Consumption estimation of non alcoholic beverages, sodium, food supplements and oil

María Luisa López Díaz-Ufano

Abstract:

The interest in the type and quantity of non alcoholic beverage, sodium, food supplements and oil consumption is not new, and numerous approaches have been used to assess beverage intake, but the validity of these approaches has not been well established.

The need to intake liquids varies depending on the diet, the physical activity carried out, the environmental temperature, the humidity, etc. The variety of beverages in the diet can contribute to increasing the micro nutrient intake: vitamins, antioxidants, minerals.

Risks associated to high sodium consumption are: an increase in high blood pressure, vascular endothelial deterioration, bone demineralisation, kidney disease, stomach cancer. Progress in health, investigation, education, etc. are leading to an increase in food supplement consumption. Olive oil represents one of the basic pillars of the Mediterranean diet and its normal presence in nutrition guarantees an adequate content of some important nutrients; not only oleic acid and linoleic acid but also tocopherols, phytoestrogens and phenolic compounds.

Biomarkers of intake are able to objectively assess dietary intake/status without the bias of self-reported dietary intake errors and also overcome the problem of intra-individual diet variability. Furthermore, some methods of measuring dietary intake used biomarkers to validate the data it collects. Biological markers may offer advantages and be able to improve the estimates of dietary intake assessment, which impact into the statistical power of the study. There is a surprising paucity of studies that systematically examine the correlation of beverages intake and hydration biomarker in different populations.

Conclusion: There is no standardized questionnaire developed as a research tool for the evaluation of non alcoholic beverages, sodium, food supplements and oil intake in the general population. Sometimes, the information comes from different sources or from different methodological characteristics which raises problems of the comparability. In the European Union, current epidemiological studies are scarce.

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Key words: Sodium, Food supplements, Oil, Biomarkers, beverage assessment.

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Resumen:

El interés por el tipo y la cantidad de bebidas no alcohólicas, sodio, suplementos y aceite consumidos no es nuevo, y numerosos enfoques se han utilizado para evaluarla, pero la validez de estos enfoques no se ha establecido correctamente.

Las necesidades de líquidos varían dependiendo de la dieta, de la actividad física realizada, de la temperatura ambiental, de la humedad, etc. La variedad de bebidas en la dieta puede contribuir a incrementar la ingesta de micronutrientes: vitaminas, antioxidantes, minerales.

Los riesgos asociados al elevado consumo de sodio son: aumento de hipertensión arterial, deterioro endotelial vascular, desmineralización ósea, enfermedad renal, cáncer de estómago. Los avances en salud, investigación, educación, etc. llevan a un creciente consumo de suplementos alimenticios. El aceite de oliva representa uno de los pilares básicos de la Dieta Mediterránea y su presencia habitual en la alimentación garantiza un adecuado aporte de algunos nutrientes importantes, no sólo ácido oleico y linoleico, si no también tocoferoles, fitoesteroles y compuestos fenólicos.

Los biomarcadores de ingesta permiten evaluar objetivamente la ingesta dietética sin el sesgo producido por los errores del auto-reporte. Además permiten superar el problema de la variabilidad intra-individual. Algunos métodos para medir ingesta alimentaria utilizan biomarcadores para validar los datos que recoge. Los marcadores biológicos ofrecen ventajas y son capaces de mejorar las estimaciones de la evaluación de ingesta dietética. Sin embargo, existen muy pocos estudios que examinen sistemáticamente la correlación entre la ingesta de bebidas y los biomarcadores de hidratación en diferentes poblaciones.

Conclusión: Aún no existe, en población general, un cuestionario estandarizado desarrollado como herramienta de investigación para la evaluación de la ingesta de bebidas no alcohólicas, sodio, suplementos y aceite. El uso de información de diferentes fuentes y diferentes características metodológicas plantea problemas de comparabilidad entre estudios. En Europa los estudios epidemiológicos actuales son escasos.

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Palabras clave: Sodio, Suplementos, Aceite, Biomarcadores, Consumo de bebidas.
Introduction

In order to know about individual or group food consumption there are several tools available, that estimate consumption along a determine period of time. There is no ideal method to value food take in a precise way. The assessment methods that are used estimate intake with different levels of accuracy.

Individual methods to value food consumption permit you to relate the diet with other variables of the person, as for example their age, sex, economic situation, style of life, biochemical nutritional status, health state, etc.

It’s important to know the features of the most used questionnaires, their implementation possibilities and their limits. Table I summarizes the key features, applications and limitations of different food consumption assessment methods.

Choosing a food consumption assessment method will depend principally on the desired objectives.

In the year 1993 experts on food and nutrition studies, gathered by the General Direction of Public Health of the Health and Consumption Ministry, reached a consensus about recommending, for assessment studies on individual consumption in Spanish population, the use of the 24hrs method for 2 or 3 non consecutive days. And this method may be complemented with a food consumption questionnaire.

<table>
<thead>
<tr>
<th>Table I</th>
<th>Features, applications and limitations of commonly used food consumption assessment methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Features and applications</strong></td>
<td><strong>Limitations</strong></td>
</tr>
</tbody>
</table>
| **Food record** | • It estimates real intake quantitatively.  
When the number of days are increased, the estimation approximates to normal intake.  
Useful in epidemiological studies and nutritional counseling.  
The precision of the questionnaires increases.  
From the estimation register to the food weight register and lastly the double weight register with complementary chemical analysis.  
• It requires proper cooperation from the participant. He/she must know how to read and write.  
The participant’s cooperation, the cost of the method and modifying the consumption pattern that is produced increase from the estimation register to the food weight register and lastly the double weight register with complementary chemical analysis. |
| **24 hr recall** | • It estimates real intake quantitatively.  
When the number of days are increased, the estimation approximates to normal intake.  
Useful in epidemiological studies and nutritional counseling.  
It does not modify consumption patterns.  
It may be used with illiterate subjects.  
• Memory failure. Difficult to use with children and elderly.  
Difficulty when trying to quantify the size of the serving consumed. |
| **Diet history** | • It estimates real intake quantitatively.  
Useful in epidemiological studies and nutritional counseling.  
It does not modify consumption patterns.  
It may be used with illiterate subjects.  
• Long and expensive.  
Polling experts are required. |
| **Food Frequency Questionnaires** | • It estimates qualitatively normal intake according to food groups. It can quantify normal consumption servings.  
Useful in epidemiological studies to be able to classify subjects by consumption categories and useful in nutritional counseling.  
Quick and easy.  
It does not modify consumption patterns.  
It does not require polling experts.  
Low applying costs.  
• Less precise than quantitative methods.  
Difficult use on children, elderly and subjects with low intelligence levels.  
It requires memory.  
It is qualitative or semi-quantitative.  
Questionnaire requires validating before use.  
High cost. |
| **Fast methods** | • They identify consumption habits.  
Useful to detect risky consumption, diet support.  
Very easy to apply.  
Low cost.  
• Less precise than previous methods. |
| **Biochemical methods to value food intake.** | • It provides direct, objective information about nutrient availability.  
It does not provide information about the global diet.  
Not all nutrients have a proper biochemical indicator. |

Consumption estimation of non alcoholic beverages, sodium, food supplements and oil
Non-alcoholic beverages consumption estimate

The need to intake liquids varies depending on the diet, the physical activity carried out, the environmental temperature, the humidity, etc.

It is essential to replace water and salt loss in order to maintain an adequate hydration level and a good health state. Food provides between 20%-25% of the total water intake, whereas beverages represent the other 75%-80%.

The variety of beverages in the diet can contribute to increasing the micro nutrient intake: vitamins, antioxidants, minerals, etc.

When it comes to assessing beverage consumption one has to take into consideration the type of beverage: We have non-bottled water (with different types of treatments to obtain the quality necessary for human consumption and this will depend on different geographical regions); bottled water (that is classified in mineral water, stream water and prepared waters); juices (natural or not, vegetables); milk (whole-milk, semi-skimmed, skimmed, fortified); dairy milk shakes; soft drinks (light / zero); coffee (with or without milk, with or without sugar, with sweetener); tea (with or without sugar, with sweetener, with milk; other teas (with or without sugar); beer (with or without alcohol); cider, soups, energy drinks (Table II).

To estimate intake one may use the following type of registers:

- Dilution techniques.
- Bio-electrical impedance.
- Plasma indicators.
- Urine indicators.
- Body weight changes.
- Water loss.
- Clinic.

<table>
<thead>
<tr>
<th>BEVERAGES</th>
<th>Never or rarely</th>
<th>At month</th>
<th>At week</th>
<th>At day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap water</td>
<td></td>
<td>1-3</td>
<td>1</td>
<td>2-3</td>
</tr>
<tr>
<td>Bottled water (w. or w/o gas)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stream water 1 glass=200cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural juice (orange or others)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned or bottled juice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural vegetable juice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned or bottled vegetable juice</td>
<td>1 can = 330cc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-skimmed milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skimmed milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soya drink 1 glass = 200cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft drinks</td>
<td>1 glass = 200cc</td>
<td>1 can =330cc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft drinks light/zero</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black coffee w or w/o a little milk with sugar</td>
<td>1 cup = 30cc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black coffee w or w/o a little milk w/o sugar</td>
<td>1 cup = 30cc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee with milk and sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee with milk w/o sugar</td>
<td>1 cup=200cc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea with sugar</td>
<td>1 cup=200cc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea w/o sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other teas 1 cup=200cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soups 1 bowl=250cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Must 1 glass=200cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol free beer 1 bottle=200cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beer 1 can=330cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cider 1 glass=200cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. **Dilution techniques.** They use bio-markers. They permit you to measure directly the hydration state. They are very exact. Problems: The indicator must be distributed evenly, it’s necessary to know the discharge or metabolic breakdown of the indicating substance, the bio-marker must be easy to measure, non-toxic and must not alter the body’s water distribution. The technical requirements and high costs make them be rarely-used techniques.

2. **Bio-electrical impedance.** There are different bio-electrical impedance analysis (AIB): AIB mono-frequency, AIB multi-frequency and bio-electrical impedance spectroscopy (EIB). The factors that can affect the impedance reliability are: configuration and position of the electrodes; electrical frequency; body position; internal and external temperature, perspiration; previous exercise; hormone changes; hematocrit; body fat distribution and metal objects (prostheses, pacemaker, etc).

3. **Plasma indicators:** Plasma Osmolarity: 280 moms/liter; Plasma volume; Sodium; Others: Hematocrit, Potassium, Adrenaline, Noradrenaline, Cortisol, Aldosterone, Blood urea nitrogen (BUN), Relation between BUN/Creatinine, Testosterone.

4. **Urine indicators.** Urine Osmolality (particles/kg of water), Osmolarity (particles / liter of solution), Urine volume: *dehydration when one eliminates* < 30 ml/h and volume over 300-600 ml/h indicates that there is an excessive intake of liquids.

5. **Body weight changes.** It’s a reliable, valid, precise, fast and cheap marker. Well used in sport. If the loss is 5% body weight the clinical signs depend on interstitial liquid loss (sunken eyes, dry mucous membranes, sunken fontanelle); if the loss is between 5-10% body weight, the clinical signs depend on interstitial deficit added to intravascular liquid deficit (lethargy, tachycardia, low blood pressure, urine output decrease), and last of all if the loss is between 10-15% body weight, the clinical signs will be caused by dehydration of the interstitial and intravascular space (low blood pressure, oliguria, rapid pulse, etc).

6. **Water loss.** To assess an individual’s hydration one has to take into consideration the daily minimum water loss and its production (Table III).

### Table III

<table>
<thead>
<tr>
<th>Source</th>
<th>Loss (cc)</th>
<th>Production (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory loss</td>
<td>-250 / -350</td>
<td></td>
</tr>
<tr>
<td>Urine loss</td>
<td>-500 / -1000</td>
<td></td>
</tr>
<tr>
<td>Facaces loss</td>
<td>-100 / -200</td>
<td></td>
</tr>
<tr>
<td>Unconscious loss</td>
<td>-450 / -1900</td>
<td></td>
</tr>
<tr>
<td>Metabolic production</td>
<td>+ 250 / + 350</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-1300 / -3450</td>
<td>+ 250 / + 350</td>
</tr>
<tr>
<td>Net loss</td>
<td>-1050 / -3100</td>
<td></td>
</tr>
</tbody>
</table>

7. **Clinical.** Symptoms: Dry mouth, dizziness, vertigo, no tear drop production, sunken eyes, sunken fontanelle (babies), lethargy.

Signs: Low blood pressure, orthostatic hipopresion, tachycardia, thready pulse, signs of skin folds, delayed capillary refill, shock.

### Sodium consumption estimation

The physiological needs of sodium consumption vary depending on the age, sex, weight, physiological state (growth, pregnancy, breastfeeding), physical activity level, etc. These physiological needs are also influenced by environmental conditions (hot climates), certain types of jobs (bakers, stokers) and pathological situations (diarrhea, vomiting).

Risks associated to high sodium consumption are: an increase in high blood pressure, vascular endothelial deterioration, bone demineralisation, kidney disease, stomach cancer.

The WHO\(^6\) recommends healthy population an average consumption of 5 g of salt per day. *Salt = sodium (grams) x 2.5 - multiply 2.5 by the content of grams of sodium that the food label indicates.* Nevertheless, making out the sodium intake is not easy, as it is difficult to know how much salt one uses when cooking and there are any foods that are not well labeled.

To be able to estimate how much sodium has been consumed one must ask if the subject never uses salt, or if he always uses salt, and if salt is used, which type (iodized or not).

Sodium excretion measurement through urine (24hr urine) is the objective biochemical parameter to be able to know how much sodium has been consumed, as all sodium consumption is eliminated through urine. For adults, the normal sodium levels in urine are 20mEq/l/day\(^7\).

### Food supplement consumption estimation

Progress in health, investigation, education, etc. are leading to an increase in food supplement consumption.

Vitamins are organic substances of diverse chemical structure that the body is not able to synthesize, reason why it needs exogenous intake in small quantities, generally from the diet, with the exception of vitamin D which is endogenously synthesized under the influence of ultraviolet light. Vitamins are essential when it comes to maintaining many metabolic functions. To not have enough in the diet provokes deficiencies or hypovitaminosis. Though different in their structure and function, they are classified, according to their solubility, in water-soluble and lipid-soluble.

Minerals have numerous functions in the human organism, represent 4% of body weight. The amount of a mineral in the body element is no functional importance index, the copper zinc or iodine present in very
small amounts perform vital functions. Most mineral are found in any balanced diet.

Its deficiency states are often linked to the industrialization of food, its preparation, unbalanced diets, increased needs, drug interactions and/or intestinal malabsorption.

To be able to estimate their consumption questionnaires of the type showed on table IV may be used.

Once the quantity of consumption register is done (24hrs method for 2 or 3 consecutive days, completed with the food consumption register) we must consult the specific labeling of each of them to know the micro nutrient content and therefore be able to calculate the intake of these.

For consumption estimation, biochemical parameters are more precise, specific and sensitive indicators than consumption assessment methods (questionnaires). The most frequently used samples are blood and urine, though on some occasions other samples are used: tear drops, hair, saliva, nails, skin tissue, etc. Samples of hair and nails have especially been used to assess the nutritional situation in minerals and trace elements.

In general, vitamin intake assessment could be done analyzing the serum levels. Though the ideal situation is to be able to use a functional parameter, as for example assessing the enzyme activity of some metabolic process in which the vitamin intervenes.

Vitamin A: Its deficiency could be determined through clinical signs (Xerophthalmia and night blindness). As a biochemical parameter, the levels of retinol in plasma or of its transportation protein (RBT) can be determined.

Vitamin D: To be able to know its nutritional situation the levels of 25-hydroxycholecalciferol in plasma are measured.

Vitamin E: We have the following biochemical parameters to know its levels:

- Plasma level of tocopherol: it is recommended to express the levels as mg of tocopherol per gr of total lipid serum.
- Level of tocopherol in erythrocytes or platelets.
- Red blood cell hemolysis level: Cell hemolysis over 20% indicates vitamin deficiency.

Vitamin K: The classic criteria of nutritional state assessment is done determining the prothrombin time (PT).

Vitamin C: Its levels of serum can be determined easily. Levels below 0.1mg/dl are considered deficient. It has no relation with the appearance of clinical signs of scurvy. Assigning vitamin C levels in leukocytes is somewhat more difficult but has a more direct correlation with its levels in skin tissue. Values below 20mg/dl indicate deficiency. After 120 days of deficient feeding, the storage elements might start to run out.

Vitamin B complex: There are different specific parameters for each of them, that we will use depending on what is being investigated. There are also hematologic alterations as for example neutrophil hyper-segmentation, and in the last stage of the deficiency megaloblastic anemia is produced.

To value minerals there are direct methods of assessment measuring their levels in plasma or blood cells. The nutritional situation can also be assessed indirectly taking into consideration the enzyme activity of which it takes part.

Iron: There is no unique parameter to diagnose sensitively and specifically iron deficiency, they are used combined. Ferritin serum (early indicator of iron depletion, it measures its deposits, its levels are deficient when they are below 12ng/ml in adults) must be assessed: also transferrin (serum levels, iron fixing properties, saturation percentage) and erythrocyte protoporphyrin (hemoglobin precursor). Sideremy is subjected to numerous fluctuations, it even varies very much in the same individual along the day.

Zinc: Its plasma levels, the levels of zinc in red blood cells and the erythrocyte metallothioneins can be determined.

Copper: To be able to evaluate the deficiency of this mineral the following elements are established: level of copper in plasma, erythrocyte and / or leukocytes, protein levels that unite to copper (serum ceruloplasmin or erythrocyte metallothionein) and the activity of the copper dependent enzymes (cytochrome oxidase, super-oxide dismutate).

Selenium: The serum levels reflect recent mineral intake. These levels have been used on hair and nails as indicators of long term intake. With serum le-

<table>
<thead>
<tr>
<th>SUPPLEMENTS</th>
<th>Never or rarely</th>
<th>At month 1-3</th>
<th>At week 1-2-4</th>
<th>At day 5-6 1</th>
<th>2-3 4-6</th>
</tr>
</thead>
</table>

Table IV

Example of a food frequency questionnaire to assess the consumption of supplements

Brand of the vitamin or mineral supplement or the diet product.
Vitamins and minerals urine excretion increases as does its intake and decreases if it is deficient. On many occasions it is the principal method to assess the nutritional state. In general the urine levels are expressed by mg of excreted creatinine. Lipid-soluble vitamins can not be determined in urine as they are not soluble in water except vitamin K whose metabolite, the gamma-carboxyglutamic acid, is eliminated through urine. Excess tests also permit us assess the vitamin and mineral nutritional situation. The quantity eliminated is proportional to the excess of the nutrient in the organism. To detect vitamin B6 deficiency an excess of tryptophan test is carried out; for folate deficiency the histidine excess test and for vitamin B12 deficiency the valine and histidine excess test.

Oil consumption estimation

Oils can be subdivided into saturated (coconut, palm), monounsaturated (olive) and polyunsaturated (corn, soya, sunflower). This is a simplified classification as in each subgroup there are important differences that effect their properties.

Olive oil represents one of the basic pillars of the Mediterranean diet and its normal presence in nutrition guarantees an adequate content of some important nutrients; not only oleic acid and linoleic acid but also tocopherols, phytoesterols and phenolic compounds. The content of fatty acids, olive oil tocopherols, differs significantly depending on the variety of olive. Phytoesterol content can vary depending on the ripening of the olive when collecting. On the other hand, the content of poly-phenols will depend on the olive oil’s refining, being extra olive oil especially rich in these. The European Food Safety Authority (EFSA)* recommends a minimum consumption of 20 gr per day to benefit from the effects of poly-phenols that extra virgin olive oil contains.

Not only must one have in mind the variety of oils, but also the type of preservation (temperature, light, oxygen presence, type of packaging) and the use given (raw, fried).

The recommended quantity of daily olive oil consumption has problems in practice as there is no unanimity in the guides (spoon fulls, cubic centimeters, milliliters, grams).

Oil consumption can be assessed with a questionnaire similar to that showed on table V.

Once the quantity of consumption register is done (24hrs method for 2 or 3 consecutive days, completed with the food consumption register) we must consult the specific labeling of each of them to know the micro nutrient content and therefore be able to calculate the intake of these.

Determining essential fatty acids in plasma (oleic acid, linoleic acid and arachidonic acid) and vitamin E can indicate the amount of oil consumed.

References


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