

# Peter Chew Formular for calculate Covid-19 Vaccine efficiency

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## Research Article

**Keywords:** COVID-19, Peter Chew Formular, Biochemist, Global issue analyst

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Abstract

Background: The World Health Organization (WHO) said the situation in India was a "devastating reminder" of what the coronavirus could do. India shifts from mass vaccine exporter to importer, worrying the world. Every country needs to vaccinate its citizens faster, vaccination can reduce viral load. This results in vaccination that can reduce transmission, preventing serious illness and death'. Therefore, Countries with higher levels of vaccination can prevent them from becoming "Second India".

Preprint study, Vaccination Education App (1). [Peter Chew, 2021] shows that most people do not take the covid-19 vaccine because they question the safety and effectiveness of the vaccine. Therefore, it is important to create a simple formula for calculate the efficiency of the covid-19 vaccine. The purpose of creating this calculation formula is to allow the public to calculate the efficiency of the covid-19 vaccine by themselves, so that they can understand the effectiveness of the vaccine and decide to take the vaccine. This helps to get a high response to COVID vaccination

Methods: Use the Data publish at The New England JOURNAL of MEDICINE, Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine [Fernando P. Polack et all , 2020]. Calculate of Pfizer BioNTech's COVID-19 vaccine efficiency by using normal formular and Peter Chew Formular , show that the same result are obtain, which is 95.0599 %. In addition, By using public news information, the public can use the Peter Chew formula to easily calculate Covid-19 vaccine efficacy. This is to ensure public can do the calculation themselves. A calculation of relative risk is also provided to provide more information to persuade the public to take the vaccine.

Results: The efficiency of Pfizer BioNTech's COVID-19 vaccine for Malaysian medical worker calculated by using the Peter Chew formula is 95.0599 %. In addition, the calculation of Peter Chew's formula also shows that before the vaccination, about 12 medical staff were infected every day, but after the full vaccination, only about one medical worker was infected every two days. The calculation of relative risk can also make it easier for the public to know that people who are not vaccinated with Pfizer BioNTech's COVID-19 vaccine are 22 times more likely to be infected than people who are fully vaccinated. The above results can convince those who easily question the effectiveness of vaccination.

Conclusions: Peter Chew Formular easy to calculate, and the data required for the Peter Chew Formular calculation easy to obtain from public news. This is to ensure that the public can calculate the efficacy of the vaccine by themselves. The information on the calculation can let public compare the average target group get infected every day before and after fully vaccination is also an advantage to let public know the effectiveness of vaccination. One of the advantage of Peter Chew formulator is that we can assume a high target population of vaccination with  $k = 100$ , such as the medical worker group. When  $k = 100$ , the Peter Chew formular calculation becomes very simple. The Proof of Peter Chew Formular must also be shown.

Keywords: COVID-19, Peter Chew Formular, Biochemist, Global issue analyst

## 1. Background:

The World Health Organization (WHO) said the situation in India was a "devastating reminder" of what the coronavirus could do. India shifts from mass vaccine exporter to importer, worrying the world. Every country needs to vaccinate its citizens faster, vaccination can reduce viral load. This results in vaccination that can reduce transmission, preventing serious illness and death'. Therefore, Countries with higher levels of vaccination can prevent them from becoming "Second India".

Preprint study, Vaccination Education App (1). [Peter Chew, 2021] shows that most people do not take the covid-19 vaccine because they question the safety and effectiveness of the vaccine. Therefore, it is important to create a simple formula for calculate the efficiency of the covid-19 vaccine. The purpose of creating this calculation formula is to allow the public to calculate the efficiency of the covid-19 vaccine by themselves, so that they can understand the effectiveness of the vaccine and decide to take the vaccine. This helps to get a high response to COVID vaccination

From Wikipedia, Vaccine efficacy is the percentage reduction of disease in a vaccinated group of people compared to an unvaccinated group, using the most favourable conditions. Vaccine efficacy was designed and calculated by Greenwood and Yule in 1915 for the cholera and typhoid vaccines. It is best measured using double-blind, randomized, clinical controlled trials, such that it is studied under "best case scenarios." Vaccine effectiveness differs from vaccine efficacy in that vaccine effectiveness shows how well a vaccine works when they are always used and in a bigger population whereas vaccine efficacy shows how well a vaccine works in certain, often controlled, conditions. Vaccine efficacy studies are used to measure several possible outcomes such as disease attack rates, hospitalizations, medical visits, and costs.

### Formula

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The outcome data (vaccine efficacy) generally are expressed as a proportionate reduction in disease attack rate (AR) between the unvaccinated (ARU) and vaccinated (ARV), or can be calculated from the relative risk (RR) of disease among the vaccinated group. The basic formula<sup>[6]</sup> is written as:

$$VE = \frac{ARU - ARV}{ARU} \times 100 \%$$

Where VE = vaccine efficacy

ARU = attack rate in unvaccinated people

ARV = attack rate in vaccinated people.

An alternative, equivalent formulation of vaccine efficacy,

$$VE = (1 - RR) \times 100\%$$

where RR is the relative risk of developing the disease for vaccinated people compared to unvaccinated people.

The study, published by The Journal of Infectious Diseases, Vaccine Epidemiology: Efficacy, Effectiveness, and the Translational Research Roadmap [Geoffrey A. Weinberg et al., 2010]

The outcome data (vaccine efficacy) generally are expressed as a proportionate reduction in disease attack rate (AR) between the unvaccinated (ARU) and vaccinated (ARV) study cohorts and can be calculated from the relative risk (RR) of disease among the vaccinated group with use of the following formulas

$$\text{EFFICACY} = \frac{ARU - ARV}{ARU} \times 100. \quad \text{AND} \quad \text{EFFICACY} = (1 - RR) \times 100$$

The study, published by The Lancet, COVID-19 vaccine efficacy and effectiveness—the elephant (not) in the room [Piero Olliaro et al., 2021] Vaccine efficacy is generally reported as a relative risk reduction (RRR). It uses the relative risk (RR)—ie, the ratio of attack rates with and without a vaccine—which is expressed as  $1 - RR$ .

#### WORLD HEALTH ORGANISATION(WHO) 1985

According to article WORLD HEALTH ORGANISATION, FIELD EVALUATION OF VACCINE EFFICACY [Walter A. Orenstein et al., 1985] ([http://apps.who.int/iris/bitstream/handle/10665/61021/EPI\\_GEN\\_84\\_10.Rev.2\\_eng.pdf;jsessionid=6DDAC5B5661FFEC419412D254A292BCA?sequence=1](http://apps.who.int/iris/bitstream/handle/10665/61021/EPI_GEN_84_10.Rev.2_eng.pdf;jsessionid=6DDAC5B5661FFEC419412D254A292BCA?sequence=1)).

The ideal vaccine efficacy study is a clinical trial starting with persons susceptible to disease. In a double blind randomized placebo controlled fashion, \*\* half of the children receive vaccine and half receive placebo. To calculate vaccine efficacy both groups are followed prospectively to determine attack rates for disease in vaccinees and non vaccinees. This type of study is generally not possible after a vaccine has been licensed because the vaccine is of proven benefit and use of a placebo is unethical. In most countries today, measles vaccine has been used in a proportion of the population. These vaccinees are a self-selected rather than a randomly selected group and their susceptibility prior to vaccination is generally unknown. Nonetheless, vaccine efficacy studies are still possible if biases are reduced to a minimum in order to recreate as closely as possible the "ideal" conditions of the prospective clinical trial.

Calculation of vaccine efficacy - General principles Vaccine efficacy is measured by calculating the incidence rates (attack rates) of disease among vaccinated and unvaccinated persons and determining the percent reduction in the incidence rate of disease among vaccinated persons relative to unvaccinated persons. The basic formula is written as:

$$VE = \frac{ARU - ARV}{ARU} \times 100 \%$$

$$= \frac{\frac{b}{b+c} - \frac{a}{a+d}}{\frac{b}{b+c}} \times 100 \%$$

Where VE = vaccine efficacy

ARU = attack rate in unvaccinated population

ARV = attack rate in vaccinated population.

(1) The attack rate in the unvaccinated (ARU) =  $\frac{b}{b+c}$ ,

b is the number of unvaccinated cases during the outbreak and

c is the number of unvaccinated who did not develop measles during the outbreak.

(2) The attack rate in the vaccinated (ARV) =  $\frac{a}{a+d}$ ,

a is the number of vaccinated cases during the outbreak and

d is the number of vaccinated who did not develop measles during the outbreak.

For example, if the vaccine were totally effective, there would be no disease in the vaccinated population and the calculation would simplify to  $\frac{ARU - 0}{ARU} \times 100 = 100$  percent. By ARU contrast, if the vaccine had no effect at all, ARU would equal ARV and the calculation would simplify to  $\frac{0}{ARU} \times 100 = 0$  percent.

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$$VE = \frac{b - \frac{a}{k\%}}{b} \times 100\% \text{ (Peter Chew Formular)}$$

Where VE = vaccine efficacy

B = unvaccinated infect rate,

A = vaccinated infect rate.

k% = the percentage of a vaccinated group is compared with an unvaccinated group

For research and vaccination of medical worker, usually the total number of unvaccinated = total number of vaccinated, so k% = 100%.

Therefore ,

$$VE = \frac{b - a}{b} \times 100\% \text{ (Peter Chew Formular).}$$

## Proof of the Peter Chew Formular

From the normal formular

$$\begin{aligned} VE &= \frac{ARU - ARV}{ARU} \times 100 \% \\ &= \frac{\frac{b}{b+c} - \frac{a}{a+d}}{\frac{b}{b+c}} \times 100 \% \end{aligned}$$

If the process of vaccination is  $k\%$  of the total target group. Therefore total vaccinate population just  $k\%$  of total unvaccinated population  $[(a+d) = k\% (b+c)]$ .

If the vaccination process is  $k\%$  of the total target unvaccinated population. Therefore, the total number of vaccinated population is  $k\%$  of the total number of unvaccinated people  $[(a + d) = k\% (b + c)]$ .

$$VE = \frac{\frac{b}{b+c} - \frac{a}{k\% (b+c)}}{\frac{b}{b+c}} \times 100 \%$$

$$VE = \frac{b - \frac{a}{k\%}}{b} \times 100\% \text{ (Peter Chew Formular).}$$

$$\text{If } k \cong 100, \quad VE = \frac{b - a}{b} \times 100\%$$

Note: According to article from Proofs and Mathematical Reasoning [Agata Stefanowicz et al, 2014]. Mathematical proof is absolute, which means that once a theorem is proved, it is proved for ever. Until proven though, the statement is never accepted as a true one.

## Peter Chew Formular is similar to the sum of n terms of geometric series

Geometric series.

$$S_n = \frac{a(1 - r^n)}{1 - r}.$$

$$\text{If } |r| < 1, \quad r^\infty \approx 0, \quad S_\infty = \frac{a}{1 - r}$$

## Relative risk(From Wikipedia, the free encyclopedia)

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The relative risk (RR) is the ratio of the probability of an outcome in an exposed group to the probability of an outcome in an unexposed group [ $RR = \frac{P(\text{exposed group})}{P(\text{unexposed group})}$ ].

For example, in a study examining the effect of the drug apixaban on the occurrence of thromboembolism, 8.8% of placebo-treated patients experienced the disease, whereas only 1.7% of patients treated with the drug experienced the disease, therefore the risk ratio is calculated as 1.7/8.8, which is 0.19. This can be interpreted as those receiving apixaban had 19% the risk of recurrent thromboembolism than did patients receiving the placebo. In this case, apixaban is considered to be a protective factor rather than a risk factor because it is associated with causing a reduced risk of disease.

Assuming the causal effect between the exposure and the outcome, values of RR can be interpreted as follows:

RR = 1 means that exposure does not affect the outcome,

RR < 1 means that the risk of the outcome is decreased by the exposure, which can be called a "protective factor"

RR > 1 means that the risk of the outcome is increased by the exposure

The study , published by NCBI ,The National Center for Biotechnology Information advances science and health , Relative Risk [Steven Tenny et all, 2020]. Relative risk is a ratio of the probability of an event occurring in the exposed group versus the probability of the event occurring in the non-exposed group. [ $RR = \frac{P(\text{exposed group})}{P(\text{unexposed group})}$ ].

The study published in National Library of Medicine, Study designs for evaluating different efficacy and effectiveness aspects of vaccines [M E Halloran et all, 2020]. Vaccine efficacy and effectiveness (VE) are generally measured as 1 minus some measure of relative risk (RR) in the vaccinated group compared with the unvaccinated group (VE = 1 - RR).

Relation between Vaccine efficiency (VE) and Relative Risk ( $RR = \frac{P(\text{exposed group})}{P(\text{unexposed group})}$ )

Let  $P(e) = P(\text{exposed group})$  and  $P(ue) = P(\text{unexposed group})$ .

$$VE = \frac{ARU - ARV}{ARU} \times 100 \%$$

$$= \frac{\frac{b}{b+c} - \frac{a}{a+d}}{\frac{b}{b+c}} \times 100 \%$$

$$= \frac{P(ue) - P(e)}{P(ue)}$$

$$= 1 - \frac{P(e)}{P(ue)}$$

$$VE = 1 - RR$$

$$RR = 1 - VE$$

## 2. Method

Example 1:

According to study, publish in The New England JOURNAL of MEDICINE, Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine[Fernando P. Polack et all, 2020]. By A total of 43,548 participants underwent randomization, of whom 43,448 received injections: 21,720 with BNT162b2 and 21,728 with placebo. There were 8 cases of Covid-19 with onset at least 7 days after the second dose among participants assigned to receive BNT162b2 and 162 cases among those assigned to placebo; BNT162b2 was 95% effective in preventing Covid-19

$$\text{Data 1 [ } k\% = \frac{21\,720}{21\,728} \times 100\% = 99.96318\% ]$$

	Covid-19 positive	Covid-19 negative	Total
Vaccinated	8(a)	21712(d)	21 720(a+d)
Placebo	162(b)	21566(c)	21 728(b+c)
Total	170	43278	43448

Example :

Normal Calculation:

$$\begin{aligned} \text{VE} &= \frac{\frac{b}{b+c} - \frac{a}{a+d}}{\frac{b}{b+c}} \times 100\% \\ &= \frac{\frac{162}{162+21566} - \frac{8}{8+21712}}{\frac{162}{162+21566}} \times 100\% \\ &= 95.0599\% \end{aligned}$$

Peter Chew Formular

$$\begin{aligned} \text{VE} &= \frac{b - \frac{a}{k\%}}{b} \times 100\% \\ &= \frac{162 - \frac{8}{0.9996318}}{162} \times 100\% \\ &= 95.0599\% \end{aligned}$$

Peter Chew formular[k=100]

$$\begin{aligned} \text{VE} &= \frac{b - a}{b} \times 100\% \\ &= \frac{162 - 8}{162} \times 100\% \\ &= 95.0617\% \end{aligned}$$

Note: If the total vaccination  $\approx$  the total placebo , we can let  $k\% = 100\%$ , then the final answer of VE is almost the same, 95.06%. Therefore, the advantage of Peter Chew formulor is that we can assume a high target population of vaccination with  $k = 100$ , such as the medical worker group. When  $k = 100$ , the calculation becomes very simple.

Let we modify the Data 1. Let process of vaccination just 90% the total target group. So for vaccinated data, all are 90% form original data.

$$\text{Modify Data 1 [ } k\% = \frac{19548}{21\,728} \times 100\% = 89.967\% ]$$

	Covid-19 positive	Covid-19 negative	Total
Vaccinated	7.2(a)	19540.8(d)	19 548(a+d)
unvaccinated	162(b)	21566(c)	21 728(b+c)

Normal Calculation:

$$\begin{aligned} \text{VE} &= \frac{\frac{b}{b+c} - \frac{a}{a+d}}{\frac{b}{b+c}} \times 100\% \\ &= \frac{\frac{162}{162+21566} - \frac{7.2}{7.2+19548}}{\frac{162}{162+21566}} \times 100\% \\ &= 95.0599\% \end{aligned}$$

Peter Chew Formular

$$\begin{aligned} \text{VE} &= \frac{b - \frac{a}{k\%}}{b} \times 100\% \\ &= \frac{162 - \frac{7.2}{0.89967}}{162} \times 100\% \\ &= 95.0599\% \end{aligned}$$

Peter Chew formular[k=100]

$$\begin{aligned} \text{VE} &= \frac{b - a}{b} \times 100\% \\ &= \frac{162 - 7.2}{162} \times 100\% \\ &= 95.556\% \end{aligned}$$

Note: If the total vaccination  $\approx$  90% of the total placebo, the result of  $k\% = 100\%$  (95.556%) is not much different from the original answer of 95.06%. Therefore, the advantage of Peter Chew formulor is that we can assume a high target population of vaccination with  $k = 100$ , such as the medical worker group. When  $k = 100$ , the calculation becomes very simple.

EXAMPLE 2 : Calculation of Pfizer BioNTech's Covid-19 vaccine efficacy for Malaysian health care workers . This example shows how the public calculates the efficacy of the Covid-19 vaccine through local news.

1. News: Second dose of Covid-19 vaccinations to start on on Wednesday (March 17) Cause Fully vaccinated (two weeks after the second dose). Base on CDC .

Fully vaccination is 1 APRIL [After second dose plus 2 weeks].

2. News(17 April): Covid-19: Healthcare workers infected after vaccination had less severe symptoms, says Health DG: Report 9 health care workers infected after Fully vaccinated. We assume till 16 April, 9 health care workers infected. 1 APR to 16 Apr 2021 = 16 days. So we can assume 9 health care workers infected officers infected per 16 days after Fully vaccination. It mean after FULLY VACCINE, Average health care workers infected =  $9/16 = 0.5625$  per day.

3. News: COVID-19 Outbreak in Malaysia. 25<sup>th</sup> January 2020, the first case of COVID-19 was detected in Malaysia ,

4. News (5 Feb 2021): Covid-19: Almost 5,000 healthcare workers infected so far, two-thirds of them women. there are 4,756 healthcare workers have been infected with Covid-19 so far (Before Vaccination).

Let us assume start day as 25<sup>th</sup> January 2020(first case of COVID-19 was detected in Malaysia ), 25<sup>th</sup> January 2020 till 5 feb 2021 around 376 (11+365) days. So, it mean before vaccination, Average health care workers infected =  $4756/376 = 12.65$  per day.

Data

	Covid-19 positive
Vaccinated	0.5625(a)
unvaccinated	12.649(b)

Peter Chew Formular

[For health care worker , We assume k% = 100%, please refer to example 1]

$$\begin{aligned}
 VE &= \frac{b - a}{b} \times 100\% & RR &= 1 - 0.9555 \\
 &= \frac{12.649 - 0.5625}{12.649} \times 100\% & &= 0.0445 \\
 &= 95.55 \% & \frac{1}{RR} &= 22.47
 \end{aligned}$$

Note: This calculation result is consistent with the real-world study conducted by Pfizer-BioNTech's Covid-19 vaccine, and its effectiveness is about 95%.  $\frac{1}{RR} = 22.47$  Indicates that the risk of infection of the unvaccinated target population is 22 times that of the vaccinated target population.

5. News (5 Feb 2021): MOH Study Shows Pfizer Vaccine 95% Effective: Adham

A real-world study conducted among health care workers in Malaysia showed the Pfizer-BioNTech vaccine was 95 per cent effective in preventing Covid-19, Dr Adham Baba said today.

Note: By using public news information, the public can use the Peter Chew formula to easily calculate Covid-19 vaccine efficacy..

3.Results: The efficiency of Pfizer BioNTech's COVID-19 vaccine for Malaysian medical worker calculated by using the Peter Chew formula is 95.0599 %. In addition, the calculation of Peter Chew's formula also shows that before the vaccination, about 12 medical staff were infected every day, but after the full vaccination, only about one medical worker was infected every two days. The calculation of relative risk can also make it easier for the public to know that people who are not vaccinated with Pfizer BioNTech's COVID-19 vaccine are 22 times more likely to be infected than people who are fully vaccinated. The above results can convince those who easily question the effectiveness of vaccination.

4. Conclusions: Peter Chew Formular easy to calculate, and the data required for the Peter Chew Formular calculation easy to obtain from public news. This is to ensure that the public can calculate the efficacy of the vaccine by themselves. The information on the calculation can let public compare the average target group get infected every day before and after fully vaccination is also an advantage to let public know the effectiveness of vaccination. One of the advantage of Peter Chew formulator is that we can assume a high target population of vaccination with  $k = 100$ , such as the medical worker group. When  $k = 100$ , the Peter Chew formular calculation becomes very simple.

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#### Notes

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#### Ethical approval:

This article does not contain any studies with human participants or animals performed by any of the authors.

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