Fluid Intake for Kidney Disease Prevention: An Urban Myth?

Alex Chang and Holly Kramer†*

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Any healthcare provider who works with patients afflicted with chronic kidney disease (CKD) has, at some point, discussed the importance of healthy kidneys and CKD prevention with patients' family members and friends. What should an expert recommend for the prevention of kidney disease? Certainly, early recognition and control of hypertension and diabetes, and avoidance of nephrotoxic agents, would be included in the conversation. One may also discuss the importance of maintaining a healthy weight through exercise and diet, given that the majority of kidney disease is due, at least in part, to nutritional factors. However, many individuals seeking advice for the prevention of kidney disease request specific guidelines for water intake and query on the amount of water intake needed to "flush" out toxins in the kidney. The "urban myth" of eight 8-ounce glasses of water (a half gallon or 1.9 L) per day to enhance health (1) appears to originate from the U.S. Food and Nutrition Board of the National Research Council in 1945, which recommended daily water intake of 2.5 L (2). These guidelines were based on opinion, not scientific evidence (3), and suggested the majority of the 2.5 L/d of water intake be derived from prepared foods (2). This portion of the 1945 recommendation has been largely ignored (3). In 2004, these recommendations were amended to account for the numerous individual and environmental factors that influence water requirements. The Food and Nutrition Board did not set exact guidelines for water intake but instead suggested general requirements at 2.7 L for women and 3.7 L for men, with fluid pertaining to all food and nonalcoholic beverages, including caffeinated drinks (4). While hydration has been suggested to provide multiple benefits in different aspects of health and well-being, including cognitive function, weight loss, and prevention of diseases, associations have not been supported by strong scientific evidence (3,5).

Specific clinical scenarios exist in which increased water intake may prevent kidney disease, but no clinical trials have examined fluid intake as an intervention for kidney disease incidence and progression. For instance, drinking more than 2 L/d is considered standard care for the prevention of recurrent kidney stones (6). Increasing fluid intake (noncaffeinated beverages) may also prevent the development and growth of cysts in patients with polycystic kidney disease (PCKD) via suppression of vasopressin levels. However, the benefits of suppressing vasopressin levels through increased fluid intake remain unproven, and increasing water intake should only be considered among individuals who can safely excrete the extra water load (individuals with stage 1 to 2 CKD, and no severe protein or sodium restriction and no use of medications that affect diluting segments of the kidney) (7). Aside from kidney stone disease prevention, most nephrologists do not support the lay community adage that drinking a half gallon of water a day prevents kidney disease. Nonetheless, given the strong interest by the lay community, it is quite surprising that data on water intake and incident kidney disease and kidney disease progression remain so limited.

In this issue of *CJASN*, Dr. Clark and colleagues report an association between fluid intake and incident kidney disease and eGFR progression. The study included 3371 Canadian adults aged 18 years and older who participated in the Walkerton Health Study, a cohort designed to determine the health consequences of exposure to contaminated water (8). A total of 2148 individuals provided a 24 hour urine sample at study entry and at least two annual creatinine measurements were available for estimated GFR (eGFR). The percentage annual change in eGFR was categorized as <1% (referent), 1 to 4.9% (mild to moderate decline), or ≥5% (rapid decline). All participants had a baseline eGFR ≥60 ml/min per 1.73 m^2 (mean 87 ml/min per 1.73 m^2). Urine volume was used as a surrogate marker for fluid intake and then grouped into four categories based on baseline values (<1 L/d; 1 to 1.9 L/d; 2 to 2.9 L/d; ≥3 L/d). This study showed an inverse association between eGFR decline and urine volume, with the lowest urine volume group having the highest percentage annual decline in eGFR (1.3%) and the highest urine volume group having the lowest percentage annual decline in eGFR (0.5%). Compared with the group with 24 hour urine volumes of 1 to 1.9 L/d, individuals in the highest urine volume group (≥3 L/d) had a 54% lower risk of an eGFR decline ≥5% after adjustment for covariates including baseline eGFR. No other urine volume group was significantly associated with higher or lower odds of rapid eGFR decline compared

*Department of Medicine, Division of Nephrology and Hypertension, and †Department of Preventive Medicine and Epidemiology, Loyola Medical Center, Maywood, Illinois

Correspondence: Dr. Holly Kramer, Loyola Medical Center, Department of Preventive Medicine, Maguire Building Room 3389, 2160 First Avenue, Maywood, IL 60153. Phone: 708-327-9039; Fax 708-327-9009; E-mail: hkramer@lumc.edu

with the referent group (1 to 1.9 L/d). Similar findings were noted for mild to moderate eGFR decline. Information on dietary factors such as sodium, potassium, fiber, total fat and calories, or body size was not included in the analysis.

As discussed by the authors, these findings conflict with a previous report that showed a moderate but direct association between urine volume and GFR decline among the Modification of Diet in Renal Disease (MDRD) Study participants (with or without polycystic kidney disease), which may not be the appropriate cohort for comparison because all MDRD participants had established CKD with baseline GFR ranging from 25 to 55 ml/min per 1.73 m^2. The association between water intake and GFR loss may differ by CKD stages, and high fluid intake could be harmful in persons with impaired ability to secrete a water load (7). In contrast, a population-based survey in Australia demonstrated similar associations between self-reported fluid intake and presence of CKD to those reported by Clark *et al*. The study of fluid intake and CKD in Australia was cross-sectional, and dietary modifications, including fluid restriction, could follow a diagnosis of CKD rather than precede it.

Observational studies may demonstrate associations that may or may not be true. True associations could be causal or a function of a third factor related to both the exposure of interest and the disease. Considerations for a potential causal association between high fluid intake and reduced GFR loss among individuals with eGFR ≥60 ml/min per 1.73 m^2 remain speculative. Anastasio *et al.* showed higher GFR and effective renal plasma flow among healthy individuals given a water load of 0.5 ml/kg every 30 minutes compared with healthy individuals given 4 ml/kg every 30 minutes under fasting conditions (9). The low-water-intake group also showed lower sodium excretion compared with the high-water-intake group, which may have been a function of acute suppression of vasopressin levels in the high-water-intake group (9). Moreover, a cross-sectional study of 141 adults without CKD showed a negative and significant correlation between 24 hour urine output and pulse pressure in the setting of uniform sodium and potassium intake (10). In other words, the lower the urine output, the higher the pulse pressure for a given sodium and potassium intake. Given these data and data from other studies (11), it has been postulated that a chronically low fluid intake leads to elevated vasopressin levels and increased GFR via tubuloglomerular feedback mechanisms and hyperfiltration. Decreased sodium excretion would theoretically also occur due to vasopressin upregulation of amiloride-sensitive epithelial sodium channels (12). Over a prolonged period of time, these combined factors could translate to heightened risk for GFR loss. One of the weaknesses in this theory is that higher GFR does not necessarily indicate higher intracapillary pressures and a hyperfiltration state (13). Moreover, a randomized study of older men with benign prostatic hypertrophy, who were given a prescription to increase their fluid intake by 1.5 L/d, showed no change in eGFR compared with the placebo group after 6 months (14).

The findings by Clark *et al*. could also be the result of confounding. In this study of Canadian adults, the average urine output was 1.6 L, consistent with average urine output of healthy adults (10,15,16). In the highest urine output group, urine output exceeded 3 L/d or twice the average urine output. Given average insensible water losses of approximately 0.8 L including both skin and fecal losses (17,18), individuals would need to consume >3.8 L/d of fluid or >1.5 additional L/d above and beyond their average consumption. Personal characteristics linked with both fluid intake and GFR decline, such as medication compliance, use of nephrotoxic medications, and diet may differ across fluid intake categories. Such residual confounding would be difficult to tease away in any observational study. Systematic error is also possible, given the potential error in creatinine-based GFR estimates in normal or mildly decreased kidney function and lack of repeated measurements of 24 hour urine volume at each time point.

In summary, the study by Clark *et al*. provides the strongest data, to date, supporting higher fluid intake as a preventive measure for GFR loss among individuals with eGFR ≥60 ml/min per 1.73 m^2. Additional studies are needed to confirm the preliminary findings by Clark *et al*. and to investigate whether small differences in GFR decline for a given exposure, such as fluid intake, translate to risk differences for end-stage kidney disease. Given the strong interest in the lay community for the potential health benefits of increased fluid/water intake, more research is needed to provide the public with better answers for kidney disease prevention.

Disclosures

None.

References

1. McCartney M: Waterlogged? *BMJ* 343: 1–3, 2011
2. Food and Nutrition Board, National Academy of Sciences: *Recommended dietary allowances*. National Research Council, Reprint and Circular Series, No. 122: 3–18, 1945
3. Valtin H: "Drink at least eight glasses of water a day." Really? Is there scientific evidence for "8x8"? *Am J Physiol Regul Integr Comp Physiol* 283: R993–R1004, 2002
4. Institute of Medicine (U.S.) Food and Nutrition Board. Panel on Dietary Reference Intakes for Electrolytes and Water, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes: *Dietary reference intakes: Water, potassium, sodium, chloride and sulfate*. Washington DC, National Academies Press, 2004. http://www.nap.edu. Accessed September 6, 2011
5. Negoianu D, Goldfarb S: Just add water. *J Am Soc Nephrol* 19: 1041–1048, 2008
6. Goldfarb DS: Reconsideration of the 1988 NIH Consensus Statement on Prevention and Treatment of Kidney Stones: Are the recommendations out of date? *Rev Urol* 4: 53–60, 2002
7. Torres VE, Bankir L, Grantham JJ: A case for water in the treatment of polycystic kidney disease. *Clinical J Am Soc Nephrol* 4: 1140–1150, 2009
8. Clark WF, Sontrop JM, Macnab JJ, Suri RS, Moist L, Salvadori M, Garg AX: Urine volume and change in eGFR in a community-based cohort study. *Clinical J Am Soc Nephrol* 6: 2634–2641, 2011
9. Anastasio P, Cirillo M, Spitali L, Frangiosa A, Pollastro RM, DeSanto NG: Level of hydration and renal function in healthy humans. *Kidney Int* 60: 748–756, 2001
10. Bankir L, Perucca J, Weinberger MH: Ethnic differences in urine concentration: Possible relationship to blood pressure. *Clinical J Am Soc Nephrol* 2: 304–312, 2007
11. Bouby N, Ahloulay M, Nsegbe E, Dechaux M, Schmitt F: Vaso-

pressin increases glomerular filtration rate in conscious rats through its antidiuretic action. *J Am Soc Nephrol* 7: 842–851, 1996
12. Nicco C, Wittner M, DiStefano A, Jounier S, Bankir L, Bouby N: Chronic exposure to vasopressin upregulates ENaC and sodium transport in the rat renal collecting duct and lung. *Hypertension* 38: 1143–1149, 2001
13. Griffin KA, Kramer H, Bidani AK: Adverse renal consequences of obesity. *Am J Physiol Renal Physiol* 294: F685–F696, 2008
14. Spigt MG, Knottnerus JA, Westerterp KR, Olde Rikkert MG, Schayck CP: The effects of 6 months of increased water intake on blood sodium, glomerular filtration rate, blood pressure, and quality of life in elderly (aged 55–75) men. *J Am Geriatr Soc* 54: 438–443, 2006
15. Curhan GC, Taylor EN: 24-hour uric acid excretion and the risk of kidney stones. *Kidney Int* 73: 489–496, 2008
16. Tayo B, Luke A, McKenzie CA, Kramer H, Cao G, Durazo-Arvizu R, Forrester T, Adeyemo AA, Cooper R: Patterns of sodium and potassium excretion and blood pressure in the African Diaspora. *J Hum Hypertens* [published online ahead of print, May 9, 2011]. doi: 10.1038/jhh.2011.39
17. Kuno Y: *Human Perspiration*, Springfield IL, Charles C. Thomas, 1956, 233–250
18. Newburgh CH, Woodwell JM, Falcon-Lesses M: Measurement of total water exchange. *J Clin Invest* 8: 161–196, 1930

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