# Daily Plain Drinking Water Intake Per Capita by Socio-Demographic Segments of Household Population

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*Abstract -* **The aim of this study is to determine the daily per capita plain drinking water intake as a component of daily total water intake (TWI) and to associate the plain intake with socio–demographic segments of household population in Afikpo and Unwana Towns, Nigeria. A representative sample of 1150 household population was classified by gender, age bracket, educational qualification, and occupation. Information on daily plain drinking water intake per capita was obtained through a structured questionnaire. The mean daily per capita plain water intake was determined to be 1.55 L (0.60 std.dev) for the male and 1.50L (0.53 std. dev.) for the female. The sample population had a daily plain drinking water intake per capita mean of 1.52L with skewness of 0.117. Daily plain water intake had a positive statistical association with socio-demographic segments of the population (R = 0.473). These results could imply that the recommended daily water adequate intake (AI) guidelines values by both the European Food Safety Authority (EFSA), the US Institute of Medicine (IOM) are not met in households of low-income countries, such as the current study area. Hence, there is a need to address issues relating to access to safe drinking water in low-income countries, together with public enlightenment on the health benefits of daily intake of adequate drinking water.**

*Keywords:* Plain drinking water, adequate intake, socio-demographic, dehydration, total water intake.

## 1. Introduction

Water is a fundamental requirement for life. Daily water intake is desired by humans to maintain proper body functions such as metabolism, blood circulation, temperature regulation, proper tissue structure, among others [1, 2]. Healthy human body consists of about 60% of water [3, 4]. However, human body loses water through normal healthy processes including urination, sweating, defecation and breathing. Hence, healthy living requires that the human body remains hydrated through daily intake of adequate drinking water.

Knowledge of the quantity of drinking water that satisfies an individual's daily water intake is important in many respects. From health point of view, not taking adequate water intake leads to dehydration [5, 6], an adverse health condition identified as a possible cause of some mild-to-serious health problems. Effects of dehydration include headache, fatigue, dizziness, absent-mindedness, heat shock, low blood volume (hypovolemic shock), urinary tract infections, kidney stones, kidney failure and seizure [5, 7]. Zhang et al. [8] suggest that dehydration reduces vitality, self-esteem, attention and cognitive function. Furthermore, mild dehydration in children can retard school performance, by prompting poor attention, short-term memory and weak cognitive acuity [9]. For the elderly, low-intake dehydration has been associated with poorer cognitive performance, increased hospitalization, worsened course of illness and recovery [10, 11].

Low water intake has been negatively associated with mortality risk for all causes of death among the US population [12]. In addition, patients diagnosed for adverse health conditions, such as respiratory illness, urinary systems infection, diabetes and cardiac disorder, associated with dehydration were found to be at a significantly higher risk of death within 30 days to one year of diagnosis [13].

From health-risk-assessment perspective, an estimation of per capita water consumption per day helps to determine the exposure risk to water consumers for chemical and microbial contaminant in water [14, 15]. Another use for estimate of daily drinking water intake is the planning and analysis of domestic water availability [16].

The European Food Safety Authority (EFSA), the US Institute of Medicine (IOM), and the World Health Organization (WHO) are among the organizations that have provided guideline values for daily water intake for various characteristics of individuals such as gender, age, health status weight and climate of residence [17]. EFSA recommends water adequate intake (AI) as 2.5 L/day for adult males and 2.0 L/day for adult females. It also recommends additional 0.3L/day and 0.6-0.7L/day for pregnant and lactating women respectively [18]. The AI values were derived from extensive review of scientific evidence the US survey data for healthy population [19]. The IOM proposes AI

for total water intake (TWI) as 3.7 L/day for males and 2.7 L/day for females, basing its recommendations on observations and experimental evidence of median water intake of healthy individuals living in US and Canada [20, 17]. The WHO [17] recommends minimum daily drinking water intake of 5.3 L/person, to meet the needs of most people, including lactating women doing moderate activity at moderately high temperatures.

TWI is the sum of all water received by the body from drinking water, beverages (juice, tea, coffee, wine, beer, soft drink, etc), food moisture, and metabolic water (from oxidation of protein, carbohydrate and fat). Conclusions from studies suggest that food moisture contributes about 20% to TWI [18], metabolic water contributes 5% to 10 % [21], while water and beverages contribute as much as 80% [22]. It implies that an individual who consumes fewer beverages daily will need to drink more water daily to remain adequately hydrated.

The actual quantity of plain water that an individual drinks daily may be subject of a personal choice or habit, especially in adults [23]. Many people drink water daily to quench their thirst or to settle food in their stomach after meals. Yet some others habitually drink more water daily, hoping to improve their health. Daily intake of water is normally voluntary for healthy adults, but the daily drinking water requirement for each individual depends on various factors such as body weight, activity, climate, nutrition, health status as well as other socio- cultural variables and contexts [17], including water availability [24]. Therefore, an estimate of per capita daily drinking water intake that fits all individuals or a group of individuals in all contexts is not practicable [17]. It is then important that estimates for daily drinking intake per capita reflect the peculiar needs or contexts of water consumers and water safety stakeholders.

With increasing awareness of the benefits of proper hydration of the body, health experts are recommending a deliberate and habitual drinking of adequate water daily [25, 26]. For risk assessment purposes, daily drinking water intake per capita seems to have a default value of 2L/day, taking 60 kg as an average weight of an individual [27].

Investigation of daily drinking water intake among households can provide the basis for investigations regarding adequate access to drinking water and positive behaviour towards daily water consumption for improvement of health by relevant segments of the society. Most investigations of daily water intake have focused on total water intake rather than on the specific components of TWI. More information is therefore required on the various components of TWI for a

proper understanding of issues surrounding adequate hydration for healthy individuals.

The aim of this study is to determine the daily per capita plain drinking water intake and to associate the intake with socio–demographic segments of household communities. Plain drinking water intake was chosen in this study because it is typically the most common means of hydration for healthy individuals in the developing countries where access to and affordability of beverages remain a challenge. This study was designed to determine the current per capita consumption of plain drinking water per day in Afikpo and Unwana communities of Ebonyi State. Nigeria.

## 2. Methodology

### 2.1 Research design, study population and sampling technique

The research design is a survey that focuses on determining the quantity of plain drinking water ingested orally by an individual per day within a specific population setting, and describing the effect of socio-demographic variables on the quantity ingested. The population of the study consists of all persons resident in Afikpo and Unwana Towns of Afikpo North Local Government Area of Ebonyi State, Nigeria. The sample population size1150 persons which were stratified according to age bracket, since daily water intake is generally associated with age [28]. The strata of total sample size consist of five categories of age bracket: approximately 6% (73 persons)represent ages under 5 , approximately15% (172 persons ) ages between 5 and under 12, 30% (345perons) ages between 12 and under 18 , 40% ( 460 persons) ages between 18 and 65 years and 10% ( 115 persons) ages of 65 and above. The dimension of each stratum was based on a preliminary survey of 20 randomly chosen households in the study area. Number of individuals in each of the other socio-demographic categories (gender, educational qualification and occupation) was determined from the sample population.

### 2.2 Research instruments and data reliability

The research instrument is a structured questionnaire administered by trained personnel. Questionnaire administration was complimented by a face-face interaction to obtain information on daily per capita plain drinking water intake (L/person/day) and socio-demographic variables: gender, age bracket, educational qualification and occupation of respondents. A test-retest reliability proof was used to establish the reliability of the instruments. Hence, the instrument was administered on 60 respondents including subjects drawn from the population but not the direct respondents within the research sample. The split half method

was used to estimate the reliability of the test while the reliability of the questionnaire was tested using Cronbach's alpha coefficient method. The reliability values (r) alpha (α) all lay between 0.7 and 0.86, which were considered acceptable.

## 2.3 Statistical analysis

Analyses for daily plain drinking water intake per capita were conducted for the sample population and by separate socio-demographic categories: age bracket, gender, educational qualification, and occupation. All analyses used a combination of Microsoft Office Excel 2007 and the IBM SPSS Statistic version 20. Data were presented as means, standard deviations, and 95 % confidence interval. A Linear regression model was fitted to assess the associations between per capita water consumption as dependent variable and socio-demographic variables (gender-two categories, age bracket-five categories, educational status-four categories, and occupation-five categories) as outcome variables. Mean daily per capita drinking water intake for male and female gender was compared with AI values of EFSA and IOM.

## 3. Results and Discussion

### 3.1 Daily plain drinking water intake per capita for the study population

Fig. 1 shows the distribution of per capita daily plain drinking water intake (L/person per day) among the study population of 1150 people. The mode of the per capita water intake is 1.53 L/person per day, while the median is 1.51L/person per day. This indicates that per capita daily plain drinking water intake is approximately normally distributed in Afikpo and Unwana Towns. The average per capita daily plain drinking water values (male and female) recommended as adequate water intake (AI) by EFSA is 2.25Land is3.2L by IOM. This means that mean daily drinking water per capita determined in this study is about 68% and about 63% of AI guideline values by EFSA and IOM respectively. The result corroborates with a previous study conducted by [29].

As mentioned above, studies [22] suggest that drinking water and beverages constitute about 80% of the total water intake. It implies in places where a majority of the population takes as much as 40% of daily water intake in form of beverages, the mean value of per daily per capita water intake of 1.52L may be sufficient, since the remaining daily requirement can be met from beverages. However, in populations (like the current study population) where beverages are out of reach to many due to high cost or physical scarcity, few people are accustomed to a daily intake of beverages. The distribution has a positive skewness of 0.117 implying that most of the values of per capita plain drinking water intake are on the left side of the mean (1.52 L per person per day).
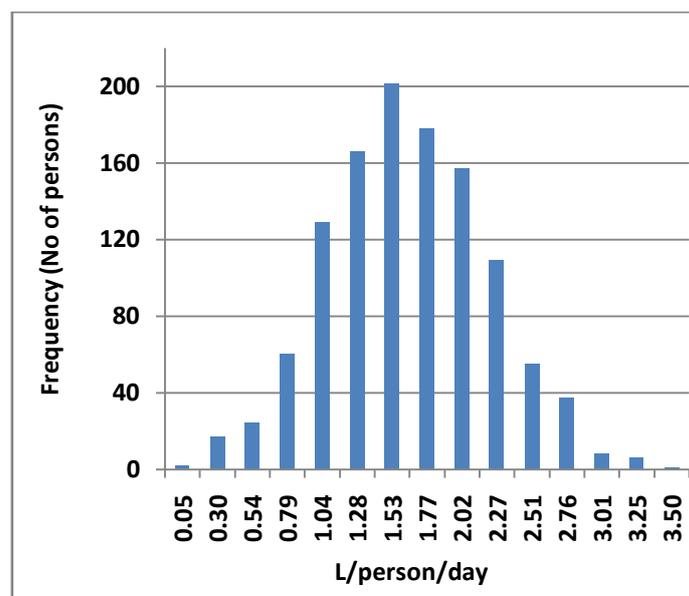


Figure 1: Distribution of daily per capita plain drinking water intake among study population (N=1150)

### 3.2 Daily plain drinking water intake by demographic variables

Tables 1 to 4 show the per capita water intake along some demographic variables: age bracket (table 1), gender (table 2), educational qualification (table 3), and occupation (table 4).

**Table 1: Per capita daily drinking water intake by age bracket**

| Age bracket | Per capita daily water intake (L/person per day) | | | |
| | Mean | 95% Confidence Interval for Mean | | Std Dev. |
| | | Lower bound | Upper bound | |
|---|---|---|---|---|
| below 5years | 0.7385 | 0.6397 | 0.8373 | 0.42358 |
| 5years to below 12 years | 1.5374 | 1.4583 | 1.6166 | 0.52417 |
| 12 years to below 18 years | 1.5628 | 1.5098 | 1.6157 | 0.49666 |
| 18years to below 65 years | 1.6943 | 1.6437 | 1.745 | 0.54765 |
| 65 years and above | 1.1949 | 1.127 | 1.2628 | 0.36577 |

From table 1, children below five years have the lowest per capita daily water intake with a mean of 0.7385L. This is understandable because people in this category have the lowest body weight among the age categories stated in table 1. Moreover, children below 2 years meet their daily water intake requirements mostly from breast or other types of milk. Ashima et al. [30] deduced from the US National Health and Nutrition Examination Survey 2005–2006 that the mean daily total water intake in US children aged 2-5 was 1.4, of which plain water intake constituted 0.98L (or 71%). Bottin et al. [31] infer that encouraging children to drink water early in life could help them develop healthy habits that would support adequate fluid intake for proper hydration through their adult life.

**Table 2: Per capita daily drinking water intake by gender**

| Gender | Per capita daily plain water intake (L/person per day) | | | |
| | Mean | 95% Confidence Interval for Mean | | Std Dev. |
| | | Lower bound | Upper bound | |
|---|---|---|---|---|
| Male | 1.5472 | 1.4975 | 1.597 | 0.59563 |
| Female | 1.4985 | 1.4558 | 1.5412 | 0.53116 |

Table 2 suggests that males (with a mean daily plain drinking water intake of 1.5472 L per person) drink more water than females (with a mean daily plain drinking water intake of 1.4925L per person). This disparity has been reported by other studies [5, 32], and it is mostly likely attributable to the difference in body weight between males and females due to height effects. On the average males are taller than females and weigh higher [32]. The mean values of per capita daily plain drinking water intake for male as percentages of AI recommended by ESFA and IOM respectively are 62% and 42%. For female, the values are 75% and 56% as percentages of AI by ESFA and IOM recommendations respectively. As explained above, beverages may not make the difference of the shortfall to the 80% of AI, since only about 20% of the intake comes from food.

**Table 3: Per capita daily drinking water intake by educational qualification**

| Educational qualification | Per capita daily water intake (L/person per day) | | | |
| | Mean | 95% Confidence Interval for Mean | | Std Dev. |
| | | Lower bound | Upper bound | |
|---|---|---|---|---|
| no qualification | 1.2995 | 1.2314 | 1.3676 | 0.62498 |
| Primary School certificate | 1.572 | 1.5164 | 1.6276 | 0.52566 |
| Secondary school certificate | 1.5808 | 1.5249 | 1.6367 | 0.49799 |
| Tertiary education certificate | 1.7389 | 1.6654 | 1.8125 | 0.48748 |

Table 3 indicates that people with higher educational qualification drink more water than those with less qualification. The mean drinking water intake of people with tertiary education was determined to be 1.74 L/person per day versus 1.58L/person per day, 1.572L/person per day and 1.3L/person per day for secondary, primary and zero educational qualifications across all ages. This may be because of increased awareness regarding to health benefits of daily adequate water intake that will most likely increase with education.

**Table 4: Per capita daily drinking water intake by occupation**

| | Per capita daily water intake (L/person per day) | | | |
| | | 95% Confidence Interval for Mean | | |
| Occupation | Mean | Lower bound | Upper bound | Std Dev. |
|---|---|---|---|---|
| Farmer | 1.4403 | 1.3713 | 1.5092 | 0.62732 |
| Students | 1.5448 | 1.4833 | 1.6063 | 0.51809 |
| Unemployed | 1.5995 | 1.5243 | 1.6746 | 0.53209 |
| Civil servants | 1.5566 | 1.4735 | 1.6398 | 0.5444 |
| Traders | 1.5164 | 1.4385 | 1.5943 | 0.54871 |

## 3.5 Linear regression model of the associations between per capita water consumption and socio-demographic variables

Tables 5 - 7 show results of fitting a linear regression model between per capita daily water intake (L/per person per day) as the outcome variable and key socio-demographic parameters as the explanatory variable variables. Table 5 is the model summary shows a Spearman's coefficient of correlation (R) of 0.473 and coefficient of determination ($R^2$) of 0.224. It means that 22.4% variance in per capita plain daily drinking water intake can be explained by the linear regression model. Table 6 is an ANOVA table which indicates that the association is statistically significant (F= 27.318; P<0.005). Most of the occupational variables are not significant predictors of daily per capita drinking water intake.

**Table 5: Model Summary[b]**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .473[a] | .224 | .216 | .49895 |

a. Predictors: (Constant), traders, 65 years and above, Gender, secondary school certificate, below 5years, unemployed, tertiary education certificate, 12 years to below 18 years, civil servants, 5years to below 12 years, students, no qualification.

**Table 6: ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 81.610 | 12 | 6.801 | 27.318 | .000[b] |
| | Residual | 283.060 | 1137 | .249 | | |
| | Total | 364.670 | 1149 | | | |

a. Dependent Variable: Per capita drinking water intake (L/per person per day)
b. Predictors: (Constant), traders, 65 years and above, Gender, secondary school certificate, below 5years, unemployed, tertiary education certificate, 12 years to below 18 years, civil servants, 5years to below 12 years, students, no qualification.

Table 7 is coefficients table with constant representing the base of comparison which is the male gender, coded as males = 0. The result suggests that only the age bracket is a significant predictor of per capita daily drinking water intake (p<0.005) in Afikpo and Unwana Towns, Ebonyi State, Nigeria. This may be due to different physiological and socio-logical differences that come with difference in age; for example, differences in body weight, differences in body function, and differences in level of activity. It has been suggested that the elderly should drink more water, because the body function of the elderly does not adequately trigger the sensation of thirst [33].

Generally, other socio-demographic parameters (gender, education attainment and occupation) are not. Individually, people with no qualification and those with tertiary qualification are significant predictors (p<0/05) from category of educational qualification; traders are significant predictors from category of occupation.

Table 7: Coefficients[a]

| | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. |
| (Constant) | 1.804 | .047 | | 38.467 | .000 |
| Gender | -.050 | .030 | -.044 | -1.683 | .093 |
| below 5years | -.889 | .074 | -.385 | -12.033 | .000 |
| 5years to below 12 years | -.157 | .050 | -.099 | -3.159 | .002 |
| 12 years to below 18 years | -.123 | .036 | -.100 | -3.405 | .001 |
| 65 years and above | -.500 | .053 | -.265 | -9.422 | .000 |
| no qualification | -.152 | .042 | -.121 | -3.642 | .000 |
| secondary school certificate | .002 | .039 | .001 | .044 | .965 |
| tertiary education certificate | .110 | .048 | .070 | 2.298 | .022 |
| students | -.077 | .044 | -.059 | -1.776 | .076 |
| unemployed | -.051 | .050 | -.034 | -1.024 | .306 |
| civil servants | -.081 | .052 | -.050 | -1.541 | .123 |
| traders | -.150 | .050 | -.100 | -3.004 | .003 |

a. Dependent Variable: Per capita drinking water intake (L/per person per day)

## 4. Conclusion

This study has quantified the daily per capita plain drinking water intake along socio-demographic categories in Unwana and Afikpo Towns, Ebonyi State, Nigeria. The results of the study show that for most people across socio-demographic groups, daily plain water intake is less than the guideline values of ESFA and IOM for daily water adequate intake (AI). The results could imply that the recommended AI will not be met since beverages (including fruits) are typically not affordable, or are not even available in low-income communities, such as the current study area. There is statistically significant association between daily plain water intake and socio-demographic elements of household communities. Issues relating to adequate access to drinking water needs to be addressed in Afikpo and Unwana Towns. There is also a need for public enlightenment on the health benefits of deliberate drinking of adequate water daily for all socio-demographic groups. Further research is required to support the current findings, and in addition to determine the contribution of beverage to the daily total water intake per capita.

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