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Evaluating Small Area Differential Privacy Life Expectancy

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The decennial census provides policy-makers, researchers, and various public and private entities with high-quality geographic and demographic information. Differential privacy (DP) refers to the process of introducing random error into publicly available data products such as the decennial census. The most recent update to the U.S. Census Bureau's disclosure avoidance methodologies (DAS), known as the 'Top Down Algorithm' (TDA), utilizes DP to add error to the 2020 decennial census. Below the state level, the infusion of noise to higher levels of geography, such as the county, compounds and can further distort lower small area geographies population counts, such as the tract or block group. This means that as DP is implemented down the geographic spine from the state all the way to the block level, the error is compounded and thus, is more pronounced for lower-level geographies. This study seeks to disentangle how DP may bias neighborhood-level (census tract) life expectancy (LE) estimates and highlights the potential trade-offs between privacy-preserving methods and detecting health disparities in vulnerable populations. We calculated LE using mortality records from Florida between 2009 and 2013 for 4,175 census tracts. We then evaluate the U.S. Census Bureau's demonstration products with/without DP for two different uncertainty levels (ϵ) = 4, (ϵ) = 29.2. LE estimates characterized as biased (greater than 3 years) were temporarily assigned a value to indicate a DP biased LE estimate (e.g., '1'). Correlation coefficients were used to compare LE calculated from original (non-DP) age-specific population estimates with those from DP-infused counts. The study then analyzed the demographic and socioeconomic characteristics of census tracts with biased DP life expectancy estimates. Factors significantly correlated with increased log-odds of biased LE estimates included the % Black population (1.03, p-value < 0.001). Conversely, total population (0.21, p-value < 0.001), % female-headed households (0.86, p-value < 0.001), and % population 25+ years with no high school diploma (0.94, p-value < 0.001) exhibited significant negative associations with biased LE estimates. Future studies should consider the additional uncertainty created by DP when assessing public health interventions and tracking population health over time.

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