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Impact of physical activity and sedentarism on hydration status and liquid intake in Spanish older adults. The PHYSMED study

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Abstract

Introduction: Data on hydration status in older adults are scarce and there are very few studies focusing on the impact of physical activity (PA) on drinking behavior.

Objective: To assess the impact of physical activity and sedentarism on fluid intake in Spanish elderly.

Methods: 433 non-institutionalized Spanish older adults (58% females), aged 55-88 years, volunteered for the PHYSMED study. PA data were obtained by means of the Minnesota and EXERNET questionnaires. Population was divided into four groups: ILS (inactive and low sedentary), IHS (inactive and high sedentary), ALS (active and low sedentary) and AHS (active and high sedentary). Serum from fasting blood samples was analysed for osmolarity.

Results: The mean of total liquid intake was 1,751 ± 628 mL/d. Significant differences were observed for total liquid intake between ILS/ALS and IHS/ALS ($p < 0.001$). ALS subjects consumed a higher amount of beverages such as water, juice, milk, coffee, sport drink, beer, wine and distilled drinks than the other PA groups. There was a significant difference for water intake between PA groups ($p < 0.01$). Serum osmolarity values were within references ranges in all subjects, and there was a significant difference between PA groups ($p < 0.01$).

Conclusions: Spanish older adults meet the DACH recommendations set by the German, Austrian and Swiss nutrition societies' liquid intake recommendations in the mean independently of PA and sedentary level. All participants are within reference ranges of serum osmolarity. Subjects in the active and low sedentary group consumed higher amounts of water and other beverages than in the other PA groups.

Key words: Beverages. Water intake. Physical activity. Elderly. Sedentary lifestyle.

INTRODUCTION

Quantification of water and beverage intake is an emerging topic in nutritional sciences as the optimal functioning of our body requires a proper hydration level (1,2). Likewise, water intake and hydration status have recently gained attention as one of the many and potentially manageable factors associated with disease development and wellbeing (3). Water is an essential nutrient for human body and major key to survival (4).

However, the current lack of a hydration assessment gold standard greatly impedes attempts to link water intake and negative health outcomes as well as to make public dietary guidelines (5,6). The questions "what do you drink", "how much do you drink per day" and "how much fluids do you drink" are frequently omitted in the common dietary questionnaires, and recommendations for beverage intake are, or were until recently, missing in most "food pyramids" (7,8).

Maintaining an adequate fluid balance is an essential component of health at every stage of life, especially in elderly population since older adults are at higher risk of developing dehydration for various physiological reasons (7). Moreover, in elderly individuals, adequate fluid consumption has been associated with fewer falls, lower rates of constipation and laxative use, as well as better rehabilitation outcomes in orthopedic patients (9-11). Also, dehydration can precipitate emergency hospitalization and increases the risk of repeated hospitalizations (12).

Elderly may frequently meet difficulties in gaining access to beverages due to decreased mobility, visual problems, swallowing disorders, cognitive alterations, use of drugs and fear of incontinence (7). Numerous factors such as high ambient temperature and humidity levels, heat stress and physical activity can influence water needs (13). Therefore, adequate intake of fluids must be increased in relation to these conditions (1). High temperature and humidity also might provoke exacerbated dehydration, but there

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is limited information about the effects of seasonality and climate on water intake (14).

The benefits of regular physical activity (PA) on health and disease prevention are well recognized (15). PA reduces both morbidity and mortality and can minimize the physiological effects of an otherwise sedentary lifestyle increasing the active lifespan (16,17). On the other hand, prolonged sitting has emerged as a risk factor for early mortality and has deleterious health effects. Nevertheless, sedentarism has not been included in the past in studies about physical activity (17). In spite of the powerful benefits of PA and optimal hydration status, there are only a few studies analysing together fluid intake, PA and sedentarism in elderly population. Hence, these parameters are a key point to define public health recommendations.

The aim of this study was to assess the impact of physical activity and sedentarism on fluid intake in Spanish older adults.

METHODS

STUDY DESIGN, SAMPLE AND ETHICS

The present study was based on a cross-sectional multicenter study aiming at identifying cardiovascular risk factors in sedentary and active elderly subjects. The survey was conducted from April 2013 to May 2014 in Madrid and Majorca (Spain). Participants were voluntaries recruited at health centers, sport federations, sport facilities and municipal clubs located at Madrid and Majorca. A total of 433 subjects, 186 male (43%) and 247 females (57%) aged 55 to 88 years old were included in this study. The exclusion criteria were age under 55, being institutionalized, suffering from a physical or mental illness that would have limited their participation in the physical fitness tests or their ability to respond to the questionnaires, or drug intake for clinical research.

All measurements at each institution were conducted according to the survey protocol. The study was performed according to the principles established in the Declaration of Helsinki and approved by the Ethical Committee of the Technical University of Madrid. Written informed consent was obtained from all participants.

HYDRATION QUESTIONNAIRE

A hydration questionnaire was developed by the Research Group based on food-frequency and eating habits questionnaires published in the literature (18,19), taking into account the modern beverage market.

The questionnaire is divided into two parts. The first part includes questions about the different types of fluids consumed one day before the questionnaire was filled out. The second part records the fluid intake during a normal week for each beverage type. The beverages included were: water, juice, soft drinks, diet drinks, milk, shake, coffee, tea or infusions, sport drinks, beer, wine and distilled drinks.

PHYSICAL ACTIVITY AND SEDENTARISM ASSESSMENT

PA was assessed by means of two validated self-reported questionnaires; the Minnesota Leisure Time Physical Activity Questionnaire measuring the activity during the previous year, and the EXERNET questionnaire, both of them validated for the Spanish population (20-22).

The Minnesota questionnaire includes diverse physical activities and participants are asked about PA duration, weekly and monthly frequencies. Time for each activity was expressed in minutes per day (min/d). On the other hand, the Exernet Questionnaire included four questions about regular physical activity duration, time spent walking, time spent doing housework and time spent sitting per day. All questions were bounded and answers included six options which were classified as less than 1 hour, between 1 and 2 hours, between 2 and 3 hours, between 3 and 4 hours, between 4 and 5 hours and more than 5 hours. The only exception was for regular physical activity duration. All activities were recorded in min/day.

In order to compare between different levels of PA and sedentarism, our population was classified in 4 groups: inactive and low sedentary (ILS), inactive and high sedentary (IHS), active and low sedentary (ALS) and active and high sedentary (AHS) taking into account cluster analyses set by Aparicio-Ugarriza et al. (23).

SERUM OSMOLARITY

Fasting blood samples were collected from each participant by standard venipuncture on vacuum Vacutainer® tubes in Madrid and Palma (Majorca), at the biochemical laboratory of the High Sports Council, Madrid, Son Espases Hospital and University of the Balearic Islands, Palma (Majorca), respectively. Serum was separated in 1 mL eppendorfs and was processed to analyse osmolarity using an osmometer Osmo Station OM-6050 (Menarini Diagnostics, Florence, Italy, CV ≤ 1%).

STATISTICAL ANALYSIS

Descriptive values are shown as mean ± standard deviation. One-way ANOVA was performed to analyse the differences between serum osmolarity, total liquid intake and beverages consumption and *post hoc* analyses were conducted with Bonferroni adjustment according to the PA and sedentarism groups (ALS, AHS, IHS and ILS).

All analysis were performed using the Statistical Package for Social Science software (SPSS, version 21.0;SPSS, Chicago, IL, USA) and values of $p < 0.05$ were considered to be statistically significant.

RESULTS

Table I includes descriptive characteristics of the sample split by sex. Males were heavier and taller than females ($p < 0.01$) and

Table I. Descriptive characteristics of the study sample[1,2]

	Male (n = 186)	Female (n = 247)	p
Age (years) *	65.4 ± 6.6	67.5 ± 6.6	< 0.01
Height (cm) *	170.2 ± 6.6	156.6 ± 5.6	< 0.01
Weight (kg) *	79.9 ± 10.8	65.4 ± 10.4	< 0.01
BMI (kg/cm[2]) *	27.5 ± 3.1	26.7 ± 4.3	< 0.05
City†			
Madrid	78 (49.1)	122 (49.4)	N.S.
Mallorca	108 (58.1)	125 (50.6)	
Serum osmolarity (mOsm/L)*	289.25 ± 5.25	289.17 ± 4.46	N.S

[1]Results are expressed as follows: *mean ± SD; †n (%).
[2]Significant differences between sex by one way ANOVA test. N.S.: non significant.

had a higher BMI ($p < 0.05$). No differences by sex were observed for mean serum osmolarity.

Figure 1 shows serum osmolarity according to PA groups. All subjects were within reference ranges of serum osmolarity and significant differences were found between PA groups ($p < 0.01$). After Bonferroni's adjustment, there was a significant difference between IHS and ALS ($p < 0.05$). The mean higher serum osmolarity was obtained for ALS group (290.97 mOsm/L).

Figure 2 shows the mean (± SD) total liquid intake per day consumed according to PA groups. The ALS group and AHS group consumed 2,056.2 ± 679.6 mL/d and 1,899.9 ± 633.4 mL/d, respectively. On the other hand, the mean of total liquid intake was 1,647.8 ± 569.4 mL/d for ILS group and 1,647.5 ± 597.2 mL/d for IHS group. There were significant differences between ALS and ILS groups and also between ALS and IHS groups ($p < 0.001$).

Figure 3 shows the mean beverage consumptions per day divided by PA groups. Water was the beverage most consumed for all PA groups and there were significant differences between them ($p < 0.01$). ALS drank more beverages such as water, juice, milk, coffee, sport drink, beer, wine and distilled drinks than the other PA groups. Significant difference was only observed for water between PA groups ($p < 0.01$). Moreover, AHS showed a trend to consume more soft and light soft drinks, shake and tea than the other PA groups (non-significant values).

DISCUSSION

The results from this cross-sectional study indicated that the mean of total liquid intake in our sample was high (1,751.3 mL/d, data are not shown) compared with the DACH recommendations set by the German, Austrian and Swiss nutrition societies (DACH) (1,310 mL/d) (24). The ALS group consumed significantly higher amounts of water ($p < 0.01$) and showed a trend of high consumption of other fluids (NS) than the other PA groups. There were differences ($p < 0.01$) in serum osmolarity between PA groups. However, despite these differences, all subjects were within serum osmolarity reference ranges.

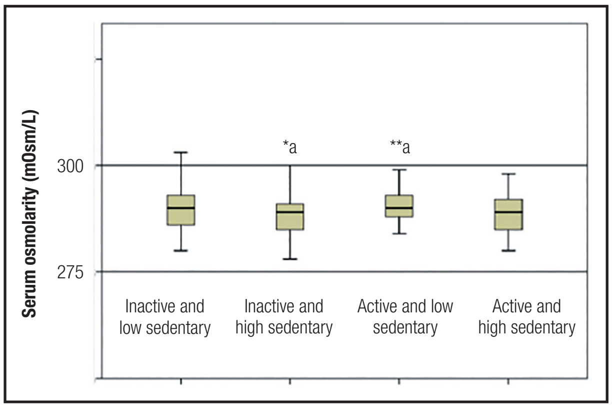

Figure 1.

Serum osmolarity divided by PA groups. Horizontal lines represent serum osmolarity reference ranges limits. *a significant difference (level set at $p < 0.05$) between inactive and high sedentary and active and low sedentary after Bonferroni's adjustment.

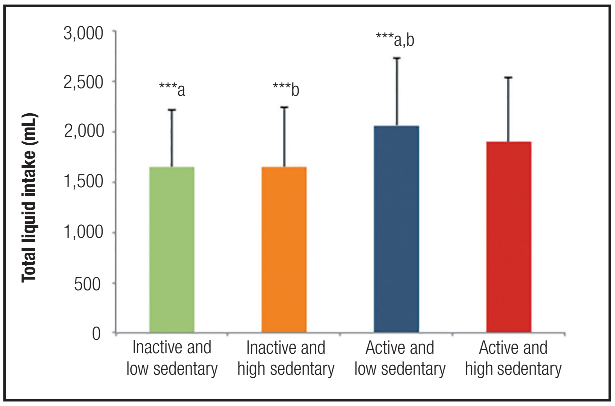

Figure 2.

Mean (±SD) total liquid intake/day (mL/d) according to PA groups. ***a,b significant differences (level set at $p < 0.001$) between inactive and high sedentary and active and low sedentary.

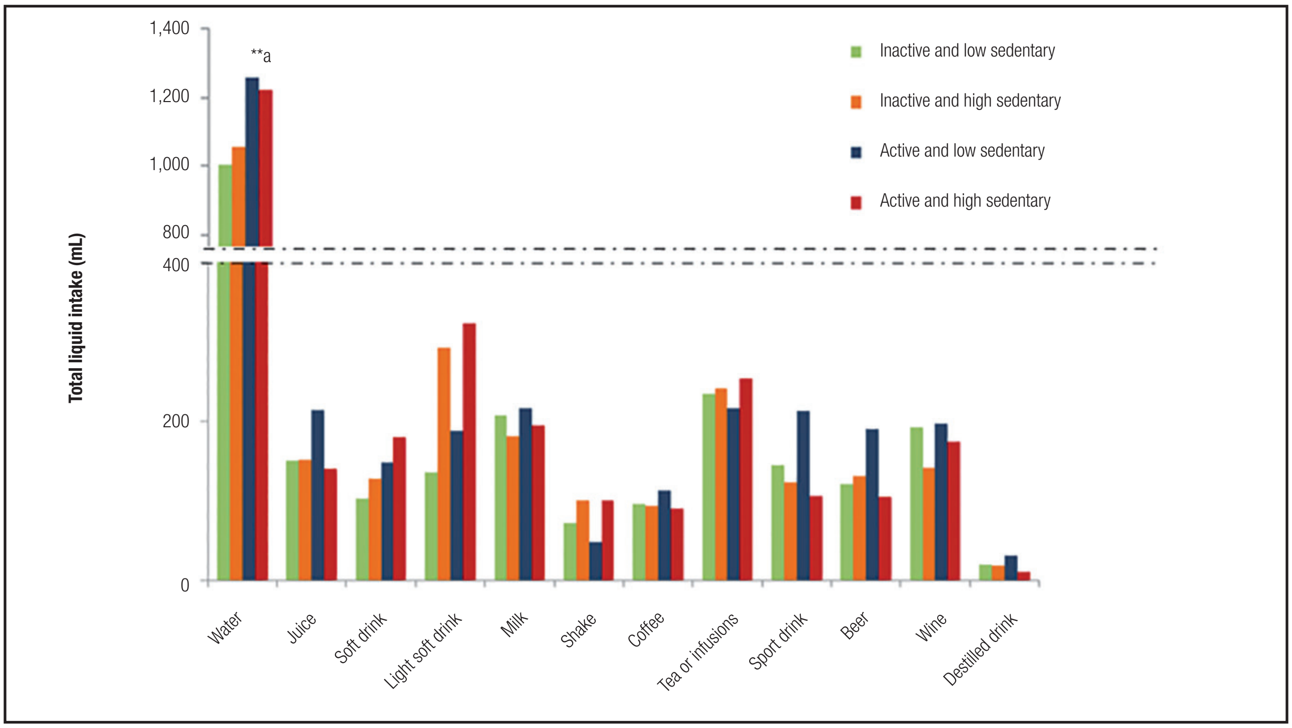

Figure 3.

Mean beverage consumptions/day divided by PA groups. **Significant differences ($p < 0.01$) between PA groups for water.

There is no consensus in the literature regarding water and beverage intake recommendations. We compared to the DACH recommendations because they split recommendations into water from beverages and from food specifically for people aged over 65 years. In contrast, the World Health Organization in 2005 (25) recommended 2.2 L/d and 2.9 L/d for females and males, respectively. The European Food Safety Authority in 2010 (26) established 2 L/d for females and 2.5 L/d for males as the total water intake without differentiating into water from food and beverages. Other authors consider that the minimum water intake for drinking water and beverages must range from 1.5-1.8 L/d, although some adaptations are established depending on age, sex and medications (7).

Likewise, the best way of measuring hydration in humans is still a general controversy (27) because there are different methods such as estimates of water balance (thirst rating, total water intake and output or body weight changes), hydration markers (plasma or urine osmolarity) and total body water measurements by bioelectrical impedance or isotope dilution (28). In our study, we measured serum osmolarity as it is closely controlled and rarely varies by more than 2% around a set point of 280-290 mOsm/L (1). According to Jequier et al. (1), a basal mean value of 287 mOsm/L is maintained in well-hydrated individuals. In our sample, the mean of serum osmolarity levels was 289 mOsm/L for both sexes, though a significant difference was obtained between PA groups ($p < 0.01$).

On the other hand, in our study, water was the beverage most consumption in all PA groups and a significant difference was obtained between them ($p < 0.01$) followed by light soft drinks. In their study, Zizza et al. (29) found that water was the most consumption, followed by coffee. De Francisco et al. (30) observed that people with high PA levels drank more fluids compared with those with low PA levels. We found the same patterns in our study since both active groups (ALS and AHS) had higher intakes than both inactive groups.

Furthermore, we found that ALS subjects drank higher amounts of water, juice, milk, coffee, sport drinks, beer, wine and distilled drinks than the other PA groups. Additionally, AHS consumed more soft and light soft drinks, milk shakes and tea than the other PA groups.

STRENGTHS AND LIMITATIONS

This study has several strengths. One of them was the use of clusters. Clustering of activities produces an alternative approach to summarizing physical activity participation and may provide a helpful methodological development when questionnaires are used to assess physical activity. An additional strength was the use of a specific hydration questionnaire in order to obtain reliable data on water and beverage intake. Moreover, the sampling procedure and the strict standardization of the field work among the cities involved in the study avoided to a great extent the kind of confounding bias.

On the other hand, this study has also several limitations. First, it is directly related to the intrinsic nature of the Exernet Questionnaire, in which for several questions only closed answers were available and also for the subjectiveness of the physical activity and sedentary questionnaires. Secondly, our study has a cross-sectional design, therefore impeding the determination of cause-effect relationships.

CONCLUSIONS

The mean of Spanish older adults meets DACH liquid intake recommendations independently of physical activity and sedentary level; furthermore, all participants are within reference ranges of serum osmolarity. Subjects in the active and low sedentary group consumed higher amounts of water and other beverages than in the other PA groups. Physical activity and sedentarism should be considered to obtain a holistic approach to beverage intake and hydration status in future researches. Additionally, longitudinal studies are needed in order to establish behavior patterns.

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