Editorial

Broadening Vaccine Value: Translating Comprehensive Assessment into Sustained Population Protection

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Vaccination is one of the most successful public health interventions, having substantially reduced morbidity, mortality, and disability from infectious diseases worldwide. Its contribution, however, extends beyond the prevention of individual cases and the reduction of healthcare expenditure. Vaccination can interrupt transmission, protect vulnerable populations, preserve healthcare capacity, reduce disruption to education and employment, and contribute to social and economic stability. These benefits are particularly important in the context of emerging infections, population mobility, demographic change, and increasing constraints on public health resources. Nevertheless, many of these effects remain insufficiently represented in conventional health technology assessment, while the continued investment required to maintain disease elimination is often underestimated. In this issue of Biomedical and Environmental Sciences, two studies provide complementary evidence on these questions[1,2]. Song et al. developed a comprehensive framework for vaccine value assessment, and Gong et al. examined measles seroprevalence in countries that had achieved measles elimination. Together, the studies highlight the need to broaden the assessment of vaccine value and to sustain the population protection through which that value is realized.

Conventional vaccine evaluation generally focuses on direct health outcomes, quality-adjusted life-years, and costs incurred or averted within the healthcare system. Although these measures remain essential, they do not fully capture the distinctive characteristics of vaccines. Unlike many therapeutic interventions, vaccines may benefit both vaccinated and unvaccinated individuals by reducing pathogen transmission. Their effects may also extend to healthcare delivery, household welfare, educational attainment, labor participation, health equity, and preparedness for public health emergencies. Failure to consider these broader effects may lead to an incomplete estimation of vaccine value and, consequently, insufficient investment in immunization programmes.

Song et al. address this limitation through a two-phase study combining a systematic literature review with a two-round modified Delphi process involving multidisciplinary experts[1]. The resulting framework consists of five value categories, 21 value elements, and 75 actionable value items. Traditional value elements received high levels of expert consensus, while five broader elements were identified as priorities for future integration into health technology assessment: enhancement of health-system security, macroeconomic gains, social equity and ethics, prevention of institutional disruptions, and value to other interventions. The framework therefore moves beyond the conceptual recognition of broader vaccine benefits by specifying indicators that may support their consideration in evidence generation and decision-making.

The prioritization of these elements is relevant to current immunization policy. Health-system security has received increased attention because outbreaks can place substantial pressure on clinical services and divert resources from other health priorities. Institutional disruptions, including interruption of schooling and employment, can generate consequences that are not adequately measured through healthcare expenditure alone. Equity is also central to vaccination because infectious disease burden and barriers to immunization are often concentrated among socially or geographically disadvantaged populations. Furthermore, vaccination may increase the value of other health interventions by reducing coinfections, preserving healthcare capacity, and supporting the continuity of essential services. Incorporating these effects does not imply that every element must be monetized or

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included in every assessment. Their relevance will vary according to the disease, vaccine, target population, and policy question. The framework instead provides a structured basis for determining which dimensions should be measured quantitatively and which should be considered through deliberative assessment.

The practical value of a comprehensive framework depends on the availability of appropriate evidence. Recent studies published in this journal illustrate the range of evidence relevant to vaccine assessment. A propensity score-matched test-negative study using medical data from three provinces of China estimated the real-world effectiveness of the pentavalent rotavirus vaccine and showed differences according to dose completion, time since vaccination, and disease severity[3]. Analyses of influenza vaccination have identified temporal changes in coverage and disparities across population groups, emphasizing that vaccine availability does not necessarily ensure sustained or equitable uptake[4-6]. Studies of vaccination regimens and new vaccine platforms further demonstrate the continuing importance of generating evidence on immunogenicity, effectiveness, and programme feasibility[7]. Taken together, these investigations show that vaccine value is determined not only by product characteristics, but also by access, acceptance, delivery, and performance under real-world conditions.

The study by Gong et al. provides a further perspective by examining whether population immunity is sustained after measles elimination has been achieved[2]. The authors synthesized 351 datasets involving 562,772 participants from 31 countries with verified measles elimination. The overall median seroprevalence was 92.8%, but considerable variation was observed among countries and age groups. Only 26% of the countries had seroprevalence of at least 92%, whereas 45% had levels below 85%. Seroprevalence was lowest among children aged 0–2 years and increased with age. Of particular concern, median seroprevalence in datasets from the three years before and after elimination verification was 94.9% and 83.5%, respectively. This comparison suggests that an immunity gap may persist even after elimination; interruption of endemic transmission does not necessarily guarantee the maintenance of sufficient population immunity.

Measles elimination is not a permanent endpoint, but a public health achievement that must be continuously maintained. Because measles is highly transmissible, even relatively small immunity gaps may permit transmission following virus importation. Susceptible individuals may accumulate through missed or delayed vaccination, incomplete schedules, primary vaccine failure, and population movement. In measles elimination settings, opportunities for exposure to wild-type virus and the associated immune boosting are reduced. In this setting, vaccine-induced antibody levels may decline over time[8]. National vaccination coverage can conceal substantial variation across regions, birth cohorts, and population groups. Consequently, average coverage at the national level may appear adequate while local clusters of susceptibility remain[9].

The results of seroprevalence studies require careful interpretation. Differences in sampling strategies, age distributions, laboratory assays, and thresholds for seropositivity may contribute to heterogeneity across studies. In addition, serological findings should be interpreted alongside vaccination histories, case surveillance, and assay characteristics. The absence of detectable antibodies does not necessarily indicate complete loss of protection, as immunological memory is not fully represented by routine serological measurements[8]. The observed difference between the periods before and after elimination verification should therefore not be interpreted as evidence that elimination itself caused a reduction in immunity. Rather, the study identifies population groups and settings in which protection may be insufficient and demonstrates the importance of monitoring immunity after elimination.

The two studies are closely connected from a policy perspective. Maintaining measles elimination produces benefits beyond the prevention of measles cases. It protects infants who are too young to be fully vaccinated and individuals who cannot receive measles-containing vaccines. It reduces the costs of outbreak investigation, contact tracing, emergency vaccination, laboratory testing, and infection control. It also reduces disruption to healthcare facilities, schools, households, and communities. These benefits align with broader value elements identified by Song et al., including health-system security, social equity, and prevention of institutional disruption[1]. Sustaining elimination can therefore be regarded as an important expression of vaccine value rather than merely the continuation of a previous programme achievement.

Several actions are needed to translate these

findings into public health practice. First, vaccine evaluation should consider both the initial achievement and the long-term maintenance of population protection. Surveillance, risk communication, catch-up vaccination, and outbreak preparedness are integral components of immunization value and should be reflected in programme planning and resource allocation. Second, national coverage estimates should be complemented by age-specific and subnational analyses to identify immunity gaps that may be obscured by population averages. Particular attention should be given to infants, migrants, underserved communities, and populations affected by delayed vaccination or vaccine hesitancy. Third, appropriately designed serological surveys can complement vaccination records and case-based surveillance, especially when directed toward defined programme questions. Finally, broader value elements should be considered prospectively when research and evidence-generation plans are developed, rather than retrospectively after clinical and economic evaluations have been completed.

In summary, the studies by Song et al. and Gong et al. extend the understanding of vaccine value in complementary directions. The comprehensive assessment framework provides a structured approach to recognizing health, social, and economic benefits that are often omitted from conventional evaluation. The comparative measles seroprevalence study demonstrates that the benefits of vaccination cannot be assumed to persist after elimination without continued programme effort. Broadening the assessment of vaccine value and maintaining population immunity should therefore be pursued as connected public health priorities. Through comprehensive evaluation, targeted surveillance, and sustained investment in immunization systems, the full value of vaccines can be more appropriately recognized and preserved.

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