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Hydration Status: Influence of Exercise and Diet Quality

Abstract: *Physical activity, adherence to a healthy diet, and healthy beverage pattern are considered essential components of a healthy lifestyle. We aimed to evaluate the associations between physical exercise, diet quality, and total fluid intake, along with fluid recommendations compliance in a sample of adults. Data on fluid intake from different types of beverages were collected in a cross-sectional study, in 1161 men and women between 18 and 65 years of age, using a fluid-specific diary. Exercise was evaluated with a self-reported questionnaire, and quality of diet was assessed using the Healthy Eating Index-2010 (HEI). Mean volume of water consumed was 1497.5 mL for men, 1309.5 mL for women. A total of 37.4% did not follow the recommendations of the European Food Safety Agency for total water intake. There was a statistically significant difference ($P = .002$) between total water intake and follow-up of recommendations, as well as for sex ($P < .001$). Mean HEI-2010 score was 65.21. There were no statistically significant differences ($P = .301$) in HEI index among better or worse hydration. Sport variables had influence on milliliters of water consumed ($P < .001$). Participants who engaged in more physical exercise exhibit a healthier pattern of fluid intake. Healthy individuals with the*

highest scores for HEI-2010 did not present the healthiest beverage patterns.

Keywords: hydration; exercise; diet; Healthy Eating Index-2010

Lifestyle is one of the most important factors conditioning health. Physical activity and adherence to a healthy diet, including adequate hydration and a healthy beverage pattern, are considered essential components of a healthy lifestyle that reduces the risk of several noncommunicable chronic diseases.¹

higher energy content beverages, mainly coming from sugar-sweetened beverages, should be discouraged.⁵

The differences in recommendations may be due, in part, to the wide individual variation found in response to hydration needs, as fluid loss is affected by environmental factors.⁵⁻¹⁰ But it is important to evaluate determinant factors for covering the fluid intake recommendations other than classical individual factors (sex, age, body surface) and environmental conditions.

The percentage of the population with inadequate water intake varies from 5%

There is no clear consensus about how much fluid an individual should intake.

Although there are several guidelines in scientific literature and media for achieving optimal hydration status, there is no clear consensus about how much fluid an individual should intake (Table 1),² neither sufficient research regarding the amount of water required to prevent disease or improve health.³ As a result, neither upper nor lower consumption thresholds have been clearly linked to a specific benefit or risk for humans.⁴ As for other fluids, it is recommended that consumption of

to 35% among European countries. Recent research regarding the risk of disease, disability, and death has confirmed the importance of poor hydration with respect to the overall disease burden and quality of life.¹¹

What is more, the benefits of physical exercise on health and the adverse effects of sedentary behavior are both well recognized.¹² While more physically active men and women tend to have a higher daily fluid intake,¹³ the beverage pattern as a whole of individuals with

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Table 1.Water Intake Recommendations of Four International Authorities^a.

	European Food Safety Authority (2010) ⁶	National Health and Medical Research Council (2006) ⁷	Institute of Medicine (2004) ⁸	World Health Organization (2003) ⁹
Men	2.5 liters	3.4 liters	3.7 liters	Sedentary: 2.9 liters
				Active: 4.5 liters
Women	2.0 liters	2.8 liters	2.7 liters	Sedentary: 2.2 liters
				Active: 4.5 liters

^aReference values for total water intake (food + fluid), liters/day.

different levels of physical exercise has not been well ascertained yet. Debate exists regarding the quantity of fluid that should be consumed during exercise, especially in children who may be at greater risk of dehydration. While some sport authorities recommend that adults should drink between 400 and 800 mL or between 600 and 1000 mL of fluid per hour to optimize exercise performance, others advise “drinking to thirst” in order to avoid consuming a very large volume of water.¹⁴

Lifestyle factors such as food habits affect water intake as well. The promotion of a healthy diet can improve hydration status at the population level. In turn, adherence to a health-conscious diet is associated with higher beverage consumption as is physical activity.¹⁵ Some studies conducted on the US population have reported that increased water consumption was associated with higher diet quality, better eating patterns, and even higher levels of physical activity.¹⁶ Among the dietary patterns are more variety and greater consumption of vegetables, fruits, whole grains, and low-fat dairy products. It has also been associated to the Healthy Eating Index (HEI).¹⁷

Individuals who participate regularly in recreational sports and/or exercise are dehydrated during exercise and drink at a rate according to their perceived thirst, which barely replaces two thirds of their fluid losses. However, debate exists regarding the quantity of fluid that should be consumed during exercise.¹⁶

Awareness of the need for healthy-hydration advice, within the context of dietary and lifestyle guidelines for the management and prevention of existing public health problems, should be better emphasized. Occasional or moderate consumption of sugar-sweetened beverages in addition to a healthy, balanced diet is not an issue of contention. However, public health systems and health care professionals in the front line should be aware of the potential detrimental effects of excessive or habitual consumption on long-term health, particularly in children and adolescents. Health care professionals are well positioned to identify and promote behavioral changes that decrease sugar-sweetened beverage consumption and encourage water intake.¹⁴

Very few studies have examined the association between beverage intake patterns and healthy lifestyle characteristics. In this sense, it is important to assess whether lifestyle determines the percentage of individuals meeting fluid intake recommendations established at a population level.¹

Objective

The main aim of the present study was to evaluate the association between physical exercise practice or high-quality diet and the total fluid intake, and the percentage of population covering fluid recommendations in a sample of adults.

Material and Methods

Design

A cross-sectional cohort study was designed. A total of 1181 adults aged 18 to 65 years were randomly recruited from 4 different geographical territories, Spain, Portugal, Uruguay, and Mexico, until the quotas were met. Information on participants' anthropometric measures, exercise, diet, and hydration was collected using validated questionnaires. Data were collected, individually, by trained and formed nutritionists and dieticians, standardizing the data collection protocol and monitoring the study. Participants provided written informed consent. Minor modifications to wording and customs were made for Uruguay and Mexico's surveys, for a better unification of the answers in the database.

Study Factors

The following information on demographics factors was collected: age, sex, height (m), weight (kg), and nationality. Physical exercise practice of more than 30 minutes a day was evaluated with a nonvalidated self-reported questionnaire and categorized as follows: 5 times a week or more, 3 to 4 times a week, between 1 and 2 times a week, and once every 2 weeks or less. Type and hours per day of each exercise performed was also detailed.

Information about the quantity of daily fluid intake (in milliliters or liters) from

different types of beverages was also collected, differentiating water from other beverages (hot beverages; milk and dairy products; juices; sweet regular beverages: carbonated soft drinks, noncarbonated soft drinks, and other sugared soft drinks; sweet light beverages: diet carbonated soft drinks, diet noncarbonated soft drinks, or other diet soft drinks; and alcoholic drinks). The questionnaire assessed the moment of the day when the participants consumed fluids, and the type and the volumes of beverages using standard portion sizes. Total fluid intake is defined as the sum of all these beverages.

The percentage of individuals who did not meet the European Food Safety Agency (EFSA) recommendations was calculated based on the EFSA recommendations for total water intake (water from food and beverages) set at 2.5 and 2 L/day for men and women, respectively. EFSA takes the assumption that foods contribute about 20% to total water intake; therefore, the EFSA recommendations for total fluid intake were set at 2 and 1.6 L/day for men and women, respectively, most of which should preferably be consumed as water.¹⁸

Diet was evaluated using The Healthy Eating Index-2010 (HEI-2010). It is a dietary assessment tool comprising 12 components designed to measure quality in terms of how well diets meet the recommendations of the *2010 Dietary Guidelines for Americans*,¹⁹ that is, more vegetables, fruits, whole grains, and low-fat dairy products and less refined grains, saturated fatty acids, and added sugars. Diet quality is assessed from 2 perspectives: 9 components address nutrient adequacy (dietary components to increase) and the remaining 3 components assess moderation (dietary components to decrease).²⁰

For adequacy components, a score of zero is assigned for “no intake,” and the scores increase proportionately as intakes increase up to the standard. For moderation components, a reverse scoring is applied, that is, levels of intakes at the standard get the maximum score, with scores decreasing as intakes

increase. Component scores can range from 0 to 5, 0 to 10, or 0 to 20, with a maximum total score of 100. A score corresponding to 100% indicates that the recommendation on average was met or exceeded. For the adequacy components, higher scores reflect higher intakes. For the moderation components, higher scores reflect lower intakes because lower intakes are more desirable. For all the components, a higher percentage indicates a higher quality diet. “Empty calories” refers to calories from solid fats (ie, sources of saturated fats and trans fatty acids) and added sugars (ie, sugars not naturally occurring) plus calories from alcohol beyond a moderate level.²¹ The components are defined as follows and described more fully in Table 3. Guidance on how to use the HEI-2010 in research, including SAS code and macros, is available online.²²

Inclusion Criteria

- Men and women with aged between 18 and 65 years
- Sufficient level of understanding to allow their participation in the study
- Acceptance and voluntary participation after signing an informed consent

Exclusion Criteria

- Nonage
- Participants that did not complete the record correctly
- Participants not able to read and write in the language of the questionnaire

Statistical Analyses

Questionnaire responses were analyzed using the Statistical Package for the Social Sciences (SPSS) version 21.0. Frequency, percentage, and other descriptive statistics were used to describe and summarize data.

Data are presented as means and 95% confidence intervals (CI) for continuous variables, or as numbers and percentages for dichotomous variables. We compared the distribution of the selected characteristics between groups using χ^2 tests for categorical variables or Student's *t* tests or analysis of variance (ANOVA), as appropriate, for continuous variables.

P values <.05 were considered statistically significant.

Results

Response Rate

A total of 1181 surveys were returned. Twenty surveys were excluded due to respondent's nonage or incongruent answers. Thus, a total of 1161 participants (439 men and 718 women) were taken in consideration with a mean age of 37.9 ± 16.1 years and recruited from Spain, Portugal, Uruguay, and Mexico. There were no significant differences between country and gender ($P = .240$), but there were significant differences when analyzed by age ($P < .05$, Kruskal-Wallis). The baseline characteristics of participants are summarized in Table 2.

The mean volume of water consumed (tap water, filtered tap water, natural mineral water, sparkling mineral water, flavored water, and fountain water) was 1403.5 mL/day for the whole population (1497.5 mL for men and 1309.5 mL for women).

The percentage of individuals who did not follow the recommendations of the EFSA for total water intake was calculated (37.4% of both sexes; 36.7% men and 38% women; Table 3). There was a statistically significant difference ($P = .002$) between the total water intake and the follow-up of recommendations.

The mean quantity of liquid intake from different types of beverages was above the EFSA recommendations (2000 mL/day for men and 1600 mL/day for women), 2222.9 mL/day for men and 1938.1 mL/day for women. There was statistically significant difference between total water intake and sex ($P < .001$) and country ($P < .001$); statistically significant difference was also found for total fluid intake ($P < .001$; Figure 1). Meeting the EFSA recommendations also resulted in statistically significant difference ($P < .001$). Women consumed 20.9% more total fluid intake than recommended by the EFSA, while men consumed 10.7% more. EFSA recommendations were better met by men.

Table 2.
Information on Demographics Factors, by Country and Sex^a.

	Spain (n = 620)		Portugal (n = 199)		Uruguay (n = 132)		Mexico (n = 210)		Total (N = 1161)		
	Male (n = 253)	Female (n = 363)	Male (n = 77)	Female (n = 122)	Male (n = 36)	Female (n = 96)	Male (n = 73)	Female (n = 137)	Male (n = 439)	Female (n = 718)	Both Sexes
Sex (%)	40.8	58.5	38.7	61.3	27.3	72.7	34.8	65.2	37.8	61.8	99.7 ^b
Age (M ± SD)	35.1 ± 15.4	34.5 ± 15.4	49.8 ± 14.2	46.3 ± 12.9	38.8 ± 15.1	43.5 ± 19.6	30.3 ± 13	38.0 ± 14.5	37.2 ± 16	38.4 ± 16.1	37.9 ± 16.1
Height, m (M ± SD)	1.75 ± 0.07	1.63 ± 0.06	1.73 ± 0.08	1.61 ± 0.06	1.76 ± 0.07	1.61 ± 0.08	1.71 ± 0.08	1.59 ± 0.08	1.74 ± 0.07	1.62 ± 0.07	1.66 ± 0.09
Weight, kg (M ± SD)	77.1 ± 11.1	61.2 ± 10.2	77.4 ± 13.8	60.3 ± 9.6	77.8 ± 16.2	63.9 ± 14.2	78.1 ± 15.5	65.6 ± 12.5	77.4 ± 12.8	62.3 ± 11.3	68 ± 14
BMI, kg/m ² (M ± SD)	25.2 ± 3.6	23.1 ± 3.7	25.9 ± 4	23.2 ± 3.6	25.4 ± 4.4	25.1 ± 5.7	26.6 ± 4.7	26 ± 5	25.6 ± 4	23.9 ± 4.4	24.5 ± 4.3

Abbreviations: M, mean; SD, standard deviation; BMI, body mass index.

^aData expressed as mean ± standard deviation, sample size (n), or percentage.

^bMissing data about the sex of 4 Spanish participants.

Table 3.
Data About the Knowledge and Follow-up of Hydration Recommendations, by Country and Sex^a.

	Spain (n = 620)		Portugal (n = 199)		Uruguay (n = 132)		Mexico (n = 210)		Total (N = 1161)		
	Male (n = 253)	Female (n = 363)	Male (n = 77)	Female (n = 122)	Male (n = 36)	Female (n = 96)	Male (n = 73)	Female (n = 137)	Male (n = 439)	Female (n = 718)	Both Sexes
Mean quantity fluid (mL)	2432.5 ± 892.1	2049.9 ± 738	1369.5 ± 619.8	1410.2 ± 532.3	2616.7 ± 1171.1	2135.4 ± 892.7	2202.6 ± 673	1973.5 ± 608.9	2222.9 ± 935.4	1938.1 ± 746.9	2049.1 ± 835.8
Mean quantity water (mL)	1608.7 ± 794.9	1372.3 ± 642.9	1013 ± 553.4	1018.4 ± 455.1	1675 ± 819.6	1386.5 ± 729.9	1535.6 ± 640.8	1348.6 ± 523.9	1497.5 ± 767.5	1309.5 ± 619.8	1384.3 ± 685.3
Follow EFSA recommendations, n (%)											
Yes	186 (73.5)	252 (69.4)	16 (20.8)	29 (23.8)	29 (80.6)	62 (64.6)	47 (64.4)	102 (74.5)	278 (63.3)	445 (62)	723 (62.3)
No	67 (26.5)	111 (30.6)	61 (79.2)	93 (76.2)	7 (19.4)	34 (35.4)	26 (35.6)	35 (25.5)	161 (36.7)	273 (38)	434 (37.4)

Abbreviation: EFSA, European Food Safety Agency.

^aData expressed as mean ± standard deviation, or sample size (n) and percentage.

Figure 1.

Data on mean total fluid intake versus mean total water intake (mL), by country.

When analyzing total HEI scores and the compliance of EFSA recommendations, there were no statistically significant differences ($P = .301$) in HEI index among those who hydrate better or worse, so it cannot be affirmed that both groups eat differently.

The mean HEI-2010 score was 65.21 (Table 4). Few people scored very high or very low on the HEI-2010. Only 1.6% of the sample had a mean score below 50. Similarly, 3.1% of the sample had a HEI-2010 score higher than 80.

Any category contributed disproportionately to the mean score. Mean components scores were lowest for seafood and plant proteins (1.23) and total protein foods (1.29). The percentage of the sample scoring 0 in a category was highest for seafood and plant proteins (23.7%) and whole grains (10.9%). The ranking in the fatty acids category has a bimodal distribution, that is, 26.7% of the sample scored 0 ((PUFAs + MUFAs)/SFAs < 1.2) yet 32.8% scored 10 ((PUFAs + MUFAs)/SFAs > 2.5), where PUFA is polyunsaturated fatty acid, MUFA is monounsaturated fatty acid, and SFA is saturated fatty acid. The moderation group components had a perfect score of 10 or 20.

A post hoc (Tukey HSD) test revealed statistically significant differences in total HEI-2010 score between countries:

Spain-Portugal ($P < .001$), Spain-Uruguay ($P < .001$), and Spain-Mexico ($P < .001$).

To see the influence of hydration on sport, a χ^2 analysis was performed. In this case, the analysis was performed with all the variables related to sport (if participants exercise or not, days a week, whether they are active or not, and hours of exercise a day; see Table 5) and the variable related to hydration, “participant meets the EFSA recommendation.” There were no statistically significant differences for any of the variables.

On the contrary, all sport variables have influence on the amount of milliliters of water consumed ($P < .001$), while the HEI index does not have it in any case.

Discussion

According to ENIDE data,²³ the only research investigating beverage intake among the Spanish population, the average beverage consumption was 1646.5 mL/day, which reflects insufficient fluid intake for that study population. However, in our study the mean quantity of liquid intake from different types of beverages exceeded the EFSA recommendations (2000 mL/day for men and 1600 mL/day for women). However, neither men nor women consumed

sufficient amounts of water (1497.5 mL for men and 1309.5 mL for women), according to EFSA reference values. Contrary to our findings, mean total water intake in 1724 British adults from the National Diet and Nutrition Survey (2000/2001) was nearly identical to the EFSA reference adequate intake for both genders.²⁴

The comparison is difficult to do when we want to compare American and Spanish populations. The NHANES study, developed in the United States between 2005 and 2010, used the proposal by the Institute of Medicine (IOM) of the United States as reference value, set as 3.7 L/day for men and 2.7 L/day for women.⁸ This leads us to consider the need to investigate why the recommendations of the EFSA and the IOM are so different if both recommendations include the water from food and beverage sources. The clarification of this issue deserves further study.

The HEI-2010 is a mechanism that allows individuals to assess the overall quality of their diets, not simply isolated components. It was developed using the most current scientific information available.²⁵

The HEI-2010 reflects the complexity of dietary patterns; no one single component drives the index. Having a good score on only one component does

Table 4.The Quality of Participant's Diets, as Measured by the Healthy Eating Index-2010 (HEI)^a.

Dietary Component (Maximum Score)	Spain Score (%)	Portugal Score (%)	Uruguay Score (%)	Mexico Score (%)	Total Score (%)	P Value
Adequacy (higher score indicates higher consumption)						
Total fruit (5)	1.99 (39.8)	2.22 (44.5)	2.09 (41.8)	1.63 (32.5)	1.97 (39.4)	<.001*
Whole fruit (5)	3.27 (65.4)	3.87 (77.3)	3.3 (66)	2.69 (53.7)	3.26 (65.2)	<.001*
Total vegetables (5)	2.1 (42.1)	2.72 (54.3)	2.93 (58.6)	2.31 (46.2)	2.34 (46.8)	<.001*
Greens and beans (5)	1.2 (24.1)	1.46 (29.3)	0.82 (16.3)	2.26 (45.2)	1.4 (28)	<.001*
Whole grains (10)	4.6 (46)	5.87 (58.7)	4.32 (43.2)	6.48 (64.8)	5.18 (51.8)	<.001*
Dairy (10)	3.95 (39.5)	2.42 (24.2)	2.62 (26.2)	2.11 (21.1)	3.2 (32)	<.001*
Total protein foods (5)	1.27 (25.4)	1.29 (25.7)	1.12 (22.4)	1.47 (29.5)	1.29 (25.8)	.001*
Seafood and plant proteins (5)	1.45 (28.9)	1.5 (30)	0.39 (7.8)	0.98 (19.5)	1.23 (24.6)	<.001*
Fatty acids (10)	4.62 (46.2)	6.61 (66.1)	4.78 (47.8)	6.34 (63.4)	5.29 (52.9)	<.001*
Moderation (higher score indicates lower consumption)						
Refined grains (10)	10 (100)	10 (100)	10 (100)	10 (100)	10 (100)	1.000
Sodium (10)	10 (100)	10 (100)	10 (100)	10 (100)	10 (100)	1.000
Empty calories (20)	20 (100)	20 (100)	20 (100)	20 (100)	20 (100)	1.000
Total score (100)	64.41 (64.4)	68 (68)	62.52 (62.5)	66.35 (66.3)	65.21 (65)	<.001**

^aThe component and total scores are presented both as an absolute number and as a percentage of the maximum possible score, by country.*Statistically significant differences ($P < .05$) between all countries. **Statistically significant differences ($P < .05$) in total HEI-2010 score between Spain-Portugal, Spain-Uruguay, and Spain-Mexico.

not ensure a high score. A great number of components contributed to lower than ideal scores. Respondents were least likely to achieve a perfect score in seafood and plant proteins, total protein foods, greens and beans, and total fruit and dairy. Only in the moderation components category did 100% of the subjects achieve a perfect score of 10 or 20. The HEI-2010 provides important evidence on the types of dietary improvements that need to be made to bring food consumption patterns more in line with the recommendations.

In our sample, Portuguese subjects showed a higher total HEI-2010 score followed by Mexicans, Spanish, and Uruguayans. Spanish stood out in high dairy consumption and low fatty acids

ingestion compared to the other 3 countries, while Portuguese did better on whole fruit consumption and worst in fatty acids intake. Uruguayans were in average with other countries except for a very low consumption of greens and beans and seafood and plant proteins. Mexicans showed the highest consumption of whole grains but a poorer intake of total fruit and seafood.

Unfortunately, our results are not in agreement with those reported by other investigators regarding healthier dietary patterns related to healthier beverage patterns.²⁶⁻²⁸ The statistically significant difference ($P < .001$) found between total water intake and the sex in our study could be explained by the fact that women tend to have a healthier lifestyle,

which includes a healthier dietary pattern including beverages. This fact may explain why females tend to adhere more closely to the recommendations.²⁹

In the study by Ferreira-Pêgo et al,¹ individuals with greater adherence to the Mediterranean diet showed a higher intake of water and wine and a lower consumption of sweetened regular beverages.

The relatively low contribution of caloric soft drinks to the energy intake could be attributable to the Mediterranean pattern of consumption that this society follows. By contrast, the NHANES study of the United States³⁰ has the highest contribution to energy intake from sweetened beverages.

Table 5.Information on Exercise, by Country and Sex^a.

	Spain (n = 620)		Portugal (n = 199)		Uruguay (n = 132)		Mexico (n = 210)		Total (n = 1161)		
	Male (n = 253)	Female (n = 363)	Male (n = 77)	Female (n = 122)	Male (n = 36)	Female (n = 96)	Male (n = 73)	Female (n = 137)	Male (n = 439)	Female (n = 718)	Both sexes
Do exercise	207 (81.8)	273 (75.2)	64 (83.1)	89 (72.9)	27 (75)	76 (79.2)	40 (54.8)	80 (58.4)	338 (77)	518 (72.1)	856 (73.7)
Days of exercise											
Once every 2 weeks	24 (11.6)	26 (9.5)	12 (18.8)	18 (20.2)	0 (0)	14 (18.4)	5 (12.5)	15 (18.8)	40 (11.8)	73 (14.1)	114 (13.3)
1-2 days/week	45 (21.7)	94 (34.4)	26 (40.6)	38 (42.7)	10 (37)	28 (36.8)	8 (20)	10 (12.5)	89 (26.3)	170 (32.8)	260 (30.4)
3-4 days/week	79 (38.2)	93 (34.1)	22 (34.4)	25 (28.1)	12 (44.4)	18 (23.7)	12 (30)	34 (42.5)	125 (37)	170 (32.8)	296 (34.6)
≥5 days/week	57 (27.5)	55 (20.1)	4 (6.3)	8 (9)	5 (18.5)	16 (21.1)	15 (37.5)	22 (27.5)	81 (24)	100 (32.8)	183 (21.4)
Hours of exercise											
<1 hour/day	51 (24.6)	96 (35.2)	21 (32.8)	37 (41.6)	5 (18.5)	37 (48.7)	7 (17.5)	34 (42.5)	84 (24.9)	204 (39.4)	288 (33.6)
1-2 hours/day	136 (65.7)	161 (59)	34 (53.1)	45 (50.6)	15 (55.5)	35 (46.1)	30 (75)	40 (50)	215 (63.6)	281 (54.2)	499 (58.3)
>2 hours/day	16 (7.7)	11 (4)	7 (10.9)	7 (7.9)	7 (25.9)	3 (3.9)	3 (7.5)	6 (7.5)	33 (9.8)	27 (5.2)	60 (7)

^aData expressed as sample size (n) and percentage.

Participants who engaged in more physical exercise consumed more water, milk and milk products, juices, and wine and less sweetened regular beverages. Compared to the lowest category, the possibility of meeting the EFSA recommendations of total fluid intake was greater in individuals with 8 or more points on the Mediterranean diet adherence questionnaire (odds ratio = 1.94; 95% confidence interval = 1.25-3.01) and in those who practice physical exercise 3 times a week or more (odds ratio = 1.71; 95% confidence interval = 1.22-2.39).¹

To the best of our knowledge, the possible associations between physical exercise and total fluid intake or different types of beverages consumption have not been subject to a great deal of research among the general populations to date. In our study, individuals who engaged in most physical exercise presented a higher total daily fluid and water consumption, probably because they had an increased fluid loss and consequently a higher demand of fluid intake. However, this study is not able to conclude whether these higher intakes cover the higher intake demand. Individuals who engaged most in physical exercise tended to comply better with the EFSA's total fluid intake recommendations as reported previously by Ferreira-Pêgo et al.³¹

Similar results were observed in the Bahia study,³² where participants who took part in intense physical activity consumed more fluid daily (2355 mL vs 1988 mL for those with a low physical activity level) and did so more times per day (6.46 vs 5.75). In the ASNS 2007,³³ a higher physical activity level was also associated with a higher water intake. For individuals who exercised 4 to 6 times per week for at least 30 minutes, mean water consumption was 1.26 to 0.97 L/day compared with 0.75 to 0.73 L/day for those who exercised rarely and 0.6 to 0.88 L/day for those who stated they never exercised.¹⁶ This was also seen in the ASNS 2012, in which men and women with high physical activity levels had higher total daily water intakes than those with low high physical

activity levels (2876 mL vs 2610 mL for men and 2785 mL vs 2446 mL for women; $P < .015$ for women).

In our study, compliance with the EFSA recommendations for total fluid intake was not mainly associated with higher HEI-2010 scores. However, water intake in the ASNS 2007³³ differed according to the participants' food consumption pattern, with those on a vegetarian diet consuming significantly more ($P < .01$) tap water than those on a typical Austrian or even a health-conscious diet (1.23 L/day vs 0.88 L/day and 1.16 L/day, respectively; $P < .001$ between normal and health-conscious diets). In the ASNS 2012, a high intake of fruit and vegetables (defined as at least 2 servings per day of each) was also associated with a higher intake of water in 333 adults aged 18 to 80 years.¹⁵

Limitations

This study is a cross-sectional design, which provides evidence for association but not causal relationships.

Conclusion

The present study shows clearly that neither men nor women consumed adequate total water intake when compared with the EFSA reference values. What is more, there were differences among the countries included in this study.

The diet quality of the sample also fell short of recommendations. The diet quality scores would be improved by increasing the intake of fruit, vegetables, especially dark greens and beans; replacing refined grains with whole grains, increasing seafood, meat, and poultry; and decreasing the intake of sodium (salt) and empty calories from solid fats and added sugars.

On the one hand, participants who adhere more closely to a healthy diet did not show better compliance with total fluid intake recommendations. On the other hand, participants who engage in more physical exercise have a healthier fluid intake pattern. Apart from that, participants with a healthier lifestyle in

general had a greater probability of complying with EFSA's total daily fluid intake. Adequate total fluid intake is associated with a higher physical exercise but not with a high quality diet.

These results suggest that there is a relationship between physical exercise and a better fluid intake pattern, but not with a healthier diet. However, future studies are warranted to confirm our results and to establish cause-effect associations in order to design future public health recommendations.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **AJLM**

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