Estimating Differences in Risk of Chronic Kidney Disease Based on Water Intake in a National Sample

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Keywords

Kidney disease · National health and nutrition examination survey · Hydration · Chronic kidney disease of unknown origin · Human nutrition

Abstract

Background: In agricultural communities in Central and South America, Egypt, India, and Sri Lanka, an unexplained form of chronic kidney disease affects agricultural workers. Termed chronic kidney disease of unknown origin (CKDu), it disproportionately affects young men in their 30s–40s and is unrelated to the traditional risk factors of diabetes, hypertension, and obesity [1–3]. Recent investigations suggest that agricultural work in the USA carries similar risks, as reduced kidney function has been found among those working in US agriculture [4–5]. However, researchers are yet to determine the etiology of the disease [6–8]. Central to the hypotheses of CKDu is the reduced blood flow to the kidneys due to inadequate hydration during periods of intense physical labor. **Objectives:** The primary aim of the current investigation was to identify if a relationship between hydration and kidney function exists among the general population by using the data from the National Health and Nutrition Ex-

amination Survey (NHANES). We hypothesize that reduced hydration will be associated with reduced kidney function.

Methods: Data were retrieved from the NHANES dataset from 3 sample years 2005/2006, 2007/2008, and 2011/2012. Data were merged across all 3 periods with survey weights adjusted for combining across multiple years. Participants were excluded if they had missing data for hydration or kidney function, or if they were <19 year. Kidney function was categorized low risk, moderate risk, or high risk for impaired function based on estimated glomerular filtration rate and albumin creatinine ratio according to the National Kidney Foundation [9]. Hydration was classified based on total water intake (TWI) extracted from plain water intake and water from food. Participants were labeled as high if they met or exceeded sex-specific water recommendations, 3.7 and 2.7 L/day for men and women, respectively; otherwise they were labeled as low. A survey-weighted proportional odds logistic regression model was fitted to assess the association between water intake and kidney function, while controlling for other demographic, socio-economic, behavioral, and socio-economic risk factors [10–12]. **Results:** Of the 13,056 participants initially sampled, 10,651 participants are included in the analysis after cleaning and including survey weights. 9,125 (85.67%) of participants were in the low-risk group,

1,128 (10.59%) were classified as medium-risk, while the remaining 398 (3.74%) were high risk (Fig. 1). Adjusting for survey weights, results suggest that the estimated rate of high-risk kidney function was 5% more for low water drinkers compared to high water drinkers (Fig. 2). There is strong evidence of a difference in CKD risk categories based on TWI ($\chi^2(1) = 13.1$, p value <0.0001) from a survey-weighted proportional odds logistic regression model, but only moderate evidence of a difference when controlled for sodium/potas-

sium ratio, education, age, gender, ethnicity, income, BMI, blood pressure, diabetes, smoking, and alcohol consumption ($\chi^2(1) = 3.3$, p value = 0.067). **Conclusions:** Not meeting recommended daily TWI was associated increased presentation of high-risk kidney function. Even though the NHANES data are not focused on areas where chronic kidney disease is prevalent, results from this are an indication that hydration does play a role in kidney function.

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Fig. 1. Distribution of kidney function risk by study participants using survey weights.

Fig. 2. Association between TWI and kidney function after adjusting for survey weights. TWI, total water intake.

Statement of Ethics

This article does not contain any studies involving animals performed by any of the authors. This article does not contain any studies involving human participants performed by any of the authors. Study approval statement: No review by the Institutional Review Board was required because the analysis of de-identified, publicly available data does not constitute human subjects research as defined at 45 CFR 46.102 and that it does not require IRB review. Consent to participate statement: Health information collected in the NHANES is kept in strictest confidence. During the informed consent process, survey participants are assured that data collected will be used only for stated purposes and will not be disclosed or released to others without the consent of the individual or the establishment in accordance with section 308(d) of the Public Health Service Act (42 U.S.C. 242m).

Conflict of Interest Statement

Author Evan C. Johnson has previously received grant funding from Danone Research. All other authors have no conflicts of interest to declare.

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Author Contributions

David Lartey contributed to acquisition, analysis, and interpretation of data; drafting the work; and final approval of the version to be published. Mark Greenwood and Greta Linse contributed to acquisition, analysis, and interpretation of data; critical revision of the work; and final approval of the version to be published. Sally Moyce, Evan C. Johnson, and Cynthia Curl contributed to the design of the work and interpretation of data; critical revision of the work; and final approval of the version to be published. – Meredith Spivak contributed to acquisition and interpretation of data; critical revision of the work; final approval of the version to be published.

Data Availability Statement

The data that support findings of this study are publicly available. Reasonable requests for coded and weighted data should be addressed to the corresponding author, D.L.

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