

# Measuring the Benefits of Mass Vaccination Programs in the United States

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## Abstract

Measuring the Benefits of Mass Vaccination Programs in the United States: Since the late 1940s, mass vaccination programs in the USA have contributed to the significantly reduced morbidity and mortality of infectious diseases. To assist the evaluation of the benefits of mass vaccination programs, the number of individuals who would have suffered death or permanent disability in the USA in 2014, had mass vaccination never been implemented, was estimated for measles, mumps, rubella, tetanus, diphtheria, pertussis, polio, Haemophilus influenzae type b (Hib), hepatitis B, varicella, and human papillomavirus (HPV). The estimates accounted for mortality and morbidity trends observed for these infections prior to mass vaccination and the impact of advances in standard of living and health care. The estimates also considered populations with and without known factors leading to an elevated risk of permanent injury from infection. Mass vaccination prevented an estimated 20 million infections and 12,000 deaths and permanent disabilities in 2014, including 10,800 deaths and permanent disabilities in persons at elevated risk. Though 9000 of the estimated prevented deaths were from liver cirrhosis and cancer, mass vaccination programs have not, at this point, shown empirical impacts on the prevalence of those conditions. Future studies can refine these estimates, assess the impact of adjusting estimation assumptions, and consider additional risk factors that lead to heightened risk of permanent harm from infection. To measure the benefit of a mass vaccination program targeting an infectious disease, it is useful to assess what the risk of death or permanent injury would be from the disease in the absence of the mass vaccination program. There is an abundance of medical literature detailing the risks associated with infectious diseases; however, the information is scattered through dozens of sources that are often lengthy and consider only a narrow scope of the risks involved. For example, some sources describe the symptoms of a disease without specifying how many patients fully recover; other sources describe the number of deaths from an infection without addressing permanent disability in survivors. Moreover, some sources do not account for the pre-vaccine rates of decline in mortality for some infectious diseases. We tried to address these challenges in our estimates. Mass vaccination programs have been highly successful in reducing the 57 million deaths caused by infectious diseases in the world each year. The World Health Organization's (WHO) global initiatives have eradicated smallpox and reduced the incidence of measles and polio

deaths. In the last 7 years, vaccination reduced the incidence of measles-related deaths by 74%. Polio is now endemic only in four countries, as opposed to 185 countries in 1988.

In the United States, the success of mass vaccination programs may be one of the greatest public health achievements of the twentieth century. Prior to the institution of mass vaccination programs, 100,000 cases of diphtheria, whooping cough, and tetanus occurred each year. After the institution of vaccination programs, the incidence of these diseases is between 1 and 5000 cases per year. Vaccines against measles, mumps, rubella, and Haemophilus have also reduced annual disease incidence to less than 500 cases per year.

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