INTRODUCTION:

To our knowledge, this is the first study to investigate the effects of beverage type and fluid intake on stone formation among persons with spinal cord injury (SCI). Drinking more fluids has been widely advocated for persons with SCI as a way to prevent stone formation in the kidney and/or bladder, although there is no direct evidence to support this belief. Most of the studies done in preventing stone formations relate to the general population. Stones found in the general population are mainly made of crystalline salt compound called calcium oxalate. On the other hand, the majority of stones that form in persons with SCI contain struvite (a magnesium ammonium phosphate) mixed with various amounts of carbonate apatite (calcium phosphate). This difference in the contents of stone formation means that it is impossible to know if studies in the general population can be applied to persons with SCI. In addition, studies in the general population suggest that consumption of tea, coffee, and beer seems to protect against the formation of stones. Some of the same studies suggest that apple and grapefruit juices appear to contribute to stone formation. However, no one has studied the roles of different types of beverages in the control of the struvite stone formations found in persons with spinal cord injury.

METHOD:

To address the lack of knowledge in this area, we did this study to clarify the close relationship among beverage type and fluid intake with the risk of stone formation in persons with SCI. The study included 41 cases (21 kidney, 15 bladder, and 4 both) where stone formation was diagnosed and 208 age-duration-matched control subjects. Participants were interviewed by phone and asked information on frequency of individual beverage use, smoking status, and health status. Other potential risk factors for stones were also examined using a computerized database and medical chart reviews.

Participants in the study were asked questions about 11 beverages, including water, tea, coffee, juice, soda, non-carbonated fruit-flavored beverages, Gatorade, milk, beer, wine, and liquor. They were also asked the average frequency of use of each beverage (the number of times per day, week, or month) and the size of container used for the specific beverage. We then calculated the daily intake of each beverage along with the total daily fluid intake of all reported beverages.

RESULTS:

We found that the risk of urinary stones was more likely in Caucasians than for African Americans, for persons with
tetraplegia with ASIA* grades A, B, or C than for those with less severe injury, and for persons using indwelling catheterization than for other methods. The risk was approximately 3 times greater for current smokers compared with non- and ex-smokers. Stone subjects also tended to have a family history of kidney stones, lower body mass index (weight/height$^2$), worse renal function, and higher urine specific gravity (stone forming compounds in the urine).

Table 1 shows the percent of users and their reported average daily intake of each beverage. Among both those diagnosed with stone formation and the control group, water was reported as the most often used beverage, followed by juice, soda, and tea. Of those in the control group drinking juice, 54% reported drinking cranberry juice most often and 25% reported drinking orange juice most often. In contrast, 45% of people with stone formations reported drinking orange juice most often and 32% reported drinking cranberry juice most often.

We found that a greater intake of tea and juice was each associated with a decreased risk of stone formation by 60% or more. Greater intake of coffee, another beverage containing caffeine, showed an increasing trend in the risk for stone formation. We saw a decrease in the likelihood of stone formation for persons drinking lower amounts of Gatorade when compared to never drinking Gatorade. However, we did not see a consistent decreasing trend with an increase in Gatorade use. Alcoholic beverages (beer, wine, and liquor) did show a decreasing, but non-significant, trend in stone risk. An increase in consumption of the remaining beverage types tended to reduce the risk of stone formation, but the relation was not statistically significant and somewhat inconsistent.

Logically, high fluid intake should reduce stone formation because the increased urine volume dilutes the concentration of stone-forming components. The benefits of increased fluid intake on reducing urinary saturation of calcium salts has been supported by intervention studies.$^9$11

Direct evidence of a decreased stone occurrence in relation to greater fluid intake has been provided by some studies,$^{3,4,12}$ but not in our results and others.$^{5,7,13,14}$ This inconsistent finding suggests that total fluid intake might not be a sole determinant of urinary dilution status, although it has been shown correlated to urine volume among healthy men.$^3$ In

**Table 1**

<table>
<thead>
<tr>
<th>Beverage</th>
<th>% Users</th>
<th>Average (ml/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>98</td>
<td>1,546</td>
</tr>
<tr>
<td>Juice</td>
<td>84</td>
<td>127</td>
</tr>
<tr>
<td>Soda</td>
<td>77</td>
<td>127</td>
</tr>
<tr>
<td>Tea</td>
<td>71</td>
<td>118</td>
</tr>
<tr>
<td>Milk</td>
<td>58</td>
<td>30</td>
</tr>
<tr>
<td>Noncarbonated beverage</td>
<td>52</td>
<td>7</td>
</tr>
<tr>
<td>Coffee</td>
<td>51</td>
<td>8</td>
</tr>
<tr>
<td>Gatorade</td>
<td>43</td>
<td>0</td>
</tr>
<tr>
<td>Beer</td>
<td>43</td>
<td>0</td>
</tr>
<tr>
<td>Liquor</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Wine</td>
<td>13</td>
<td>0</td>
</tr>
</tbody>
</table>

* Consuming specific beverage at least once a month.

In the present analysis, we found urine specific gravity was a significant risk factor for stones and was determined by fluid intake, beverage type, sweating, and renal function. In other words, the balance between amount of fluid intake, water/fluid loss, body size, and beverage type might be more important in determining stone formation rather than one specific factor.

**CONCLUSION:**

This investigation suggests that beverage type should have the potential to determine the risk of stone formation among persons with spinal cord injury, even after adjusting for total fluid intake. The protective effect of increased consumption of tea and juice, particularly cranberry and oranges juices, needs support by further studies. The results might lead to an effective way of preventing stone formation in persons with SCI.

- Class A - complete injury with no motor or sensory function preserved in the sacral segments S4-S5.
- Class B - incomplete injury with sensory but no motor function preserved below the neurological level and includes the sacral segments S4-S5.
- Class C - incomplete injury where motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than “3” (less than active movement against gravity).

REFERENCES:


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Related Publications: