

The impact of demographic changes on varicella and herpes zoster epidemiology in the era of universal varicella vaccination in South Korea

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Abstract

Background

Varicella-zoster virus (VZV) causes both varicella and herpes zoster (HZ). Primary infection of VZV leads to varicella, which mostly affects children. Once infected, VZV becomes latent in dorsal root ganglia, and its reactivation causes HZ later in life. The reactivation of VZV is believed to be associated with waning cell-mediated immunity, which is postulated to be boosted exogenously via re-exposure to VZV, through contact with varicella-infected individuals. Thus, reduced exposure to varicella was considered to increase the risk for HZ. Varicella incidence was reduced by universal varicella vaccination and dwindling birth rates. Since South Korea is rapidly aging society, the potential impact of demographic changes appears to be substantial. In South Korea, universal one-dose varicella vaccination was included in the National Immunization Program in 2005. We explored the impact of both vaccination and demographic changes on the epidemiology of varicella and HZ in South Korea.

Methods

We developed a deterministic compartment model to evaluate the impact of different varicella vaccination strategies on the incidence of varicella and HZ in the dynamic population using the Korean population projection data and stable population with the constant age structures since 2005. We also calculated age-standardized incidence rates of varicella and HZ during 2003-2015 using the National Health Information Database (NHID) including approximately 50 million Koreans.

Results

Mathematical modeling demonstrated the differences between the dynamic and stable population. In the dynamic population, the varicella incidence rates decreased by 37% (9.2 to 5.8 per 1000 population) and HZ increased by 152% (2.5 to 6.3 per 1000 population) from 2005 to 2065. In the dynamic population, one-dose varicella vaccination with 95% coverage resulted in 76% reduction in varicella incidence rates in 2065 whereas in the constant population, reduction by 42% was estimated. In the dynamic population, the HZ incidence rates increased by 163% from 2005 to 2050 then decreased, resulting in the overall increase by 124% between 2005 and 2065. However, in the stable population, the HZ incidence rates increased by 29% until 2025 then decreased, showing the overall decrease by 28% between 2005 and 2065.

The crude and age-standardized incidence rates which were calculated using the NHID data showed the reduction by 67% and 47%, respectively for varicella and increment by 267% and 210%, respectively for HZ between 2003 and 2015.

Conclusions

Demographic changes appear to substantially affect the epidemiology of varicella and HZ in the future in South Korea. Incorporating the demographic changes in the mathematical model will provide the better predictions and information for developing vaccination strategies against varicella and HZ.

Keywords: Demographic changes, varicella, herpes zoster, epidemiology, mathematical modeling

References

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Biography

Sun Hee Park currently works as a professor in the division of infectious diseases in Medical College, the Catholic University of Korea. She received an MD in 1999 and a PhD in 2009 from the Catholic University of Korea, and received an MPH (Epidemiology-biostatistics concentration) from Johns Hopkins Bloomberg School of Public Health in 2013. Her current research project is to develop mathematical models to predict the epidemiology of varicella-zoster virus diseases following vaccination.