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Original Research

Knowledge about sources of dietary fibres and health effects using a validated scale: a cross-country study

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ABSTRACT

Objectives: Dietary fibre (DF) is one of the components of diet that strongly contributes to health improvements, particularly on the gastrointestinal system. Hence, this work intended to evaluate the relations between some sociodemographic variables such as age, gender, level of education, living environment or country on the levels of knowledge about dietary fibre (KADF), its sources and its effects on human health, using a validated scale.
Study design: The present study was a cross-sectional study.
Methods: A methodological study was conducted with 6010 participants, residing in 10 countries from different continents (Europe, America, Africa). The instrument was a questionnaire of self-response, aimed at collecting information on knowledge about food fibres. The instrument was used to validate a scale (KADF) which model was used in the present work to identify the best predictors of knowledge. The statistical tools used were as follows: basic descriptive statistics, decision trees, inferential analysis (t-test for independent samples with Levene test and one-way ANOVA with multiple comparisons post hoc tests).

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Results: The results showed that the best predictor for the three types of knowledge evaluated (about DF, about its sources and about its effects on human health) was always the country, meaning that the social, cultural and/or political conditions greatly determine the level of knowledge. On the other hand, the tests also showed that statistically significant differences were encountered regarding the three types of knowledge for all sociodemographic variables evaluated: age, gender, level of education, living environment and country.

Conclusions: The results showed that to improve the level of knowledge the actions planned should not be delineated in general as to reach all sectors of the populations, and that in addressing different people, different methodologies must be designed so as to provide an effective health education.

Introduction

Dietary fibre (DF) is a broad category of non-digestible food ingredients originating from plant materials that includes non-starch polysaccharides, oligosaccharides, lignin, and analogous polysaccharides.[1–3]

The most widely spread classification of DF some years ago was related to its solubility in water. However, other classifications are presently accepted and include microbial fermentation in the large intestine as well as viscosity, since these have shown to greatly influence the physiologic effects of DF.[4,5] Cellulose, hemicellulose and lignin are the structural parts of plant materials and belong to the category of insoluble fibre because they do not dissolve in water and are not metabolized by intestinal bacteria. On the other hand, pectins, gums and polysaccharides exist within and around the plant cells and belong to the category of soluble fibre since they are water soluble (acquiring a gel-like structure) and fermentable by colonic bacteria.[1,2]

However, the definition of DF has extended to include oligosaccharides with properties similar to soluble DF and resistant starches that escape enzymatic digestion in the small intestine and, hence, act as DF in the large intestine.[6] Contrarily to common DF, prebiotic DF is not classified in terms of solubility or viscosity, being defined in terms of resistance to digestion and absorption in the small intestine, partial or complete fermentation by microbiota in the large intestine, and the ability to stimulate growth of select bacteria.[2,7] Inulin and transgalactooligosaccharides fill the three criteria mentioned, and hence are considered prebiotics. According to Roberfroid et al.[8] in the future other oligosaccharides and polydextrose may also come to be classified as prebiotics.

A very significant number of scientific studies confirm the important role of DF consumption in reducing many diseases like cancer, diabetes, obesity and coronary heath diseases.[9,10] According to Huang et al.[11] and based on several recent meta-analyses including a large number of subjects and prospective studies, a high intake of whole grains and cereal fibre showed significant and consistent protective effects on diseases such as type 2 diabetes, cardiovascular disease and certain cancers (e.g. colorectal cancer).

A study by Threapleton et al.[12] investigated the intake of DF and any potential dose–response associations both with coronary heart disease and cardiovascular disease, and concluded that DF consumption is in fact associated with a lower risk of both diseases.

Yokoyama et al.[13] conducted a systematic review and meta-analysis of controlled clinical trials and observational studies that have focused on the association between vegetarian diets, composed of fibre rich foods, and blood pressure, and they concluded that consumption of vegetarian diets is associated with lower blood pressure, and hence could constitute a useful non-pharmacologic approach for this problem.

Murphy et al.[14] studied the DF intake and the risks of cancers of the colon and rectum, along a period of 11 years and considering 4517 documented cases of colorectal cancer. They observed that total DF was inversely associated with colorectal cancer, as well as with colon and rectal cancers. Furthermore, the association between total DF and risk of colorectal cancer risk did not differ by age, by sex, or by anthropometric, lifestyle and dietary variables. Still they observed that while both fibre from cereals and fibre from fruits and vegetables were similarly associated with colon cancer; for rectal cancer, the inverse association was only evident for fibre from cereals.

Encarnação et al.[15] highlights the role of DF in lowering the risk of developing colorectal cancer through the fermentation of the DF by intestinal microbiota, which produces butyrate, which in turn has been reported as a chemopreventive agent. Furthermore, they reviewed recent new insights that focus on butyrate role not only in preventing colorectal cancer but also in treating it. Similar reports were made by Bordano and Lazarova[16] and by Le Leu et al.[17]

According to Norat et al.[18] there is evidence that high intakes of fruits and vegetables may reduce the risk of cancers of the aerodigestive tract.

Constipation is a common, often chronic, condition that is a health concern for providers of care. The regular consumption of DF, together with the ingestion of fluids and exercise constitute a first-line treatment of constipation.[19,20] Tabbers and Benninga[21] conducted a systematic review to investigate constipation in children, including 12 studies. They present evidence of the effectiveness and safety of two interventions in particular, which are the use of DF and probiotics. DF supplements have been reported as useful for the management of chronic constipation and irritable bowel syndrome.[22]

Insulin resistance syndrome, especially with diabetes, is becoming increasingly prevalent worldwide, due to increased consumption of low-fibre and refined-carbohydrate diets.[23] The study by Balk et al.[24] studied the association of diet and lifestyle with glycated haemoglobin in type 1 diabetes. A 7-year prospective cohort analysis was performed in 1659 patients participating in the EURODIAB Prospective Complications Study, and the results obtained suggest that low intake of vegetable protein and DF is associated with worse glycaemic control in type 1 diabetes.

Seal and Brownlee[25] report an increasing evidence, based both on observational and intervention studies, that increased intake of less-refined, whole-grain foods has positive health benefits, among which stand type 2 diabetes. The InterAct Consortium study on DF and incidence of type 2 diabetes in eight European countries followed 11,559 participants with type 2 diabetes along 10.8 years. The results of the study evidence that the intake of total and cereal fibre is inversely related to the risk of type 2 diabetes.[26]

Whincup and Donin[27] highlight diet and nutrition as being strongly implicated in the aetiology of type 2 diabetes, and report specially low DF intake as an important factor. Furthermore, the authors demonstrate the diet patterns associated with the low intake of DF. In fact, prospective observational studies show that there appears to be low cereal fibre intake, rather than low fruit and vegetable fibre intake. The results presented strengthen the evidence implicating cereal fibre as an important determinant of type 2 diabetes risk and suggest that randomized controlled trials aimed at examining the effect of cereal fibre supplementation on type 2 diabetes risk should be conducted.

Although DF is a theme thoroughly investigated in terms of their quantification, analysis and their effects on the human being, little is known about the perceptions of people about DF or their levels of knowledge. Hence a study was conducted by Guiné et al.[28] aimed to develop and validate an instrument to evaluate the knowledge of the general population about DFs. In that study, a group of questions were evaluated and two factors resulted from the structural equation modelling (SEM) applied: one related to dietary fibre and promotion of health (DFPH) and the other related to sources of dietary fibre (SDF).

The aim of the present work was to use the validated scale developed by Guiné et al.[28] to assess the knowledge about dietary fibre (KADF) in terms of the two variables defined (sources and effects on human health) so as to evaluate the relations between some sociodemographic variables such as age, gender, level of education, living environment or country on the levels of knowledge.

Methods

Data collection

The methodological study of psychometric validation was conducted by means of a questionnaire survey, applied in 10 different countries situated in different parts of the globe for the evaluation of geographical influence on the level of KADF, among other factors. Hence the participants resided in several countries from different continents (Europe, America, Africa), which integrated a project of the CI&DETS Research Centre (IPV, Viseu, Portugal).

The participation in the survey was voluntary, and the questionnaire was applied by direct interview only to adult citizens, after verbal informed consent was obtained. In each country the sample was selected attempting to reach different sectors of the population, namely in terms of age, literacy, gender or geographical area of residence, including people from different cities and smaller villages in each of the participating countries.

All the answers were anonymous and no personal data were ever collected or related to any answers, so as to protect the participants. All ethical issues were strictly guaranteed when designing and applying the questionnaire.

Instrument

The instrument was a questionnaire of self-reported response, which aimed to collect information on KADF. This measuring instrument was previously validated by structural equation modelling so that a model comprising two factors with four items each was considered.[28] Table 1 shows the questions included in the model, distributed by factors, and that aimed to evaluate knowledge about SDF and about the relations between fibres and diseases. They were all presented in ordinal Likert scale according to the following answer format: 1—strongly disagree, 2—disagree, 3—neither agree nor disagree, 4—agree and 5—strongly agree. Question (d) was listed in reverse, so that 1 is strongly agree and 5 is strongly disagree. The higher the score, the higher is the level of knowledge about food fibres. The questionnaire was prepared in English and then translated into different languages for application in the participating countries in their native languages.

The measured variables were used to compute more suitable working variables as highlighted in Table 2.

Statistical analysis

To analyse the results the SPSS (Statistical Package for Social Sciences), version 21.0 for Windows, was used. Basic descriptive statistics was used as well as decision trees, together with inferential analysis (t-test for independent samples with Levene test and one-way ANOVA with multiple comparisons post hoc tests). Apart from the significance of the test (P-value), also the test power (π) and dimension of effects (η^2) were used to evaluate the tests. The level of significance considered was 5% in all tests.

Results

Sample characterization

The methodological study of psychometric validation was conducted with 6010 participants, from which 65.7% were female and 34.3% male, aged between 17 and 84 years, with an average age of 34.5 years (±13.74 SD), distributed as follows: one third stand in the class from 17 to 24 years, inclusive; another third stand in the class from 25 to 40 years, inclusive;

Table 1 – Validated items included in the questionnaire.[28]

Item	Items in factor SDF (knowledge about: sources of dietary fibre)
(a)	Only plant foods have fibre.
(b)	Foods of animal origin such as meat, eggs and dairy products contain no fibres (unless added).
(c)	Dietary fibre comes only in plant foods.
(d)	Dietary fibre may originate in plant and animal foods.
Item	**Items in factor DFPH (knowledge about: dietary fibre and promotion of health)**
(e)	Eating dietary fibres in appropriate amounts can prevent and/or treat diseases.
(f)	Fibres can prevent and/or treat bowel cancer.
(g)	Fibres can prevent and/or treat constipation.
(h)	Fibres can prevent and/or treat diabetes.

Table 2 – Computed and transformed variables.

Variable	Description
SDF	Sum of scores of the four items which belong to this factor: (a) + (b) + (c) + (d)
DFPH	Sum of scores of the four items which belong to this factor: (e) + (f) + (g) + (h)
Knowledge	Sum of SDF and DFPH
SDF_percent	SDF_percent = (SDF − n)/[n × (U − L)] × 100 With: n = no. of items in the factor (=4) U = upper limit of the measuring scale (=5) L = lower limit of the measuring scale (=1)
DFPH_percent	DFPH_percent = (DFPH − 4)/4 × (5 − 1) × 100
Knowledge_percent	Knowledge_percent = (Knowledge − 8)/8 × (5 − 1) × 100
Classification_Knowledge	Cut points in percentiles 25 and 75: Group 1—low knowledge: score knowledge ≤23 Group 2—medium knowledge: score knowledge between 24 and 30 Group 3—high knowledge: score knowledge ≥31
Classification_DFPH	Cut points in percentiles 25 and 75: Group 1—low knowledge: score knowledge ≤14 Group 2—medium knowledge: score knowledge between 15 and 16 Group 3—high knowledge: score knowledge ≥17
Classification_SDF	Cut points in percentiles 25 and 75: Group 1—low knowledge: score knowledge ≤9 Group 2—medium knowledge: score knowledge between 10 and 13 Group 3—high knowledge: score knowledge ≥14

DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre.

and finally the last third stands in the class from 41 to 84 years, inclusive.

The participants resided in 10 countries from three different continents (Europe, America and Africa), and Fig. 1 shows the geographical distribution of the participants.

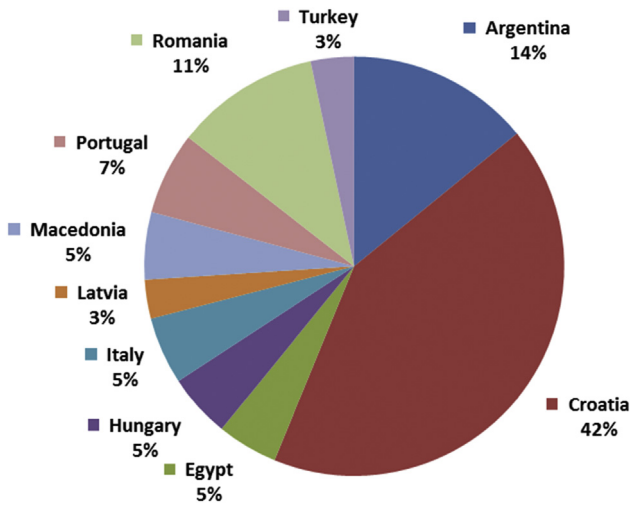

Fig. 1 – Distribution of the participants by country.

Global level of knowledge

The statistics for knowledge about fibres indicate a minimum score for the global knowledge of 3.1% and a maximum of 96.8% with an average rate of 59.5% (±16.1% SD; Table 3). The levels of knowledge for the variables related to health and sources of fibre have a range of 100.0%, with average percentages of 70.3% (±17.3% SD) and 48.6% (±24.2% SD), respectively. In short, participants' knowledge about the health effects of fibre is higher than those obtained regarding the sources of fibre. The coefficients of variation indicate moderate dispersions for DFPH and high for the SDF.

Table 4 reports the scores obtained for the global knowledge (Variable Classification_Knowledge as defined in Table 2) as well as the relationship with sociodemographic variables. It is possible to verify that 25.4% of respondents revealed a low level of knowledge, about half (49.6%) had a reasonable knowledge and the rest (25.0%) showed a high level of knowledge.

Analysing the profile of those who revealed a weak knowledge, it was found that nearly 6 in 10 respondents were female, are aged up to 24 years (46.7%), have university education (51.5%), reside in urban areas (75.0%) and are mainly from Croatia (43.1%). In turn, those who showed a medium knowledge were also mostly from female gender (65.0%), aged

Table 3 – Statistics for the variables accounting for knowledge.

Variable	Min (%)	Max (%)	Mean (%)	Standard deviation (%)	CV (%)
DFPH	0	100.0	70.3	17.3	24.6
SDF	0	100.0	48.6	24.2	49.7
Knowledge	3.1	96.8	59.5	16.1	27.0

DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre; CV = coefficient of variance.

25–40 years (34.1%), with literary qualifications at higher education level (52.7%), living in urban areas (79.9%) and again from Croatia (40.2%). Finally, the profile of the participants who revealed a high level of knowledge corresponds to women (68.9%), aged at least 41 years (40.2%), with university education (61.6%), residing in urban areas (86%) and from Croatia (44.9%). The chi-squared test showed statistically significant differences ($P < 0.05$) for all variables (Table 4).

The study was complemented with a multivariate analysis procedure called the decision tree through the algorithm CHAID (Chi-square Automatic Interaction Detection). The stepwise method evaluates the input of each variable in the model and verifies whether the contribution is significant or not, among the predictor variables. In the study was intended to decompose the initial variable, degree of knowledge, to obtain the most likely determinants. The independent variables used to construct the decision tree were gender, age, educational level, place of residence and country of origin (Fig. 2 and Fig. S1 – supplementary material). All these variables are explanatory of the model, standing distributed by 31 nodes, from which 18 are terminals.

The first box in Fig. 2 corresponds to node 0, or root, and the information in the box in Fig. S1 – supplementary material indicates that the probability for a medium knowledge is 49.6%. The first depth level of the tree is obtained by the country of origin, which indicates that this is the variable that best predicts the degree of knowledge. The sample is segmented into six distinct groups of countries: Romania, Portugal and Turkey; Hungary and Croatia; Macedonia and Argentina; Latvia; Egypt; Italy, for which the probabilities of medium knowledge are, respectively: 48.2%, 47.0%, 56.4%, 60.6%, 50.2% and 46.5%. Node 4 (Latvia) is a terminal node.

The second level of depth shows that for the group of countries Romania Portugal and Turkey, the variable that best predicts the degree of knowledge is the qualifications. For these countries, the probability of those with primary or university education having a medium knowledge is 45.3% while for those with secondary school is 54.3%. For the remaining countries the age is the predictor variable so that for Hungary and Croatia the probability of having average knowledge stands at 46.0% for those aged ≤24 years, 47.3% for the group 25–40 years and 47.9% for age ≥41 years. For the group of countries Argentina and Macedonia the probabilities of having a medium knowledge are 50.2% and 58.1% for those aged ≤24 years and ≥25, respectively, being the node 13 terminal. Nodes 14 and 15, relative to Egypt, are also terminals and indicate the probability of 59.3% of respondents aged ≤24

Table 4 – Classification of knowledge according to sociodemographic variables.

Variable	Knowledge								χ^2	P-value
	Low		Medium		High		Total			
	n	%	*n*	%	*n*	%	*n*	%		
Gender	1522	25.4	2973	49.6	1502	25.0	5997	100.0	9.715	0.008
Female	973	63.9	1931	65.0	1035	68.9	3939	65.7		
Male	549	36.1	1042	35.0	467	31.1	2058	34.3		
Age	1524	25.4	2980	49.6	1506	25.1	6010	100.0	189.272	<0.0005
≤24 years	712	46.7	958	32.1	386	25.6	2056	34.2		
25–40 years	476	31.2	1017	34.1	514	34.1	2007	33.4		
≥41 years	336	22.0	1005	33.7	606	40.2	1947	32.4		
Education	1521	25.4	2972	49.6	1501	25.0	5994	100.0	47.171	<0.0005
Primary school	39	2.6	118	4.0	41	2.7	198	3.3		
Secondary school	698	45.9	1287	43.3	535	35.6	2520	42.0		
University degree	784	51.5	1567	52.7	925	61.6	3276	54.7		
Living environment	1516	25.4	2957	49.5	1495	25.1	5968	100.0	60.196	<0.0005
Rural	379	25.0	595	20.1	206	13.8	1180	19.8		
Urban	1137	75.0	2362	79.9	1289	86.2	4788	80.2		
Country	1524	25.4	2980	49.6	1506	25.1	6010	100.0	262.231	<0.0005
Argentina	177	11.6	489	16.4	181	12.0	847	14.1		
Croatia	657	43.1	1197	40.2	676	44.9	2530	42.1		
Egypt	133	8.7	141	4.7	7	0.5	281	4.7		
Hungary	88	5.8	130	4.4	78	5.2	296	4.9		
Italy	105	6.9	145	4.9	62	4.1	312	5.2		
Latvia	60	3.9	109	3.7	11	0.7	180	3.0		
Macedonia	78	5.1	165	5.5	69	4.6	312	5.2		
Portugal	66	4.3	184	6.2	132	8.8	382	6.4		
Romania	134	8.8	310	10.4	226	15.0	670	11.1		
Turkey	26	1.7	110	3.7	64	4.2	200	3.3		
Total	1524	25.4	2980	49.6	1506	25.0	6010	100.0		

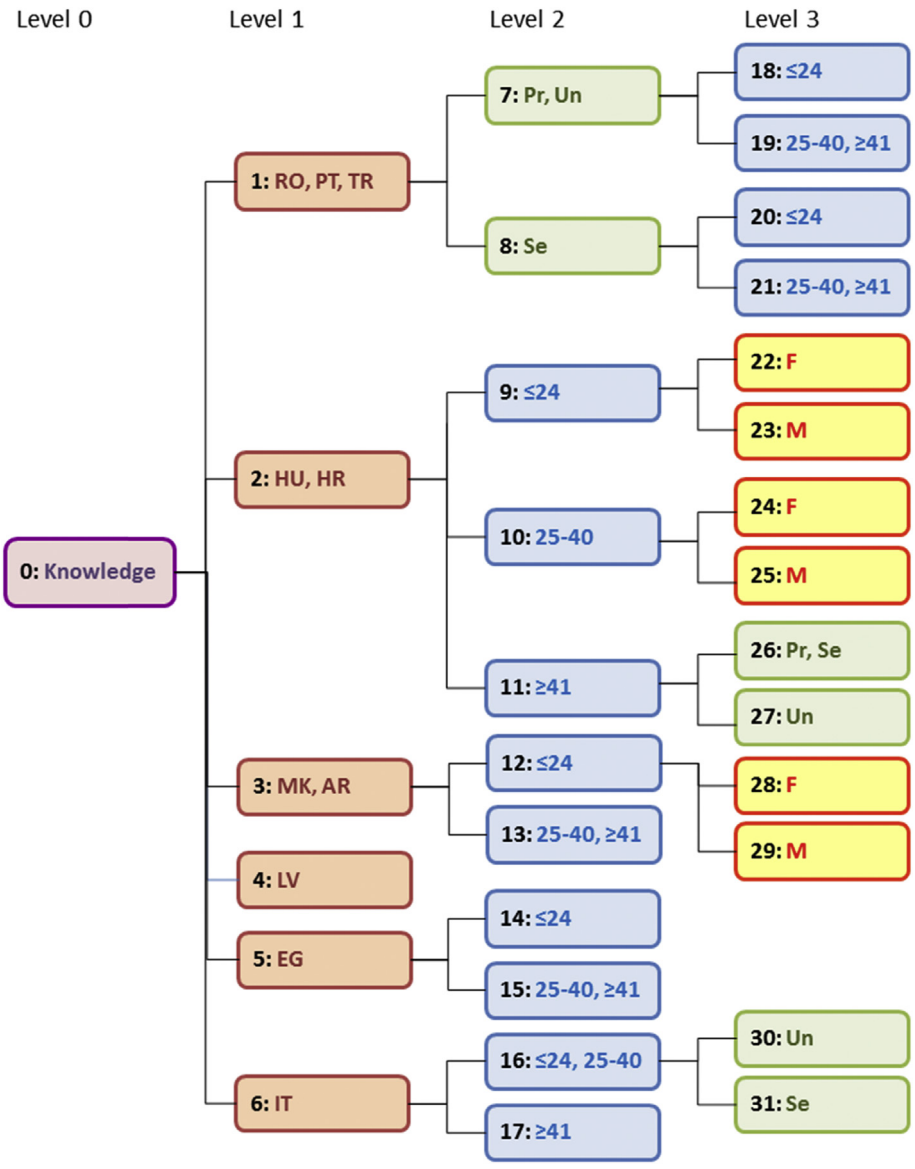

Fig. 2 – Decision tree for the knowledge as related to the predictor variables (country codes: AR = Argentina, EG = Egypt, HU = Hungary, HR = Croatia, IT = Italy, LV = Latvia, MK = Macedonia, PT = Portugal, RO = Romania, TK = Turkey; education codes: Pr = primary school, Se = secondary school, Un = university; gender codes: F = female, M = male).

having a low knowledge while for those aged ≥25 years there is a probability of 64.9% for those over the age of 24 years to have a medium knowledge. With regard to Italy, the probability of a medium knowledge is 46.0% for participants aged up to 40 years and 48.0% for those over the age of 40 years, corresponding this last to a terminal node.

The third level of depth features 14 terminal nodes. The age is the best predictor for medium knowledge for those participants from Romania, Portugal and Turkey, regardless of the level of education. However, the gender predicts average knowledge for Hungary and Croatia despite of the existence of two terminal nodes whose predictor variables are the qualifications. In these cases, there is a probability of 51.9% for those with primary and secondary education to have a medium knowledge and a probability of 45.5% for who have higher education to demonstrate a high level of knowledge. The following two terminals indicate that gender is a predictor of average knowledge on respondents aged less than or equal to 24 years in countries like Macedonia and Argentina. Finally, the last two terminal nodes indicate that university and secondary school levels appear to be predictors of medium knowledge for those aged between 25 and 40 years old from Italy.

Knowledge about: dietary fibre and promotion of health

Table 5 refers to the relation between the sociodemographic variables and the knowledge about the health effects of DF. It is observed that among the participants with low knowledge about DFPH, 60.4% are female, 40.1% are aged up to 24 years, 49.2% have secondary education, 74.9% live in urban areas and 44.9% are from Croatia. Participants with a medium level of

Table 5 – Classification of knowledge about dietary fibre and promotion of health according to sociodemographic variables.

Variable	Knowledge								χ^2	P-value
	Low		Medium		High		Total			
	n	%	*n*	%	*n*	%	*n*	%		
Gender	2177	36.3	1983	33.1	1837	30.6	5997	100.0	57.440	<0.0005
Female	1315	60.4	1305	65.8	1319	71.8	3939	65.7		
Male	862	39.6	678	34.2	518	28.2	2058	34.3		
Age	2181	36.3	1984	33.0	1845	30.7	6010	100.0	60.542	<0.0005
≤24 years	875	40.1	621	31.3	560	30.4	2056	34.2		
25–40 years	703	32.2	670	33.8	634	34.4	2007	33.4		
≥41 years	603	27.6	693	34.9	651	35.3	1974	32.4		
Education	2173	36.3	1981	33.0	1840	30.7	5994	100.0	94.031	<0.0005
Primary school	90	4.1	60	3.0	48	2.6	198	3.3		
Secondary school	1069	49.2	784	39.6	667	36.3	2520	42.0		
University degree	1014	46.7	1137	57.4	1125	61.1	3276	54.7		
Living environment	2162	36.2	1968	33.0	1838	30.8	5968	100.0	70.917	<0.0005
Rural	543	25.1	368	18.7	269	14.6	1180	19.8		
Urban	1619	74.9	1600	81.3	1569	85.4	4788	80.2		
Country	2181	36.3	1984	33.0	1845	30.7	6010	100.0	273.773	<0.0005
Argentina	279	12.8	283	14.3	285	15.4	847	14.1		
Croatia	980	44.9	906	45.7	644	34.9	2530	42.1		
Egypt	145	6.6	80	4.0	56	3.0	281	4.7		
Hungary	73	3.3	75	3.8	148	8.0	296	4.9		
Italy	124	5.7	113	5.7	75	4.1	312	5.2		
Latvia	82	3.8	58	2.9	40	2.2	180	3.0		
Macedonia	143	6.6	104	5.2	65	3.5	312	5.2		
Portugal	80	3.7	145	7.3	157	8.5	382	6.4		
Romania	229	10.5	148	7.5	293	15.9	670	11.1		
Turkey	46	2.1	72	3.6	82	4.4	200	3.3		
Total	2181	36.3	1984	33.0	1845	30.7	6010	100.0		

knowledge are mostly female (65.8%), aged over 40 years (34.9%), having higher education (57.4%), living in urban areas (81.3%) and from Croatia (45.7%). As to those showing a high level of knowledge, the profile is basically female (71.8%), with age over 40 years (35.3%), with university education (61.1%), living in urban areas (85.4%) and coming from Croatia (34.9%). Also in this case, the differences between the groups for the different variables studies were statistically significant.

The decision tree in Fig. 3 (and Fig. S2 – supplementary material) refers to the knowledge about DFPH. Again the country is the best predictor for level 1, but with respect to level 2 the level of education, age group or living environment appear as predictors, depending on the country. The predictors in level 2 are age and gender only. The number of terminal nodes is 19. The highest percentage in node 0 is 36.3% and corresponds to the low level of knowledge about DFPH.

Knowledge about: SDF

The results in Table 6 refer to the relations between knowledge about the sources of fibre and the sociodemographic variables. It was found that in relation to gender, women are those with lower levels of knowledge (69.3%) but the percentages for medium and high knowledge are similar (63.7% and 64.5%, respectively). In terms of age, the low knowledge occurs for the age group of ≤24 years (43.5%), while those with medium (34.1%) and high knowledge (41.2%) correspond to the age groups 25–40 years and ≥41 years, respectively. As for qualifications, the low (56.1%), medium (51.4%) and high (56.8%) knowledge lie in those having university education. Similarly, the highest percentages were found for those living in urban areas for all levels of knowledge: low (76.9%), medium (78.6%) and high (56.8%). Finally, it is also in Croatia that occur the highest percentages for low (41.2%), medium (38.7%) and high knowledge (46.7%). Again, all the sociodemographic variables considered were found associated with the knowledge about SDF.

Fig. 4 (and Fig. S3 – supplementary material) presents the decision tree for the knowledge about SDF. Node 0 shows that the highest percentage corresponds to the medium level of knowledge about SDF (36.3%), and once more the country is the best predictor for level 1. Hence, regardless of the type of knowledge, country is in fact always the best predictor for level 1. Interestingly, it is also a predictor for those aged between 25 and 40 years and from Croatia, Portugal and Turkey. The predictor for level 2 are only age or living environment, while gender and school level appear as predictor for level 3. The number of terminal nodes for this tree is higher, 22.

Inferential statistics

Table 7 establishes the relation between gender and knowledge about fibres in its three versions. It is observed that women demonstrated best global knowledge as well as knowledge about the health effects of fibre, when compared to men, while men showed better knowledge regarding the sources of fibre. Not assuming equal variances, the value of *t* is statistically significant for the knowledge about DFPH and global knowledge, with small effects ($n^2P = 0.013$) and low dimension ($n^2P = 0.003$) and test power to a type 1 error of

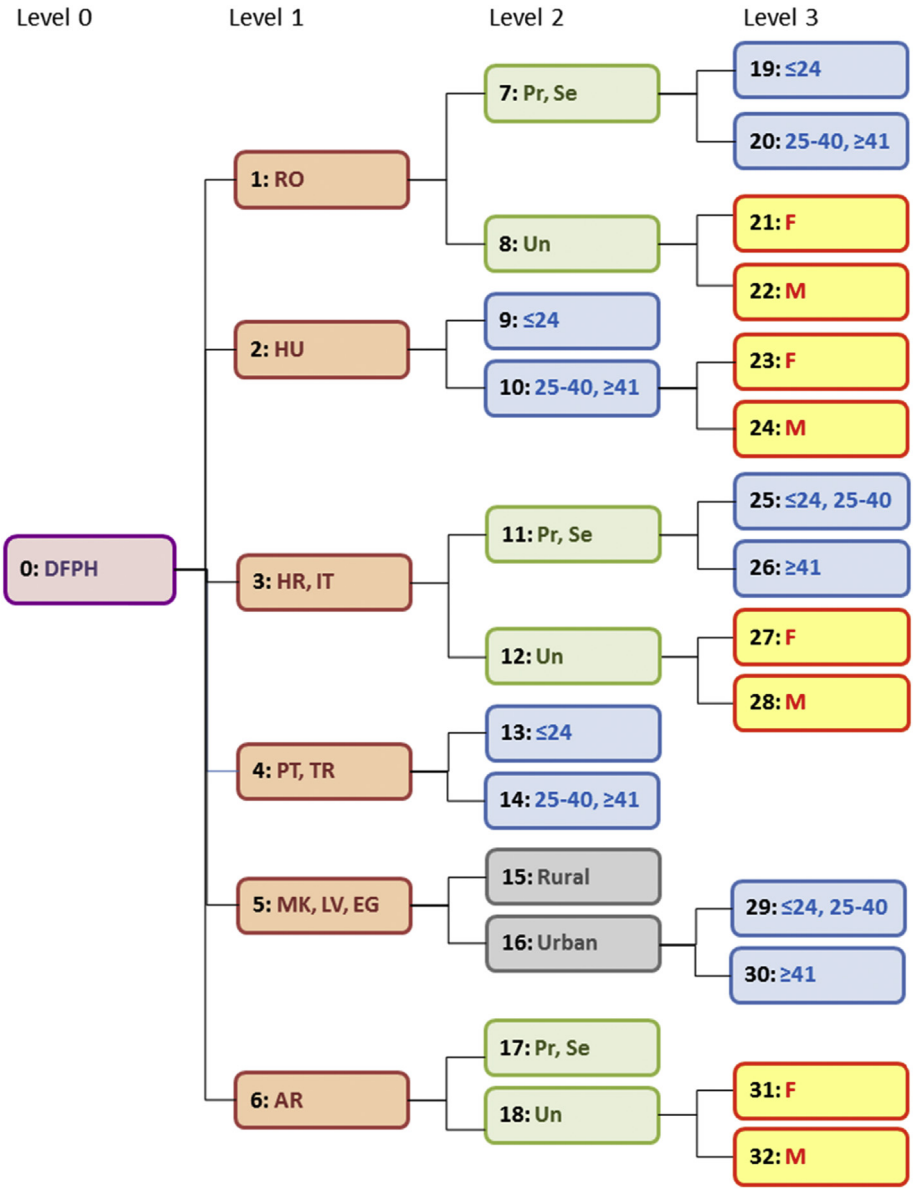

Fig. 3 – Decision tree for the knowledge about DFPH as related to the predictor variables (country codes: AR = Argentina, EG = Egypt, HU = Hungary, HR = Croatia, IT = Italy, LV = Latvia, MK = Macedonia, PT = Portugal, RO = Romania, TK = Turkey; education codes: Pr = primary school, Sea = secondary school, Un = university; gender codes: F = female, M = male).

100.0% and 98.7% respectively, considering a significance of 5%.

The results in Table 8 relate to the relation between knowledge about fibres and age, and they show that those with less knowledge are participants aged up to 24 years. Those aged between 25 and 40 years revealed more knowledge about the health effects of DF, with an average percentage of 71.16%, while for the knowledge about the sources of fibre and global knowledge the age group that demonstrated higher knowledge was over 40 years, with average percentages of 53.29% and 62.80%, respectively. The differences were statistically significant ($P < 0.0005$) for all knowledge variables among the different age groups. The eta coefficients indicate that there are effects with an average dimension with test powers for a type 1 error of 100.0% for all variables (at 5% level of significance). Post hoc tests revealed statistically significant differences in cases except for knowledge about DFPH between the age groups 25–40 and ≥41 years.

Table 9 presents the results relating to the differences in knowledge considering the levels of education. It is seen that knowledge about the health effects and global knowledge have the greatest expression in participants with university education, being the differences statistically highly significant, with test power for a type 1 of 100.0% in both cases and average and small size effects, respectively. The post hoc test showed statistically significant differences between all groups ($P = 0.000$). In relation to the knowledge about SDF, it was found that those with lower educational qualifications demonstrated

Table 6 – Classification of knowledge about sources of dietary fibre according to sociodemographic variables.

Variable	Knowledge								χ^2	P-value
	Low		Medium		High		Total			
	n	%	*n*	%	*n*	%	*n*	%		
Gender	1836	30.6	2178	36.3	1983	33.1	5997	100.0	15.472	<0.0005
Female	1272	69.3	1388	63.7	1279	64.5	3939	65.7		
Male	564	30.7	790	36.3	704	35.5	2058	34.3		
Age	1842	30.6	2181	36.3	1987	33.1	6010	100.0	181.074	<0.0005
≤24 years	801	43.5	733	33.6	522	26.3	2056	34.2		
25–40 years	617	33.5	743	34.1	647	32.6	2007	33.4		
≥41 years	424	23.0	705	32.3	818	41.2	1947	32.4		
Education	1839	30.7	2174	36.3	1981	33.0	5994	100.0	23.516	<0.0005
Primary school	44	2.4	95	4.4	59	3.0	198	3.3		
Secondary school	763	41.5	961	44.2	796	40.2	2520	42.0		
University degree	1032	56.1	1118	51.4	1126	56.8	3276	54.7		
Living environment	1834	30.7	2165	36.3	1969	33.0	5968	100.0	46.203	<0.0005
Rural	424	23.1	463	21.4	293	14.9	1180	19.8		
Urban	1410	76.9	1702	78.6	1676	85.1	4788	80.2		
Country	1842	30.6	2181	36.3	1987	33.1	6010	100.0	344.651	<0.0005
Argentina	236	12.8	384	17.6	227	11.4	847	14.1		
Croatia	759	41.2	844	38.7	927	46.7	2530	42.1		
Egypt	156	8.5	110	5.0	15	0.8	281	4.7		
Hungary	131	7.1	79	3.6	86	4.3	296	4.9		
Italy	119	6.5	102	4.7	91	4.6	312	5.2		
Latvia	67	3.6	101	4.6	12	0.6	180	3.0		
Macedonia	66	3.6	142	6.5	104	5.2	312	5.2		
Portugal	119	6.5	108	5.0	155	7.8	382	6.4		
Romania	135	7.3	246	11.3	289	14.5	670	11.1		
Turkey	54	2.9	65	3.0	81	4.1	200	3.3		
Total	1842	30.6	2181	36.3	1987	33.1	6010	100.0		

lower knowledge, but with marginal significance between groups ($F = 2.916$; $P = 0.054$) and 57.1% test power.

The results of the *t*-test used to relate the place of residence with the knowledge about DF, show that the participants residing in urban areas have more knowledge in all domains than the residents in rural areas (Table 10). Assuming equal variances by Levene test for health effects and unequal variance for sources of fibre and global knowledge, the value of *t* is significant. The global knowledge shows a medium-sized effect ($n^2P = 0.012$) while the knowledge about SDF ($n^2P = 0.006$) and about DFPH ($n^2P = 0.008$) show lower dimensions but with test powers for type 1 error of 100.0% for all variables (5% significance).

The results in Table 11 reveal that Portugal is the country that, on average, shows better knowledge about DFPH (76.27 ± 6.14), but very close to Hungary (76.18% ± 17.87) and Turkey (75.50% ± 8.15), whereas Egypt (64.92% ± 15.48) and Macedonia (66.02% ± 20.22) are the countries where people revealed the lowest knowledge about the health effects of DF.

With regard to knowledge about SDF Turkey leads the group with the highest percentage (52.81 ± 25.33%) followed in descending order by Romania (52.42 ± 22.21%) and Portugal (51.60 ± 27.95%). It was also found that participants from five countries revealed an average level of knowledge about SDF lower than 50.0%, highlighting the cases of Egypt (33.54 ± 15.47%) and Latvia (39.58 ± 15.82%).

As for the overall knowledge about fibres, it shows Turkey as the country with better knowledge (64.15 ± 5.16%) followed by Portugal (63.92 ± 16.61%). Again Egypt (49.23 ± 10.15%) leads the countries with the lowest level of knowledge. The *F* values are statistically significant ($P < 0.0005$) and the test powers to an error type are of 100.0% (5% significance) with average size effects.

Discussion

This study used a validated tool, KADF, previously developed by the authors[28] and validated by SEM. This scale included eight validated questions, four in each of two factors: SDF and DFPH. This model was, therefore, the basis for the present work, which evaluated the knowledge about DF in a global way and also regarding each of the factors, based on the questions that composed each of them. Furthermore, the differences were evaluated between groups, considering several sociodemographic factors, namely gender, age, education, living environment and country, since these would be expected to some extent to influence the way people get information and/or process it about health issues in general and about healthy eating and DF in particular.

The general level of knowledge was found to be moderate, corresponding to about half of the respondents, with only one quarter showing a high level of knowledge about DF. This result is important, because although still one quarter of the population reveals a low level of knowledge, most already demonstrated to be aware of the SDF, and hence may adapt their diets towards a consumption more in accordance with the recommendations; being also aware of the benefits of DF for the human health, and can hence dedicate themselves to promoting health through the ingestion of adequate amounts of DF.

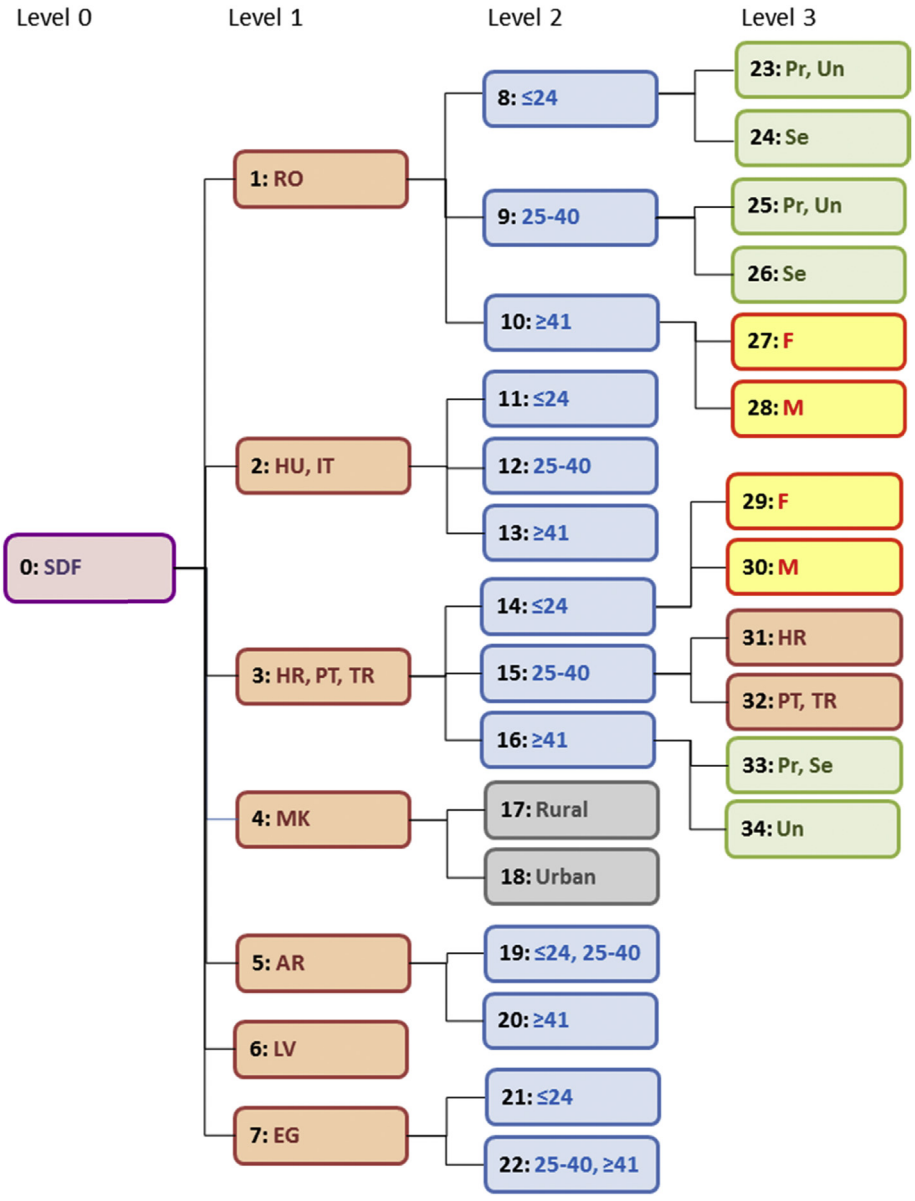

Fig. 4 – Decision tree for the knowledge about SDF as related to the predictor variables (Country codes: AR = Argentina, EG = Egypt, HU = Hungary, HR = Croatia, IT = Italy, LV = Latvia, MK = Macedonia, PT = Portugal, RO = Romania, TK = Turkey; Education codes: Pr = Primary school, Se = Secondary school, Un = University; Gender codes: F = Female, M = Male).

Table 7 – The t-test for the different types of knowledge about DF in relation to gender.

Type of knowledge	Gender				Levene's P	t	P-value	Eta (η^2)	Power (π)
	Female		Male						
	Mean (%)	SD	Mean (%)	SD					
DFPH (health)	71.81	16.06	67.59	18.37	0.001	8.723	<0.0005	0.013	1.000
SDF (sources)	48.43	24.72	48.97	23.27	0.000	−0.818	0.404	0.000	0.130
Knowledge (global)	60.12	16.30	58.28	15.72	0.014	4.201	<0.0005	0.003	0.987

DF = dietary fibre; DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre.

Table 8 – One-way ANOVA for the different types of knowledge about DF in relation to age.

Type of knowledge	Age						F	P-value	Eta (η^2)	Power (π)
	≤24 years		25–40 years		≥41 years					
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD				
DFPH (health)	67.76	18.16	71.16	19.99	70.37	16.49	38.164	<0.0005	0.013	1.000
SDF (sources)	44.04	24.35	48.76	24.44	53.29	22.94	74.686	<0.0005	0.024	1.000
Knowledge (global)	55.90	16.08	59.96	16.03	62.80	15.50	95.855	<0.0005	0.031	1.000

DF = dietary fibre; DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre.

Table 9 – One-way ANOVA for the different types of knowledge about DF in relation to education.

Type of knowledge	Education						F	P-value	Eta (η^2)	Power (π)
	Primary		Secondary		University					
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD				
DFPH (health)	67.23	16.81	67.84	18.05	72.39	16.47	52.988	<0.0005	0.017	1.000
SDF (sources)	49.62	19.29	47.71	22.71	49.21	25.56	2.916	0.054	0.001	0.571
Knowledge (global)	58.42	14.30	57.82	15.47	60.84	16.59	25.531	<0.0005	0.008	1.000

DF = dietary fibre; DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre.

Table 10 – The t-test for the different types of knowledge about DF in relation to living environment.

Type of knowledge	Living environment				Levene's P	t	P-value	Eta (η^2)	Power (π)
	Rural		Urban						
	Mean (%)	SD	Mean (%)	SD					
DFPH (health)	67.21	16.62	71.20	17.40	0.461	−7.115	<0.0005	0.008	1.000
SDF (sources)	44.73	23.04	49.51	24.42	0.005	−6.304	<0.0005	0.006	1.000
Knowledge (global)	55.97	15.11	60.36	16.25	0.000	−8.789	<0.0005	0.012	1.000

DF = dietary fibre; DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre.

The general level of knowledge was found to be significantly different for all groups considered; meaning that all the variables tested influenced the knowledge about DF. The same trend was observed for the knowledge about the sources of fibre and for the health benefits of DF. In this way it was confirmed that people from different groups in terms of age, gender education, living environment or country demonstrate different perceptions and information about DF. Women, e.g., are expected to pay particular attention to those aspects related to the maintenance of a slim body, for aesthetical reasons, although not exclusively. Also the more educated people are usually propitious and receptive to all types of information, which includes information about how to maintain a healthier body and how to have a more adequate diet. Living in rural or urban environments also contributes for differences in the lifestyles and access to the sources of information that convey evidence about the role of DF as a part of a healthy lifestyle.

Although all these variables were seen to influence the knowledge about DF, decision trees were used to help categorize them, in order to perceive which ones were more important as predictors for the level of knowledge. It was interesting to find that in all three cases, country appeared as the best predictor for knowledge. This is not surprising having in mind that each of the countries included in the study has particularities in terms of cultural, political and social environments, which, certainly can influence the way people access education and information. In fact, the educational systems and curricula as well as the healthcare systems are much different even between European countries not to mention when comparing with African or Latin American countries. However, not only it is important to educate people about healthy eating practices but it is also imperative to respect some traditional cooking practices and use them and vehicles to support the new recommendations and advice, so as to gain people's confidence and adherence.

The second best predictor of knowledge was age, and, in this way, it is important to design effective educational strategies for the different age groups, in view of their own life experience and expectations. While young people usually do not think so much about disease because they assume they are healthy just by being young, people of middle age start to think seriously about how to maintain their health for a longer time and avoid diseases in the future. Finally elder people give extreme importance to all those aspects that will help them live longer and with a good quality, minimizing any adverse effects that they might already experience.

Table 11 – One-way ANOVA for the different types of knowledge about DF in relation to nationality.

Type of knowledge	Country	Mean (%)	SD	F	P-value	Eta (η^2)	Power (π)
DFPH (health)	Argentina	72.15	17.77	19.239	<0.0005	0.028	1.000
	Croatia	69.50	15.38				
	Egypt	64.92	15.48				
	Hungary	76.18	17.87				
	Italy	68.06	16.12				
	Latvia	67.18	14.68				
	Macedonia	66.02	20.22				
	Portugal	76.24	14.06				
	Romania	70.23	23.32				
	Turkey	75.50	15.08				
SDF (sources)	Argentina	46.83	19.51	25.237	<0.0005	0.036	1.000
	Croatia	50.74	25.71				
	Egypt	33.54	15.47				
	Hungary	41.93	29.51				
	Italy	44.71	22.49				
	Latvia	39.58	15.82				
	Macedonia	50.72	19.83				
	Portugal	51.60	27.95				
	Romania	52.42	22.21				
	Turkey	52.81	25.33				
Knowledge (global)	Argentina	59.49	14.27	24.242	<0.0005	0.035	1.000
	Croatia	60.12	16.62				
	Egypt	49.23	10.15				
	Hungary	59.05	17.29				
	Italy	56.39	14.95				
	Latvia	53.38	11.00				
	Macedonia	58.37	15.78				
	Portugal	63.92	16.61				
	Romania	61.32	17.09				
	Turkey	64.15	16.05				

DF = dietary fibre; DFPH = dietary fibre and promotion of health; SDF = sources of dietary fibre.

Conclusion

The results from the decision trees elaborated to evaluate the effects of the input variables considered on the variables related to knowledge (output variables) revealed that the best predictor for the three types of knowledge considered (about DF, about its sources and about its effects on human health) was always the country. In this way, the social, cultural and/or political conditions which are naturally different from country to country seem to greatly determine the level of knowledge. On the other hand, the inferential tests performed also showed that statistically significant differences were encountered regarding the three types of knowledge for all sociodemographic variables evaluated: age, gender, level of education, living environment and country. Consequently, these results show that actions delineated in general as to reach all sectors of the populations might not be effective to improve the level of knowledge, and instead a strategy aimed at planning different approaches might reveal itself more adequate.

Author statements

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Ethical approval

No ethical approval was necessary for undertaking the present work, by means of questionnaire. The participation in the survey was voluntary, and done only to adult citizens. Verbal informed consent was obtained from all participants and it was ensured that the data provided were kept strictly confidential.

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Competing interests

None declared.

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Appendix A. Supplementary materials

Supplementary materials related to this article can be found at http://dx.doi.org/10.1016/j.puhe.2016.08.015.