a reduction in these risk factors in individuals with a higher fiber intake. The results of our study are in agreement with what is described in the literature, since individuals who present hypertension and/or CVD have an average intake of 28.3 g of dietary fiber. This is lower than in individuals without any associated pathology, who have an intake of 33.5 g of dietary fiber, showing a tendency that those with a higher intake have a decreased risk of developing both hypertension and CVD.

The pathogenesis of constipation is multifactorial, focusing on genetic predisposition, low fiber intake, physical inactivity, medication intake, and may also be related to other underlying health problems. The results of this study show that 12 of the 22 participants with pathologies are taking medications (for those pathologies). However, some medication may be associated with the development of constipation [12]. Therefore, the remaining 10 participants of the 22 who have pathologies and constipation provide evidence that constipation may also be related to other health problems, since they take medications unrelated to the onset of constipation, as do the 36 participants who do not take medications but have associated pathologies.

The findings of the present study show that individuals with constipation have a dietary fiber intake of 29 g, while healthy individuals consume 33.5 g, which is in accordance with what is described in the literature. Tantawy et al [40] report that obesity appears to be considered a risk factor for constipation and that an increased fiber intake was associated with a substantial reduction in constipation in women. According to the data obtained in our study, the individuals who have obesity and constipation have an average intake of 24.3 g of dietary fiber, which is in line with what is described in the literature, even though this intake is within the recommended values in Portugal.

As to gender differences, the present study shows that female participants without pathological conditions ingest fibers, on average, 28.1 g, which is an intake above the recommended, while male participants consume 22.2 g, which is below the recommended value in Portugal and is well below the desired amount, according to the ADA.

The results of the study showed a trend in accordance with previous studies [1, 3, 6]. However, there are limitations associated with the study, such as: due to the sample size, a generalization to the Portuguese population is not allowed; there is a different sample size for the different genders; due to the nature of the cross-sectional design, the results do not indicate a cause-effect relationship as being established; the study data were self-reported and in these cases, a memory bias may occur. Another limitation is related to the fact that participants may want to report information that they think is acceptable, valuing the consumption of healthier foods, thus leading to a social desirability bias. The tool used to quantify food intake was the FFQ, applied in the "Google forms" model, since the FFQ was validated for its application on paper and not in the model presented, which may lead to a greater difficulty in answering, especially among people with less ability to use computers. The complexity of the questionnaire is also a limitation, which may explain some disparity in the answers obtained [41]. In addition to the limitations, it is important to highlight some strengths, specifically the use of the FFQ, for being a previously tested and validated questionnaire and for being the most accepted method to measure food intake, especially when studying chronic diseases and the participants' adherence to the collection of information in an online format [23].

5. Conclusions

The present study assessed dietary fiber intake and its relationship with clinical conditions, and it was concluded that participants with higher fiber intake had no associated pathologies, while participants with decreased intake had various pathologies such as obesity, hypertension, CVD, and constipation. It is known that the human microbiome contributes in a fundamental way to health maintenance and, for this reason, adequate dietary fiber intake and compliance with the recommended daily intake is important for the prevention of chronic diseases, while inadequate intake is associated with a depletion of the gastrointestinal microbiota and, subsequently, with an increased occurrence of these diseases. A gender difference in fiber ingestion was also observed, with women reporting a higher intake than men which might reveal a greater concern towards diet by women than from men. Overall, even considering the shortcomings of the study, the data obtained seems to be in accordance with the great amount of data corroborating a correlation between an adequate fiber intake and improved health, its relationship with gut microbiota and the implications for either intestinal or extra-intestinal disorders [42].

Author Contributions

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, M. L. P.; methodology, M. L. P., and M. B.; software, R Core Team 2019, and Microsoft Excel 365; validation, J. P., M. J. C., P. P., and M. N.; formal analysis, M. L. P., J. P., M. J. C.,

P. P., and M. N.; investigation, M. L. P., M. B., J. P., M. J C., P. P., and M. N.; resources, M. L. P. and M. B.; data curation, M. L. P., J. P., M. J. C., P. P., and M. N.; writing—original draft preparation, M. L. P., and M. B.; writing—review and editing, M. L. P., M. J. C., P. P., and M. N.; visualization, M. L. P., M. J. C., P. P., and M. N.; supervision, M. L. P., and M. N.; project administration, M. L. P. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare that have no competing interests.

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