HSI Health Sciences Investigations Journal

share

Send us an email: hsijournal@ug.edu.gh
Visit us: https://www.hsijournal.ug.edu.gh

ISSN Online 2704-4890 | ISSN Print 2720-7609

Online first publication

Original Research Article

HSI Journal (2024) Volume 6 (Issue 1):751-756. https://doi.org/10.46829/hsijournal.2024.7.6.1.751-756

Open Access

Adequacy of dietary fibre intake among hypertensives in a University Hospital in Accra, Ghana: A cross-sectional study

Edinam NUMADZI [1], Ruth OWU [1], Portia NKUMSAH-RIVERSON [1], Rebecca STEELE-DADZIE [1], George A ASARE [2], Matilda ASANTE [1*]

[1] Department of Dietetics, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana, Korle-Bu, Ghana; [2] Department of Medical Laboratory Sciences, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana, Korle-Bu, Ghana

Received February 2024; Revised April 2024; Accepted June 2024

Abstract

Background: Dietary fibre, as a component of a healthy diet, has been shown to lower blood pressure and blood lipids and regulate body weight.

Objective: The study aimed to assess dietary fibre intake among people living with hypertension and its association with the socio-demographic characteristics of respondents.

Methods: A cross-sectional study was conducted among 186 participants (82 males, 104 females) attending the University of Ghana Hospital at Legon, Ghana. Dietary fibre intake was assessed using a quantitative food frequency questionnaire that measured food intake over a month. Blood pressure and anthropometric measurements were taken following standard World Health Organisation (WHO) guidelines. Lipid profile values were obtained from each participant's folder.

Results: Participants' median (IQR) dietary fibre intake per day was 14.8 g (2.4 to 38.1). The majority of the participants (88%, n = 165) had low intakes compared to the recommended daily intakes. The analysis revealed no association between either systolic (β = -0.114; p = 0.315) or diastolic blood pressure (β = -0.007; p = 0.947) and dietary fibre intake. The individual predictors indicated that BMI significantly predicted diastolic blood pressure (p = 0.033), and total energy intake significantly predicted systolic blood pressure (p = 0.019). The major source of dietary fibre was a cereal legume mix (tom brown), which contributed 24.5% of fibre to the daily fibre intake.

Conclusion: Reported dietary fibre intake among the study population was below the recommendation for fibre intake according to the United States Food and Drugs Administration Daily Reference Value. Dietary fibre intake was not associated with either systolic or diastolic blood pressure. Nutrition education strategies such as promoting whole meals and consuming plant-based foods should be intensified among people living with hypertension to encourage the consumption of meals rich in fibre.

Keywords: Dietary fibre, hypertension, blood pressure, anthropometry, blood lipids

Cite the publication as Numadzi E, Owu R, Nkumsah-Riverson P, Steele-Dadzie R, Asare GA, Asante M (2024) Adequacy of dietary fibre intake among hypertensives in a University Hospital in Accra, Ghana: A cross-sectional study. HSI Journal 6 (1):751-756. https://doi.org/10.46829/hsijournal.2024.7.6.1.751-756

INTRODUCTION

Hypertension (blood pressure > 140/90 mm Hg) is a primary cause of cardiovascular morbidity (CVD) and mortality [1]. In 2010, the prevalence of hypertension was estimated to be more than a quarter of the world's population (31.1%), with a higher prevalence in low and middle-income countries [2]. A similar finding was reported by the World Health Organization (WHO), with the highest prevalence observed in the WHO African Region (27%) and the lowest in the WHO Region of the Americas (18%) [3]. This observed situation has been associated with an increase in unhealthy lifestyles such as low intake of fruits and vegetables, high salt and fat intake, sedentary lifestyle, smoking, alcohol consumption, anxiety and stress [4]. In Ghana, the overall prevalence of

* *Corresponding author*
Email: masante@ug.edu.gh

hypertension in 2018 was 30.3%, with a higher prevalence in females than males [5]. The prevalence in the urban areas was higher than the pooled prevalence in the rural areas [5]. Hypertensive patients usually present also with poor glycaemic control and unfavourable lipid profiles compared with the general population [6]. Dietary intake plays a key role in the prevention and management of hypertension and metabolic syndrome. Dietary fibre reduces the glycaemic index of foods and attenuates insulin response by enhancing insulin sensitivity and vascular endothelial function, which has been shown to have a cause-effect relationship with hypertension [7]. Increasing fibre intake by 7 - 15 g/day has been shown to lower blood pressure and reduce the risk of developing hypertension compared to diets lower in fibre [8]. Abatement in non-communicable diseases and cardio-metabolic risk factors have been associated with increased intake of dietary fibre [10-11]. There is a paucity of evidence on dietary fibre intake among hypertensive patients living in Ghana. This study, therefore, assessed dietary fibre intake among individuals with hypertension and the major sources of fibre among the study population.

MATERIALS AND METHODS

Study design and sampling

A hospital-based cross-sectional study was conducted at the diet therapy unit of the University of Ghana Hospital, Legon. Enrolled participants were patients reporting to the diet therapy unit of the University Hospital. The total enumeration technique, which involves selecting all eligible participants at the study site, was used to recruit participants. Daily visits were paid to the hospital, and with the assistance of the dietician, eligible patients 18 years and above diagnosed with hypertension were identified and recruited if they consented and signed a form to participate in the study after it had been explained to them.

Assessment of Dietary Fibre

Dietary fibre intake was assessed using a 31-item quantitative food frequency questionnaire adapted from a similar study [11]. The questionnaire had seven food groups, namely; (1) cereals and grains, (2) roots and tubers, (3) breads, (4) legumes, (5) nuts and seeds, (6)baked products, and (7) fruits and vegetables. Food models and household measures were used to assist in the estimation of portion sizes of usual food intake. Daily dietary fibre intake was calculated using the nutritional analysis software Microdiet (version 3.0, Downlee Systems, UK) and the Ghanaian and West African food composition tables after portion sizes were converted into grams. Dietary fibre intake was classified as either inadequate (< 25 g/day) or adequate (≥ 25 g/day) [12]. The percentage of fibre contribution for each of the foods was generated using Microdiet Nutrition analysis software.

Blood Pressure and Body Composition Measurements

Height was measured to the nearest 0.1 cm with a stadiometer (Omron HBF - 516C, USA). Weight, BMI and visceral fat were assessed using the Omron Body Composition Monitor (Seca 213, Germany). All measurements were taken using standard measurement protocols [13]. Visceral fat was classified as normal (1 - 9), high (10 - 15) and very high (> 15). Blood pressure was measured by a nurse using a calibrated upper arm BP monitor (Omron M2 HEM-7120). Measurements were taken as participants relaxed and sat in a chair (feet on the floor, back supported) for more than 5 minutes before BP measurement. High blood pressure reading was defined as BP readings ≥ 14 0/90 [14]. Three blood pressure measurements were used in the calculation of the patients' average systolic and diastolic pressure. Lipid profile (total cholesterol, total triglycerides, high-density lipoprotein cholesterol, and low-density lipoprotein) values were obtained from participants' hospital folders. Clinical laboratory results obtained within the previous three months at the time of data collection were used for the study. Anonymity and confidentiality were ensured throughout the study.

Socio-demographic data

Socioeconomic and demographic information, medical history and physical activity information were collected using a structured questionnaire. Physical activity was categorised as high intensity (vigorous-intensity activity such as jogging, soccer, bicycling, swimming), moderate intensity (brisk walking, lawn mowing, dancing) or light intensity (slow walking, stretching, domestic chores).

Statistical Analysis

Data analyses were performed using IBM SPSS Statistics for Windows, Version 20.0 Armonk, NY: IBM Corp., Released 2011. Data were presented as median (minimum, maximum), n (%), or mean ± standard deviation. Population characteristics were stratified by fibre intake status using student's t-test, Mann-Whitney U test and chi-square. Respondents were stratified into two groups based on the daily fibre intake of < 25 g/day for low intake or ≥ 25 g per day for high intake. In determining the association between blood pressure and higher fibre intake (≥ 25 g/day), a multilinear regression model was constructed with systolic and diastolic blood pressure values as the dependent variables. The multivariate model was adjusted for age, total caloric intake and BMI.

RESULTS

Of the 186 participants included in the study, 44.1% (n = 82) were males and 55.9% (n = 104) were females. The median age was 58 years. The median BMI was 28.4 kg/m^2, and the median fibre intake was 14.7 g/day. The majority of the respondents (88.7%, n = 165) had a low intake of fibre. Table 1 provides a summary of the clinical and background characteristics of the respondents stratified according to their daily fibre intake. There were no significant differences between the lower and higher fibre intake groups in terms of gender, physical activity, ever visiting the dietitian, marital

share
Send us an email: hsijournal@ug.edu.gh
Visit us: https://www.hsijournal.ug.edu.gh

Table 1. Background characteristics and laboratory profile of respondents stratified by the adequacy of fibre intake

	Below recommended fibre intake (< 25 g/day)	At or above recommended fibre intake (≥ 25 g/day)	P-value (CI)
N	165	21	
Age (years)	59 (19 - 83)	57 (19 - 72)	0.011ǂ
Gender			
Male	42.4%	57.1%	0.201 ǂ
Female	57.6%	42.9%	
Marital status			
Single	24.8%	33.3%	0.403 ǂ
Married	75.2%	66.7%	
Employment status %	52.1%	61.9%	0.397 ǂ
	47.9%	38.1%	
Physical activity:(Yes) %	78.8%	66.7%	0.211ǂ
	21.2%	33.3%	
Dietitian Visit: (Yes) %	70.3%	57.1%	0.220 ǂ
No	29.7%	42.9%	
BMI (Kg/m^2)	29.3±5.5	30.5±6.3	0.383 ⊦
Weight (kg)	75.6 (43.8 – 177.9)	78.4 (51.0 – 110.1)	0.231ǂ
Height (cm)	164.4±7.9	166.2±6.2	0.187 (-5.4 – 1.7) ǂ
Visceral fat	11 (2 - 23)	11 (3 - 23)	0.824 ǂ
Systolic Blood Pressure (mmHg)	136.7±15.6	140.0±24.2	0.681 ǂ
Diastolic Blood Pressure(mmHg)	81.4±10.6	88.7±15.4	0.039 ⊦
Total cholesterol	4.9 (2.4 – 10.4)	5.2 (3.2 – 7.9)	0.269 ǂ
Triglyceride	1.2 (0.4 – 4.2)	1.3 (0.6 – 2.1)	0.847 ǂ
HDL	1.3 (2.4 – 24.5)	1.2 (0.8 – 4.8)	0.708 ǂ
LDL	3.0 (0.5 – 7.9)	3.2 (1.7 – 5.3)	0.262 ǂ
Hypertension medication %			
Yes	12.1%	9.5%	0.728 ǂ
No	87.9 %	90.5%	

Data expressed as mean ± SD, median (IQR), or n (%). ǂ Mann-Whitney U test. ǂ chi-square test. ⊦ t-test. HDL: high-density lipoprotein, LDL: low-density lipoprotein, BMI: body mass index. CI: confidence interval

Table 2. Daily nutrient intake of respondents stratified by the adequacy of fibre intake

	Below recommended fibre intake (<25 g/day)	At or above recommended fibre intake (≥ 25 g/day)	P-value
N (%)	165 (88.7)	21 (11.3)	
Caloric Intake (kcal/day)	1698 (445 – 3420)	3092 (1477 – 4809)	0.000 ǂ
Carbohydrate (g/day)	288.1 (65.9 – 556.4)	528.7 (239.4 – 836.8)	0.000 ǂ
Protein (g/day)	39.1 (7.9 – 103.8)	80.2 (32.3 – 142.9)	0.000 ǂ
Fat (g/day)	49.5 (10.7 – 200.2)	84.6 (27.0 – 223.2)	0.015 ǂ

Data expressed as median (IQR). ǂ-Whitney U test

Table 3. Percentage contributions of major food sources of fibre in the diet of participants

Food item	% Contribution
Tombrown	24.5%
Fufu	15.7%
Oats	15.1%
Corn porridge	14.4%
Vegetable Salad	14.4%
Kenkey	13.2%
Waakye	12.9%
Mango	12.7%
Wheat	12.6%

status, BMI, visceral fat, systolic blood pressure, lipid profile and taking a blood pressure medication. Patients in the higher fibre intake group were younger than those in the low fibre intake group. Patients in the low-fibre intake group had a lower mean diastolic blood pressure (81.4 ± 10.6 mmHg) than respondents who consumed more fibre per g/ day (88.7 ± 15.4 mmHg). Daily macronutrient intake, based on the adequacy of dietary fibre intake, is described in Table 2. Patients taking adequate amounts of fibre had higher intakes of total energy, carbohydrate, protein, and fat than did patients who consumed lower than the recommended fibre intake.

share
Send us an email: hsijournal@ug.edu.gh
Visit us: https://www.hsijournal.ug.edu.gh

Table 4: Linear regression analysis: diastolic blood pressure and adequate fibre intake (> 25 g/day). Model adjusted for sex, age, total energy intake, and sodium intake

Variables	β	P - value
Fibre intake (g/day)	-0.007	0.947
Sex	-0.056	0.470
Age (years)	-0.145	0.051
Total energy intake (kcal/ day)	0.159	0.160
BMI (Kg/m^2)	0.164	0.033

Table 5: Linear regression analysis: systolic blood pressure and adequate fibre intake (≥ 25 g/ day). Model adjusted for age, total energy intake, and sodium intake.

Variables	β	P - value
Fibre intake (g/day)	-0.114	0.315
Sex	-0.130	0.093
Age (years)	0.052	0.484
Total energy intake (kcal/ day)	0.267	0.019
BMI (Kg/m^2)	-0.114	0.315

A greater proportion of the participants consumed fibre from the cereals and grains, roots and tubers group. Identification of the major sources of fibre among the respondents was generated using the nutrient analysis software MICRODIET. Weanmix (a cereal legume mix), millet porridge, oats, vegetable salad, kenkey (fermented corn dumpling), waakye (rice with black-eyed beans), mango and wheat were identified as the main sources of fibre. Tombrown (roasted corn porridge), which was identified as the highest source of fibre, contributed 24.5% of the overall fibre intake in participants, followed by fufu (pounded plantain and cassava) which contributed 15.7% (Table 3). Although these foods were identified as the major sources of fibre, the portion size consumed by an individual will influence the overall dietary intake. Multiple regression models (Table 4 and Table 5) showed no association between both systolic (p = 0.315) and diastolic blood pressure (p = 0.947) and adequate dietary fibre intake. The individual predictors indicated that BMI significantly predicted diastolic blood pressure (p = 0.033) (Table 4), and total energy intake significantly predicted systolic blood pressure (p = 0.019) (Table 5).

DISCUSSION

This study sought to assess dietary fibre intake among patients living with hypertension. This is based on the premise that dietary fibre has been shown to have numerous health benefits, and it is important for health practitioners to work towards adequate intake of this nutrient in various populations. The present analysis demonstrated no association between dietary fibre intake and blood pressure after adjusting for potential confounders (age, sex, total energy intake and BMI). Alarmingly, the proportion of participants with insufficient daily fibre intake (≤ 25 g) was over 80%. This high level of inadequate dietary fibre is probably responsible for the non-significant association between blood pressure and dietary fibre intake. The p-value was 0.947 for the DBP and 0.315 for the SBP. Dietary fibre is being promoted as an adjunct therapy in the management of high blood pressure due to the benefits it provides [15]. A recent meta-analysis confirmed the role of dietary fibre in reducing the risk and managing cardiometabolic conditions of which hypertension is a part [15]. From this meta-analysis, there was strong evidence to suggest that increasing dietary fibre intake reduces systolic blood pressure by 4.3 mmHg and diastolic blood pressure by 3.1 mmHg. Intake of dietary fibre, especially from grains, lowers both systolic and diastolic blood pressure among mid-life women [16]. The high fibre contribution from tom brown can be attributed to the ingredients used in its preparation. Tom brown is a cereal-legume mixture mostly prepared with whole-grain cereals such as maise, wheat, millet and sorghum. Despite the beneficial role of dietary fibre in hypertension prevention and management, the exact mechanism is not clear. There have been several postulated mechanisms, which include reducing LDL cholesterol and triglyceride, improving the elasticity of blood vessel walls, improving endothelial function and less directly improving insulin sensitivity [15,16]. In sub-Saharan Africa (SSA), maise, sorghum, and wheat serve as major staples for most of the population. The role of maise in the diet of inhabitants of SSA can be compared to that of rice among Asians. [10,17]. In the past few years, strategies adopted in the management of hypertension include incorporating foods rich in fibre. This has influenced dietitians' recommending local staples rich in fibre. Although oat is not a locally produced staple, it appeared among the commonly consumed cereals by participants in this study. This may be due to the perceived health benefits associated with its fibre content. Oats are particularly high in β glucan, a type of dietary fibre with suggested lowering effects on plasma glucose, low-density lipoprotein cholesterol, and systolic and diastolic blood pressure [18,19].

The proportion of participants with insufficient daily fibre intake (≤ 25 g) was over 80%. This result is consistent with studies conducted in other countries, with the majority of study participants having consumption patterns less than the Adequate Intake (AI). A study among Ghanaian migrants in the UK and those resident in Ghana reported a mean dietary fibre intake of 8.3 ± 3.1 vs. 6.7 ± 2.2 g/1,000 kcal, which is below the recommendation of 14 g/1000 kcal/day by the American Diabetes Association [20]. In Ireland, among a population of older adults, median dietary fibre intake was found to be less (18.3 g) than the AI of 25 g [21]. Similarly, in a sample of adults in Spain (age 18 years - 64 years), the mean fibre intake was lower than the recommended (12.59 ± 5.66 g) [22], which is not different from what is reported in Australia (median intake of 20.7

share
Send us an email: hsijournal@ug.edu.gh
Visit us: https://www.hsijournal.ug.edu.gh

g) [23] and UK (17.3 ± 6.6 g) [24]. Contrary to these findings, Lie et al. (2018) [10] reported a high intake of dietary fibre (24.9 ± 9.7 g/day) among Ghanaians, although the high intake may be linked to the geographic area (rural community) where most of the locally consumed staples are rich in fibre. A systematic review of obesity in adults and the nutrition transition in Sub–Saharan Africa by Steyn and Mchiza [25] in Cape Town showed that dietary fibre intake had decreased from 20.7 g to 16.7 g as a result of changing dietary patterns. In suburban Chicago, urban Seychelles, and Jamaica, dietary fibre intake was reported to be below 20 g/ day [10]. These findings highlight the need to promote strategies and policies to increase dietary fibre intake. In this current analysis, the high-fibre intake group was also found to have higher energy and macronutrient (carbohydrate, protein, fat) intake compared with those taking in less fibre. This is similar to a study conducted among people living with type 1 diabetes [26]. As a result, the high-fibre group had a higher mean BMI than the lower-fibre intake group. Being younger was significantly associated with higher daily fibre intake, contrary to findings by Seljaket al. [27].

A main limitation of this study is the recall bias associated with the reporting of dietary intakes. The use of the quantitative food frequency questionnaire as the main dietary assessment tool may not accurately reflect the individual's usual intake. Another limitation is the unavailability of the fibre content of some Ghanaian foods, which had to be substituted with similar foods from others. These, however, are established limitations of all current dietary measurement tools that should be acknowledged. Furthermore, the population used consisted of previously diagnosed hypertensive individuals on anti-hypertensive medication, resulting in well-controlled blood pressure, which cannot be solely attributed to their dietary intake. Both exposure and outcome were measured at the same time. Hence, the results are not causal. Also, failure to administer the FFQ over the same period as the clinical laboratory results poses as a limitation in our study

Conclusion

The dietary fibre intake of the majority of the participants in the study was found to be inadequate. Dietary fibre intake was not associated with either diastolic or systolic blood pressure. Larger studies with this population, including but not limited to randomised clinical trials, should be conducted.

DECLARATIONS

Ethical consideration

The study was approved by the College of Health Sciences Ethics and Protocol Review Committee, University of Ghana (Ref No. EPRC/APRIL/2019).

Consent to publish

All authors agreed on the content of the final paper.

Funding

None

Competing Interest

The authors declare no conflict of interest for this paper

Author contributions

MA conceptualised the topic. All authors contributed to analysing the results and writing the manuscript. All the authors approved the final version of the manuscript for publication.

Acknowledgements

The authors thank the staff and patients of the Diet Therapy Unit of the University of Ghana Hospital. Special thanks go to the administrator and medical director of the facility for the opportunity given to conduct the study.

Availability of data

Data is available upon request to the corresponding author.

REFERENCES

1. Chobanian A V., Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jones DW, Materson BJ, Oparil S, Wright JT, Roccella EJ (2003) Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension 42:1206–1252.
2. Mills KT, Stefanescu A, He J (2020) The global epidemiology of hypertension. Nat Rev Nephrol 16:223–237.
3. WHO (2020) Hypertension [Internet]. World Health Organization. 2019 [cited 2020 Sep 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/hypertension
4. Dreher, ML (2018) Fiber and Hypertension. In: Dietary Fiber in Health and Disease. Nutrition and Health. Humana Press. 291-303 Cham.
5. Atibila F, Hoor G ten, Donkoh ET, Wahab AI, Kok G (2021) Prevalence of hypertension in Ghanaian society: a systematic review, meta-analysis, and GRADE assessment. Syst Rev 10:220.
6. Ference BA, Graham I, Tokgozoglu L, Catapano AL (2018) Impact of Lipids on Cardiovascular Health. J Am Coll Cardiol 72:1141–1156.
7. Streppel MT (2005) Dietary Fiber and Blood Pressure. Arch Intern Med 165:150.
8. Dreher ML (2017) Dietary Fiber in Health and Disease. Dietary Fiber in Health and Disease. Springer International Publishing
9. Wei B, Liu Y, Lin X, Fang Y, Cui J, Wan J (2018) Dietary fiber intake and risk of metabolic syndrome: A meta-analysis of observational studies. Clin. Nutr. 37:1935–1942.
10. Lie L, Brown L, Forrester T, Plange-Rhule J, Bovet P, Lambert E, Layden B, Luke A, Dugas L (2018) The Association of Dietary Fiber Intake with Cardiometabolic

Risk in Four Countries across the Epidemiologic Transition. Nutrients 10:628.

11. Healey G, Brough L, Murphy R, Hedderley D, Butts C, Coad J (2016) Validity and Reproducibility of a Habitual Dietary Fibre Intake Short Food Frequency Questionnaire. Nutrients 8:558.
12. Quagliani D, Felt-Gunderson P (2017) Closing America's Fiber Intake Gap. Am J Lifestyle Med 11:80–85.
13. CDC. Body Composition Procedures Manual. 2018;(July).
14. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA, Williamson JD, Wright JT (2018) Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults. J Am Coll Cardiol 71:e127–e248.
15. Reynolds AN, Akerman A, Kumar S, Diep Pham HT, Coffey S, Mann J (2022) Dietary fibre in hypertension and cardiovascular disease management: systematic review and meta-analyses. BMC Med 20:139.
16. Du P, Luo K, Wang Y, Xiao Q, Xiao J, Li Y, Zhang X (2021) Intake of Dietary Fiber From Grains and the Risk of Hypertension in Late Midlife Women: Results From the SWAN Study. Front Nutr 8:625
17. Ekpa O, Palacios-Rojas N, Kruseman G, Fogliano V, Linnemann AR (2019) Sub-Saharan African Maise-Based Foods - Processing Practices, Challenges and Opportunities. Food Rev. Int. 35:609–639.
18. Keenan JM, Pins JJ, Frazel C, Moran A, Turnquist L (2002) Oat ingestion reduces systolic and diastolic blood pressure in patients with mild or borderline hypertension: a pilot trial. J Fam Pract 51:369
19. Rebello CJ, O'Neil CE, Greenway FL (2016) Dietary fiber and satiety: the effects of oats on satiety. Nutr Rev 74:131–147.
20. Gibson R, Knight A, Asante M, Thomas J, Goff LM (2015) Comparing dietary macronutrient composition and food sources between native and diasporic Ghanaian adults. Food Nutr Res 59:27790.
21. Kehoe L, Walton J, McNulty B, Nugent A, Flynn A (2021) Energy, Macronutrients, Dietary Fibre and Salt Intakes in Older Adults in Ireland: Key Sources and Compliance with Recommendations. Nutrients 13:876
22. González-Rodríguez L, Perea Sánchez J, Aranceta-Bartrina J, Gil Á, González-Gross M, Serra-Majem L, Varela-Moreiras G, Ortega R (2017) Intake and Dietary Food Sources of Fibre in Spain: Differences with Regard to the Prevalence of Excess Body Weight and Abdominal Obesity in Adults of the ANIBES Study. Nutrients 9:326.
23. Fayet-Moore F, Cassettari T, Tuck K, McConnell A, Petocz P (2018) Dietary Fibre Intake in Australia. Paper I: Associations with Demographic, Socioeconomic, and Anthropometric Factors. Nutrients 10:599.
24. Gibson R, Eriksen R, Chambers E, Gao H, Aresu M, Heard A, Chan Q, Elliott P, Frost G (2019) Intakes and Food Sources of Dietary Fibre and Their Associations with Measures of Body Composition and Inflammation in UK Adults: Cross-Sectional Analysis of the Airwave Health Monitoring Study. Nutrients 11:1839.
25. Steyn NP, Mchiza ZJ (2014) Obesity and the nutrition transition in Sub-Saharan Africa. Ann N Y Acad Sci 1311:88–101.
26. Beretta MV, Bernaud FR, Nascimento C, Steemburgo T, Rodrigues TC (2018) Higher fiber intake is associated with lower blood pressure levels in patients with type 1 diabetes. Arch Endocrinol Metab 62:47–54.
27. Seljak BK, Valenčič E, Hristov H, Hribar M, Lavriša Ž, Kušar A, Žmitek K, Krušič S, Gregorič M, Blaznik U, Ferjančič B, Bertoncelj J, Korošec M, Pravst I (2021) Inadequate Intake of Dietary Fibre in Adolescents, Adults, and Elderlies: Results of Slovenian Representative SI. Menu Study. Nutrients