Heterogeneity in Rotavirus Transmission Dynamics and Impact of Vaccination in Ghana

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Background
Ghana introduced monovalent rotavirus vaccine in April 2012 and despite the high coverage, vaccine performance has been modest compared to developed countries. The predictors of low vaccine effectiveness in low- and middle-income countries, and in addition, the drivers of sub national heterogeneity in rotavirus vaccine impact are poorly understood. A better understanding of the factors that accounts for this variability could help to develop strategies to improve vaccine effectiveness and impact.

Method
We fit mathematical models to rotavirus surveillance and case-control data in children <5 years old from three different hospitals in Ghana: Korle-Bu Teaching Hospital in Accra, Komfo Anokye Teaching Hospital in Kumasi, and War Memorial Hospital in Navrongo. The models were fitted to both pre- and post-vaccine data to estimate parameters describing the transmission rate, waning of maternal immunity, and vaccine response rate.

Results
The seasonal pattern and age distribution of rotavirus cases varied among the three study sites in Ghana. Our model was able to capture the spatio-temporal variations in rotavirus incidence across the sites and showed good agreement with the observed age distribution. The estimated transmission rate was highest in Accra and lowest in Navrongo, while the duration of maternal immunity was longer (~6 months) in Accra and Kumasi and shorter (~3 months) in Navrongo. The proportion who responded to the vaccine was estimated to be high (>70%) in Accra and Kumasi and lower (<30%) in Navrongo.

Conclusions
Rotavirus vaccine impact varies within Ghana. We estimated a low vaccine response rate for Navrongo, where rotavirus is highly seasonal and incidence limited to a few months of the year. The findings highlight the need to explore the relationship between rotavirus seasonality, maternal immunity, and vaccine response rate to determine how they influence vaccine effectiveness and to develop strategies to improve vaccine impact in settings with highly seasonal rotavirus transmission.