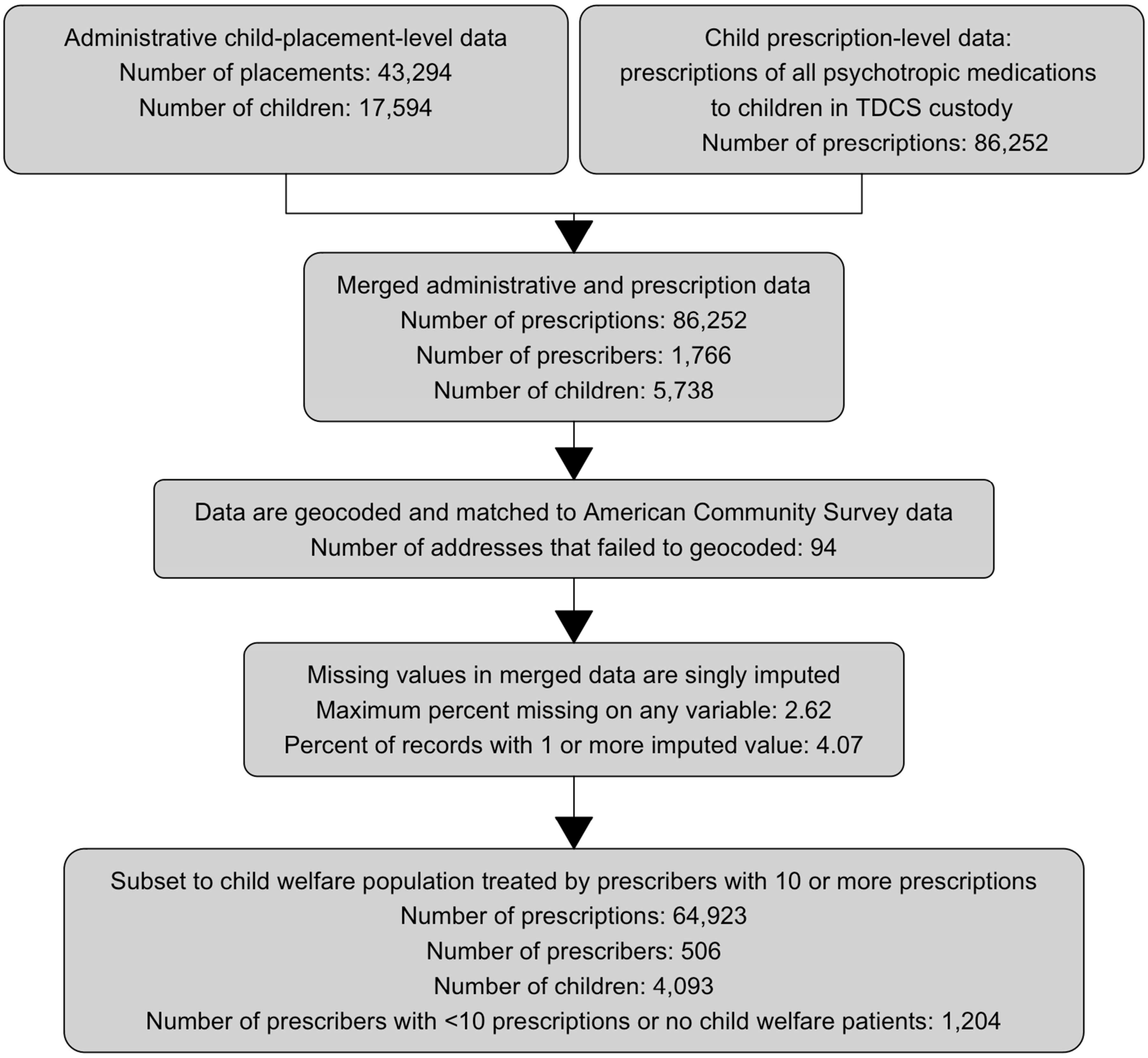

Analyses details

All continuous covariates were modeled using restricted cubic splines. Correlation between prescriptions from the same prescriber was accounted using a prescriber-level intercept. R Statistical Software was used for all analyses.

The log-odds of the jth prescription belonging to the ith provider receiving a red flag is modeled as

$$\begin{aligned} \left[y_{ij} | \beta, \gamma_i, \mathbf{x_{ij}}, \tau^2\right] &\sim \text{Bernoulli}(p_{ij}) \\ logit(p_{ij}) &= \beta_0 + \gamma_i + \mathbf{x_{ij}}\beta \\ \gamma_i &\sim N(0, \tau^2) \end{aligned}$$

Where y_{ij} is the red-flag status of the jth prescription from provider i, $\mathbf{x_{ij}}$ is the corresponding vector of basis functions for child- and prescription-level covariates, and γ_i is a random intercept for provider i.

Once the model is fit, a risk-standardized rate of red-flag prescriptions, hereafter referred to as the Standardized Prescribing Rate (SPR), is estimated for each prescriber by calculating the ratio of the predicted number of red-flagged prescriptions to the expected number of red-flagged prescriptions and multiplying by the proportion of red-flags within the population of prescribers. The predicted number of red-flags is calculated using the fitted model that includes the unique prescriber-level intercept, thereby estimating the number of red-flag prescriptions for that provider. By contrast, the expected number of red-flags excludes the prescriber-level intercept, thereby only incorporating estimates made across the entire population of prescribers. Letting P_i represent the predicted number of red-flags for provider i, E_i represent the expected number of red-flags for provider i, and mu be proportion of prescriptions receiving red-flags in the population, the SPR for provider i is calculated as

$$\begin{aligned} SPR_i &= \mu \times \frac{P_i}{E_i} \\ &= \frac{\sum_{i,j} y_{ij}}{\sum_i n_i} \times \frac{\sum_{j=1}^{n_i} E\left[y_{ij} | \beta, \gamma_i, \mathbf{x_{ij}}, \tau^2\right]}{\sum_{j=1}^{n_i} E\left[y_{ij} | \beta, \mathbf{x_{ij}}, \tau^2\right]} \end{aligned}$$

Prescribers are classified as falling into “alert” and “alarm” zones if they have adjusted risk statistics more than two and three standard deviations above the benchmark of the proportion of red-flagged prescriptions in the population, respectively. Confidence intervals about the proportion of red-flag prescriptions in the population were based on exact Poisson confidence limits. Letting $\lambda_n = n\mu$ be the expected number of red-flags at n prescriptions, the confidence limits for a size α confidence interval at n prescriptions is given as

$$CI(\mu)_n^\alpha = \left[\frac{\chi^2_{2\lambda,1-\alpha/2}}{2n}, \frac{\chi^2_{2(\lambda+1),1-\alpha/2}}{2n}\right]$$