PING YAN, Public Health Agency of Canada

A proportional incidence rate model for aggregated data on vaccine effectiveness against COVID-19 hospital/ICU admissions

We develop a proportional incidence model that estimates vaccine effectiveness (VE) at the population level using conditional likelihood for aggregated data. Our model assumes that the population counts of clinical outcomes for an infectious disease arise from a superposition of Poisson processes with different vaccination statuses. The intensity function in this model is calculated as the product of per capita incidence rate and the at-risk population size, both of which are time-dependent. We then formulate a log-linear regression model with respect to the relative risk, defined as the ratio between the per capita incidence rates of vaccinated and unvaccinated individuals. In the regression analysis, we treat the baseline incidence rate as a nuisance parameter, like the Cox proportional hazard model in survival analysis. We apply the proposed models and methods to age-stratified weekly counts of COVID-19-related hospital and ICU admissions among adults in Ontario, Canada. The data, spanning from 2021 to February 2022, encompass the Omicron era and the rollout of booster vaccine doses. We also discuss the limitations and confounding effects while advocating for the necessity of more comprehensive and timely individual-level data that document the clinical outcomes and measure potential confounders.