Author's response to reviews

Title: Water and beverage consumption among adults in the United States: Cross-sectional study using data from NHANES 2005-2010

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Author's response to reviews: see over
General comments to editors and reviewers

We thank both reviewers for their helpful and constructive feedback of our paper. The paper has undergone substantial revision based on reviewer feedback. The most major change was a re-analysis of our data based on feedback from Reviewer #1. In light of the re-analyses, all of the numbers have changed. However, the general results and conclusions were not impacted. We thank the reviewer for bringing this to our attention.

In revising the manuscript and responding to specific reviewer comments we also made a number of text edits to ensure consistency and clarity.

We find the revised manuscript much improved and thank all for their helpful comments.

Reviewer comments are provided below in red text and our responses follow.

REVIEWER #1

The article is well written. I have a major issue with the use of the 2-day average describe below and some on the interpretation of the AI.

We thank the reviewer for his helpful comments regarding the statistical analysis. We have made major changes to the analysis based on reviewer feedback and highlight these changes here.

The reviewer raises an important issue regarding the 2-day mean. The second 24-hour recall (completed by telephone) results in systematically lower estimates of energy and subsequently lower estimates of total water and water from various sources. In addition, the second recall day appears to result in a somewhat “healthier” dietary pattern in terms of energy density and nutrient density of the diet. Using the naïve 2-day mean will result in a downwardly biased estimate of total water. Upon the recommendation of the reviewer we re-analyzed our data using methods developed by the National Cancer Institute to estimate usual intake.

The results of the study have changed marginally. First, total water intakes increased slightly as expected based on the under-reporting in the second recall. Second, we were able to better estimate the proportion of adults whose water intake was below IOM AI levels. All such values are greater than the proportions estimated in the initial draft as expected based on the limitations of naïve means from two 24-hour recalls.

Major compulsory Revisions:

Although the authors acknowledge the limitation of the use of the 2-day methods while comparing to the AI, there is no reason they cannot use usual intake. All the tools are available for them to use the NCI method for example (documentation, source code). This will have a significant impact on the estimate reported.
As noted above we have revised the analysis based on reviewer feedback.

The AI for water represents the median consumption of 19-30 year-olds survey respondents to NHANES III. It should be viewed as an individual goal and compared to the median intake of a population group. Percent of people above or below this amount are hard to interpret. This should be part of the limitations of the study especially in the context that the authors recommend not to compare with data collected before 2005.

We thank the reviewer for raising this important point. In the revised manuscript we have added additional information regarding the limitations of the AI values for water. Despite the challenges of interpretation we still find it noteworthy that 95% of older men consume less than 3700 mL of water and 83% of older women consume less than 2700 mL of water.

I would also like a discussion about the use of the 2-day average vs the use of the 1st recall only for mean intake estimation. In general, the second-day is biased (respondents know they will have to answer again and may change their food intake).

As discussed above, we have revised the analysis to estimate usual intake.

By taking respondents with 2 valid recalls, how many with only a first 24-recall were excluded? Could this biased the estimates?

As discussed above, we have revised the analysis to estimate usual intake, which now uses data for all individuals completing at least one 24-hour recall. A second 24-hour recall was available for 88% of respondents.
REVIEWER #2

This manuscript addresses a timely and important topic – water/fluid consumption among US adults – using a large, nationally representative sample (NHANES data 2005-2010). The methods used were appropriate to achieve the objectives of the investigation; the results are presented clearly and interpreted appropriately. The limitations of relying on self-reported dietary intake data are acknowledged. The major strength of this analysis is that it provides updated information (i.e., a prior 2009 publication {Kant, AJCN} on this topic used 1999-2006 NHANES data-although different methodologies were used to obtain water intake data in these two analyses) on water/fluid consumption trends across socio-demographic factors; additional strengths are a comparison to the DRIs and data on contributions of beverages/food sources to total fluids and energy intake.

Minor essential revisions:
Background, paragraph 1 , second sentence – please add citations for original research articles (two RCTs: Tate 2012, Dennis 2010) and/or a systematic review (Muckelbauer 2013) to provide stronger evidence to support this statement.

We thank the reviewer for this suggestion and have added these references.

Background, paragraph 5, first sentence – please clarify if there is just one prior investigation on this topic (ref 12) or if others exist (i.e., “With some exceptions…”).

We have added additional references here to show that many others have examined total water intake using nationally representative data.

Additional justification for the importance of the present investigation would be a helpful addition to the Introduction section, for example, what new/important information does the present paper add to the body of literature on this topic, or what limitations exist in currently available publications?

The main contribution of this report is that it uses the most recently available data and also breaks down water consumption by beverage category. We have added this information to this paragraph.

Results, first paragraph under the “Water intake from plain water, beverages and foods” subheading – were differences across age ranges assessed, for the data presented in Tables 2-3, and Figure 1? Trends are discussed (i.e., “declined with age,”, “age-related trends”), but it is not clear if these were simply observations or actual statistical analyses.

Formal hypothesis testing was limited to evaluating whether significant differences were present between sub-groups within specific beverage categories (e.g., differences by age group for tap water consumption). However, in Tables 2-3 and Figure 1, as the reviewer notes, we did not conduct specific hypothesis testing. This was not done for a number of reasons. First, there are a very large number of contrasts that could be made. For example, one might be interested in formally comparing the average contribution of milk to coffee among 20-50y age group or comparing milk across age groups. Second, there
would often be a discrepancy between differences in the absolute value (mean) and the population proportion (%). Finally, in the text we only discuss strong differences between age group that are qualitatively different or divergent. Rather than focusing on statistical significance for differences we focus on those where there are substantial differences by group. For example, in Table 2/Figure 1 age has a clear and strong impact on the consumption of soda. We tend not to focus the discussion of differences that are more equivocal, such as those for milk or fruit juices/drinks.

To address the comments of the authors we have revised the text slightly to not imply that specific hypothesis testing was done. We removed the term “trends” and added some language to imply that these differences were qualitative (e.g., “tended”).

Discussion, second and third paragraphs – additional discussion points could be added which address the apparent discrepancy between indicators of whether or not we are/are not meeting the IOM DRIs. It is very important to address inadequate fluid consumption particularly with older adults, who are at risk for dehydration and have impaired thirst sensations, compared to younger adults.

We thank the reviewer for raising this point. We have added some additional discussion regarding this point.

Yet when fluid intake is expressed relative to total energy, it appears that on average, intakes are adequate. If underreporting of dietary intake is likely, this could affect the interpretation of the water density results. Which indicator is more valid to determine adequacy?

The reviewer raises a very good point here. Providing a clear answer to which indicator is more valid to determine individual or population-wide adequacy is beyond the scope of this paper. We think both measures have their value but would tend to place somewhat more weight on the AI values described by IOM for a number of practical reasons. First, while EFSA does discuss water density, it is only tangentially discussed in the IOM DRI report. Second, as noted by the reviewer, accurately measuring water density is dependent on accurately measuring energy intake/expenditure.

With regards to the second point, while the 24-hour recall is one of the best tools suited at capturing information on dietary intakes for a large population, energy is almost certainly under-reported either through omission of some foods or under-estimating amounts consumed. These sources of error are likely differential with respect to both individual-level characteristics (e.g., more obese individuals more likely to be energy under-reporters) and foods consumed (e.g., foods perceived to be less healthful are more likely to be under-reported or omitted). In addition, in a population that is not weight stable, the estimates of energy intake are likely not representative of energy expenditure.

An additional challenge in interpreting the density of water is determining whether water sources will be accurately recalled, specifically as they may relate to systematic error in dietary reporting. Some water sources are likely to be under-reported due to perceptions of healthfulness or social desirability (e.g., alcohol or sugar-sweetened beverages), while
other beverages may not (e.g., coffee or water as a beverage).

First, both While the EFSA report highlights water density as an additional marker of adequate hydration and water density is mentioned by the IOM we have added some additional language to place greater emphasis on the absolute results and comparisons to the IOM AI values (e.g., 2700 mL for women and 3700 mL for men).

Also, are hydration biomarkers included in NHANES data and if so, could they be included in the present analysis?

Urine osmolality data was collected as part of 2009-2010 NHANES, but not in previous cycles. Since the goal of the present report was to characterize total water intake by population sub-group, the numbers of individuals with urine osmolality measures is likely too small for stable estimations of adequate intake. In addition, it has been shown that this measure is most valid when taken first thing in the morning, so that recent water intake cannot influence the measure. Limiting to early morning measurements would further limit the sample size. Finally, there are some concerns regarding the validity in measuring adequacy of hydration, due in large parts to large temporal variability and the absence of established cut-points for adequate hydration.

Discussion, paragraph beginning with “Future guidelines on beverage consumption…” – there has been a major emphasis on reducing sugar-sweetened beverage consumption in recent years. Yet this does contribute to total fluids, as much as 5-10% for younger adults. Messages to reduce SSB consumption could be accompanied by a recommendation to drink water, which is consistent with one of the seven key selected messages for consumers in the 2010 USDG.

This is an excellent point. We have revised this paragraph to discuss recommendations to reduce SSB intake and to use plain water as a replacement beverage. In addition, we note that continued surveillance of total water intake is important if interventions to reduce SSB consumption are effective (i.e., to ensure that reductions in SSB do not have a dramatic impact on total water intake). The original intent was to note that the discussion of water as it relates to adequate hydration was sparse, but the reviewer is correct that plain water is often discussed in light of reducing SSB consumption.

Figure 1 – perhaps the shortfalls could be represented differently, to emphasize the point that total fluids fall short of that recommended. For example, rather than being a solid part of the bar graph as with the other beverages, the shortfalls could be depicted using dotted lines with no fill, so readers can clearly see what is consumed vs recommended. Also, abbreviations for some small sections of the bar graph are included with the ml amount, while others are only expressed as numbers. A more consistent formatting could help the reader to more clearly see/interpret the results.

Figure 1 has undergone substantial revision. We have re-formatted the description of the shortfall category based on reviewer feedback and revised the labeling.