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RESEARCH ARTICLE

Beverage and water intake of healthy adults in some European countries

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Abstract

Introduction: Nutritional surveys frequently collect some data of consumption of beverages; however, information from different sources and different methodologies raises issues of comparability. The main objective of this review was to examine the available techniques used for assessing beverage intake in European epidemiological studies and to describe the most frequent method applied to assess it. *Materials and methods*: Information of beverage intake available from European surveys and nutritional epidemiological investigations was obtained from gray literature. *Results*: Twelve articles were included and relevant data were extracted. The studies were carried out on healthy adults by different types of assessments. The most frequent tool used was a 7-d dietary record. Only Germany used a specific beverage assessment tool (Beverage Dietary History). *Conclusion*: From the limited data available and the diversity of the methodology used, the results show that consumption of beverages is different between countries. Current epidemiological studies in Europe focusing on beverage intake are scarce. Further research is needed to clarify the amount of beverage intake in European population.

Keywords

Beverages, epidemiological European studies, water

History

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Introduction

Intake of water is done mainly through consumption of drinking water and beverages (80%) plus water containing foods (20%). Food water content is usually below 40% in bakery products, between 40% and 70% in hot meals, >80% in fruit and vegetables and about 90% in both human and cows' milk. Diets rich in vegetables and fruit provide significant amounts of the total water intake, whereas, for example, fast food products as a rule have low liquid content (Przyrembel, 2006).

Water is often either disregarded in national and international assessment of nutrients intake or rarely mentioned. There is no standardized questionnaire developed as a research tool for the evaluation of water intake in the general population. At times, the use of information from different sources and methodological characteristics raises issues of comparability that are difficult to address. Furthermore, dietary intake of water is a highly variable event, which experiences significant differences by day of the week, body size, physical activity and climatic exposure (Fulgoni, 2007) on a basic underlying pattern of consumption.

During the 1980s and 1990s, several nutritional studies were conducted in Europe (Serra-Majem, 2009) that gathered relevant data regarding beverage intake although it was not their main objective: the European Community Concerted Action on Nutrition and Health (EURONUT) attempted to identify relevant dietary factors in epidemiological research based on the use of 3 d food records. A subsequent study named Survey in Europe on Nutrition and the Elderly (SENECA 1988–1999) was carried out as part of the EURONUT project (de Groot et al., 2004). Both studies estimated the intakes of all foods and beverages. The WHO project Monica (Multinational Monitoring of trends and determinants in cardiovascular disease) ran from 1980s to 1990s, and also collected information of beverages intake. Its objective was to describe trends in dietary patterns in Europe and how they related to trends in coronary heart disease. The European Prospective Investigation into Cancer and Nutrition (EPIC, 1992) was a cohort study which aimed to investigate the relationships between diet, nutritional status, lifestyle and environmental factors and the incidence of cancer and other chronic diseases in 10 European countries. Habitual intake of total fluid from these countries was collected. Fluid includes alcoholic beverages, milk and other dairy beverages, coffee, tea, herbal tea, water, fruit and vegetable juices and soft drinks (Ross et al., 2011).

Data Food Networking (DAFNE) (Lagiou & Trichopoulou, 2001) was a project investigating home budget datasets and food databanks from 16 European countries. Data are available in a user-friendly application tool, DafneSoft (Athens, Greece), which is freely accessible. European Information Campaign on Diet and Nutrition (EURALIM; Morabia et al., 1998) was carried out from 1996 to 1998, and researched cardiovascular risk factor variables from different European studies in order to create a common database. The European Food Consumption Survey method (EFCOSUM 1999–2001; Brussaard et al., 2002) project encompassed a total of 23 European participating countries whose objective was to define a method for monitoring food consumption in nationally representative samples of all age–sex categories in Europe in a comparable way and to assess energy and

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macronutrient intake. HECTOR Healthy Eating Out (2006–2009) aimed to enhance knowledge on eating out in Europe, to identify Europeans' dietary patterns when eating out (HECTOR, 2009). European Food Consumption Validation (EFCOVAL, 2006) follows in the footsteps of the EFCOSUM project, which advised the use of repeated, non-consecutive 24-h periods (''24-h dietary recalls'') through strictly standardized procedures, for reliable and comparable transnational data collection.

All of these studies picked up information of beverages intake. However, to our knowledge, all of them have not updated the information collected, and the software is still working with the data collecting from 1990s. It would be a very simplistic way continuing using those values collected 20 years before, as if they were representative of current European populations.

At present, in the European Union, there has not been developed recent epidemiological studies that focus on beverage intake. This hinders research on this topic, which is needed to underpin nutrition policies for these populations.

To fill this knowledge gap, an additional approach is needed to deal with the standard searches conducted in known (open access) literature databases, i.e. the identification of commonly overlooked gray literature sources from European countries. So far, available hydration data in European countries have often only been used by local health policies and have remained largely unexploited because they are either not published in an accessible manner or not available in English. In this study, we use gray literature as the basic source of information, and selecting data from national surveys specifically.

The main objective of this review was to examine the available techniques in assessing hydration status in epidemiological studies in Europe and describe which is the most frequent method applied to assess water (or liquid) intake in populations.

Materials and methods

Sources of data on beverage or liquid intake were available from European surveys and nutritional epidemiological investigations were selected from gray literature. These papers were found through web search of diverse European Institutions and using the Cochrane Plus Library. No language restrictions were applied.

The keywords used for the search were: beverages, water intake, nutrition assessment and epidemiologic studies. Finally, we used the Google Internet searcher to try to locate any research on European studies that evaluated beverage intake. All these searches were based on the document provided by European Food Safety Authority (EFSA, 2010).

The inclusion criteria were: studies conducted among healthy adult population and performed in European countries. Studies evaluating health problems, pesticides, food pollution and food additives were excluded.

After collecting the data, we assigned three major groups of liquid intake (total water, non-alcoholic beverages and alcoholic beverages). In some cases, information of total water was collected as mineral water or tap water. Non-alcoholic beverages data were divided into four subgroups (fruit and vegetable juices, coffee, tea and other hot drinks, milk and milk drinks, and carbonated, soft, isotonic drinks and others). With the average intake of water, soft drinks and alcohol beverage intake, we calculated total fluid intake, reported in g/d.

Results

Twelve epidemiological studies accomplished between years 2003 and 2011 were included and all relevant data regarding beverage consumption were extracted. A detailed overview of the study characteristics is given in Table 1.

Beverages studies were carried out on representative samples of an apparently healthy population. The beverage information was collected by different types of assessment: four countries used a 7-d dietary record (Sweden, UK, Denmark and France), three countries applied a 3-d dietary record (Italy, Spain and Finland), other three countries employed a 24-h recall (Belgium, Austria and The Netherlands), one country used a 4-d semi-weighted food record (Ireland) and only one country applied a Beverage Dietary History (Germany). Some countries employed more than one assessment method in the same study. A Spanish study used a 24-h recall and a FFQ in addition to a 3-d record, a Finland study applied a 48-h dietary recall plus a 3-d record and the Belgian study employed a 24-h recall and FFQ too.

Most studies analyzed their data according to gender. However, in some cases, we used the total population data (Austria, Spain and The Netherlands), because these studies included additional results of beverage assessment or they were not shown by gender.

All studies were conducted in adults (aged 18–80 years). However, three studies included younger people in their samples: Belgium included people from 15 years, Germany from 14 years and the Netherlands from 7 years.

None of the studies collected information from all categories evaluated. Among the studies that reported water intake, six studies presented the information for total water intake (Sweden, Belgium, Germany, Spain, Finland and France). Only two studies (Italy and Austria) reported information of mineral water and tap water. Data consumption of only mineral water was measured in the Netherlands and the UK. No data from water intake were found in the Denmark study. The amount of total water intake varied from 1243.6 ml/d in Belgian women; on the other hand, the lowest intake was 483 ml/d in Sweden (men).

Mineral water showed similar values along the studies; as regards for tap water, there is not enough data to make a comparison. Regarding non-alcoholic beverages, the values recorded for fruit and vegetable juices change dramatically: Germany reports the values of 513 g/d for men and 337 g/d for women, whereas Italy reported 30 g/d for both sexes. Concerning data of the group consuming coffee, tea and other hot drinks, the values obtained are similar [ranging from 470.7 to 729 g/d, with the exception of Italy, who again recorded the lowest values for this group of beverages (135 for men and 138 g/d for women)]. The range of data included in the milk and milk drinks category diverged from 81.9 g/d in a study from France (women) to 341 g/d in men from a Denmark study.

For carbonated, soft, isotonic drinks and others (non-alcoholic beer included), the range increased from 4 g/d for women from Germany to 363 g/d for Belgian men. However, neither Italy nor Denmark and France reported the information of this category. Regarding alcoholic beverages, the range oscillated from 58 g/d in Italian women to 500 g/d in men from the UK.

The average of total beverage intake was shown only in two countries (UK and Denmark). These values are similar: range was from 1988 g/d for UK to 2317 g/d for Denmark. However, if we compare the results of total beverage intake obtained from the sum of values reported in each country, the results obtained are quite different (from 941 g/d for Italy to 2659 g/d for men in Germany).

Discussion

This study reports a current comprehensive overview of European hydration data using gray literature sources of information. From the limited data available, the results of this review show that the studies on beverage intake in European countries are diverse with regard to design: they differ in dietary assessment, composition

Table 1. Beverage intake in some European countries (g/d).

	Austria	Belgium		Denmark		Finland		France		Germany		Ireland	Italy		Spain	Sweden		The Netherlands	UK	
	Austrian Nutrition Report 2003 (Elmadfa et al., 2003)	The Belgian Food Consumption Survey 2004 (De Vriese et al., 2006)		Danish National Survey of Diet and Physical Activity 2003–2008 (Knudsen et al., 2012)		The National FINDIET Survey 2007 (Paturi et al., 2008)		INCA 2 Individual and National Study on Food Consumption 2006–2007 (French Food Safety Agency, 2009)		National Nutrition Survey II 2008 (Max Rubner-Institut, 2008)		National Adult Nutrition Survey 2011 (Irish Universities Nutrition Alliance, 2011)	INRAN-SCAI National Survey on Food Consumption in Italy 2005–2006 (National Research Institute for Food and Nutrition, 2010)		ENIDE Encuesta Nacional de Ingesta Alimentaria 2011 (Spanish Agency for Food Safety & Nutrition, 2011)	Riksmaten-Adults Food and Nutrition Among Adults in Sweden 2010–2011 (Amcoff et al., 2012)		DNFCS Dutch National Food Consumption Survey 2007–2010 (Van Rossum et al., 2011)	NDNS National Diet & Nutrition Survey 2004 (Hoare et al., 2004)	
Beverage assessment instruments	24-h recall	Repeated 24-h recall self-administered FFQ		7-d dietary record		48-h dietary recall, 3-d dietary record		7-d dietary record		Beverage dietary history		4-d semi-weighed food record	3-d dietary record		24-h recall, 3-day dietary record FFQ	4-d dietary record		2 Non-consecutive 24-h dietary recall	7-d dietary record	
Gender		Men	Women	Men	Women	Men	Women	Men	Women	Men	Women		Men	Women		Men	Women		Men	Women
n	746	1546	1537	1569	1785	730	846	2624		7093	8278	1274	1068	1245	3000	792	1005	3819	1008	1243
Age (years)	19–60	15–>75	15–>75	18–75	25–64	18–79	14–80	18–64	18–64		18–64	18–80		7–69	19–64					
Total water (ml/d)		1155.7	1243.6			563	803	767.8	807.5	1110	1119	564			1022	483	643			
Mineral water	442	594.9	715.4										475	498	397.25			557.7	239	314
Tap water	711												175	193						
Non-alcoholic beverages																				
Fruit and vegetable juices	106.9			70	73	260	177	158.2	123.2	513	337	50	30	30	74.4	67.1	54.5	104.6	48	47
Coffee, tea and other hot drinks	451.8	445.5	447.6			647	583	470.7	541.1	571	506	551	135	138	93.6	458.8	456.8	696.7	729	653
Milk and milk drinks	37.1	104.2	82.4	341	306	337	234	89.9	81.9	131	98	213	94	110	214.1	275.0	233.8	26.3	225	200
Carbonated, soft, isotonic drinks and others (non-alcohol beer)	271.5	363.1	212.6			70	41			8	4	118			125.1	132.2	95.2	301.3	239	201
Total non-alcoholic beverages	2020.3	1507.7	1458.0			1426	1512	1486.6	1553.7	2351	2285	1496	851	883	1529.2	1416.1	1483.3	1662.1	1480	1415
Alcoholic beverages	163.2	247.1	78.0			234	61	255.6	63.2	308	81	330	163	58	117.3	173.6	77.6	183.4	500	139
Total beverages	2183.5	1754.9	1536.0	2317.0	2186.0	1660.0	1573.0	1742.2	1616.9	2659.0	2366.0	1826.0	1014.0	941.0	1646.5	1589.7	1560.9	1845.5	1988.0	1585.0

databases, sampling procedures and age range, and this may confound comparisons between countries. Information obtained from gray literature, even though it was not sufficient to fill an evident knowledge gap in hydration data from European countries, has been the most important source of data in this study. All studies from European countries included had similar beverage intakes. However, when different categories of beverages were taken into account, the situation changed dramatically.

If we observe the fluid intake and water consumption in different populations, we can see large differences in the values obtained in the national surveys, which cannot be explained solely by the population characteristics. The data collected give a clear indication of the situation in Europe. How to explain that the average consumer is so different in countries, such as Germany and Denmark? Are they really different populations from the viewpoint of beverage consumption? Great part of these differences derived from the methodology used. Which one is the best tool to collect beverage intake information? The choice of an appropriate method is essential in order to have a precise and reliable recollection. Nevertheless, many existing methods for this assessment mainly focus on the calories, macronutrients and micronutrients. Registration of water is often not accurate enough in such surveys. In general, they are focused at the moment of consumption, i.e. meals and snacks. But many people consume water between meals without necessarily consuming other calories, and this amount does not generally show up on records. This results in a low estimate of the amount of water consumed by the different populations. In the German Survey, the Beverage Dietary History was developed only to assess beverage intake. We consider that this reliable beverage intake questionnaire may be desirable for practitioners as well as for researchers assessing habitual beverage intake, although some refining may be needed.

What is the real implication of not having enough records that obtain accurate water consumption? If we note that the recommendations of water consumption or ''adequate intake'' are based on these surveys, it is easy to understand that they are not always adapted well enough to populations and even less to different physiological states.

In addition, evaluations of beverage intake are based on the quantitative assessment of foods consumption, which are converted to nutrients through the use of food composition tables. Normally, the tables used are locally produced in each country. This is one of the risks of bias that can be occurring when intakes of different countries are compared. Another important limitation to consider is the timing of the reviewed studies. Weather variations along the year, could affect the volume of beverage and water consumption. However, most of the studies considered the seasonal variability in methodology and data collection in order to reduce this bias. Only the studies of Austria 2003 and Denmark 2003–2008 did not mentioned anything about this issue.

In some cases, the quantities recorded are extremely low, as shown in the German study, which was collected from carbonated, soft isotonic and others, non-alcoholic beverages (8 g/d for men and 4 g/d for women). This makes no sense, and is practically irrelevant from the point of view of the nutrition and hydration.

It is really necessary to focus on developing a method that provides more accuracy and reliability to record all liquids drank at different times, before, during and after meals, specifying each case the amount consumed and the types of beverages. A better use of the recent data from European countries and its further analysis will enable the evaluation of the current hydration status of their populations.

Conclusion

Since water is considered an essential nutrient for life, we believe that water intake must be taken into account in every nutrient assessment study. Unfortunately, most studies underestimate water collection as part of the diet, since it contributes with no calories and no nutrients. However, alcohol or coffee intakes are always evaluated.

From the data available and the diversity of methodology used, the results show that consumption of beverages is different between countries. Current epidemiological studies in Europe that focus on beverage intake are scarce.

For future research, we recommend reviewing gray literature, and its accessibility and reliability need further attention. Further investigation is needed to clarify the amount of beverage intake in European population, using a standardized assessment and to derive into harmonized and integrated results in reliable recommendations.

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Declaration of interest

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