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**Urinary Creatinine Concentrations in the US Population:  
Implications for Urinary Biological Monitoring Measurements**

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#### Abbreviations:

10<sup>th</sup> = 10<sup>th</sup> percentile of weighted distribution

90<sup>th</sup> = 90<sup>th</sup> percentile of weighted distribution

50<sup>th</sup> = 50<sup>th</sup> percentile or median of weighted distribution

BMI = body mass index

C = Celsius

CDC = Centers for Disease Control and Prevention

dL = deciliter

FFM = fat free mass

g = gram

GFR = glomerular filtration rate

kg = kilogram

MA = Mexican American

μg = microgram

mg = milligram

mL = milliliter

N = sample size

N/A = not applicable

NCHS = National Center for Health Statistics

NE = could not be reliably estimated

NH = non-Hispanic

NHANES II = The Second National Health and Nutrition Examination Survey (1976-1980)

NHANES III = The Third National Health and Nutrition Examination Survey (1988-1994)

PE = population estimate

UER = urinary excretion rate

US = United States

WHO = World Health Organization

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## **Abstract**

Biological monitoring (i.e., biomonitoring) is used to assess human exposures to environmental and workplace chemicals. Urinary biomonitoring data typically are adjusted to a constant creatinine concentration to correct for variable dilutions among spot samples. Traditionally, this approach has been used in population groups without much diversity. The inclusion of multiple demographic groups in studies using biomonitoring for exposure assessment has increased the variability in the urinary creatinine levels in these study populations. Our objectives were to document the normal range of urinary creatinine concentrations among various demographic groups, evaluate the impact that variations in creatinine concentrations can have on classifying exposure status of individuals in epidemiological studies, and recommend an approach using multiple regression to adjust for variations in creatinine in multivariate analyses.

We performed a weighted multivariate analysis of urinary creatinine concentrations in 22,245 participants of the Third National Health and Nutrition Examination Survey (1988-1994) and established reference ranges (10th to 90th percentiles) for each demographic and age category. Significant predictors of urinary creatinine concentration included age group, sex, race/ethnicity, body mass index, and fat free mass. Time-of-day that urine samples were collected made a small, but statistically significant difference, in creatinine concentrations. For an individual, the creatinine adjusted concentration of an analyte should be compared to a 'reference' range derived from persons in a similar demographic group (e.g., children with children, adults with adults). For multiple regression analysis of population groups, we recommend that the analyte concentration (unadjusted for creatinine) should be included in the analysis with urinary creatinine added as a separate independent variable. This approach allows the urinary analyte concentration to be appropriately adjusted for urinary creatinine and the statistical significance of other variables in the model to be independent of effects of creatinine concentration.