THE IMPACT OF CLIMATE CHANGE ON KIDNEY STONE PRESENTATIONS IN SOUTH CAROLINA

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Introduction

- High ambient temperatures and humidity increase risk of kidney stone disease due to reduced urine volume and increased concentration [1,2,3]
- Climate change is expected to increase the incidence of kidney stone disease
- **Wet-bulb temperature (WBT)**, which accounts for both heat and humidity, has been shown to predict kidney stone presentations better than heat alone[4,5]
- **Objective**: Quantify the increased incidence and cost of kidney stone disease from projected future climate

Methods

- The historical temperature-dependence of kidney stone presentations was estimated using a **time series analysis** and **distributed lag non-linear model**, and then mapped onto projections of future temperature
  - Daily historic cases from the South Carolina all-payer claims database
  - Daily historic wet-bulb temperature from NASA Land Data Assimilation Systems
  - Daily projected wet-bulb temperatures across South Carolina from Dr. Ethan Coffel (Dartmouth College)
- Two **representative concentration pathways** (RCP) were selected to demonstrate two possible futures:
  - **RCP 8.5** = "business as usual"
  - **RCP 4.5** = strong greenhouse gas emission mitigations
- **Cost** per presentation estimated using the average of total costs incurred by any kidney stone patient initially presenting through the emergency room

Results

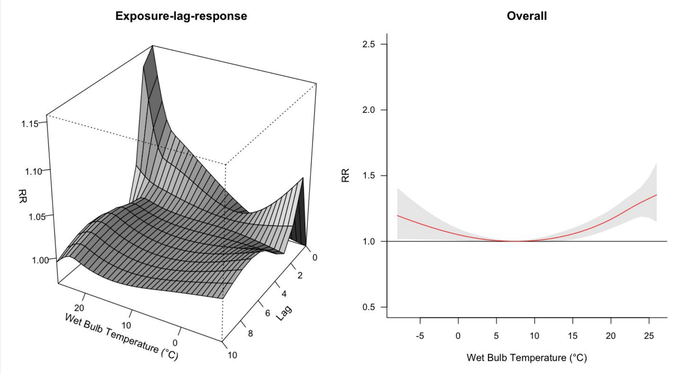

Figure 1. The exposure-lag-response relationship between daily wet bulb temperatures and kidney stone presentations in South Carolina

- Left: 3D relationship of wet-bulb temperature (x-axis), lag (z-axis) and risk of kidney stone presentations, compared to 10C
- Right: relative risk of kidney stone presentations cumulated over 10 days associated with a daily mean WBT

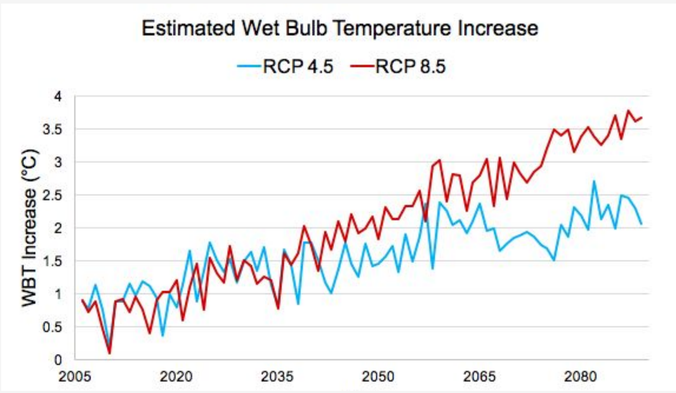

Figure 2. Increase in average annual WBT above the average WBT from 1997-2014, through 2089 under RCP 4.5 (blue) and RCP 8.5 (red)

- RCP 8.5 predicts the 'business as usual' pathway of continued greenhouse gases, and thus projects higher average annual temperatures than RCP 4.5

Table 1. Estimates of the number of future kidney stones and associated excess charges attributable to ambient wet-bulb temperatures.

	RCP 4.5		RCP 8.5	
Years	Stones Attributable to WBT Increase (95% CI)	Associated Excess Charges	Stones Attributable to WBT Increase (95% CI)	Associated Excess Charges
2025-2029	93.9 (32.0 - 150.7)	$894,486.71	158.7 (49.8 - 259.4)	$1,511,768.27
2030-2034	112.2 (14.4 - 204.8)	$1,068,811.59	111.7 (14.6 - 204.3)	$1,064,048.62
2035-2039	171.8 (79.0 - 255.1)	$1,636,558.21	324.7 (108.5 - 522.3)	$3,093,075.97
2040-2044	164.3 (59.3 - 260.8)	$1,565,113.59	350.2 (111.9 - 566.7)å	$3,335,987.69
2045-2049	177.8 (68.2 - 280.0)	$1,693,713.91	458.7 (182.7 - 710.2)	$4,369,553.27
2050-2054	197.3 (72.5 - 310.5)	$1,879,469.94	586.2 (222.9 - 917.9)	$5,584,111.89
2055-2059	335.2 (159.2 - 505.9)	$3,193,098.44	736.4 (178.8 - 1234.1)	$7,014,909.58
2060-2064	394.7 (113.1 - 649.0)	$3,759,892.47	804.6 (291.5 - 1272.2)	$7,664,579.37
2065-2069	327.0 (125.7 - 511.3)	$3,114,985.65	868.1 (214.1 - 1436.6)	$8,269,477.20
2070-2074	295.8 (39.5 - 529.1)	$2,817,776.01	838.2 (157.9 - 1437.3)	$7,984,651.29
2075-2079	402.3 (72.7 - 702.6)	$3,832,289.69	1067.7 (230.1 - 1803.7)	$10,170,856.82
2080-2084	529.9 (171.3 - 858.9)	$5,047,800.91	1116.6 (157.3 - 1944.0)	$10,636,675.77
2085-2089	533.2 (182.4 - 841.9)	$5,079,236.54	1288.9 (199.1 - 2221.2)	$12,277,996.96
Total (2025-2089)	3,735	$35,583,233.66	8,710	$82,977,692.70

Discussion

- Kidney stone disease incidence will continue to increase under multiple models of future climate
- Climate change mitigation efforts could decrease the burden of kidney stone disease
- The effect of temperature is greatest in the short term following a high heat and humidity day
- Limitations:
  - We assumed a constant population, so this estimate does not account for increased incidence due to an increased at-risk population
  - A constant exposure-risk response is assumed for the duration of the projection, though it is likely that human behavior will adapt (e.g., by drinking more water on hot days), changing the shape of the curve over time
- Under the "sustainable growth" "shared socioeconomic pathway," emissions are predicted to be greater than those in RCP 4.5; thus, RCP 4.5 could already be overly optimistic

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