Mini Review

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Can your work affect your kidney's health?

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Abstract: Working conditions that impair sufficient water intake have been associated with kidney problems such as kidney stones, urinary symptoms and chronic kidney disease (CKD). Higher prevalence of these morbidities was linked to occupations that do not facilitate worker access to drinking water and toilets, as well as people who perform activities in a hot environment. In this mini-review, we aim to describe and interpret available evidence in the areas of occupation, hydration and kidney health. This review explores examples of documented kidney health problems affecting professions ranging from astronauts and teachers in developed countries to rural workers in low-income settings living in water-restricted or hot environments.

Keywords: chronic kidney disease of unknown etiology (CKDu); hydration; kidney stones; occupational medicine; urinary tract symptoms.

Introduction

At first, research about hydration in healthy populations focused on the effects of dehydration for performance and safety in athletes and military and provided robust evidence of its crucial importance. In the last few decades, the focus has shifted to other areas, including association with diseases (1). Since then, poor hydration status has been linked to several morbidities (2), including kidney problems such as kidney stones,

urinary infection and potentially chronic kidney disease (CKD) (3–5).

In practice, staying well hydrated means drinking sufficient water during the day, and consequently, emptying the bladder whenever required. This might not be a problem for people who spend most of their time at home, but it can be difficult for many who work in occupations that discourage simple physiological needs. It is particularly challenging for those who perform physically demanding activities in a hot environment (6, 7).

Evidence linking working conditions with kidney health risks brought relevance to a few questions about people's work environment:

- Is access to toilets restricted most of the time?
- Is access to potable water or time to drink the desired amount of water restricted most of the time?
- Is the work performed in a hot environment?

If the answer to any of these questions is affirmative, workers can be chronically exposed to conditions which make appropriate hydration difficult, and due to this, those individuals are probably more susceptible to kidney problems.

In this brief review, we aimed to present evidence about occupation, hydration and kidney health. Although this relationship has received attention in recent years, the investigation is still scarce in many vulnerable populations.

Search strategy

A search for articles was performed in PubMed and Google Scholar without any time limits. The search terms used were the following: occupational, workers, hydration, kidney, renal, kidney stone, nephrolithiasis, heat stress, urinary tract infection, urinary tract symptoms, chronic kidney disease of unknown etiology (CKDu), Mesoamerican nephropathy. We also searched the reference lists of identified articles for additional relevant articles. As literature is scarce in this topic (except for CKDu), we included in this review most articles found in our search addressing different occupations.

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Hydration and kidney

Hydration is a dynamic balance between water intake and loss. Small increases in plasma osmolality, sensed by osmoreceptors, trigger a release of the hormone arginine vasopressin (AVP) from the pituitary gland. AVP has an antidiuretic activity, increasing water reabsorption in the kidney, reducing the volume of water lost via urine and protecting plasma osmolality across a broad spectrum of daily fluid intake volumes (8, 9).

However, this vital regulation is not free from adverse consequences when behavioral and/or environmental conditions chronically induce high AVP levels. On kidneys, increased AVP induces glomerular hyperfiltration, decreases low urine output and increases urine concentration and these alterations have been associated with renal disorders (8, 10).

Kidney stones

High fluid intake is strongly associated with a reduction in the risk of incident and recurrent kidney stones by increasing urine flow rate and volume, which in turn decreases urinary solute concentration and supersaturation (11).

Reports linking occupation and kidney stones began to appear 40 years ago. Since then, a higher incidence of kidney stones (4–20-fold increased risk compared to control subjects or general population) was detected in observational studies involving lifeguards, glass plant employees, steel industry and outdoor workers (3, 12–14). In 1980, a prevalence of 24% was found in a small sample of Israeli lifeguards (11 out of 45) (14). In a retrospective cross-sectional study that included 10,326 male steel workers, the prevalence of kidney stones in those exposed to hot temperatures was 8.0%, while it reached 0.9% in those working in areas at room temperature (3). Pin et al. conducted a questionnaire survey to determine the prevalence of urinary stone disease in 406 male workers in several occupations in a tropical environment. The prevalence of urinary stone disease was 6 times higher in outdoor workers (5.2%) compared to indoor workers (0.85%) (13).

Outer space is also a working environment that increases the risk of kidney stones. Up to 2007, 14 renal stone episodes were documented in 12 US astronauts (nine stone events occurring in seven crew members postflight and one in-flight episode endangered a flight but was relieved by spontaneous stone passage). Urinary patterns that increase the risk of stone formation appear to

be decreased urine output and increased urinary calcium and phosphate excretion (15).

In 2004, a case report of kidney stone and bladder dysfunction in a worker under a climate-controlled environment raised awareness about other possible occupations at risk. The case involved a chauffeur who was not allowed to stop the car to urinate on many long trips and avoided drinking any liquids before driving. According to the authors, the limitations to fluid consumption and voiding likely contributed to the development of kidney stones and a dilated, poorly functioning bladder (16).

Infrequent voiders syndrome, urinary tract symptoms and infection

The intentional restriction of fluid intake, in order to reduce the necessity to urinate throughout the day, has been named “infrequent voiders syndrome”. This disorder has been associated not only with kidney stones but also with lower urinary tract symptoms (LUTS) and urinary tract infections (UTI). The most common patient populations are women and men who experience prostate issues and infertility (17).

According to Markland et al., infrequent voiding can occur in the work environment due to toilet access limitations, lack of autonomy to use the toilet when needed and adaptive behaviors to avoid urine production such as fluid restriction. Examples of occupations that also affect urinary holding behavior are those that involve heavy lifting, stressful job demands, working in hot/cold environments and specific clothing requirements that could limit the ability to use the toilet when needed (4).

Although these matters are still underexplored, these conditions have been reported for drivers and medical staff in developed countries as well as labourers in rural, underdeveloped regions worldwide (18–20).

In India, a cross-sectional study included 312 women working in three occupational sectors: brick manufacturing, steel manufacturing and agriculture. The authors found that 87% of the 200 women who had inadequate or no toilet access at their workplaces mentioned experiencing genitourinary problems periodically. Frequent and recurring burning sensations and UTI were reported by 11% (18).

In another cross-sectional study, based on a questionnaire survey answered by 907 nurses randomly selected in Taipei, 65% reported having experienced at least one type

of LUTS. Although toilet facility adequacy was considered good or very good by more than 70% of nurses during the regular 8-h shifts, 68% of nurses usually or always delayed urinating, 58% usually or always reduced fluid consumption and more than 80% did not drink fluids until they felt thirsty and/or were too busy to drink fluids. Furthermore, lower health-related quality of life scores were found in nurses who reported LUTS (19).

Teaching also can increase the risk of renal disease. A study in which 791 teachers in the US responded to a survey, 15.8% had UTI in the preceding year and half of the respondents made a conscious effort to drink less while working to avoid going to the toilet. Compared to women who drank the volume they desired at work, they had a 2.21-fold higher risk [95% confidence interval (CI) 1.45–3.38] of UTI after controlling for confounders (20).

Chronic kidney disease

In the past few years, occupational and environmental factors have been associated with a CKD epidemic that affected communities located in a tropical climate. It has been detected in younger male agricultural workers particularly in Central America and Asia, in the absence of traditional risk factors such as hypertension and diabetes (21, 22).

Because the cause is not elucidated, this condition was named CKD of unknown origin (CKDu). Initial theories to explain these epidemics included exposure to contaminated drinking water, pesticides, heavy metals and infectious agents. However, evidence supporting these theories is inconsistent (23, 24).

Many researchers believe that heat stress is the key factor. Heat stress occurs due to the combination of high environment temperature, heavy work load and impaired heat dissipation, usually associated with insufficient rehydration, although not always (25). It has been hypothesized in epidemiological studies involving sugarcane

workers from Central America and in experimental investigations that these factors lead to recurrent dehydration and repeated acute kidney injury episodes, which over time may lead to permanent kidney damage and CKD (5, 26–28). Whether heat stress causes CKD directly or in combination with other factors remains unproven.

This being true, millions of workers exposed to heat stress around the world are at risk, especially those living in tropical low-to-middle-income countries where safety regulations are neglected, a situation that might worsen due to future climate change (29). This includes also the under-studied population of indoor workers who perform activities in hot environments (i.e. those involved in work near furnaces, ovens and boilers) while wearing heavy protective clothing (30).

It is important to emphasize that recurrent nephrolithiasis also increases the risk of CKD (31). Moreover, epidemiological data from the general population showed that increased urine volume and higher water intake were associated with a lower risk of CKD (32, 33). This fact gives even more support to the necessity of improving the hydration status of all workers.

Preventive strategies

For those working in a hot environment, many strategies to prevent heat strain and dehydration risk can be found in documents produced by international agencies responsible for preventing occupational illnesses. They recommend investments in effective health education of workers, accessible hydration, adequate toilets, implementation of work/rest cycles, among others (Table 1) (34–36). However, these regulations are not universally implemented, affecting not only outdoor workers from informal sectors in hot low-income countries (37, 38), but also indoor activities in cooler climates (39).

Besides the health consequences of insufficient water intake (i.e. which includes symptoms such as fatigue,

Table 1: Occupational conditions and exposures associated with renal disorders and potential preventive measures.

Occupational conditions/exposure	Potential renal outcomes	Preventive measures
– Lack of easily accessible potable water	– Kidney stones	– Education
– Lack of access to toilets	– Infrequent voiders syndrome	– Self-monitoring fluid intake adequacy
– Clothes that limit availability to use the toilet	– Urinary tract symptoms	– Accessible hydration
– High temperatures in work sites	– Urinary tract infection	– Adequate toilet facilities
– Lack of rest periods	– Chronic kidney disease	– Appropriate clothing
– Strenuous physical activity		– Comply with safety heat exposure regulations
– Semipermeable or impermeable protective clothing		
– Lack of safety regulations		

headache and weakness), it also impairs cognitive function and increases the risk of injuries and absenteeism, reducing productivity (34, 40, 41). Thus, promoting adequate water intake is important not only to protect workers' health but also for business economic reasons.

A recent study carried out in a group of 60 sugarcane cutters measured the effects of providing water supply in individual backpacks, access to shaded rest areas and scheduled rest periods associated with ergonomically improved machetes and efficiency strategies. They showed health and productivity benefits. Post-intervention, there was a 25% increase in self-reported water consumption, a significant decrease in symptoms associated with heat stress and dehydration, a 43% increase in individual daily production and less adverse impacts on kidney function both across a day and across an entire harvest (42, 43).

As shown in previous sessions, occupations not exposed to heat environments are also at higher risk of kidney disorders. Thus, preventive strategies related to work environment and workers' awareness are important. Although there are some water intake recommendation guidelines for the general population, it is known that total water requirement varies inter- and intra-individually according to many factors such as body mass, diet, physical activity, environment temperature, sweating loss, acclimatization and other (44, 45).

An interesting and simple tool for self-monitoring day-to-day fluid intake adequacy proposed by Cheuvront and Kenefick can be useful. They propose daily observation of first morning measures of nude (or seminude) body weight, thirst perception and urine color. Acute loss of body weight (>1%), thirst perception and dark-colored urine are all indicative of decreased total body water. Taken singly, no marker alone provides enough evidence of fluid intake inadequacy, but the combination of any two makes inadequate fluid intakes likely. The combination of all three makes inadequate fluid intakes very likely (46).

Although not tested in a specific occupational setting, a recent randomized controlled trial showed that drinking more water can be an effective strategy to prevent recurrent cystitis in women who drink low volumes of fluids daily (<1.5 L of fluids per day) (47).

Discussion

In this mini-review, we describe some evidence of the association between kidney disorders with occupational conditions. Except for CKDu, which has received more attention and research funding due to its catastrophic consequences on the affected communities, our search for articles

covering this topic identified few publications. Most investigations had an observational cross-sectional design and used questionnaire surveys to detect renal disorders among the participants. This corroborates that the study of hydration and health is new and under researched (48). Better designed multinational investigations addressing risk factors and preventive measures are urgently needed.

Even though based on the available evidence and the lack of adverse effects, we believe that employers should promote a "hydration-friendly" environment for their workers and self-employers need to care about their own hydration habits. This might benefit cognitive performance, health and quality of life while decreasing costs and improving productivity.

Conclusion

Occupational factors that impair sufficient water intake have been associated with kidney problems, which can vary from acute urinary symptoms to the development of CKD and its consequences. There is an urgent need for multidisciplinary efforts to perform investigations that identify, implement and evaluate preventive measures to safeguard the kidney health of the working force.

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