Table: International Classification of Diseases, Ninth Revision (ICD-9) Diagnostic and Procedure codes used to Identify Kidney Stone Events

ICD-9 Diagnosis Code	Description	ICD-9-CM Procedure Code	Description
592.0	Calculus of Kidney	55.03	Percutaneous Nephrostomy Without Fragmentation
592.1	Calculus of Ureter	55.04	Percutaneous Nephrostomy With Fragmentation
592.9	Urinary calculus, unspecified	56.0	Transurethral removal of obstruction from ureter and renal pelvis
274.11	Uric acid nephrolithiasis	56.2	Ureterotomy
		59.8	Ureteral catheterization
		59.95	Ultrasonic fragmentation of urinary stones
		98.51	Extracorporeal shockwave lithotripsy of the kidney, ureter and/or bladder

Statistical Models

We used linear mixed effects models to describe the incidence trajectories over time in various age, sex and race groups. Age is comprised of 8 categories: less than 10 years old, 10-14 years old, 15-19 years old, 20-24 years old, 25-34 years old, 35-44 years old, 45-64 years old, and over 65 years old. Race is comprised of 3 categories: Caucasian, African-American and "other". The model for kidney stone case counts is given by:

$$Y_{ijklt} \sim Poisson(N_{ijklt}\theta_{ijklt}),$$

where $i=1, \ldots, 46, j=1, \ldots, 8, k=1,2, l=1,2,3, t=1, \ldots, 16$, Y_{ijklt} is the number of kidney stone cases in county i, age group j, sex k, race l at time t, N_{ijklt} is the number of people in the population in county i, in age group j, sex k, race l at time t, and θ_{ijklt} is the risk of kidney stones associated with county i, in age group j, sex k, race l at time t. For ease of presentation, we use the following variable names in the models below: "AgeCat" for age group, "Male" to indicate male sex, "Race" to indicate race category. The referent group is females less than 10 years of age of Caucasian race.

We specify random effects models for θ_{ijklt} in which we allow global smoothing using independent random effects for county, denoted by b_i:

<u>Model 0</u>: $\log\theta_{ijklt} = \beta_0 + \beta_1 t + b_i$

<u>Model 1</u>: $\log\theta_{ijklt} = \beta_0 + \beta_1 t + \beta_2 AgeCat2 + \beta_3 AgeCat3 + \beta_4 AgeCat4 + \beta_5 AgeCat5$
$\qquad + \beta_6 AgeCat6 + \beta_7 AgeCat7 + \beta_8 AgeCat8 + \beta_9 Male + \beta_{10} Race2$
$\qquad\; + \beta_{11} Race3 + \beta_{12} AgeCat2{:}t + \beta_{13} AgeCat3{:}t + \beta_{14} AgeCat4{:}t$
$\qquad + \beta_{15} AgeCat5{:}t + \beta_{16} AgeCat6{:}t + \beta_{17} AgeCat7{:}t + \beta_{18} AgeCat8{:}t + b_i$

<u>Model 2</u>:
$\log\theta_{ijklt} = \beta_0 + \beta_1 t + \beta_2 AgeCat2 + \beta_3 AgeCat3 + \beta_4 AgeCat4 + \beta_5 AgeCat5$
$\qquad + \beta_6 AgeCat6 + \beta_7 A\;\;eCat7 + \beta_8 AgeCat8 + \beta_9 Male + \beta_{10} Race2$
$\qquad + \beta_{11} Race3 + \beta_{12} Male{:}t + b_i$

<u>Model 3</u>:
$\log\theta_{ijklt} = \beta_0 + \beta_1 t + \beta_2 AgeCat2 + \beta_3 AgeCat3 + \beta_4 AgeCat4 + \beta_5 AgeCat5$
$\qquad + \beta_6 AgeCat6 + \beta_7 AgeCat7 + \beta_8 AgeCat8 + \beta_9 Mal\;\; + \beta_{10} Race2$
$\qquad + \beta_{11} Race3 + \beta_{12} AgeCat2{:}t + \beta_{13} AgeCat3{:}t + \beta_{14} AgeCat4{:}t$
$\qquad + \beta_{15} AgeCat5{:}t + \beta_{16} AgeCat6{:}t + \beta_{17} AgeCat7{:}t + \beta_{18} AgeCat8{:}t$
$\qquad + \beta_{19} Male{:}t + \beta_{20} AgeCat2{:}Male + \beta_{21} AgeCat3{:}Male$
$\qquad + \beta_{22} AgeCat4{:}Male + \beta_{23} AgeCat5{:}Male + \beta_{24} AgeCat6{:}Male$
$\qquad + \beta_{25} AgeCat7{:}Male + \beta_{26} AgeCat8{:}Male + \beta_{27} AgeCat2{:}Male{:}t$
$\qquad + \beta_{28} AgeCat3{:}Male{:}t + \beta_{29} AgeCat4{:}Male{:}t + \beta_{30} AgeCat5{:}Male{:}t$
$\qquad + \beta_{31} AgeCat6{:}Male{:}t + \beta_{32} AgeCat7{:}Male{:}t + \beta_{33} AgeCat8{:}Male{:}t$
$\qquad + b_i$

<u>Model 4</u>:
$\log\theta_{ijklt} = \beta_0 + \beta_1 t + \beta_2 AgeCat2 + \beta_3 AgeCat3 + \beta_4 AgeCat4 + \beta_5 AgeCat5$
$\qquad + \beta_6 AgeCat6 + \beta_7 AgeCat7 + \beta_8 AgeCat8 + \beta_9 Male + \beta_{10} Race2$
$\qquad + \beta_{11} Race3 + \beta_{12} Race2{:}t + \beta_{13} Race3{:}t + b_i$

<u>Model 5</u>:
$\log\theta_{ijklt} = \beta_0 + \beta_1 t + \beta_2 AgeCat2 + \beta_3 AgeCat3 + \beta_4 AgeCat4 + \beta_5 AgeCat5$
$\qquad + \beta_6 AgeCat6 + \beta_7 AgeCat7 + \beta_8 AgeCat8 + \beta_9 Male + \beta_{10} Rac\;\;2$
$\qquad + \beta_{11} Race3 + \beta_{12} Race2{:}t + \beta_{13} Race3{:}t + \beta_{14} Male{:}t$
$\qquad + \beta_{15} Race2{:}Male + \beta_{16} Race3{:}Male + \beta_{17} Race2{:}Male{:}t$
$\qquad + \beta_{18} Race3{:}Male{:}t + b_i$

<u>Model 6</u>:
$\log\theta_{ijklt} = \beta_0 + \beta_1 t + \beta_2 AgeCat2 + \beta_3 AgeCat3 + \beta_4 AgeCat4 + \beta_5 AgeCat5$
$\qquad + \beta_6 AgeCat6 + \beta_7 AgeCat7 + \beta_8 AgeCat8 + \beta_9 Male + \beta_{10} Race2$
$\qquad + \beta_{11} Race3 + \beta_{12} AgeCat2{:}t + \beta_{13} AgeCat3{:}t + \beta_{14} AgeCat4{:}t$
$\qquad + \beta_{15} AgeCat5{:}t + \beta_{16} AgeCat6{:}t + \beta_{17} AgeCat7{:}t + \beta_{18} AgeCat8{:}t$
$\qquad + \beta_{19} Race2{:}t + \beta_{20} Race3{:}t + \beta_{21} AgeCat2{:}Race2 + \beta_{22} AgeCat3{:}Race2$
$\qquad + \beta_{23} AgeCat4{:}Race2 + \beta_{24} AgeCat5{:}Race2 + \beta_{25} AgeCat6{:}Race2$
$\qquad + \beta_{26} AgeCat7{:}Race2 + \beta_{27} AgeCat8{:}Race2 + \beta_{28} AgeCat2{:}Race3$
$\qquad + \beta_{29} AgeCat3{:}Race3 + \beta_{30} AgeCat4{:}Race3 + \beta_{31} AgeCat5{:}Race3$
$\qquad + \beta_{32} AgeCat6{:}Race3 + \beta_{33} AgeCat7{:}Race3 + \beta_{34} AgeCat8{:}Race3$

$$+\beta_{35}AgeCat2{:}Race2{:}t + \beta_{36}AgeCat3{:}Race2{:}t + {}_{37}AgeCat4{:}Race2{:}t$$
$$+\beta_{38}AgeCat5{:}Race2{:}t + \beta_{39}AgeCat6{:}Race2{:}t + \beta_{40}AgeCat7{:}Race2{:}t$$
$$+\beta_{41}AgeCat8{:}Race2{:}t + \beta_{42}AgeCat2{:}Race3{:}t + \beta_{43}AgeCat3{:}Race3{:}t$$
$$+\beta_{44}AgeCat4{:}Race3{:}t + \beta_{45}AgeCat5{:}Race3{:}t + \beta_{46}AgeCat6{:}Race3{:}t$$
$$+\beta_{47}AgeCat7{:}Race3{:}t + \beta_{48}AgeCat8{:}Race3{:}t + b_i$$

Table 1 displays the coefficients and 95% credible intervals from fitting the above models. We summed the coefficients from the main effect for time with the time-by-group interaction terms to obtain the incidence trajectory over time in specific age, sex, and race groups, which are provided in Table 3 of the manuscript.

Table: Model coefficients and 95% credible intervals (CIs) from fitting seven regression models to describe kidney stone incidence over time across different age, sex and race groups.* denotes statistical significance, which is defined by the exclusion of 0 from the 95% credible intervals.

	Estimate	95% CI
Model 0		
Intercept	-6.171	(-6.253, -6.09)*
Time	0.010	(0.009, 0.011)*
Model 1		
Intercept	-10.072	(-10.196, -9.951)*
Male	0.529	(0.518, 0.539)*
Time	0.018	(-0.004, 0.039)
Age Group 10-14 years	1.601	(1.485, 1.718)*
Age Group 15-19 years	3.139	(3.038, 3.243)*
Age Group 20-24 years	3.808	(3.709, 3.910)*
Age Group 25-34 years	4.209	(4.111, 4.310)*
Age Group 35-44 years	4.291	(4.193, 4.392)*
Age Group 45-64 years	4.240	(4.142, 4.340)*
Age Group 65+ years	3.908	(3.81, 4.009)*
African American Race	-0.986	(-1.002, -0.970)*
"Other" Race	-0.515	(-0.545, -0.485)*
Time:Age Group 10-14 years	0.018	(-0.007, 0.044)
Time:Age Group 15-19 years	0.028	(0.006, 0.050)*
Time:Age Group 20-24 years	0.009	(-0.013, 0.031)
Time:Age Group 25-34 years	-0.005	(-0.027, 0.016)
Time:Age Group 35-44 years	-0.003	(-0.024, 0.019)
Time:Age Group 45-64 years	-0.023	(-0.044, -0.001)*
Time:Age Group 65+ years	-0.002	(-0.024, 0.020)
Model 2		
Intercept	-10.076	(-10.199, -9.955)*
Male	0.532	(0.521, 0.542)*
Time	0.028	(0.026, 0.030)*
Age Group 10-14 years	1.602	(1.487, 1.720)*
Age Group 15-19 years	3.150	(3.049, 3.254)*
Age Group 20-24 years	3.811	(3.712, 3.913)*
Age Group 25-34 years	4.208	(4.110, 4.308)*
Age Group 35-44 years	4.289	(4.191, 4.389)*
Age Group 45-64 years	4.237	(4.139, 4.337)*

Age Group 65+ years	3.912	(3.813, 4.013)*
African American Race	-0.987	(-1.003, -0.971)*
"Other" Race	-0.509	(-0.539, -0.479)*
Time:Male	-0.030	(-0.032, -0.028)*
Model 3		
Intercept	-9.815	(-9.979, -9.656)*
Male	0.088	(-0.110, 0.285)
Time	0.020	(-0.012, 0.051)
Age Group 10-14 years	1.690	(1.524, 1.861)*
Age Group 15-19 years	3.377	(3.231, 3.529)*
Age Group 20-24 years	3.873	(3.728, 4.023)*
Age Group 25-34 years	4.077	(3.934, 4.225)*
Age Group 35-44 years	4.045	(3.902, 4.193)*
Age Group 45-64 years	3.853	(3.711, 4.001)*
Age Group 65+ years	3.445	(3.302, 3.594)*
African American Race	-0.986	(-1.002, -0.970)*
"Other" Race	-0.504	(-0.534, -0.474)*
Time:Male	-0.004	(-0.047, 0.039)
Male:Age Group 10-14 years	-0.175	(-0.409, 0.058)
Time:Age Group 10-14 years	0.028	(-0.009, 0.065)
Male:Age Group 15-19 years	-0.500	(-0.706, -0.295)*
Time:Age Group 15-19 years	0.029	(-0.004, 0.061)
Male:Age Group 20-24 years	-0.125	(-0.328, 0.076)
Time:Age Group 20-24 years	0.015	(-0.017, 0.047)
Male:Age Group 25-34 years	0.230	(0.030, 0.429)*
Time:Age Group 25-34 years	0.012	(-0.020, 0.043)
Male:Age Group 35-44 years	0.419	(0.220, 0.618)*
Time:Age Group 35-44 years	0.016	(-0.016, 0.048)
Male:Age Group 45-64 years	0.639	(0.440, 0.837)*
Time:Age Group 45-64 years	-0.001	(-0.033, 0.031)
Male:Age Group 65+ years	0.786	(0.586, 0.985)*
Time:Age Group 65+ years	0.010	(-0.022, 0.042)
Male:Time:Age Group 10-14 years	-0.020	(-0.071, 0.031)
Male:Time:Age Group 15-19 years	-0.003	(-0.048, 0.042)
Male:Time:Age Group 20-24 years	-0.013	(-0.057, 0.031)
Male:Time:Age Group 25-34 years	-0.028	(-0.071, 0.015)
Male:Time:Age Group 35-44 years	-0.029	(-0.072, 0.015)
Male:Time:Age Group 45-64 years	-0.031	(-0.075, 0.012)
Male:Time:Age Group 65+ years	-0.020	(-0.063, 0.024)
Model 4		
Intercept	-10.073	(-10.196, -9.952)*
Male	0.529	(0.519, 0.539)*
African American Race	-0.990	(-1.006, -0.975)*
"Other" Race	-0.614	(-0.649, -0.581)*
Time	0.005	(0.004, 0.006)*
Age Group 10-14 years	1.603	(1.488, 1.720)*
Age Group 15-19 years	3.151	(3.050, 3.255)*
Age Group 20-24 years	3.813	(3.713, 3.915)*
Age Group 25-34 years	4.208	(4.110, 4.309)*

Age Group 35-44 years	4.289	(4.191, 4.389)*
Age Group 45-64 years	4.238	(4.140, 4.338)*
Age Group 65+ years	3.912	(3.814, 4.013)*
African American Race: Time	0.024	(0.020, 0.027)*
"Other" Race: Time	0.066	(0.059, 0.074)*
Model 5		
Intercept	-10.102	(-10.225, -9.981)*
Male	0.575	(0.563, 0.586)*
African American Race	-0.804	(-0.827, -0.781)*
"Other" Race	-0.572	(-0.631, -0.513)*
Time	0.025	(0.023, 0.027)*
Age Group 10-14 years	1.604	(1.488, 1.721)*
Age Group 15-19 years	3.152	(3.050, 3.255)*
Age Group 20-24 years	3.812	(3.712, 3.914)*
Age Group 25-34 years	4.206	(4.108, 4.307)*
Age Group 35-44 years	4.287	(4.189, 4.388)*
Age Group 45-64 years	4.236	(4.139, 4.337)*
Age Group 65+ years	3.912	(3.814, 4.013)*
African American Race:Male	-0.331	(-0.362, -0.300)*
"Other" Race:Male	-0.067	(-0.139, 0.006)
Male:Time	-0.031	(-0.033, -0.029)*
African American Race: Time	0.014	(0.009, 0.019)*
"Other" Race: Time	0.065	(0.052, 0.077)*
African American Race: Time:Male	0.013	(0.006, 0.019)*
"Other" Race: Time:Male	0.004	(-0.012, 0.019)
Model 6		
Intercept	-9.944	(-10.073, -9.818)*
Male	0.530	(0.520, 0.540)*
African American Race	-1.523	(-1.848, -1.218)*
"Other" Race	-2.804	(-4.098, -1.777)*
Time	0.021	(-0.002, 0.043)
Age Group 10-14 years	1.631	(1.509, 1.755)*
Age Group 15-19 years	3.136	(3.028, 3.246)*
Age Group 20-24 years	3.738	(3.632, 3.846)*
Age Group 25-34 years	4.115	(4.011, 4.223)*
Age Group 35-44 years	4.165	(4.061, 4.272)*
Age Group 45-64 years	4.082	(3.978, 4.189)*
Age Group 65+ years	3.742	(3.637, 3.849)*
African American Race: Time	0.021	(-0.048, 0.090)
"Other" Race: Time	-0.147	(-0.411, 0.106)
African American Race:Age Group 10-14 years	-0.603	(-1.003, -0.197)*
"Other" Race: Age Group 10-14 years	1.009	(-0.155, 2.412)
Time:Age Group 10-14 years	0.018	(-0.009, 0.044)
African American Race:Age Group 15-19 years	-0.257	(-0.578, 0.083)
"Other" Race: Age Group 15-19 years	1.349	(0.295, 2.663)*
Time:Age Group 15-19 years	0.023	(-0.001, 0.047)
African American Race:Age Group 20-24 years	0.270	(-0.040, 0.602)
"Other" Race: Age Group 20-24 years	1.726	(0.690, 3.026)*
Time:Age Group 20-24 years	0.003	(-0.020, 0.027)

African American Race:Age Group 25-34 years	0.386	(0.079, 0.713)*
"Other" Race: Age Group 25-34 years	1.873	(0.841, 3.169)*
Time:Age Group 25-34 years	-0.010	(-0.033, 0.013)
African American Race:Age Group 35-44 years	0.523	(0.217, 0.850)*
"Other" Race: Age Group 35-44 years	2.196	(1.163, 3.491)*
Time:Age Group 35-44 years	-0.009	(-0.032, 0.014)
African American Race:Age Group 45-64 years	0.682	(0.377, 1.009)*
"Other" Race: Age Group 45-64 years	2.540	(1.508, 3.835)*
Time:Age Group 45-64 years	-0.031	(-0.054, -0.008)*
African American Race:Age Group 65+ years	0.788	(0.481, 1.117)*
"Other" Race: Age Group 65+ years	2.813	(1.774, 4.114)*
Time:Age Group 65+ years	-0.010	(-0.033, 0.013)
African American Race:Time:Age Group 10-14 years	-0.030	(-0.118, 0.058)
"Other" Race:Time:Age Group 10-14 years	0.096	(-0.185, 0.388)
African American Race:Time:Age Group 15-19 years	-0.001	(-0.074, 0.070)
"Other" Race:Time:Age Group 15-19 years	0.210	(-0.048, 0.479)
African American Race:Time:Age Group 20-24 years	0.008	(-0.062, 0.078)
"Other" Race:Time:Age Group 20-24 years	0.152	(-0.102, 0.418)
African American Race:Time:Age Group 25-34 years	0.008	(-0.062, 0.076)
"Other" Race:Time:Age Group 25-34 years	0.160	(-0.093, 0.425)
African American Race:Time:Age Group 35-44 years	0.005	(-0.064, 0.074)
"Other" Race:Time:Age Group 35-44 years	0.183	(-0.070, 0.447)
African American Race:Time:Age Group 45-64 years	-0.002	(-0.071, 0.067)
"Other" Race:Time:Age Group 45-64 years	0.254	(0.001, 0.519)*
African American Race:Time:Age Group 65+ years	-0.003	(-0.072, 0.066)
"Other" Race:Time:Age Group 65+ years	0.317	(0.063, 0.583)*