

Comparing Vaccine Risks with Infection Risks

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Abstract

A risk associated with a vaccine is never fully understood in isolation from the risk of the infection it aims to prevent. This paper argues for a dynamic comparison that varies by age, sex, baseline immunity, disease prevalence, time since vaccination and product. It challenges both the assertion that vaccination is risk-free and the opposite assertion that any measurable vaccine harm settles the net-benefit question.

The missing counterfactual in risk debates

Risk decisions should compare the adverse effects of a vaccine with the adverse effects of the infection it is intended to prevent, in the same population and time period.

Comparative risk involves absolute rates, severity, causal attribution and context. For example, a myocarditis signal after particular mRNA vaccine doses must be considered alongside myocarditis and other harms associated with SARS-CoV-2 infection, using comparable outcome definitions and risk windows. Results from early pandemic waves cannot be assumed to apply unchanged after widespread infection-acquired immunity, variant evolution or updated formulations. An older high-risk patient and a young healthy male may have different risk-benefit profiles.

A correct comparison distinguishes individual protection, transmission effects and broader public-health outcomes while avoiding simplistic claims from relative-risk ratios alone. Absolute excess cases per dose, hospitalizations prevented, serious complications and uncertainty intervals are more useful than dramatic percentages without denominators. Time horizon matters: short-term reactogenicity, rare acute harm and longer-term disease outcomes occupy distinct categories.

Absolute infection and intervention harms

Risk comparison requires a denominator, population and time horizon. A high relative risk of a rare outcome may imply a small absolute excess, while a modest relative increase in a common severe outcome may carry substantial burden. Infection risk itself changes with circulating variants, prior immunity, exposure and available treatment; vaccine risks can vary with product formulation and dose. Therefore, a true statement about one season or age group can become misleading when quoted as a timeless rule for everyone. It is also possible for a vaccine to confer meaningful benefit overall while a particular subgroup faces a different balance.

Risk comparison is meaningful only when expressed in a common frame. A rare vaccine adverse event and a disease prevented by vaccination may differ in severity, duration, reversibility and likelihood.

Simply juxtaposing counts without standardizing exposure, population and time horizon can mislead. The appropriate comparison depends on local infection prevalence, vaccine effectiveness against relevant outcomes, individual vulnerability and the health system's capacity to detect and treat disease.

Absolute risk is crucial. A relative increase of a very rare adverse outcome may represent a small number of additional events, while a moderate reduction in a common severe infection may avert many hospitalizations. The inverse can also occur in a narrowly defined subgroup. A transparent model should show plausible ranges, sources of uncertainty and how conclusions change under different baseline infection rates rather than supply one timeless verdict.

Both sides of the comparison depend on age, immunity, local disease incidence and product performance. Serious adverse events can be real yet less common than the disease complications prevented; the balance may differ for another population or epidemiologic season. The controversial scientific standard is symmetrical accounting: identical outcome definitions, absolute numbers, uncertainty intervals and transparent assumptions rather than comparisons designed to make either side look favorable.

A population-specific comparison

An ethically serious analysis includes indirect effects such as protection of medically vulnerable contacts when evidence supports them, as well as the burdens of vaccine reactions and clinical monitoring. The design should avoid treating absence of perfect evidence as proof that either side of the comparison is risk free. A good publication allows readers to see the denominators and assumptions, makes product-specific distinctions and updates conclusions when the evidence changes.

Put risks on the same scale. Imagine comparing an adverse event reported per million doses with hospitalization attributed to an infection per hundred thousand infections. Direct comparison is misleading unless the probability of infection, vaccine effectiveness, time horizon and population are specified. The denominator for the vaccine strategy is people offered vaccination; the counterfactual is what occurs to comparable people without that strategy under the same conditions.

Heterogeneity is real. Baseline infectious risk can differ by age, season, comorbidity and epidemic conditions. So can the risk of certain vaccine reactions. A transparent analysis should show age-specific absolute estimates and uncertainty rather than asserting one net-benefit ratio for every individual across all times. It should also distinguish immediate adverse events from outcomes prevented over many months or years.

What a useful model adds. Sensitivity analyses can show the infection-incidence threshold at which the balance changes under specific assumptions, while making clear which estimates are well established and which are uncertain. This is more informative than calling a product categorically harmless or harmful. The result should guide better public understanding and clinically appropriate decisions, not present hypothetical risk scenarios as evidence that a harm has occurred.

Develop age-stratified counterfactual models incorporating infection exposure, hospitalization, death and long-term complications alongside rigorously evaluated vaccine outcomes. Present absolute expected harms under multiple plausible transmission scenarios, not just relative risk. A model incapable of changing recommendations when circumstances change is advocacy rather than risk analysis.

The relevant analytic discipline is matching comparable outcomes and risk windows. Hospitalization due to documented myocarditis should not be compared with any self-reported chest pain, nor should a broad infection outcome be compared with an arbitrarily narrow vaccine outcome. The goal is an understandable absolute-risk table that can change when evidence changes, not a permanent ideological conclusion.

Absolute risk matters more than the most dramatic anecdote

A serious vaccine reaction and a severe infection complication can both be real events. A fair decision requires estimating how many of each would occur in a defined population under different vaccination and infection scenarios. The answer may change if transmission rises, prior immunity differs or a vaccine product changes. Presenting only relative risk conceals the denominator and often inflates the intuitive meaning of a small probability. The research design should align age groups, observation windows and outcomes; a trial with short safety follow-up cannot automatically answer a long-latency question, while an observational association with infection also needs appropriate control. A model might reveal that protection is strongly favorable for one high-risk group and less decisive for another. That is not a contradiction but the expected result of conditional risk analysis. The rigorous controversial demand is transparency about assumptions on both sides, rather than a predetermined conclusion that vaccination is always dangerous or always harmless.

Transparent assumptions instead of slogans

A counterfactual risk calculation should report events per comparable number of people over a comparable period, not switch freely between events per infection, per dose and per population. For the no-vaccination scenario, infection probability and disease severity are crucial. For vaccination, effectiveness, waning and product-specific adverse events matter. Age and comorbidity can change both sides of the calculation, so one estimate cannot speak for everyone. Uncertainty should be represented by ranges and sensitivity analyses rather than hidden behind a single rounded number. A study should also distinguish risk of infection from risk of severe outcomes conditional on infection. The objective is not to produce an ideologically satisfying answer but to show which empirical inputs dominate the choice. A transparent net-risk model helps readers understand the real benefits, established adverse effects and remaining uncertainty without conflating them.

Neither side may cherry-pick only favorable time windows, ignore prior infection or use noncomparable clinical endpoints. Evidence concerning one product cannot be generalized to all vaccines, and an observed benefit cannot erase a serious adverse effect in an identifiable subgroup. The relationship between population recommendation and individual preference deserves careful explanation.

This paper offers readers a framework for making sense of changing evidence without retreating into blanket slogans. Its core standard is reciprocal rigor: the same causal scrutiny must be applied to the vaccine and to the infection. The medically relevant answer is product-, person- and time-specific.

Sources and research leads

1. Patone et al. Risks of myocarditis, pericarditis, and arrhythmias associated with COVID-19 vaccination or SARS-CoV-2 infection
2. Hviid et al. Measles, Mumps, Rubella Vaccination and Autism: A Nationwide Cohort Study

Editorial status: Third-pass conceptual research manuscript. The argument has been individually strengthened and shared boilerplate removed. Original reference leads were retained; a complete independent source-by-source scholarly verification has not been performed. No new clinical trial data are presented.