



rapport

A Vaccine for your Mind

**The science and safety behind
our greatest public health tools**

By RA Capital Management's Infectious Disease Team

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The public has taken a renewed interest in discussing vaccines, with many people asking to be convinced that vaccines are safe and effective enough to be used as widely as modern medicine recommends.

In the hope of reaching some more people seeking answers to common questions, we've prepared this Q&A document. Medicine is complicated, and the current discourse is noisy, but it's possible to bridge the gap between experts and patients by breaking down the jargon. We'll try to do that here.

We wrote this with our own friends and families in mind because we believe that everyone should be able to get clear answers to their questions. We hope it is useful to you.

WHO WE ARE

We are virologists and immunologists who understand the studies that have shaped modern medicine. We are investors who evaluate scientific ideas and fund the development of new medicines – but we are also communicators. We have to be. Developing novel medicines requires so many people and so much money that you have to be good at explaining your ideas to others and overcoming their skepticism if you hope to win people over to working with you and investing with you in those ideas.

WHAT'S NEW IN THIS DOCUMENT THAT'S NOT ALREADY AVAILABLE?

Arguably nothing here is new information. There are so many resources out there – scientific journals and societies, the news media, and government web sites, for example – to address just about any question anyone might have about vaccines that we questioned whether we needed to do this. But since there are so many people resurfacing mis-information every day, chipping away at the public's confidence in vaccines, we wanted to lend our voices and effort to surface and defend the real science and facts that hopefully help preserve public confidence in vaccines.

It's like providing a dose of an intellectual vaccine against the harms of anti-vaccine misinformation. And as long as new strains of misinformation continue to emerge every year, we'll need to continually boost the public's intellectual immunity against them.

HERE ARE SOME OTHER PLAINLY WRITTEN SOURCES OF INFORMATION:

- **FDA** - The Food and Drug Administration (FDA) reviews all new vaccines and decides what is good enough to allow on the market.
- **CDC** - The Centers for Disease Control (CDC) monitor infectious diseases and vaccine safety after vaccines launch.
- **Pubmed** - a searchable database containing just about all the medical research that's been conducted and published over many decades. Not all papers are well-written, and not all studies are well-conducted. There's plenty of fraud out there. That's why science demands that theories hold up across multiple well-conducted studies. [Here's a link to over 40k papers that relate to "vaccine safety."](#)
- **Vaxopedia**: website created by a physician, Dr. Vincent Iannelli. He has exhaustively cataloged vaccine information and misinformation and presents detailed responses about nearly any topic you can think of related to vaccines that should reassure anyone about their net benefits.

Executive Summary

The main thing to keep in mind about vaccines is how effective they are. In a [2023 retrospective study](#), the CDC estimated that routine childhood immunization in the United States averted more than 32 million hospitalizations, 1.1 million deaths, and 508 million lifetime illnesses from the 117 million children born over the last 30 years. Put another way, vaccines prevent roughly 28,000 severe complications (1,000 deaths; 27,000 hospitalizations) per 100,000 US kids who are vaccinated.

Vaccines save lives, prevent permanent disability, avoid hospitalizations, preserve productivity, and save money.

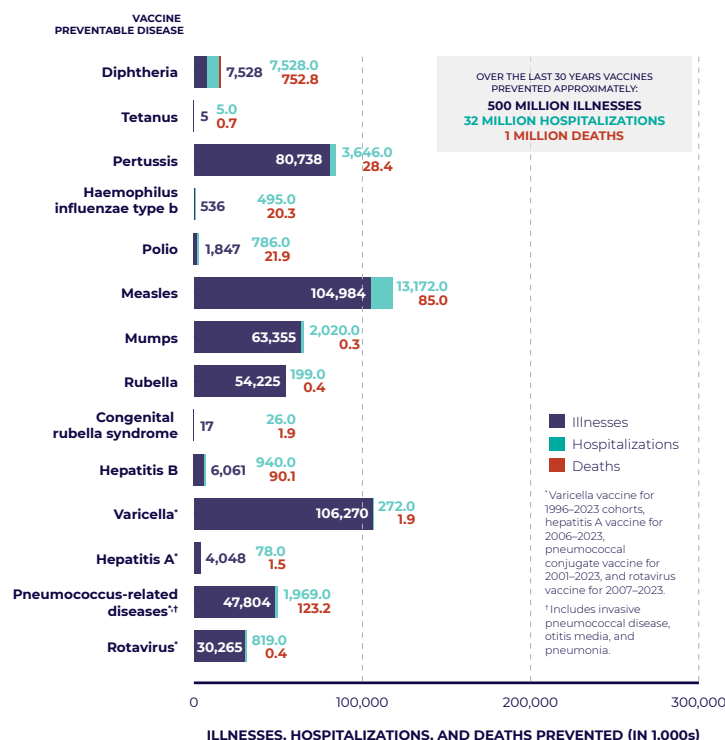
Vaccines do have some side effects. From the considerable data we have on vaccines, we know the risks of serious side effects are so low that their benefits far outweigh their risks.

Nothing in this world is risk-free. Just driving our kids to school or putting them on the school bus poses a risk to them. But we do all that we do because life is not just about avoiding risks. It's about accepting the risks that are worth accepting to get the benefits of whatever we do. So we drive – a lot. We let our kids ride bikes. They play on trampolines and use social media. We have dogs despite the risks.

Sometimes we make mistakes about risks and adjust course. We are always assessing risks. But to avoid all risk is to avoid life itself. There are countless ways to juggle the benefits and risks of life. Most would agree that car seats are worth their inconvenience. In fact, in every US state, their benefits are considered so clear that they are mandatory, for the benefit of children, which is to say for all our benefit. Airbags are also mandatory, even though they can [deploy when a car hits a pothole](#) and can injure a passenger; but the benefits outweigh the risks.

So like so much else in life, when you consider whether vaccines make sense, be sure to start with their benefits, for you and your children. Only with the benefit in mind can you consider whether the risks, both known and unknown, are worth accepting. We think that the data will

FIGURE 1:
Prevention of morbidity and mortality from childhood vaccinations



SOURCE: CDC Morbidity and Mortality Weekly Report

reassure you that it makes a lot of sense to get kids vaccinated per widely accepted medical guidelines.

And when you hear discussion of scary things like mercury, aluminum, autism, or asthma, all of which we address head-on (here's the short version: pediatric vaccines don't contain mercury and mercury levels are low in vaccines that contain mercury; aluminum levels are very low in vaccines and not shown to cause any problems; no vaccines cause autism and, if anything, data show vaccination correlated with less autism; and there's likely no link to asthma), **be sure to consider all of that not in isolation but in the context of the known benefits of vaccines.**

We know how small vaccines' risks are and those risks are well worth accepting considering the huge benefits to us and our children and society as a whole. Everything else you'll read below is just a detail that fits with that overarching conclusion about the favorable benefit-risk of vaccines. Read on to learn more.

READ ON TO LEARN MORE, WE'LL DISCUSS:

- Whether vaccines cause autism,
- Whether people should worry about mercury and alum in vaccines,
- Whether vaccines are tested versus placebos and how they are developed and approved by the FDA,
- What the true benefit of vaccines might be,
- To what extent vaccine companies are shielded from liability when someone is injured by their product,
- Why do we and our kids need certain vaccines and so many of them.

Hopefully we cover the topics you're interested in, but if not [just let us know](#), and we will try to address any additional concerns.

THIS IS A LONG DOCUMENT BECAUSE THERE ARE A LOT OF QUESTIONS, BUT HERE ARE THE ANSWERS YOU'LL FIND BELOW:

- We have many highly useful and proven effective vaccines that are safe enough that it's better to get them than to take the risk of the infection that the vaccine protects against.
- Nothing is ever perfect. Vaccines do have some side effects. But so do viruses and bacteria. We don't have the luxury of demanding perfection from vaccines because the virus or bacteria that each vaccine protects against is just waiting for us to stop vaccinating so it can cause us a lot more harm.
- Mercury used to be used in vaccines at very low and safe levels but has since been removed from nearly all vaccines to placate the public. That kind of mercury (thimerosal) doesn't linger in the body and the amount in one dose of a vaccine was about as much as you'll get from eating a tuna fish sandwich. So mercury is a non-issue when it comes to vaccines.
- Many vaccines contain very tiny quantities of aluminum (far below what's considered toxic) that boost their effectiveness. There are some signals that even the small amount of

aluminum present in vaccines may slightly tip the immune system towards or away from certain kinds of autoimmune disorders (toward asthma, away from type 1 diabetes). This is speculative for now and, if real, the rate is very low and doesn't compare to the huge benefit of vaccines.

- While vaccines do stimulate our immune systems, our bodies are exposed to countless pathogens on a regular basis that stimulate our immune systems more than most vaccines do. So while the number of vaccines that we get over our lifetime may seem high, it's not a big deal for our bodies.
- A lot of concerns about vaccines arise from seeing correlations. But correlations are not the same as one thing causing another. For example, at the same time that the rate of autism diagnosis has been climbing, so has the consumption of organic foods and use of cell phones. We see correlations all around us but it's important to differentiate just coincidence from one thing causing another. There are about 4 million babies born each year in the US and almost all get vaccinations. About 3% (120k) will be diagnosed with autism spectrum disorder, which guarantees that just by chance there will be thousands of kids who manifest symptoms within days of getting a shot, and yet that doesn't mean one thing caused another. People see something special in things that seem improbable, but when we're talking about millions of people, improbable things are certain. Have you ever met someone born on the same day as you? That would feel special. But with 4 million people born per year in the US alone and only 365 days in a year, there are going to be 10,000 people born on any given day. And yet, when it's your child who is diagnosed with autism within days of getting a vaccine, it's understandable if you might wonder if it was more than chance.
- Vaccines are regulated by the FDA and have to go through rigorous trials; the first of any vaccine type must be better than placebo. All improved versions of any vaccine type must prove themselves against earlier versions (not placebo). And vaccine development does not stop with FDA approval; they continue to be monitored for efficacy and safety after they launch. Sometimes we discover that a vaccine causes harm and we stop using that vaccine. The people who cast doubt on vaccines by calling for "more data" tend to ignore the tremendous amounts of data we already have.
- To reduce the risk of companies getting out of the business of making vaccines because of frivolous lawsuits, Congress set up in the 1980s a vaccine fund that can compensate people who petition a specialized vaccine court with claims of being harmed by a vaccine. But people who aren't satisfied with this process can still sue drug companies. Companies are still held accountable for the safety and quality of their vaccines, not just by the FDA but also by the threat of lawsuits. But making everyone first go through the vaccine court is how everyone who wants to be able to count on vaccines being available can count on those vaccines to still be made even when lots of people try to sue the company based on misinformation that the vaccine causes autism.

Those are the main insights you'll find here. But we get into data, stories, and more below.

So let's dive into the questions that keep coming up related to the effectiveness and safety of vaccines, particularly those that are given to infants and children. While the discussions are new, the topics have been around for some time; we've heard most of them before. In fact, most of these issues have mountains of high quality data that either resolve any debate, or point strongly in favor of one conclusion (remember, given the known threat of pathogens, we don't always have the luxury of certainty and perfect knowledge). We provide references for everything so that you can check our work.

Questions & Answers

1. AUTISM RISK

Key takeaways:

- The idea that vaccines cause autism originated from a fraudulent 1998 study by Andrew Wakefield that contained only 12 biased participants and was funded by lawyers intending to sue vaccine manufacturers.
- Large-scale studies show no link between vaccines and autism and, if anything, the data show that vaccinated children have a lower rate of autism, not that anyone considers that a reason to vaccinate because there's likely no cause/effect relationship.
- Thimerosal, a mercury-based preservative once used in vaccines (removed in 2001 to reassure the public), has been extensively studied and shown to have no link to autism.
- Autism diagnoses are increasing primarily due to expanded diagnostic criteria, greater awareness, increased screening, and potentially people having kids at an older age.

QUESTION: I heard that vaccines cause autism, is this true? Wasn't there a high-profile scientific publication showing a link between vaccines and autism? What about mercury in childhood vaccines, might that be the cause of autism?

ANSWER: NO, vaccines do not cause autism. This is an important and common question. Addressing the fear of potential long-term side effects is key to overcoming vaccine hesitancy. Due to its importance, we will start by answering it with a clear NO.

QUESTION: If vaccines don't cause autism, why do I still hear about this?

ANSWER: As the saying goes, a lie travels halfway around the world before the truth can get its boots on. The fuse for this particular lie was lit about 25 years ago by Andrew Wakefield's [paper](#) in The Lancet. This study attempted to link administration of the measles, mumps, and rubella vaccine (MMR vaccine) in infants to autism onset, [and it indeed was a lie](#) (we explain how it was a lie below in response to the next question).

This paper set off a media firestorm. As fear of the vaccine-autism link gained steam in the US, congressional hearings were held to debate its possibility. The New York Times published stories about Wakefield, and he appeared on 60 Minutes to discuss what he called an [epidemic of autism](#).

Robert F. Kennedy Jr., our new Secretary of HHS, promoted a link between vaccines and autism (specifically thimerosal, a preservative used in some vaccines) in his 2005 article "[Deadly Immunity](#)" published in Salon and Rolling Stone. Salon eventually pulled the article from its website, [citing](#) multiple inaccuracies and an erosion of faith in the story's value. ([Here's](#) a critical dismantling of the article if you're interested.)

Finally, in 2007, Dave Weldon, our presumptive head of the CDC, published an [introduction](#) to his Bill titled "The Vaccine Safety and Public Confidence Assurance Act of 2007." In this piece, Weldon contradicts himself by promoting a link between vaccines and autism while simultaneously dismissing independent research that disproves this connection yet claiming his support for such independent research.

And so you still hear about vaccines causing autism because a high-profile paper was published in a credible medical journal and the media, Congress, and anti-vaccine groups around the world amplified its message such that the paper and its findings are still referenced today, despite the paper's known fraudulence.

Perhaps the key lesson in all this is that even seemingly credible journals like the Lancet can make mistakes. That's no secret. In fact, that's why research must be published: so that it can be debated. And there has been plenty of such debates that have discredited the Wakefield paper both by pointing out the flaws in the Wakefield [study](#) and by pointing to additional data from other studies. See below.

QUESTION: Why do you call the Wakefield Lancet paper a lie, especially if the media covered it so closely?

ANSWER: The **1998 Wakefield paper** that attempted to link MMR vaccination in infants to the onset of autism was [retracted in 2010](#), which means that the Lancet recognized that it had made a mistake in allowing it to be published given all its flaws. Andrew Wakefield's controversial assertions about the measles vaccine causing autism have been consistently discredited by the scientific community.

The infamous 1998 Lancet paper speculated that the measles vaccine component could breach the gut-blood barrier, affecting the brain and leading to autism – a theory rooted in unsubstantiated evidence and poor study design. Wakefield's 1998 hypothesis was deemed baseless by the UK's Medical Research Council.

The paper was based on flawed data from only **12 patients** that were recruited to participate by groups that publicly denounce vaccination, resulting in heavy biasing of the subjects. **While the paper's retraction is often cited to debunk this claim, the media does not do a particularly good job in highlighting the deliberate fraud and data manipulation that fueled this misinformation. The Wakefield Lancet paper was [outright fraud](#), littered with scientific and clinical trial misconduct, and rife with conflicts of interest.**

Wakefield wanted to make it seem like vaccines caused autism and he designed the study to show it. This isn't how one does a scientific experiment. It's propaganda. These shortcomings underscore the lack of scientific rigor in Wakefield's work and led to its subsequent debunking. As a result, Wakefield had his medical license stripped by the General Medical Council in the UK.

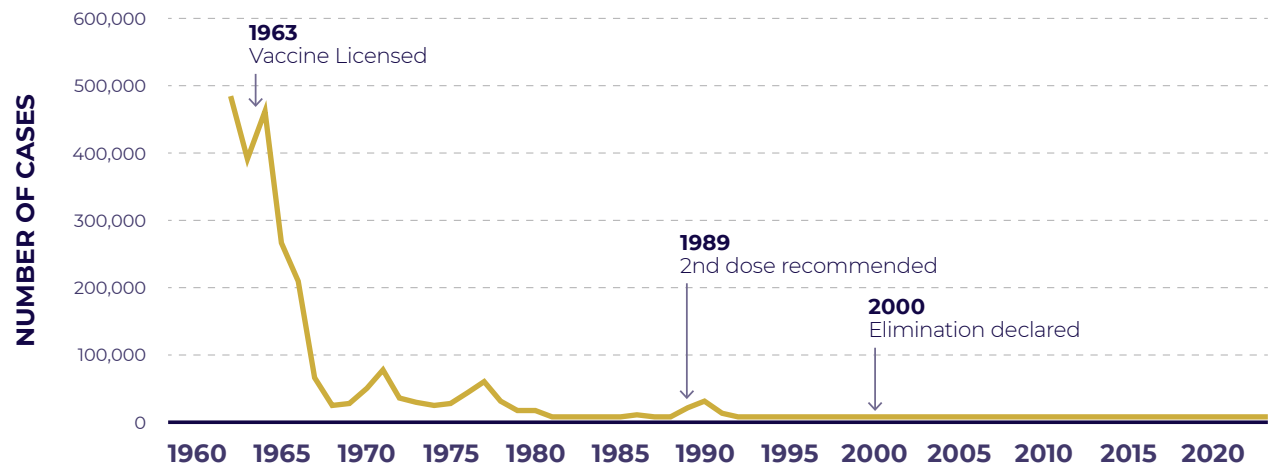
Wakefield was funded by a lawyer who, even before the paper was written, planned to use it to sue vaccine manufacturers. This lawyer [coached](#) Wakefield to produce "unassailable evidence in court...that these vaccines are dangerous." Further, Wakefield had [patents](#) published for a "safer" MMR vaccine that he would try to fund and profit from after claiming a link between autism and the currently used MMR vaccine. Brian Deer, an investigative journalist, uncovered this scam. You can read about it on his [website](#), on the [BMJ website](#), or in his book titled, The Doctor who Fooled the World. The Wakefield fraud and media sensationalism around the publication was also covered in Seth Mnookin's book, [The Panic Virus](#).

QUESTION: Okay, so the Wakefield paper that linked the MMR vaccine to autism was a crock. But can you prove that vaccines don't cause autism?

ANSWER: Vaccine-hesitant groups often point out that we don't have a study where participants are randomly assigned to different groups to test if MMR vaccinations (or the full panel of childhood vaccinations) causes autism at a higher rate than no vaccination. One group gets the actual treatment being studied, while another group gets a fake treatment (a placebo) that doesn't have any active ingredients. The participants don't know which group they're in, and researchers track their health over time to see if the treatment works and if it's safe. This is called a prospective, placebo-controlled, randomized clinical trial. The MMR vaccine used today was introduced in 1971 and has been given to more than 100 million people. The MMR/autism controversy reached a fever pitch in the early 2000s, ~30 years into its regular use.

At this point, it would be logistically difficult and highly unethical to prospectively randomize infants to not take the MMR vaccine given the vaccination rate is north of 90% and, importantly, we know it is [highly effective](#) in preventing measles infections, morbidity, and mortality, as demonstrated in **FIGURE 2**.

FIGURE 2:
**Reported Measles Cases in the United States
from 1962-2023***



SOURCE: [CDC](#)

Can you imagine talking a mother into enrolling her newborn into a trial with a 50% chance that the baby won't be vaccinated? Not only would the vast majority of parents refuse such a trial so that their babies can get the proven benefits of vaccines, but doctors and ethicists would refuse to even allow such a trial to be conducted because we know that vaccines do far more good than harm.

But that doesn't mean that we don't have more data.

Longitudinal studies have consistently affirmed the safety of vaccines, effectively debunking misconceptions and highlighting the robustness of vaccine safety monitoring systems. A comprehensive [study](#) involving over **95,000 children**, including approximately 2,000 considered at high risk for autism due to an affected sibling, found no link between MMR vaccination and autism spectrum disorders.

Some children don't get vaccinated, due to multiple reasons including lack of access or information, fear of needles, religious reasons, or their parents' concerns about vaccines. And while comparing what happens with those children to what happens to the majority who do get vaccinated can't be considered a randomized study or a blinded one (in which people don't know whether they are or aren't getting vaccinated), it's still possible to compare what happens in these two groups.

For example, A [study published in 2002](#) in NEJM analyzed a set of **537,303 children** in the Danish Civil Registration System. The researchers knew from the medical records who got an MMR vaccination and who got an autism diagnosis. In this cohort 440,655 (82%) had received the MMR vaccine; 96,648 (18%) did not receive the MMR vaccine. Notice that at this time in Denmark, the MMR vaccination rate was lower than in the US, where it's >90%.

The [study](#) identified 316 children with a diagnosis of autism and 422 with autism spectrum disorders. The researchers found that there was a relative risk of autism of 0.92 in the vaccinated compared to unvaccinated children, and a 0.83 relative risk for autism spectrum disorder in the vaccinated compared to unvaccinated children.

This means there was a **~10% greater risk of autism in the unvaccinated cohort, and a ~20% greater risk of autism spectrum disorder in the unvaccinated group.**

This does not mean that MMR vaccines reduce the risk of autism. The results were not statistically significant and could be due to chance alone. Just random fluctuations. But while it doesn't prove that MMR vaccine reduces the risk of autism, it certainly shows no hint of MMR vaccine causing autism.

Additional studies can be found [here](#), [here](#), [here](#) and [here](#).

QUESTION: Well that was just the MMR vaccine, I also read that RFK Jr and Dave Weldon say that other pediatric vaccines are formulated with thimerosal, which contains mercury, which is likely causing autism.

ANSWER:

TO THIS WE HAVE TWO OBSERVATIONS:

1. As with MMR vaccines, thimerosal has been shown to not be associated with an increased risk of autism in children. We'll show this.
2. Thimerosal, a preservative, is no longer used in pediatric vaccines, largely to reassure the public and since there were other ways of preserving vaccines. For context, the amount of mercury in a vaccine dose containing thimerosal is comparable to the amount of mercury a person would ingest from eating a few ounces of tuna fish (e.g., a tuna fish sandwich).

So thimerosal is currently a non-issue. But still, let's investigate whether it ever was.

Thimerosal is a mercury-based preservative historically used in vaccines to prevent bacterial and fungal contamination. It has a long track record of safety; extensive safety reviews by the FDA and CDC showed no link between thimerosal and autism or other health risks. Still, public concerns about mercury exposure led to its removal or reduction to trace levels in most US vaccines for children under six by 2001. Its removal was not due to particular safety concerns but to assuage the public and preserve public confidence in vaccines. Today, only some multi-dose flu vaccine vials still contain it, with preservative-free alternatives available.

Not all mercury is the same and equally scary. It is important to understand that thimerosal contains ethylmercury, an organic compound that is broken down in the body and eliminated. This is [not the type](#) of mercury that can cause [neurodegenerative problems](#). Further, multiple retrospective cohort studies have debunked the connection between thimerosal and autism.

- First, a [study](#) out of Canada published in 2006 looked at a **group of almost 28,000 children** born from 1987 to 1998. The study compared three groups: children born from 1987-1991 whose ethylmercury exposure was 100-125 µg, children born from 1992 to 1995 whose ethylmercury exposure was 200-225 µg, and children born from 1996 onward who had no ethylmercury exposure because thimerosal was entirely discontinued in the study region. All analyses from this paper indicated there was no connection between ethylmercury exposure and autism.
- Another [study](#) from Denmark was published in JAMA in 2003 **looking at 467,450** children and comparing those that were vaccinated with a thimerosal-containing vaccine to those vaccinated with a thimerosal-free formulation of the same vaccine. This study also concluded there was no link between thimerosal and autism or association between increasing doses of thimerosal and autism.
- Note, there are many more studies that corroborate the above, showing that mercury/thimerosal from vaccines does not cause autism. Find many of those studies at the CHOP [website](#) here.
- The [FDA has a web page](#) with a lot of information about thimerosal. Here's a useful insight from that page:

A vaccine containing 0.01% thimerosal as a preservative contains 50 micrograms of thimerosal per 0.5 mL dose or approximately 25 micrograms of mercury per 0.5 mL dose. For comparison, this is roughly the same amount of elemental mercury contained in a 3 ounce can of tuna fish.

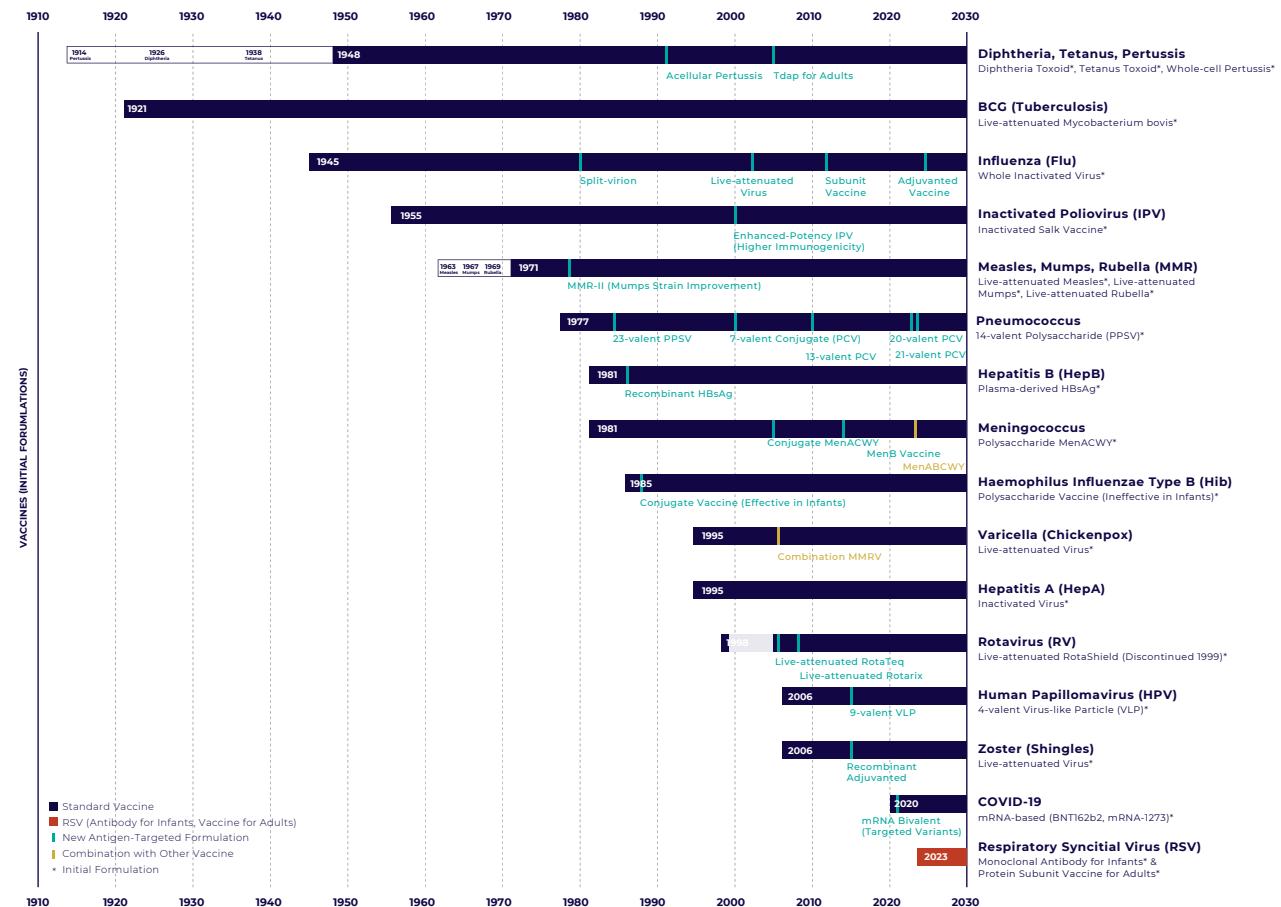
QUESTION: Okay, so MMR vaccinations do not cause autism, and thimerosal in vaccines does not cause autism, but what about vaccines in general? We give our babies so many vaccines now. Could autism be caused by the sheer number of vaccines we give?

ANSWER: Some of the studies listed above already addressed this question, because they included a follow-up period where the subjects were dosed with multiple vaccines. Those studies saw no evidence of vaccines causing autism.

Nevertheless, we would make the point that vaccines have improved over the years, with newer vaccines designed to induce a targeted immune response against specific antigens that will provide protection against an infection. The many improvements in vaccines over the years is illustrated in **FIGURE 3**. For example, the first hepatitis B vaccine was licensed in 1981 and consisted of a protein called HBsAg purified from the plasma of individuals who had chronic hepatitis B infection. However, this meant the vaccine also contained multiple other hepatitis B antigens that would all induce immune responses. By 1986, vaccines had shifted toward [purified HBsAg](#) that was expressed in cells, resulting in greater purity, safety, and protective immune responses.

FIGURE 3:

Continuous improvement of vaccines: safer and more effective versions are developed over time



SOURCE: CDC, FDA, WHO

Additionally, we present a [study](#) published in 2014 in the journal Vaccine. This was a meta-analysis of qualified cohort and case-control studies that existed in the scientific literature up until April 2014. A meta-analysis involves finding a bunch of clinical trials that are asking the same question, adding up their answers, and seeing what answer they give in their totality – giving more reliable results than just looking at one study.

This meta-analysis covered over 1.25 million children in total and concluded that vaccines are not associated with the development of autism or autism spectrum disorder (ASD). If anything, the trend went the other way, with vaccination being associated with a lower rate of autism or ASD.

A COUPLE OF ADDITIONAL COMMON SENSE POINTS:

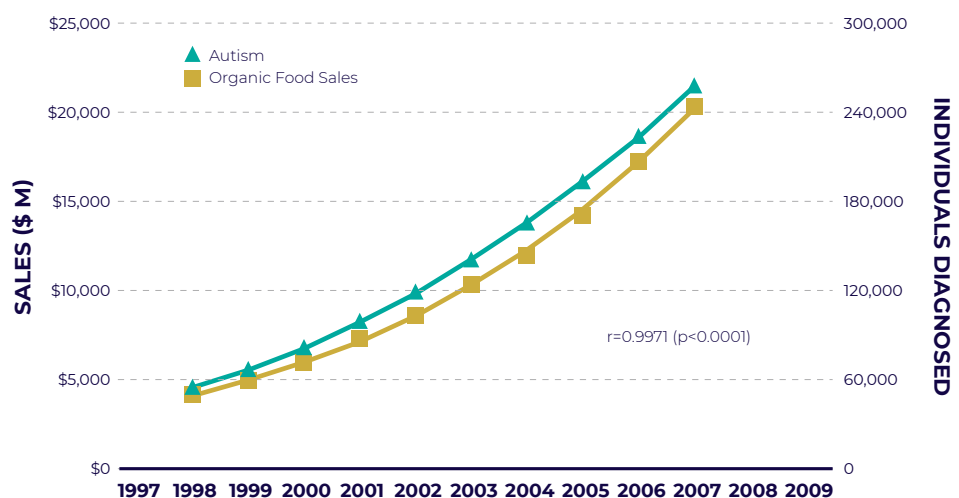
- The incidence of autism in the US in children born before 2001 was <1%. In 2001, thimerosal was removed from all recommended childhood vaccines. The incidence of autism in

children born a decade after thimerosal was removed was 2-3%. Based on these data, you would think we should add thimerosal back to vaccines, because there is now more autism after thimerosal was removed from vaccines. Of course this is not the correct conclusion because thimerosal does not cause or prevent autism. What's really happening is that parents and doctors are [more attentive](#) to diagnosing autism and autism spectrum disorders. As Bill Gates [has observed about himself](#), if he had been a child today, he probably would have been diagnosed with ASD. But back then, no one put a name to his symptoms.

- Children born in 2012 were twice as likely to have autism (according to [diagnosis rates](#)) as kids born in 2004. Only one additional vaccine was added to the childhood vaccination schedule between 2004 and 2012. It is highly unlikely that one additional vaccine caused a doubling of autism in the US. The simplest explanation remains that we're just looking for autism and therefore seeing it in more kids.
- The argument that vaccines cause autism is at least partially driven by an incorrect assertion that correlation equals causation. Pointing out that there are more vaccinations in infants and a higher incidence of autism in no way supports that more vaccinations caused more autism. It's like saying more vaccination resulted in an increase in YouTube viewership and more kids being bilingual. Conversely, perhaps the increase in autism diagnoses is driven by the increase in organic food consumption (correlation shown in **FIGURE 4**), or obesity, or mothers listening to podcasts while pregnant. Those correlations are probably a bit easier to disentangle, but they drive home the point that without data you cannot reliably say one causes the other. With vaccines, we have data saying they do not cause autism and there is no data showing that they do.

FIGURE 4:

Parallel trends in autism diagnoses and organic food sales illustrate correlation without causation



SOURCE: Organic Trade Association; US Department of Education.

If the evidence we already have showing that vaccines do not cause autism is not enough for someone, then there's no amount of evidence that will convince them. We can't explain why someone can't be convinced with the available data, but reasons may include that they don't understand scientific data, believe that all evidence is somehow faked by a global conspiracy to push vaccines, or simply have been so vocal about their belief that vaccines cause autism that they have too much to lose by acknowledging that they were wrong.

QUESTION: So, if not vaccines, why is the incidence of autism increasing over time in the US?

ANSWER: The simplest explanation is that we are diagnosing more of it. You don't see what you don't look for. We're more attentive to symptoms and increasingly labeling them and assigning them to diseases. So it can appear that the rate of many diseases is going up. This is true not only of autism but prostate cancer and breast cancer.

The formal diagnostic framework for psychiatric disorders in the United States began with the publication of the first Diagnostic and Statistical Manual of Mental Disorders (DSM) in 1952. However, autism did not appear in this early classification system until 1968, when it was categorized as part of schizophrenia in the DSM-II. It wasn't until the third edition, in 1980, that "infantile autism" was recognized as a distinct diagnostic category. By 1987, the term was further refined to "autistic disorder," reflecting evolving clinical understanding. Finally, in 2013, DSM-V [broadened](#) the diagnostic criteria of autism spectrum disorders (ASDs) to include Asperger's Syndrome and other pervasive developmental disorders.

This broadening classification, coupled with increasing awareness and a societal move toward destigmatizing mental health disorders, played a significant role in the growing number of autism diagnoses. Decoupling autism from schizophrenia not only clarified its clinical identity but also reduced the associated taboos. Additionally, the rise in adolescent psychiatry brought greater expertise to the diagnosis and care of children with developmental disorders. There has also been a significant increase in formal screening, as the [American Academy of Pediatrics](#) recommends all children are screened at 18 and 24 month check-ups. Searching/screening more intensely for any particular condition will ultimately lead to more diagnoses.

Policy changes also contributed to the increased diagnosis of autism. Advocacy and lobbying efforts enabled many middle-class families to access Medicaid assistance for autism treatment, incentivizing more diagnostic efforts. **For some children, an autism diagnosis became a pathway to accessing educational and therapeutic resources.** As renowned child psychiatrist Judith L. Rapoport, author of *The Boy Who Couldn't Stop Washing: The Experience and Treatment of Obsessive-Compulsive Disorder*, famously remarked, "I will call a child a zebra if it will get him the educational services I think he needs."

However, this surge in autism diagnoses raises important questions about diagnostic precision. The broadening of diagnostic criteria has led to what some experts describe as "diagnostic creep," encompassing individuals who may not meet the stricter definitions of autism used in earlier decades. This trend, while beneficial in some cases, has also risked overdiagnosis and the inclusion of individuals who may not fit the core characteristics of autism.

However, the rising prevalence of autism is not solely attributable to changes in diagnostic practices. Other factors, such as advancing [maternal](#) and [paternal](#) age at conception, are also thought to play a role. As a person gets older, there is something about the way that egg and

sperm are produced that results in a greater risk of genetic changes that lead to a higher probability of autism.

There may be other factors at play, but what we have plenty of data on is that vaccines do not cause autism.

2. ALUMINUM

Key takeaways:

- There is no strong evidence that aluminum in vaccines is linked to health risks.
- Vaccines prevent far more harm than any hypothetical risks – per 100,000 vaccinated children, 28,000 severe complications are prevented.

QUESTION: I've heard that infant vaccines contain aluminum and that it may be harmful. Why is aluminum necessary and how much aluminum is in vaccines?

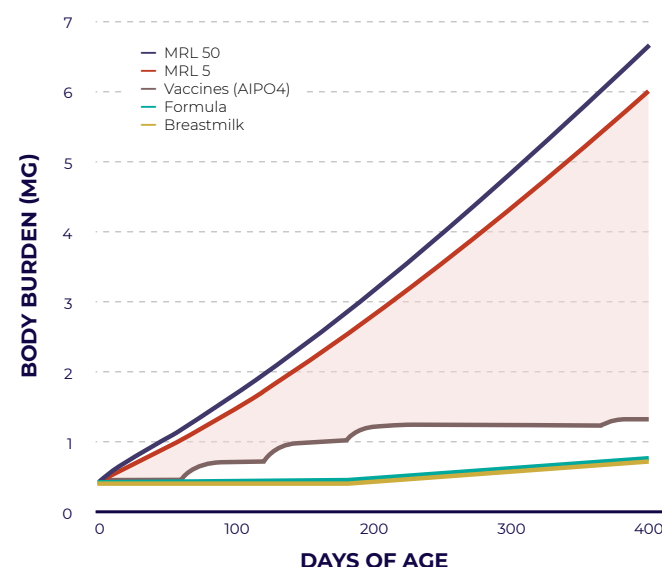
ANSWER: Yes, multiple vaccines recommended for children and for adults contain aluminum. Vaccines are defined by the antigen they include, which looks like the virus or bacteria that the vaccine protects against. Aluminum is included in vaccines as an [adjuvant](#), which is a component of the vaccine that makes it more effective by alerting the immune system that it should pay attention to the antigen and make antibodies against it.

At high levels, aluminum can be toxic. But vaccines expose us to low amounts that our bodies can clear safely.

When a vaccine containing aluminum is injected into a patient, it is absorbed into the blood from the injection site and soon cleared. Half of what's absorbed is gone within 1-2 days. Over time, the remainder of the aluminum at the injection site is slowly absorbed and cleared out of our system. Since we have a good idea of how long it takes for aluminum to get absorbed and cleared from the body, and we have a good idea for what levels would be considered toxic, scientists can calculate how much aluminum gets absorbed following injections of vaccines that contain aluminum and whether or not it approaches toxic levels.

FIGURE 5 shows data from a [study](#) carried out in 2011 by Mitkus and colleagues. The pink zone is

FIGURE 5:
Estimated aluminum exposure from vaccines in infants is well below toxicity thresholds



SOURCE: Vaccine

how much room there is between how much aluminum a vaccinated baby is likely exposed to in its first year of life and the levels that start to pose health problems. The authors state: We conclude that episodic exposures to vaccines that contain aluminum adjuvant continue to be extremely low risk to infants and that the benefits of using vaccines containing aluminum adjuvant outweigh any theoretical concerns.

ADDITIONAL DETAIL:

- The high blue and red lines correspond to minimal risk levels (MRL) of aluminum for babies of different weights. The blue line is how much aluminum would be considered at the MRL for a baby of median weight (i.e., a typical baby) as it grows over its first year – they call this line MRL 50. The red line shows how much aluminum would be at the MRL for a very low weight baby (5th percentile) – they call this line MRL 5. It makes sense that an amount of aluminum that would not be a problem for a larger baby could be a problem for a smaller one.
- To be clear, MRL stands for minimal risk level. So these levels are not themselves dangerous. Higher levels start to become a problem.
- They then show what the calculated levels of aluminum are from breast milk, baby formula, and the recommended doses of vaccines. You can see from the graph that the totality of aluminum from both a baby's diet and vaccines is still far below the MRLs. These are low, non-toxic levels and there's a wide margin of safety (i.e., the pink zone).

QUESTION: But I heard that aluminum in vaccines can cause asthma. Is that true?

ANSWER: Probably not. The one [study](#) that showed an association between vaccine-related aluminum exposure and asthma was run by the CDC relying on its Vaccine Safety Datalink, a system by which the CDC monitors and studies vaccine safety (even after FDA approval). The authors looked back at the medical history of children and compared how much aluminum they would have been exposed to given the vaccines they got and whether they developed asthma. Results indicated that with each milligram of aluminum exposure from ages 0-2, there was approximately a 1.25x higher rate of asthma. Public health experts have urged caution in interpreting these results considering that this single publication did not account for a variety of confounding factors, including geography, socioeconomic status, access to healthcare, etc. For example, parents who saw that their kids had a harder time breathing or seemed vulnerable to respiratory infections might have made sure to get them vaccinated. In other words, the cause and effect could be inverted in that maybe being more likely to have asthma caused a higher rate of vaccination and therefore more aluminum exposure. But that is speculation. It's just an example of why correlations do not indicate cause and effect. Essentially, we can't interpret from here whether aluminum increases the rate of asthma diagnoses.

Also of note, while asthma diagnoses have been increasing over several decades, they've actually dropped significantly from a peak in 2010, and the infant vaccine schedule hasn't changed from that time point to the present, shown in **FIGURE 6**. Overall, the level of evidence from this finding

FIGURE 6:

Asthma rates have historically fluctuated independently of the childhood vaccine schedule

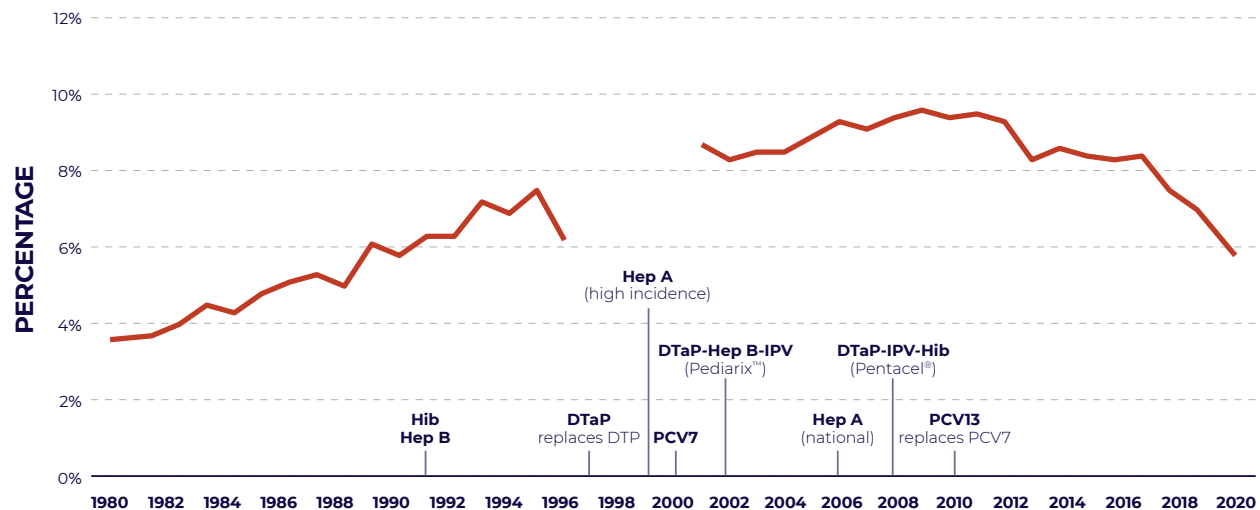


FIGURE 6 The gap in the asthma incidence data between 1997 and 2000 is a result of a methodological change in the survey that collected these data. Before 1997, the line measures whether someone in a household had asthma in the past year; from 1997-2000 the survey captured lifetime asthma status (and thus cannot be compared to earlier or later data); beginning in 2001, the survey captured current household asthma status. See link for details.

SOURCE: [CDC/Kaiser Permanente](#)

is not currently strong enough to change vaccine practice, as the benefits of avoiding infectious diseases in infants are far greater than the potential risks suggested by this one study.

Notably, another [study](#) utilizing a CDC dataset looked at whether aluminium in childhood vaccines was associated with development of type 1 diabetes (T1D). In this case the authors found that the risk of a T1D diagnosis was significantly **lower** in patients who had increased aluminum exposure via vaccines.

Hypothetically, let's just say that both the asthma and T1D studies are correct. It's unclear why aluminum may elicit a positive association with asthma, and a negative association with T1D. One hypothesis is that as aluminum stimulates our immune system, it is shifting our immune system to be better at making antibodies and away from relying on T cells to kill things. Scientists would describe this as shifting the immune system towards Th2 responses vs Th1 responses, and Th2 responses (antibodies) are known to drive asthma, while Th1 responses are known to contribute to the development of T1D (T cells). On the other hand, the [idea](#) that aluminum drives a Th2 driven immune response is mostly seen in mice and that immune shift is less clear in humans.

The bottom line is that we don't know whether the vaccines slightly increase asthma risk and/or slightly decrease T1D, but we do know that they are very effective at preventing dangerous infections. We make choices about medicine and most things we do, including driving our kids to school, letting them ride their bikes, without perfect knowledge yet knowing that there's a risk of some harm. We weigh the benefits against the risks of everything. That's how medicines are studied and judged – not by their benefits alone or their risks alone but by their benefit-risk profiles.

And vaccines, based on both their known risks and even this theoretical asthma risk, have a favorable benefit-risk profile.

BUT WHAT IF THAT STUDY IS RIGHT AND KIDS COULD POTENTIALLY DEVELOP CHRONIC ASTHMA FROM THE ALUMINUM IN VACCINES, HOW DOES THAT RISK COMPARE TO THE RISK OF HOSPITALIZATION OR DEATH FROM THE DISEASES VACCINES PROTECT AGAINST?

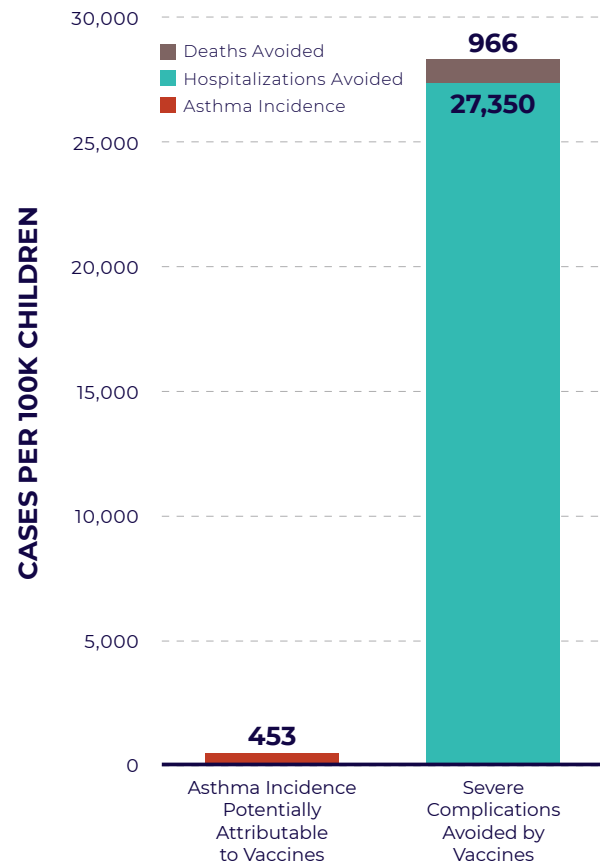
The asthma risk, if even real, is negligible compared to the far greater benefit of vaccines at preventing death and complications due to infections.

In a 2023 retrospective [study](#), the CDC estimated that routine childhood immunization—excluding influenza, RSV, and COVID vaccines—prevented over 32 million hospitalizations, 1.1 million deaths, and 508 million cases of illness among the roughly 117 million individuals born between 1994 and 2023. Those are large numbers, but they are just saying that there were nearly four million kids born per year over those 30 years and that each child was protected by vaccines from an average of 4.3 illnesses. Consider that nearly every child would get measles and chicken pox, more than half would get whooping cough, and about half would get mumps and half would get rubella. So just adding those up, we get to more than 3.5 illnesses averted per child, with all the other illnesses vaccines protecting against getting us the rest of the way to 4.3. And that's not even counting all the cases of flu and RSV and more recently COVID that vaccines prevent in kids, which can be quite serious and even lethal. These findings underscore the profound public health impact and lives saved through the CDC's recommended childhood vaccination schedule. The monetary impact of direct and societal savings has been estimated to be \$2.7 trillion. (<https://www.cidrap.umn.edu/childhood-vaccines/childhood-vaccines-have-prevented-half-billion-illnesses-saved-us-27-trillion-3#:~:text=Routine%20childhood%20immunizations%20remain%20a,childhood%20vaccines%20at%20discounted%20prices.%22>)

Beyond health and lives, vaccine keep America productive, which matters to our quality of life. Consider all the work days parents would have lost, time kids would have missed out on school, and the cost of hospitalization. It's easy to see that the value of vaccines is measured in trillions of dollars. From a productivity standpoint, averting 1.1 million deaths over that time is worth over \$70 billion per year and trillions of dollars over their lifetimes (Footnote: average income for Americans is over \$70,000 per person, inclusive of salary and bonus: <https://www.sofi.com/learn/content/average-salary-in-us/>).

FIGURE 7:

Asthma incidence potentially linked to vaccines is vastly outweighed by the prevention of severe complications and deaths through vaccination



SOURCE: CDC, CDC Morbidity and Mortality Report, Pharmacy and Therapeutics, CIDRAP U of Minnesota

To make it easier to compare all that vaccines are doing, let's look at the risk and benefit per 100,000 vaccinated children. Vaccines prevent roughly 28,000 severe complications (1,000 deaths; 27,000 hospitalizations) per 100k kids, whereas the asthma [study](#) suggests ~450 more cases of asthma. So an unvaccinated child is more than 60 times more likely to be hospitalized with a vaccine-preventable disease than develop chronic asthma from aluminum in vaccines (if aluminum even causes asthma), and over twice as likely to die.

FIGURE 7 illustrates this disparity – the risk of developing chronic asthma from aluminum is miniscule compared to just some of the benefits that vaccines provide to children (and we're not counting the theoretical reduction in T1D). The contrast underscores the extraordinary benefits of vaccination, not just for individual children but for public health as a whole.

This is not merely some happy coincidence. Risks from adjuvants like aluminum are exceedingly small compared to the overwhelming advantages in preventing severe complications, and vaccines undergo meticulous regulatory testing to ensure that each of their components are safe and effective. Vaccines are as effective and safe as they are because they are rigorously tested and reviewed by the FDA and continue to be studied by the CDC and others long after they are approved.

3. OTHER SAFETY QUESTIONS

Key takeaways:

- The MMR vaccine does not cause measles outbreaks. These outbreaks occur in communities with low vaccination rates due to lack of herd immunity.
- The FDA, CDC, and vaccine manufacturers operate independently to ensure safety of vaccines.

QUESTION: I heard some vaccines are weakened forms of the virus, but they are still alive and infect people, such as the measles, mumps, and rubella vaccine (MMR). Can the MMR vaccine cause measles outbreaks?

ANSWER: In healthy people with a normal immune system, MMR vaccine does not cause measles. The MMR vaccine contains a weakened, non-contagious form of the virus that stimulates immunity without causing disease. That immune stimulation may come with symptoms, such as fever, but that's not the same as measles. It's just the body learning to fight measles.

In people who are immune compromised, meaning their immune systems are weakened, the weakened measles virus [can cause measles-like disease](#), which is why people who are immunocompromised are not supposed to get the MMR vaccine. There is no measles vaccine on the market that they can get safely. Instead, people who can't get the MMR vaccine are dependent on the herd immunity that comes from everyone else around them getting vaccinated to prevent them from ever being exposed to measles.

If you are concerned that your child might be immunocompromised and shouldn't get MMR, just ask your doctor. If a baby is found to be immunocompromised (this occurs in about [1 in 1000 babies](#) and is often detectable with standard tests), that baby won't be vaccinated against MMR. If your child isn't immunocompromised, then getting the MMR vaccine is a really good idea.

Outbreaks occur in communities with low vaccination rates, allowing the highly contagious measles virus to spread among unvaccinated individuals. This can sometimes cause disease even in those who have been vaccinated, so-called "breakthrough infections." Breakthrough infections happen not because of MMR but despite it. This highlights the importance of maintaining high vaccination coverage to protect individuals and communities.

QUESTION: Are the CDC, FDA, and vaccine manufacturers in cahoots? Do conflicts of interest result in unsafe vaccines being approved and safety issues ignored?

ANSWER: The FDA is the primary gatekeeper to new vaccines coming to market. Its job is to ensure that the medicines it allows to come to market offer favorable benefit-risk for the patients they are meant for and that the public and physicians have the information they need to make informed decisions. Since vaccines are typically meant for all people, most of whom are healthy, the FDA's safety bar is very high. The FDA can make companies do extra studies in many cases to prove that their vaccines are safe. Any vaccine that is submitted for FDA review is examined by many people there. There's no opportunity to bribe someone to look the other way. Vaccines often take several years to develop, during which the FDA staff involved in the review change, giving new people the opportunity to reconsider what their predecessors said and allowed. And if a vaccine turns out to be dangerous, FDA leaders know that they will be hauled before Congress to explain how they could have let a flawed product come to market. The FDA staff do not want to make that mistake. So they hold companies and their vaccines to a high standard.

Once a vaccine is approved, the CDC gets involved in monitoring how safe and effective the vaccine is over time. The vaccine industry and the CDC operate independently to ensure vaccine safety.

How Common Are Side Effects?

Even though vaccines are tested extensively before approval, very rare side effects (occurring maybe in one in a million people) might not surface until millions are vaccinated. That's why continuous monitoring is essential. If an unexpected problem is identified, health authorities can take action, such as updating vaccine recommendations or, in extreme cases, recalling a vaccine.

Common Side Effects vs. Rare Reactions: It's worth distinguishing what we mean by "vaccine side effects." Most side effects of vaccines are **mild and temporary**. You've probably experienced or heard of these: a sore arm at the injection site, redness or swelling where the shot was given, a low-grade fever, or feeling a bit achy or tired for a day. These symptoms are not dangerous; they actually often mean your immune system is responding (for example, fever is a sign the body is reacting to the vaccine and building immunity). These mild effects typically go away on their own within a day or two.

Serious reactions are **exceedingly rare**. One example of a serious reaction is a severe allergic reaction (anaphylaxis). This happens in roughly one in a million vaccine doses. That's why when you get a vaccine at a clinic or pharmacy, they often ask you to wait for 15 minutes afterward – just to be safe, in the extremely unlikely event of an allergic reaction, medical staff can treat it immediately. Another rare reaction is with the oral polio vaccine (which is a live attenuated vaccine not used in the US anymore); in about one in 2.4 million doses, it could cause polio. This risk was deemed too high when polio was no longer circulating in the US, which is why since 2000 only the inactivated (injectable) polio vaccine is used in America – it carries zero risk of causing polio. This shows how policy adjusts to maximize safety.

The CDC's job is to make sure that America effectively combats diseases. Here again, there's no one person who can just make the CDC ignore or delete data that suggest a vaccine may be dangerous. The people at the CDC take their jobs seriously and you might imagine that someone would blow the whistle on anyone taking a bribe to sweep safety data under the rug.

Vaccine manufacturers are responsible for developing vaccines and conducting rigorous clinical trials to assess their safety and efficacy. They are required to submit detailed data to the FDA for evaluation and approval. Once a vaccine is approved, manufacturers must report any adverse events (i.e., side effects) to VAERS, a national surveillance system co-managed by the CDC and FDA. The CDC independently monitors and analyzes data from VAERS and other sources to identify potential safety concerns and conducts further investigations as necessary. This separation of roles ensures that vaccine manufacturers do not influence the CDC's independent assessment of vaccine safety, maintaining the integrity of immunization programs and public trust. **(SEE SIDEBAR: HOW COMMON ARE SIDE EFFECTS?)**

Vaccine safety is also monitored independently of manufacturers through collaborative effort between the CDC, hospital networks, and independent advisors outside of the CDC.

A conspiracy theorist may claim that data from studies are fake, medical reviewers are silenced, and CDC staff are all bribed. Does this seem plausible? Over many decades?

Unfortunately, the more people who believe misinformation about vaccines and decide to skip vaccination, the greater the risk to everyone (even those who get vaccinated), because most vaccines work by the principle of herd immunity, which means they work best when enough of us get them. So while it's no big deal if your kid goes to school with other kids who don't share many of your beliefs, it's a problem if those parents don't believe in vaccination. We all have a stake in trying to win over vaccine skeptics with knowledge and empathy.

4. DEMANDING MORE DATA

Key takeaways:

- The safety of all vaccines is rigorously studied before and after approval by multiple surveillance systems across different agencies.
- While continuous research is essential, ample data already exist to confirm vaccines are safe and effective.

QUESTION: Some people are just asking for more data about vaccines – they're not saying we shouldn't use them. So what's wrong with asking for more data?

ANSWER: In principle, there's nothing wrong with gathering more data. The CDC is routinely gathering more data. The question is whether people should hold off on using vaccines until they get more data. That's where asking for more data could be harmful, because it's a seemingly

reasonable way of suggesting that we disregard all the data we already have that show why vaccines are worth taking.

Vaccine Development

Safety is the top priority in vaccine development and approval. Vaccines go through a long, **careful process** before they ever reach the public. On average, it can take 10-15 years of research and testing before a new vaccine is widely available. Scientists and medical professionals are very thorough at each step to ensure a vaccine works well and does not cause dangerous side effects.

Development and Testing Phases: Vaccine development starts in the laboratory ("research and discovery"). Scientists first study the disease and brainstorm ways to trigger immunity. Once they have a promising idea (for example, a weakened virus or a piece of a bacteria), they do proof of concept studies, often in small animals like mice, to see if the vaccine can provoke an immune response. Safety is also rigorously examined in these animal models (often including mice, rabbits, and non-human primates) with a variety of toxicology studies (varying dose levels and number of doses) to determine if a vaccine potentially causes any unintended harmful effects. If those results look good and the vaccine appears safe in animals, the research moves on to testing in people.

Before human testing begins, developers must file an **Investigational New Drug (IND)** application with the FDA. This application includes all the data from lab and animal studies, as well as details on how the vaccine is made. The FDA's team of scientists and doctors reviews this information to decide if the vaccine looks safe enough to proceed to human trials. Only after the FDA gives the go-ahead can clinical trials in volunteers begin.

Clinical Trial Phases: Human testing is done in phases to carefully assess safety and effectiveness:

- **Phase 1:** A small group of usually 20-100 healthy volunteers receive the vaccine. The main goal here is to check for safety. Researchers look for any immediate side effects and gather preliminary data on how the immune system responds. Phase 1 trials help determine a safe dosage range and identify common side effects (for example, does it cause a sore arm? fever? etc.).
- **Phase 2:** If Phase 1 results are positive (meaning no serious safety concerns), the trial moves to Phase 2, which involves a few hundred volunteers, and is often when studies will begin including unvaccinated (or placebo) groups. Participants in this phase have characteristics similar to those who would need the vaccine (for instance, if it's a pediatric vaccine, some

participants will be children of the appropriate age). Phase 2 continues to evaluate safety, including looking at slightly less common side effects, and provides more data on the immune response. Researchers may refine the dosage or schedule at this stage.

- **Phase 3:** This phase includes a much larger group, often thousands of people. Phase 3 trials are usually what people hear about in the news when a vaccine is "almost ready." Importantly, Phase 3 is large enough to detect rarer side effects because it involves many more people. By the end of Phase 3, we get a clear picture of how effective the vaccine is at preventing illness and gather a robust safety profile. For example, the trial might show that a vaccine prevents, say, 95% of infections, and typical side effects might be something minor like temporary arm pain or fever. Any serious adverse events are investigated to see if they are related to the vaccine or just coincidence.
- **FDA Approval:** After Phase 3, the company developing the vaccine compiles all the data and submits a comprehensive application to the FDA for review (this is often a **Biologics License Application** for vaccines). The FDA review team goes over the data with a fine-tooth comb. They evaluate the **safety, purity, and potency** of the vaccine. The FDA also **inspects the manufacturing facilities** to ensure they meet strict quality standards (called Good Manufacturing Practices). Only if the vaccine's benefits clearly outweigh any risks, and the manufacturing process is reliable, will the FDA license (approve) the vaccine for use. It's worth noting that the United States has one of the most stringent vaccine approval systems in the world, and by the time the FDA approves a vaccine, it has been tested on tens of thousands of people and reviewed by experts.
- **Phase 4 (Post-Approval Studies):** Testing doesn't necessarily stop at approval. Sometimes, vaccines continue to be studied in what's called Phase 4 trials. These are ongoing studies that further ensure the vaccine's safety and effectiveness in an even larger, more diverse population. For example, a Phase 4 study might continue monitoring a vaccine after it's recommended to the whole population, to see if very rare side effects show up or if effectiveness holds up over several years.

There are studies that have to be done even before vaccines are tested in people in clinical trials, then there are the clinical trials that are done before a vaccine is allowed on the market, and then there's all the continued data gathering after a vaccine is approved. So if you hear someone saying confidently that we need more data, ask them if they are familiar with all the data that we already have and what the gaps in our knowledge are that they think we need to fill with more data. There's a good chance that the data they think we need is already out there, and either they don't know about it because they haven't bothered looking or they know it's out there but are counting on you not to look.

QUESTION: What kind of data do we normally have for a vaccine before it's approved and given to millions of people? What is typically required for a vaccine approval? How large are these studies and how large is the overall safety database?

ANSWER: The approval of a vaccine is a rigorous, multi-phase process designed to ensure its safety and efficacy before it becomes publicly available. **(SEE SIDEBAR: VACCINE DEVELOPMENT)**

The size of the safety database varies depending on the vaccine and target population. For instance, the FDA has recommended that for COVID-19 vaccines, the safety database should include at least 3,000 participants receiving the vaccine, with a median follow-up duration of at least two months after completion of the full vaccination regimen. Some vaccine trials may include over 10,000 subjects. For example, each of the HPV vaccines that have been on the market [were studied in clinical trials with 15,000-30,000 people](#), cumulatively over 70,000.

This extensive data collection is crucial to detect both common and rare adverse events, ensuring that any potential risks are identified and evaluated before widespread distribution.

Trials of this size can identify side-effects that may occur once in a few thousand vaccinations over a few years, but they are unlikely to identify side-effects that occur once in 100,000 people or once in a million. So the key is to establish that a vaccine is safe-enough relative to its benefit, not to identify every side-effect it could possibly have. Over time, with continued data gathering, we learn more about marketed vaccines. Sometimes, rarely, we realize that they cause problems that went undetected in pre-approval trials, that are significant enough to remove them from the market. Finding these problems and taking appropriate action shows that the drug regulatory process is working, not that it's flawed.

QUESTION: What safety data is collected for an approved vaccine, and who collects it?

ANSWER: Ensuring the safety of vaccines post-approval involves collaborative efforts between regulatory agencies, vaccine manufacturers, independent organizations, and global advisory committees. Manufacturers conduct safety monitoring and report any adverse events to regulatory bodies such as the Food and Drug Administration (FDA). This includes submitting periodic safety update reports and conducting Phase IV post-marketing studies to assess long-term safety and effectiveness. Additionally, manufacturers are required to implement Risk Evaluation and Mitigation Strategies (REMS) when necessary, to manage known or potential

risks associated with a vaccine. These measures, alongside the surveillance systems operated by agencies like the Centers for Disease Control and Prevention (CDC), ensure a comprehensive approach to monitoring vaccine safety.

Vaccines have been taken off the market due to safety issues uncovered after approval. The first rotavirus vaccine (Rotashield) was withdrawn by its manufacturer in 1999. Rotashield was approved after successfully completing clinical trials but a rare side effect (a type of bowel obstruction in about 1 in 10,000 infants) was detected once it was in broader use. Health authorities quickly investigated and that vaccine was pulled from the market. Continued monitoring of vaccine safety after approval can prompt regulators to act promptly if a vaccine is found to cause harm. Thankfully, such cases are extremely rare. See Figure 3, which illustrates the seven-year gap between Rotashield's removal and when newer, safer rotavirus vaccines became available.

QUESTION: Does the CDC do additional safety monitoring after a vaccine is approved? What resources does the CDC have for vaccine safety research?

ANSWER: The CDC employs a comprehensive approach to monitor and ensure vaccine safety in the United States, utilizing several key systems:

1. **Vaccine Adverse Event Reporting System (VAERS):** Co-managed by the CDC and the FDA, VAERS serves as a national early warning system to detect possible safety issues with US-licensed vaccines. It accepts and analyzes reports of adverse events, which healthcare providers are trained to identify and report, ensuring early detection of potential safety signals. This enable the agencies to identify potential concerns that may require further investigation. It is very important to note that simply because an adverse event appears in VAERS, it does not mean that it was related to a vaccine; the cause of the problem must be investigated and appropriately adjudicated.

Importantly: VAERS only shows correlations, not causation. For example, after most people got COVID vaccines and the pandemic was declared over, the rate of all kinds of non-COVID infections went up. That would suggest a correlation between COVID vaccination and non-COVID infections. But that's not something the COVID vaccine causes; it's just a natural consequence of people starting to hang out together and doing all the normal things they used to do, ranging from going to a mall to getting surgery. And cancer diagnosis rates went up. But that's not because COVID vaccines cause cancer but because people resumed getting colonoscopies and other cancer screens. No doubt autism diagnosis rates went up too, since, once the pandemic was over, people again took their kids to see doctors who could make that diagnosis.

2. **Vaccine Safety Datalink (VSD):** Established in 1990, the VSD is a collaborative project between the CDC's Immunization Safety Office and various healthcare organizations across the US. It uses electronic health record data from millions of individuals to monitor vaccine safety and conducts studies on rare and serious adverse events.

3. **Clinical Immunization Safety Assessment (CISA) Project:** This network of vaccine safety experts from the CDC, academic institutions, and other partners conducts clinical research and provides consultations on complex vaccine safety issues. CISA plays a crucial role in identifying trends in vaccine safety and contributes to clinical guidance, including recommendations from the Advisory Committee on Immunization Practices (ACIP)¹.
4. **V-safe:** Specifically developed for COVID-19 vaccines, V-safe is a smartphone-based tool that uses text messaging and web surveys to provide personalized health check-ins after vaccination. It allows individuals to report any side effects or health issues they experience, thereby contributing to monitoring vaccine safety in real-time.

QUESTION: Who else is dedicated to uncovering long-term or chronic adverse reactions from vaccines?

ANSWER: Groups like the **National Academy of Medicine (NAM)** and **Cochrane Reviews** critically evaluate vaccine safety data, ensuring accountability.

The **Post-Licensure Rapid Immunization Safety Monitoring (PRISM)** system, part of the FDA's **Sentinel Initiative**, uses large healthcare datasets to detect safety signals in the broader population².

Manufacturers also play a pivotal role in ensuring vaccine safety through rigorous quality control measures. Each batch of vaccines undergoes extensive testing for potency, purity, and safety before distribution. The FDA regularly inspects facilities to ensure compliance with Good Manufacturing Practices (GMP), reducing risks of contamination or production errors.

Nonprofit organizations often fund studies on long-term vaccine safety, while academic researchers contribute independent analyses. As we saw above with the retracted Wakefield study, not all studies are well-conducted. Not everyone studying vaccine safety is trying to get to the truth. Some want to prove that vaccines are dangerous and do studies in a biased way to show it. But because scientific best practice demands that all research be reviewed and confirmed, fraud and errors tend to be found out while what's true and factual tends to show up in studies over and over again.

It's kind of like the work of a detective trying to solve a crime. No one witness's testimony may be

1 CISA investigates rare reactions to vaccines, like Guillain-Barré Syndrome (GBS, an autoimmune disease that attacks neurons and can cause weakness and other problems), leading to improved safety monitoring. [In 1976, the U.S. halted its swine flu vaccination program](#) after detecting a small increased risk of GBS. Approximately 45 million people received the vaccine, and studies later found about one additional case of GBS per 100,000 vaccinated individuals (studies [here](#) and [here](#)). While the overall risk was low, the program was discontinued out of caution, making it the only flu vaccine campaign ever pulled due to GBS concerns. Today, flu vaccines are closely monitored, and any potential risk of GBS is estimated to be one to two cases per million doses, far lower than the risk of GBS from influenza itself ([study](#)). (Interestingly, flu itself causes GBS, so vaccination that reduces your flu risk reduces your risk of getting GBS from flu.)

2 Established in 2009 as part of the FDA's Sentinel Initiative, the PRISM system was designed to enhance active surveillance of vaccine safety post-licensure. By integrating health insurance claims data with state and local immunization registries, PRISM can monitor vaccine exposures and potential adverse events in near real-time across a large population base. During the 2009 H1N1 influenza pandemic, PRISM played a pivotal role in ensuring the safe rollout of the H1N1 vaccine by rapidly identifying and evaluating potential safety concerns. Its ability to analyze data from millions of individuals allowed for timely detection of adverse events, thereby bolstering public confidence in the vaccination program.

entirely reliable, but by gathering information from many witnesses and other evidence, what's consistent is more likely to be true.

Finally, public communication and education are integral to vaccine safety efforts. The websites we cite in this document are key parts of the meshwork that allows us all to follow evolving vaccine science and make sense of what's likely true from what's likely not.

Viewed in its totality, this meshwork of organizations generating and evaluating data represents the commitment of the US government and the scientific and medical communities to effectively and transparently study vaccines both before and after they are marketed to ensure that they work as intended, remain net beneficial to individuals and society, and remain trusted by as many people as possible so that we can maximize the benefits of vaccination and minimize risks.

QUESTION: Ok, but is vaccine safety monitored long-term? How does it compare to other common medicines such as weight loss drugs like GLP-1's?

ANSWER: Although the safety of all medicines is monitored after their launch, vaccine safety is more systematically and rigorously monitored than any other medicines because they are used more widely than any other medicines.

As noted above, in the United States, the CDC and the FDA employ multiple, redundant systems to monitor vaccine safety, including VAERS, VSD, and CISA. These systems are continuously collecting and analyzing reports of adverse events that occur after a person has been vaccinated, and allow us to quickly identify and investigate possible safety concerns associated with vaccines so we can remove any vaccine that poses too high a risk or at least better define for whom the benefits outweigh the risks.

The safety of all medicines is monitored in some of the ways that we monitor vaccine safety. For example, the FDA monitors the safety of medications through the FDA Adverse Event Reporting System (FAERS), which collects adverse event and medication error reports, functioning much like VAERS. Specific safety concerns for GLP-1 receptor agonists, such as potential risks of pancreatitis based on [clinical studies](#) and [preclinical data in mice](#) showing thyroid C-cell tumors, have led to post-marketing requirements for additional studies and the inclusion of warnings in prescribing information. Despite these known risks, GLP-1s remain on the market because their benefits outweigh their risks when these medicines are used by people for whom they are intended, which in the case of GLP-1s includes people with diabetes, heart failure, sleep apnea, and many people who are overweight and struggling to lose weight.

Vaccines require heightened safety monitoring because they're given to healthy people, often children, and require widespread use to be effective. While one can benefit from a GLP-1 regardless of whether others take it, vaccines work best when most people in a community take them. Convincing so many people to be comfortable taking a medicine when they are healthy therefore requires extra reassurance. This necessitates robust systems to detect rare events and maintain public trust.

5. LIABILITY AND INDEMNIFICATION

Key takeaways:

- Vaccine manufacturers are not protected from liability, and the VICP protects access to vaccines while compensating individuals for potential vaccine-associated injuries.
- The FDA has the ability to pull unsafe vaccines from the market.

QUESTION: The National Childhood Vaccine Injury Act (NCVIA) of 1986 seems to shield vaccine makers from being sued when their vaccines hurt people. Doesn't that mean that drug companies and the government know vaccines are unsafe and that companies aren't even accountable for making them safe?

ANSWER: No, on several counts. The NCVIA doesn't prevent anyone from suing a drug company. All it does is set up a systematic framework for how people who believe they have been harmed by a vaccine can pursue their claims. This was done to prevent drug companies from being bankrupted by frivolous lawsuits, and it doesn't provide complete immunity against potentially justified lawsuits.

The NCVIA was put into place by Congress (and signed into law by President Ronald Reagan) in 1986. It was a response to unfounded concerns triggered by a very inaccurate TV special aired in 1982 that falsely connected the pediatric DPT vaccine (against diphtheria, pertussis, and tetanus) with brain damage. This sparked an anti-vaccine movement and lawsuits that caused vaccine manufacturers to [shut down](#) vaccine production, threatening a shortage that would bring back deadly whooping cough. It didn't matter that DPT didn't cause brain damage if juries were siding with patients and threatening the drug companies with bankruptcies.

In this case, think of anti-vaccine misinformation like a fire that threatened the vaccine industry. And much like people and companies buy insurance against fires, similarly the vaccine industry needed insurance against the ever-present risk that misinformation-fueled lawsuits would wipe companies out.

The NCVIA was that insurance policy. Concerned public health experts wanted to combat outbreaks of preventable disease that could result from vaccine manufacturers deciding that making vaccines carried too much risk in the first place.

The NCVIA contains within it the National Vaccine Injury Compensation Program or (VICP), a "vaccine court" that offers patients a faster path to receiving compensation than traditional litigation. And it created VAERS, which we discussed above, to collect and analyze data on adverse events following vaccination, demonstrating that the US was committed to monitoring vaccine safety and didn't just take it for granted that vaccines were safe.

The VICP provides a “[no-fault](#)” alternative to the traditional court system. This means that petitioners do not have to prove that the vaccine company was negligent to receive compensation. The VICP allows patient compensation to cover all legal and medical fees, incurred both before AND after the vaccine court ruling, along with a capped \$250,000 payment for hardship and/or death. So people who thought they were harmed by a vaccine didn’t actually have to prove it, but they also couldn’t get tens of millions in damages that a jury might award based on their misunderstanding of scientific evidence.

Importantly, the NCVIA allows vaccine companies to continue to operate when controversies over safety emerge. This is essential, as vaccine controversies can emerge over the course of 1-2 years and generating evidence to confirm safety issues or refute unsubstantiated claims can take years. Keeping vaccine production going while litigious claims are reviewed by VICP is critical in maintaining vaccine coverage and keeping infectious disease outbreaks at bay. Note, petitions and payments made by VICP are all collated on the HRSA [website](#).

Over half the petitions are dismissed because the court finds no connection. Since the court began in 1989, over 11,000 people have received compensation (amounting to about \$5 billion in total). In many of those cases, the court doesn’t so much find a connection but just thinks there’s a chance that there might have been one. Even if we concluded that all cases of payment were due to a vaccine actually causing harm, the HRSA website points out that there’s only one case of compensation per one million vaccine doses. That’s very rare.

The funding for these payments comes from vaccine sales; the price of every dose includes a premium that is contributed to the vaccine fund. We estimate that, on average, each vaccine dose adds 50 cents to the vaccine fund. That’s a cost that is borne by all of society. If there were no limit on how much a vaccine manufacturer could lose from lawsuits, companies that even dared to keep making vaccines would need to self-insure by charging much more per dose, saving up for a possible flurry of lawsuits sparked by misinformation.

The creation of the VICP has allowed the vaccine industry to collectively insure against the risk of lawsuits related to extremely rare safety issues that may or may not be related to their products. This allows them to stay in business and continue to provide vaccines that, despite their rare risks, are net beneficial for all of us.

However, the VICP does not shield vaccine companies from litigation. Although the NCVIA and the VICP were designed to protect vaccine manufacturers from a surge of frivolous liability claims and to ensure a stable vaccine supply, they do not create total, unconditional immunity. People with legitimate claims involving manufacturing defects, improper labeling, or evidence of intentional misconduct can still file lawsuits in state or federal courts, subject to meeting the requirement of first going through the VICP. Examples of this happening are [here](#) and [here](#). The bar for winning these suits is high enough that most people stick with the outcome of the VICP. This framework is how Congress struck a balance between encouraging vaccine development and distribution and preserving legal recourse for individuals genuinely harmed by vaccine-related injuries.

There's a similarity between NCVIA and malpractice insurance that shields doctors from the costs of malpractice lawsuits. No doctor is perfect, and even a properly treated patient can have a bad outcome. If a lawsuit could bankrupt any doctor, when they haven't made a mistake or even when they did (because they are human), few people would want to become doctors. Since we as a society need doctors, we allow doctors to buy malpractice insurance and we create laws that keep lawsuits in check, often with caps on what juries can award. That doesn't mean doctors can make mistakes with impunity. Malpractice also comes with a risk of losing one's medical license, which is decided by a state medical board. Similarly, the FDA can pull a vaccine off the market if it considers it improperly manufactured or otherwise unsafe.

You can also view NCVIA and malpractice insurance in the context of all insurance. If you own a home, you probably have fire insurance. If you rent an apartment, your landlord has fire insurance.

Just as buying fire insurance does not mean that a homeowner or landlord is an arsonist or doesn't care about preventing fire hazards, taking out malpractice insurance does not mean a doctor is incompetent or unaccountable for their mistakes, and the NCVIA does not mean that vaccines are unsafe or that companies aren't accountable for their quality and safety. Insurance lets us own homes, rent apartments, have the benefits of seeing doctors, and continue to count on the steady production of vaccines.

The NCVIA allows vaccine manufacturers to continue to operate in a market as litigious as the US, but they remain accountable for the safety and efficacy of their products.

6. EFFICACY

Key takeaways:

- Vaccines are extremely effective and have saved millions of lives, with 4-5 million deaths prevented by vaccines worldwide each year.
- Stopping vaccination can have deadly consequences and lead to severe outbreaks of diseases that are controlled well in populations with high vaccinations rates.
- Vaccines protect against more than just infections. They can prevent cancer or even possibly reduce the risk of dementia.

QUESTION: How many lives have been saved by vaccines?

ANSWER: The World Health Organization (WHO) estimates that vaccines prevent 4 to 5 million deaths annually from diseases such as diphtheria, tetanus, pertussis, influenza, and measles. Historical campaigns have been especially impactful: the eradication of smallpox alone is estimated to have saved hundreds of millions of lives since 1980³. For measles, vaccination

³ Smallpox was eradicated globally by 1980; today's generation doesn't need smallpox shots at all. Polio eradication is within reach – only a couple countries still have wild polio circulating. If we finish that job, polio shots could eventually be stopped everywhere. Measles could be eradicated too if global coverage was high enough (measles meets the criteria: humans are the only host and we have an effective vaccine).

campaigns have averted over 23 million deaths from 2000 to 2018. COVID-19 vaccines have also had a profound impact, with estimates suggesting millions of deaths were prevented in the first year of their rollout due to their effectiveness in reducing severe illness and hospitalization. The childhood vaccine schedule alone has dramatically reduced the incidence and severity of disease.

See [here](#), [here](#), and [here](#) and the **FIGURE 8** for key studies highlighting the dramatic benefit of childhood vaccinations on disease, hospitalizations and death.

FIGURE 8:
Vaccines save lives. Millions of them

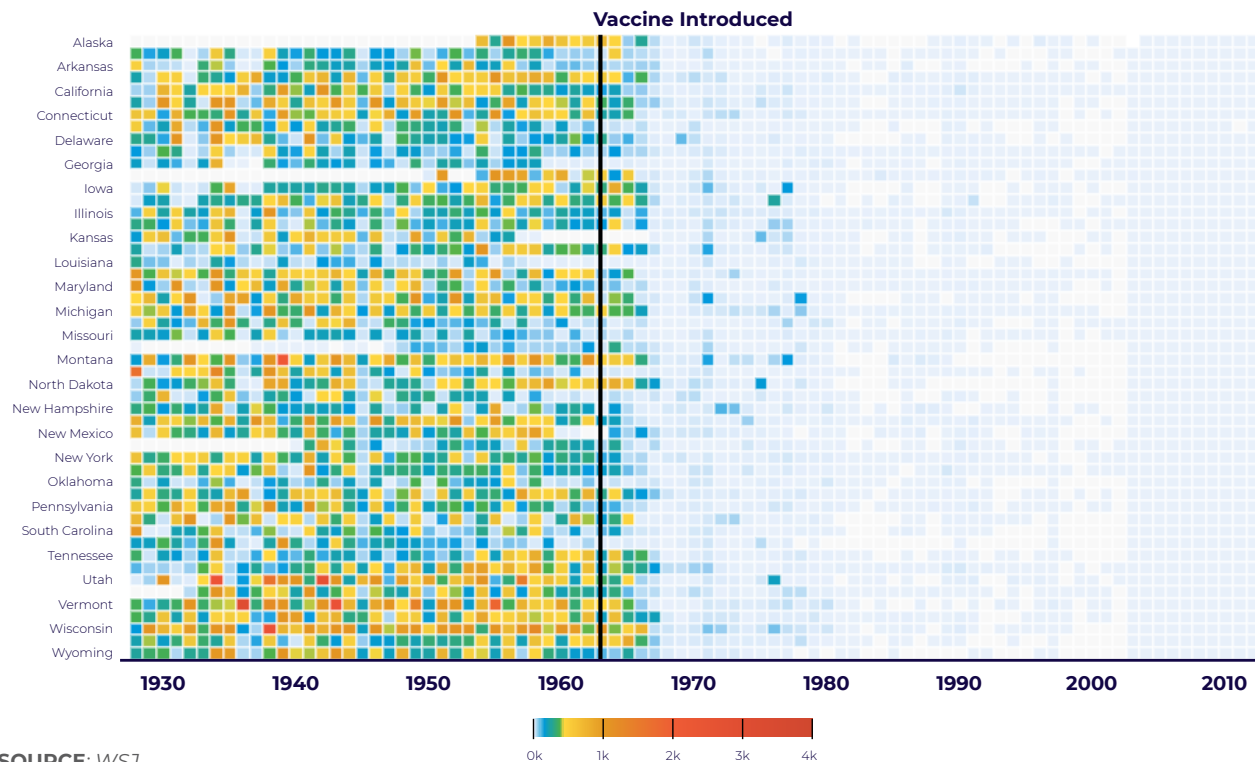
VACCINE	YEAR INTRODUCED	PRE-VACCINE ANNUAL CASES IN THE US	POST-VACCINE ANNUAL CASES	REDUCTION IN CASES (%)	ANNUAL DEATHS AVERTED IN US
Diphtheria	1940s	100,000–200,000 cases and 14,000–15,000 deaths	14 cases and 1 death reported in the US between 1996 and 2018	>99%	>14,000
Tetanus	1920s	500–600 cases and ~30 deaths	~30 cases and ~2 deaths per year between 2009 and 2018	~95%	>30
Pertussis (Whooping Cough)	1940s	~175,000 cases and ~9,000 deaths	15,000–50,000 cases annually in recent years, with periodic outbreaks; 10 deaths in 2024	~75–90%	~9,000
Measles	1963	~500,000 cases and ~500 deaths	Declared eliminated in 2000; fewer than 100 imported cases annually	>99%	~500
Mumps	1967	~150,000 cases, deaths very rare (~3 per 10,000 cases)	~1,000 cases	>99%	Up to ~45
Rubella	1969	~47,000 cases, death statistics unknown due to rarity	Declared eliminated in 2004; fewer than 10 imported cases annually	>99%	Death statistics unknown due to rarity
Polio	1955 (inactivated), 1961 (oral)	Over 21,000 cases (at peak in 1952) and ~1,900 deaths	Last indigenous case reported in 1979; no cases since	100%	~1,900
Haemophilus Influenzae Type B (Hib)	1985	~20,000 cases and ~2,200 deaths	<50 cases per year among children under five	>99%	~2,200
Hepatitis B	1981 (infants in 1991)	200,000–300,000 acute cases and 4,000–5,000 deaths	~20,000 acute cases annually in recent years, ~1,800 HepB-associated deaths in 2021	~82%	~2,200–3,200
Varicella (Chickenpox)	1995	~4 million cases and ~100 deaths	Cases have declined by over 90%; significant reductions in hospitalizations and deaths (3 deaths between 2002–2007)	>90%	~100
Pneumococcal Conjugate Vaccine (PCV13)	2000	~4 million cases and ~22,000 deaths	~31,000 cases and ~3,500 deaths	>90%	~18,500
Rotavirus	2006	~2.7 million cases (~410,000 physician visits) and 20–60 deaths	Hospitalizations and emergency department visits for rotavirus have declined by approximately 85%, no recent deaths	>85%	20–60

FIGURE 8 The introduction of the measles vaccine swiftly eliminated the disease. Take a look at Figure 9 (and [others](#)), which shows a sharp decrease in annual measles cases following the introduction of the measles vaccine in 1963.

SOURCE: CDC Pink Books, National Foundation for Infectious Diseases

FIGURE 9:

The introduction of the measles vaccine quickly stamped out the spread of the disease



SOURCE: WSJ

QUESTION: But, what happens if we stop vaccinating? How fast things will get bad? Maybe we are now okay and some vaccines are not needed?

ANSWER: We don't have to guess. We have an [example](#) where children died soon after an abrupt reduction in vaccination rates. In 2019, Samoa experienced a devastating measles outbreak, resulting in at least 83 deaths – mostly among infants and young children – and over 1,800 hospitalizations.

In 2018, two infants in Samoa died when they were given MMR vaccine that had been accidentally mixed with expired muscle relaxant instead of water. This was just human error and not a problem with the vaccine itself. The tragedy deeply shook public confidence in vaccines, leading the Samoan government to suspend its vaccination program for 10 months – despite WHO's urgent advice to resume immunizations.

It was during this time that Robert F. Kennedy Jr., visited Samoa, meeting with government officials and vaccine skeptics. His presence and [rhetoric](#) exacerbated public mistrust, making it even harder to rebuild vaccine confidence. Although WHO recommends a 95% vaccination rate to ensure herd immunity, where even the few unvaccinated people are protected by everyone who has been vaccinated, by the end of 2018, only 31% of infants were vaccinated, creating a large population of unprotected children susceptible to an outbreak.

The outbreak hit in late 2019, flooding hospitals with infected children. At least 83 children died, which is an astronomical number for a population of only 200,000 people. If you scaled that up to the whole US, it would be as if over 100,000 children died. The government implemented a mass vaccination campaign under emergency conditions to put an end to the outbreak. By 2023, the rate of MMR vaccination was 87%, slightly above the 85% rate in 2013.

Samoa teaches an important lesson: if we forget why we vaccinate, pathogens will quickly remind us. When the choice is between the risks of vaccination and the risk of facing pathogens unprotected by a vaccine, the choice should be really easy: vaccinate!

The outbreak in Samoa highlighted the deadly consequences of vaccine misinformation and inadequate public health responses. Similar crises could arise elsewhere if anti-vaccine narratives continue to gain traction. Public health officials are raising alarms, fearing that Kennedy's anti-vaccine stance could undermine global immunization efforts and increase the risk of preventable disease outbreaks in vulnerable populations. Their concerns are not theoretical. Furthering this point, we highlight that at this moment there is a growing [measles outbreak](#) in West Texas that has so far infected 48 individuals, mostly children, who all appear to be unvaccinated; 13 of them have been hospitalized.

And while the Samoa story and the current Texas outbreak center on measles, there are stories like these around the world and even sometimes in the US that involve other pathogens. Areas with lower vaccination rates can get outbreaks of whooping cough (caused by pertussis, which the Tdap vaccines protect against), which can cause such violent coughing that a person can break a rib. It's particularly dangerous for infants. But when a pregnant woman gets the Tdap vaccine in her 3rd trimester, she passes the antibodies along to her newborn, offering protection against infection during an infant's most vulnerable first few months. This [recent article](#) in *The Atlantic* paints a fuller picture of what it would be like to see a resurgence of mumps, whooping cough, measles, and other diseases.

Vaccines have been so effective at preventing all of these ancient pathogens that we never developed treatments for them. We don't have effective drugs for measles, whooping cough, polio, and the dozen other pathogens against which we now have effective vaccines. HPV vaccine protects against a virus that causes cervical cancer, for which we don't have reliable cures. Hepatitis B infection can lead to liver cancer and is, at best, managed with chronic treatment. But vaccines simply prevent it.

Ideally, we wouldn't merely accept that existing vaccines are beneficial but rally behind developing new vaccines against all the pathogens for which we don't yet have any. Imagine not having to worry about strep or norovirus. That's possible if we continue to develop new vaccines.

When we don't prevent a disease, all we can hope to do is treat it. But coming up with treatments is often not straightforward. We don't have drugs that stop norovirus and probably won't bother to develop them because of how difficult that would be. But a vaccine is possible. And even when you have treatments, such as the antibiotics that work well to treat strep throat, the challenge can be diagnosis. You have to decide to take a child to a clinic to get tested before you can

initiate treatment; often parents don't, assuming that the infection is viral. And even when they do take the time to take their child in to see the doctor and they are diagnosed with strep, taking antibiotics is not without risks. So much better to just prevent.

QUESTION: Do vaccines provide protection against anything other than infection?

ANSWER: Yes, in a variety of ways.

For example, when a person has asthma or COPD (chronic obstructive pulmonary disease), infections can be deadly. So preventing an infection that might only be annoying to a healthy person can be life saving to another and prevent their underlying respiratory disease from getting worse.

Some viruses lead to other diseases, such as cancer, so preventing the viral infection prevents not just the disease from the infection but the downstream emergence of cancer. For example, it is estimated that **12-20% of cancer cases worldwide are linked to virus infections** ([link](#), [link](#)), including human papillomavirus (HPV), hepatitis B virus (HBV), hepatitis C (HCV), and Epstein-Barr virus (EBV).

Since the introduction of the HPV vaccine, there has been a significant decline in HPV-related cancers, particularly cervical cancer (HPV causes ≥99% of cervical cancer cases). **In England, women who received the vaccine at ages 12 to 13 experienced an 83.9% reduction in cervical cancer incidence compared to unvaccinated cohorts.** Since the introduction of the human papillomavirus (HPV) vaccine in 2006, the US has seen a significant decline in cervical cancer mortality among women under 25—a 62% reduction between 2016 and 2021. This decrease is largely attributed to widespread vaccination efforts. As of 2023, approximately 78.5% of adolescent girls and 75% of boys have received at least one dose of the HPV vaccine. The Centers for Disease Control and Prevention (CDC) estimates that comprehensive HPV vaccination could prevent about 35,000 cases of HPV-attributable cancers annually, including cervical, anal, and oropharyngeal cancers. These statistics underscore the critical role of high vaccination coverage in reducing the incidence and mortality of HPV-related cancers.

Vaccines can also have surprising new uses. The **bacillus Calmette-Guérin (BCG)** vaccine is derived from a weakened strain of *Mycobacterium bovis*, a bacterium closely related to *Mycobacterium tuberculosis*, but is not used in the US to prevent tuberculosis. It has [become standard of care](#) for high-risk non-muscle-invasive bladder cancer (NMIBC). When instilled into the bladder, it triggers a strong immune response that significantly reduces the risk of recurrence and progression of the cancer.

The **smallpox vaccine** doesn't just protect against smallpox but can also be used to stop outbreaks of MPOX, a related virus.

Our understanding of the benefits of vaccination continue to evolve. Recent research indicates that the recombinant shingles vaccine, Shingrix, may be associated with a reduced risk of

developing dementia. An observational [study](#) conducted by the University of Oxford analyzed health records of over 200,000 individuals aged 65 and older in the United States. The findings revealed that those who received Shingrix (recombinant vaccine) or Zostavax (live attenuated discontinued vaccine) had 23–27% lower risk of developing dementia over the next six years compared to those who received vaccines for other infections, such as influenza and tetanus (**FIGURE 10**). If true, this reduction translates to an additional 5–9 months lived without a dementia diagnosis for Shingrix recipients.

Shingles is caused by a reactivation of a herpes virus that triggers severe pain. Herpes infects neurons so it's plausible that it may have a role in causing dementia, but this has not been proven.

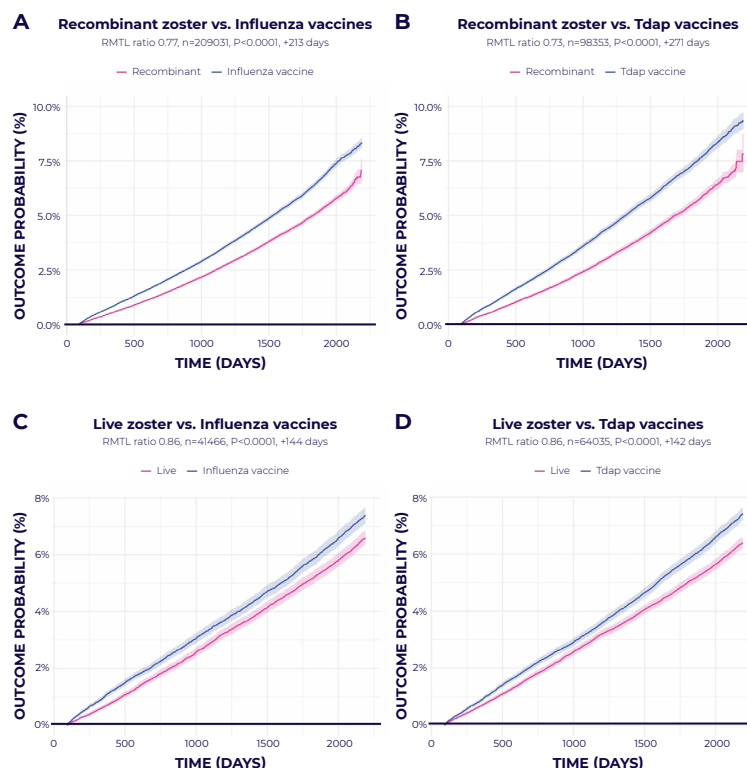
A proper skeptic might ask why we are impressed by this work but dismissed the connection between vaccines and autism and considered the link between aluminum and asthma to be speculative. That's because this publication essentially tried to disprove itself. They didn't just compare people who got Shingrix to people who didn't. If that had been the case, you might have asked whether people who were starting to manifest dementia simply forgot to get vaccinated, so maybe the dementia was causing lack of vaccination. Rather, the study compared people who got Shingrix to people who didn't get Shingrix but still got another vaccine. They showed that people who got the flu shot but didn't get Shingrix had higher rates of dementia than people who got Shingrix. And since that might cause you to wonder if the flu shot causes dementia, they also compared people who got Shingrix to those who didn't but who got a Tdap booster, and once again they saw that those who got Shingrix had the lower rate of dementia.

Furthermore, they didn't just look at Shingrix, which is the latest kind of shingles vaccine. They looked at people who got an older type of vaccine called Zostavax that used a live but weakened version of the virus that causes shingles. And they saw the same correlation when compared to people who got the flu shot or Tdap but not Zostavax.

Shingrix is a better vaccine, which is why it replaced Zostavax, and it turns out that Shingrix also

FIGURE 10:

Herpes zoster vaccination is associated with reduced dementia risk in the six years following vaccination



SOURCE: [Nature Medicine](#)

is associated with lower rates of dementia than Zostavax. So if it were simply a case of Shingrix being associated with a lower rate of dementia than flu or tetanus vaccines, we might speculate that it's the result of something in the Shingrix vaccine, maybe the adjuvant that stimulates the immune system, and not specifically the fact that Shingrix protects against virus reactivation. But it's because Zostavax, despite being a very different kind of vaccine from Shingrix, also was associated with lower dementia rates compared to flu and tetanus vaccines that make us think that the common denominator is the reduction in viral reactivation.

Looking at the correlations in this way leads one to the conclusion that lower dementia is not associated with merely being pro-vaccine nor associated with getting Shingrix specifically. It's associated with any vaccination against this particular herpes virus. That's not the same thing as definitive proof that the vaccine protects against dementia; for that, one would need to do a randomized trial, which would be unethical since no one should be denied a shingles vaccine. But this is pretty compelling evidence that a shingles vaccine might do more good than just preventing shingles.

QUESTION: But I got the COVID vaccine and still got COVID. Does that mean vaccines don't work?

ANSWER: It's understandable to question the effectiveness of COVID-19 vaccines after contracting the virus post-vaccination. Vaccines give your immune system a head start on preparing to fight an infection. It's like showing a picture of a criminal to the police; they might stop him at the outskirts of the city, but even if the criminal comes into the city and causes some harm, the picture gives the police a head start that likely lets them catch the bad guy sooner than they would have otherwise. Similarly, even when a vaccine doesn't prevent a person from becoming infected, it can blunt the severity of the infection, shortening the time to recovery, keeping them out of the hospital, and reducing the chance of disability or even death.

For instance, a [study published in the *Journal of the American Medical Association*](#) found that individuals who had received three COVID-19 doses and experienced breakthrough Delta variant COVID-19 infections had a 66% lower risk of developing fever symptoms, and their illnesses were, on average, six days shorter compared to unvaccinated individuals. Additionally, [data from the Centers for Disease Control and Prevention \(CDC\)](#) indicate that during the period from September 2023 to January 2024, individuals who received the updated COVID-19 vaccine were 54% less likely to contract COVID-19 compared to those who were unvaccinated. Importantly, [a study published in the *Morbidity and Mortality Weekly Report \(MMWR\)*](#) by the Centers for Disease Control and Prevention (CDC) assessed non-COVID-19 mortality among approximately 11 million individuals enrolled in seven Vaccine Safety Datalink sites from December 2020 to July 2021. After adjusting for age and sex, the [study](#) found that recipients of the Pfizer-BioNTech COVID-19 vaccine had a 34% lower risk of non-COVID-19 mortality compared to unvaccinated individuals. Similarly, recipients of the Moderna vaccine exhibited a 31% lower risk, and those who received the Janssen vaccine had a 54% lower risk of non-COVID-19 mortality. These findings suggest that

COVID-19 vaccination correlates with a reduced risk of death, which is far more important than whether it prevented infection.

QUESTION: I've heard "People didn't die from COVID but they died with COVID" (i.e., people think that the COVID mortality numbers were overblown). What's the reality there?

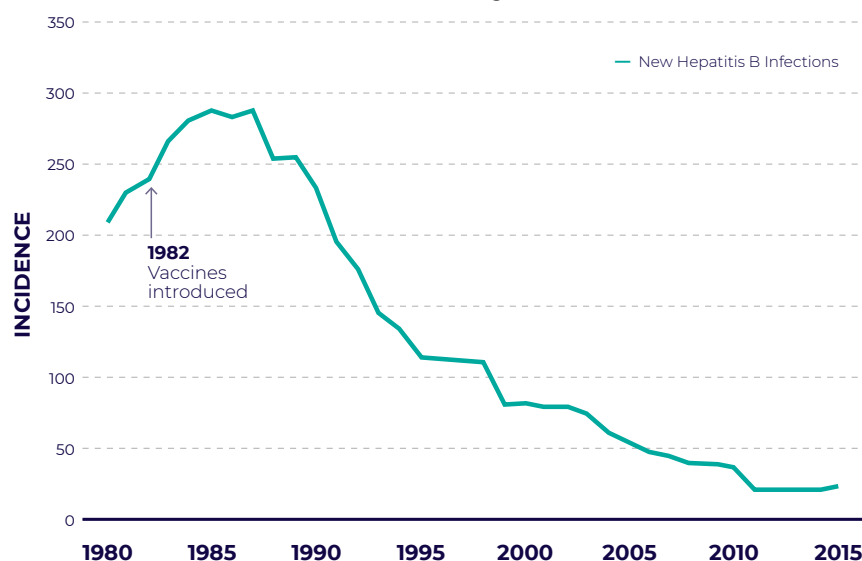
ANSWER: A common claim during the COVID-19 pandemic was that many individuals "didn't die from COVID but died with COVID," suggesting that mortality statistics were inflated. While it's true that some individuals who tested positive for COVID-19 may have died due to other causes, comprehensive analyses indicate that the majority of reported COVID-19 deaths were directly attributable to the virus. COVID-19 often exacerbated preexisting conditions or led to complications such as pneumonia or organ failure, making it the primary cause of death in many cases.

Death Certificate Analyses: In the United States, death certificates include multiple causes of death, distinguishing between immediate, underlying, and contributing factors. The National Center for Health Statistics reported that, as of October 2021, approximately 91% of deaths involving COVID-19 listed it as the underlying cause, indicating that COVID-19 initiated the chain of events leading to death. This underscores that the virus was the primary cause in the vast majority of these cases.

Excess Mortality Studies: Excess mortality refers to the number of deaths during a specific period that exceeds the expected number based on historical data. This metric captures both confirmed COVID-19 deaths and those indirectly related to the pandemic. [A study published in The Lancet](#) estimated that, between January 1, 2020, and December 31, 2021, there were approximately 18.2 million excess deaths globally, while reported COVID-19 deaths totaled 5.94 million during the same period. This significant disparity suggests that actual COVID-19 mortality was substantially higher than reported figures, indicating underreporting rather than overestimation. It also underscores the reality that COVID-19 exacerbates pre-existing conditions and may have been a significant contributor to death by another cause.

Global Estimates: [The World Health Organization \(WHO\) estimated](#) that, in 2020, excess mortality attributable

FIGURE 11:
Adult HBV vaccination nearly eliminated acute infections over the course of 33 years



SOURCE: [CDC](#)

to COVID-19 ranged from 1.34 to 1.46 million in the Americas and 1.11 to 1.21 million in Europe. These figures were about 60% and 50% higher, respectively, than the reported COVID-19 deaths, highlighting the pandemic's extensive impact and the likelihood of underreported cases of COVID infection killing people.

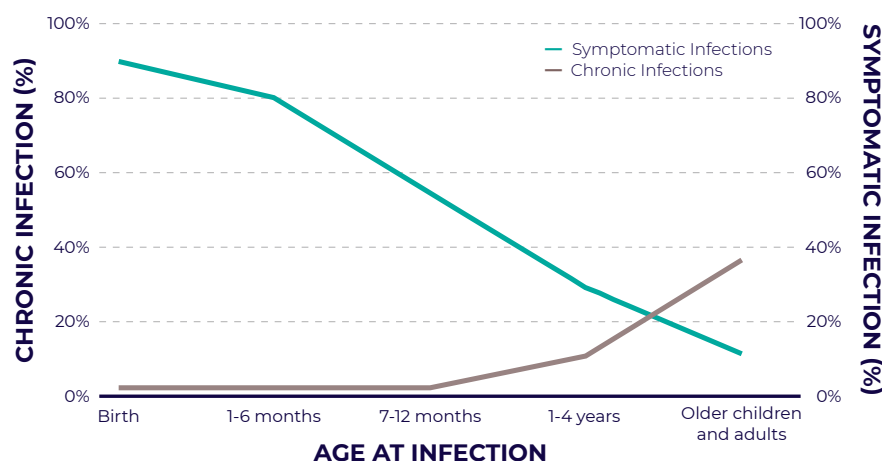
These analyses collectively demonstrate that COVID-19 was the direct cause of death for the majority of reported cases. The substantial excess mortality observed during the pandemic further indicates that official death counts may have underestimated the true toll, countering claims that COVID-19 mortality statistics were exaggerated.

QUESTION: Why does my infant need a vaccine for hepatitis B virus (HBV) on the first day of life? I thought that was only spread through sex and blood?

ANSWER: HBV is a highly infectious virus, and there is no cure for HBV once chronic infection sets in. The introduction of the adult HBV vaccine in 1982 led to an 88.5% decline in acute infections by 2015 (**FIGURE 12**). If you can avoid an acute infection, you can avoid a chronic HBV infection. Approximately 25% of people with chronic HBV will develop liver failure, cirrhosis, or liver cancer. In 1991 the CDC and ACIP implemented a strategy to eliminate HBV. This included testing pregnant women for HBsAg (a marker that indicates you are positive for HBV) and prophylaxis for infants born to HBsAg-positive mothers. This strategy also includes vaccinating all infants at birth, vaccinating previously unvaccinated children and adolescents, and vaccinating adults who are at risk of HBV infection. The primary reason why we vaccinate individuals at birth is because the risk of chronic infections in children less than one year old who are exposed to HBV is ~90%, a risk that goes down to approximately 50% in children who are between one and five years old (**FIGURE 13**). Remember, it's critical we avoid chronic infections because that is where we see the highest death rate in HBV. You might ask, since we test pregnant mothers for HBV and infants rarely contract it elsewhere, why vaccinate all babies against it? The answer is that not every mother is tested for HBV during pregnancy, and there can be failures in reporting test results. There could also be risk of contracting HBV in the household and again, we want to reduce

FIGURE 12:

Infants (<1 year) infected with HBV face a high risk of chronic infections, and this risk decreases significantly with age



SOURCE: [WHO](#)

susceptibility of chronic infection which is highest in infancy and in early childhood. Ultimately, HBV vaccination in infants/kids provides lifelong protection and helps eliminate morbidity and mortality from HBV in the US.

7. ETHICS OF VACCINE MANDATES

Key takeaways:

- Vaccine mandates protect the public, particularly those who cannot be vaccinated (e.g., immunocompromised individuals), from disease outbreaks.
- Declining vaccination rates lead to disease resurgence, such as recent increases in measles and whooping cough outbreaks.

QUESTION: Why are vaccines compulsory for certain settings, such as public schools and hospitals? Why not just let people decide with their doctors whether to get a vaccine or have their child vaccinated?

ANSWER: How would you feel about driving on the road if anyone could drive without a license? What if speed limits were optional? What if anyone could decide for themselves how much they could drink before driving?

Vaccines work best when we are all protected. You can try to drive safely, but you won't be safe if everyone else is driving like a maniac. So we subject everyone to the same rules.

In the case of viruses and bacteria, they often attack you from a base of operations in someone else's body. You can get a vaccine and put up your own defenses, but if the person next to you is shedding tons of virus, that can still overwhelm your immune system and make you sick. But if they are also vaccinated, then their own immune system is likely to be much more effective at keeping down their infection, not only protecting them but also you. When enough people are vaccinated, the virus has a hard time setting up a base of operations. Even if person X gets sick, odds are that the person will get over their infection before they bump into someone else who is unvaccinated and to whom they can pass on that infection. So the infection ends with person X. This is called herd immunity and the key is to ensure that the number of people who aren't vaccinated is low enough that the virus is unlikely to jump from person X to another unvaccinated person before person X's immune system beats their infection. For instance, to prevent measles outbreaks, roughly 95% of the population needs to be immune.

Having as many children as possible stick to the childhood immunization schedule is crucial for maintaining herd immunity and ensuring a safe and healthy society. Vaccines protect individuals from infectious diseases and prevent the spread of these diseases within the community. Herd immunity occurs when a significant portion of a population becomes immune to a disease, either through vaccination or previous infection. This collective immunity protects those who cannot be vaccinated, such as infants, individuals with certain medical conditions, or those with weakened immune systems.

A school is a place where we all send our children knowing that we are exposing them to viruses and bacteria carried by other children. If you want your child to be safe, you would want to send them to a school where the other children and adults are vaccinated.

Hospitals are a place we go to when we are sick, sometimes infected with viruses and bacteria, and sometimes not, but still vulnerable to such infections. Doctors and nurses are around so many sick people, you can expect them to be conduits of those infections. If we wish to help people get better rather than expose them to more illnesses, then we would want healthcare workers to be vaccinated.

Administering vaccines during childhood is essential because children are particularly vulnerable to infectious diseases due to their developing immune systems; everything is new to them. Their immune systems aren't prepared for anything. Vaccinated children are less likely to contract and transmit diseases, contributing to community-wide protection. Many vaccines provide long-term immunity, safeguarding individuals throughout their lives.

Declining vaccination rates can lead to the resurgence of diseases previously under control. For example, in 2023, global measles cases increased by 20% compared to 2022, largely due to inadequate immunization coverage. And this year, the US is [experiencing](#) its largest outbreak of whooping cough (pertussis) in over a decade. Outbreaks of preventable disease, and the resulting severe cases, will continue to increase if vaccination rates continue to decline in children.

Please see this [website](#) for state-by-state vaccine requirements for entering school (note, no states require children to be vaccinated for COVID-19 to enter school).

But vaccine mandates are a choice that we make as a society. If we elect leaders who eliminate those mandates and too many people opt out of vaccination, then we'll pay the consequences for that choice. More people, adults and children, will become sick and some will die.

Now that you know so much more about vaccines, why would we choose not to make the most of them? If you have a reason, send us a note so we can give it some thought add more Q&A to this document.

GLOSSARY OF SCIENTIFIC TERMS:

ADJUVANT: A substance added to a vaccine to enhance the immune response.

ANTIGEN: A foreign substance (like a virus or bacteria) that triggers an immune response. Vaccines introduce antigens to teach the body to recognize and fight specific diseases.

AUTISM SPECTRUM DISORDER (ASD): A developmental disorder that affects communication and behavior.

CASE-CONTROL STUDY: A type of study that compares people with a specific condition (cases) to those without it (controls) to identify potential risk factors.

COHORT STUDY: A study that follows a group of people over time to observe health outcomes.

CONFOUNDING FACTORS: Variables that can influence the outcome of a study and may lead to inaccurate conclusions if not properly considered.

CORRELATION: A statistical relationship between two variables, which doesn't necessarily mean one causes the other.

ETHYLMERCURY: A type of organic mercury compound found in thimerosal, a preservative used in some vaccines.

HERD IMMUNITY: When a large portion of a population is immune to a disease, making it difficult for the disease to spread and protecting those who are not immune.

META-ANALYSIS: A statistical analysis that combines data from multiple studies to provide a more comprehensive overview.

MMR VACCINE: A vaccine that protects against measles, mumps, and rubella.

MORBIDITY: The rate of disease or illness in a population.

MORTALITY: The rate of death in a population.

PATHOGEN: A microorganism (like a virus or bacteria) that causes disease.

PERVASIVE DEVELOPMENTAL DISORDERS: A group of disorders characterized by delays in social and communication skills, including autism.

PLACEBO: An inactive substance used in clinical trials to compare against the treatment being studied.

PRECLINICAL RESEARCH: Research conducted in laboratories and on animals before testing a treatment on humans.

PROSPECTIVE STUDY: A study that follows participants forward in time to observe future outcomes.

RANDOMIZED CONTROLLED TRIAL: A type of study where participants are randomly assigned to different groups to test a treatment's effectiveness and safety.

RETROSPECTIVE STUDY: A study that looks back at past data or medical records to analyze health outcomes.

THIMEROSAL: A mercury-based preservative used in some vaccines to prevent contamination.

TH1 AND TH2 RESPONSES: Two types of immune responses; Th1 is cell-mediated immunity, and Th2 is antibody-mediated immunity.

VACCINE: A preparation that stimulates the body's immune system to develop immunity to a specific disease.

VAERS (VACCINE ADVERSE EVENT REPORTING SYSTEM): A national system for reporting and tracking adverse events (any health problem) after vaccination.

VSD (VACCINE SAFETY DATALINK): A system that uses electronic health records to monitor vaccine safety.