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Epidemiology: Measles Vaccination Coverage in Africa

Wesolowski, A., Mensah, K., Brook, C. E., Andrianjafimasy, M., Winter, A., Buckee, C. O., Razafindratsimandresy, R., Tatem, A. J., Heraud, J.-M., Metcalf, C. J. E., & Al., E. (2016, April 1). *Introduction of rubella-containing-vaccine to madagascar: Implications for roll-out and local elimination*. Journal of The Royal Society Interface. Retrieved October 4, 2021, from https://royalsocietypublishing.org/doi/full/10.1098/rsif.2015.1101?etoc=.

Annotations: Wesolowski et al. focus on the implications of the rubella vaccination and use data from the measles vaccination and trends to predict this information in Madagascar. Rubella is a directly transmitted immunizing infection that occurs during childhood and has a low morbidity and mortality. The rubella-containing vaccination (RCV) is not very common in African immunization schedules, and this journal is predicting the logistics of it being implemented. Measles-rubella (MR) or a measles-mumps-rubella (MMR) is an immunization that is administered around nine months old. It is relatively inexpensive and highly efficient in preventing these diseases, and it has been around for the past fifty years. However, not everyone in Africa has access to this immunization, and it is a debate whether or not it should be administered.

Studying the measles vaccine distribution and logistics showed that it was introduced to the children vaccination program in Madagascar in 2004 and has resulted in an 85% vaccination coverage. In Madagascar, average infection of the measles occurs around age seven, but if not vaccinated early enough, it can lead to people contracting the disease at increasing ages. While determining whether to make administering RCV a priority, health officials are wondering if the advantages outweigh the risks. The advantage is that it provides a stronger investment in the measles programs, and administering it to the most vulnerable populations, child-bearing mothers and children, could greatly reduce the spread of disease. However, as birth rates increase, the burden without vaccination of congenital rubella syndrome (CRS) decreases, so RCV might not be necessary. Also, it is hard enough to get coverage for everyone to have it make a difference. Heterogenous immunization could result in increases in inequity in CRS burden.

The measles vaccine is distributed by national health authorities and nongovernmental organizations, such as UNICEF. To obtain vaccination coverage rates for Madagascar, the population was split into twenty-two regions. The routine vaccination coverage average was 77% with a low of 52% and a high of 92%. The critical community size, CCS, describes the minimum population size required to sustain the extinction boundary for an infection, but also the impact of patterns of re-introduction. The districts were focused on in this study because their smaller spatial scales were more likely to represent diverse populations. Districts within the CCS estimates of 350,000-1,000,000 were studied and then geospatial techniques were used to determine the accessibility and travel time between locations. From this they were able to determine whether districts were weakly connected, or remote. Zooming in on the population of Madagascar, as an island, it is remote and the population is sparce. Therefore, remote areas have fewer trips to other areas, and it would be less likely to spread the disease in a sparce population. Madagascar has an isolated nature, a low burden of CRS, and increased international and national public health support. Graphs show that the higher rate of vaccination, the lower the burden of CRS. After twenty years of vaccination, there is a probability of elimination that ranges from 8-15%. However, if vaccination can reach 90% in all 22 regions, the probability would increase to 39%.

Distributing the measles and RCV in Madagascar is important and dependent on the special variability in vaccine access and demography and human connectivity. Childbearing mothers and children are hit the hardest by this disease, and if 90% of the populations in the districts could get vaccinated there is a great change for elimination of the disease. Amartya Sen’s freedom of health is discussed by this topic and health and social development is what is needed in Africa.

Takahashi, S., Metcalf, C. J. E., Ferrari, M. J., Tatem, A. J., & Lessler, J. (2017, May 25). *The geography of measles vaccination in the African Great Lakes Region*. Nature News. Retrieved October 4, 2021, from https://www.nature.com/articles/ncomms15585.

Annotations: Measles continues to kill children around the world, despite the inexpensive and safe vaccine. For measles, between 90-95% of the population must be immune to stop its transmission, if the number of unvaccinated people is distributed evenly throughout a population. Measles is a virus that is spread through direct contact with an infected individual. Therefore, if there are patches of unvaccinated individuals living near each other, the rate of it spreading greatly increases. This is where the impact of spatially heterogenous vaccination is recognized. Policy makers have shifted the focus from setting country-level targets for coverage to ensuring uniformly high vaccination levels across countries to decrease the effect of the unvaccinated pockets.

Sub-Saharan Africa is where the majority of the world’s remaining measles burden is found. The occurrence was reduced by 93% by instituting the method the America’s used: routine immunization targeting children around nine months for the first dose and supplemental immunization activities (SIAs) to receive the second dose. This has not solved the problem though because there has been a resurgence due to weak routine vaccination systems and low-quality SIAs. This lack of access to quality healthcare allows the virus to infect the special clusters of unvaccinated children. In studying the demographics and special distribution of vaccination in children under five in different countries in Africa, the hope is to identify the cold spots of the lack of vaccination and create vaccination policy that will be the most effective in the regions.

The Figure of the vaccination coverage and cold spots at twenty-four months of age highlights the areas that have below a mean vaccination of 80%. Some capital cities, but mainly outside the cities, are cold spots and have a lower vaccination rate. After determining where the areas of low coverage are, the population is accessed. The study found certain areas had greater amounts of children than others in these cold spots. The number of vaccinated and unvaccinated individuals also has to be viewed in terms of the population density. There are greater chances for more cold spots and unvaccinated individuals in areas with higher populations.

Again there was significant heterogeneity in measles vaccine coverage within these Sub-Saharan countries. The approach in this study uses standard techniques with the hopes that it can be easily applied across different settings. In the effort to eliminate measles, it is important to characterize the heterogeneities. Targeting efforts at the largest sub-national administrative unit would account for the majority of sub-national variation in vaccination coverage. Spatial clustering of unvaccinated individuals and age cohorts leads to pockets where the disease can continue to thrive even if the vaccination rates increase. Access to immunizations is a critical social freedom all people deserve and will greatly increase healthcare and social development within Africa.

Cutts, F. T., Ferrari, M. J., Krause, L. K., Tatem, A. J., & Mosser, J. F. (2021, January 5). *Vaccination strategies for measles control and elimination: Time to strengthen local initiatives*. BMC Medicine. Retrieved October 4, 2021, from https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-020-01843-z.

Annotations: This article discusses that multiple African and Eastern Mediterranean countries have measles vaccination coverage below what is necessary for elimination. Geospatial estimates show the low coverage districts and a large proportion of unvaccinated children live in conflict-affected areas with remote rural areas and some urban areas. Both have little access to healthcare and have weak routine systems to effectively roll out immunizations.

The measles vaccine is capable of eliminating the disease if the world reaches herd immunity of what would ideally be 95% vaccinated. However due to weak systems and not fully putting the strategies in practice to give everyone both doses, some countries have fallen behind and their populations continue to be affected by the virus. Within countries and overtime, coverage can vary substantially. Some areas in Africa had less than 80% of the population receive the first dose of the vaccine. Remoteness, conflict, and urban slums pose problems and contribute to the inequality of the clusters of unvaccinated people. Socio-economic and cultural factors also have an effect on people’s willingness to trust the vaccine and get it. The highest incidence rates occurred in low- and middle-income countries from 2013 to 2018.

Demographic changes also have an affect on measles incidence. If the birth rate drastically increases, and the systems are slow in rolling out vaccinations, this leads to a greater density of unvaccinated children leading to an increased risk to transmit the virus. High rates of migration can have the same effect. If people are coming from areas of low vaccination and low transmission to areas of greater density of people, the transmission greatly increases and more people become infected.

In order for measles reduction to continue increasing worldwide, routine immunization needs to become more equal and efficient and SIAs need to become more effective. Vaccination services need to target the most vulnerable populations, areas, and demographics to fill the gaps and reduce the amounts of clusters of unvaccinated people. Resources need to be readily and rapidly available for those in rural areas and areas of conflict, two of the most at risk populations.

Equality and accessibility to health care is crucial to end measles outbreaks. The organizations giving out the resources need to become stronger and more prepared to help distribute the vaccine when it is needed. If greater than 95% of the population in each region can get immunized, then it will be less likely to have measles outbreaks or recurrences and there can be put an end to the virus.

Utazi, C. E., Wagai, J., Pannell, O., Cutts, F. T., Rhoda, D. A., Ferrari, M. J., Dieng, B., Oteri, J., Danovaro-Holliday, M. C., Adeniran, A., & Tatem, A. J. (2020, February 29). *Geospatial variation in measles vaccine coverage through routine and campaign strategies in Nigeria: Analysis of recent household surveys*. Vaccine. Retrieved October 4, 2021, from https://www.sciencedirect.com/science/article/pii/S0264410X20303017?via%3Dihub.

Annotations: Utazi focuses on measles vaccination rates in Nigeria and uses geolocated household survey data and covariate information to create maps of vaccination coverage. This allows us to easily see where there are fewer resources or less access to these resources that result in cold spots. The national coverage in Nigeria was greater than 50% for the past twenty years, and they have not started to introduce the second dose. SIAs were introduced in attempts to target specific age groups, nine months to fourteen years in 2005, and another one in 2017 which focused on children age nine to fifty-nine months. Because the outbreaks never ceased, the performance of routine immunizations and SIAs needed to be accessed and improved.

A two-phase sampling was done, the first consisting of selecting enumeration areas (EAs), and the second involved simple random sampling of eligible children from each EA. Data was recorded about the individuals such as age and vaccination status and then the performance of routine immunizations and SIAs were analyzed. Geospatial socio-economic, environmental, and physical covariates were also assembled and used to improve the prediction of vaccination coverage. The covariates relationships and effects on the different indicators were analyzed, and different combinations of them together were predictors for each indicator.

The vaccination maps showed significant heterogeneities in the spatial distribution of coverage before and during SIA. However, for overall SIA coverage, SIA coverage among MCV zero-dose children and coverage with at least one lifetime dose, the predicted coverage was generally higher and more spatially homogeneous. There is a figure representing the probabilities of achieving the 95% coverage on a map, showing the spots of higher probabilities in urban centers. One of the key goals of PCCS data is to identify and pinpoint areas with the lowest coverage.

Overall this source provides more of the statistical analysis on how the data was obtained and how maps were made to show the vaccination coverage across Nigeria. This mapping clearly shows the areas most in need of support and more efficient SIAs. They also show the progression of Nigeria’s measle immunization process and how we might be able to get the entire country immunized and not just certain areas.