Investigating the efficacy and adverse effects of covid vaccines: A Systematic Literature Review

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This study aims to ascertain the efficacy and safety of Covid vaccinations on a global scale. Lack of adequate knowledge about vaccines makes people reluctant to be vaccinated. Through this research, I would like to present an accurate idea about the effectiveness of vaccines and their side effects. A systematic literature review will carry out this investigation to conduct these studies properly. This review will help people discover the vaccine's effectiveness, encouraging them to take the vaccine. And by knowing about the efficiency and side effects, they will be able to determine which vaccine is more effective according to their condition. This study reflects the results of a preliminary analysis. Identifying potential vulnerabilities and opportunities for future research are advised.

Additional Key Words and Phrases: COVID-19, SARS-CoV-2, Vaccine, Corona Virus, Pandemic,clinical trial, Mutations, Double mutant variant, Triple mutant variant, Moderna, Vaccine, Pfizer/BioNTech vaccine, mRNA vaccines

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1 INTRODUCTION

Toxicology has discovered a novel coronavirus strain as the source of the COVID-19 disease, which is spread through direct contact between infected and uninfected individuals. The coronavirus disease pandemic of 2019 (COVID-19) has now spread to every country on earth, posing a severe public health threat. COVID-19 is a highly infectious and dangerous viral infection caused by the severe acute respiratory syndrome coronavirus. This brand-new hazardous virus originated in Wuhan, China, and swiftly spread worldwide. Since the deadly COVID-19 virus struck, humanity has suffered negative consequences. Since the first coronavirus case, the globe has gone through numerous periods, with the cessation of most activity. In December 2019, a cluster of pneumonia illnesses was recorded in Wuhan, China. The Chinese health officials acknowledged on January 7, 2020, following an extensive study, that the diseases were caused by a novel coronavirus called SAR-CoV-2).[9]The World Health Organization called it an epidemic on March 11. As of December 2021, Coronavirus (COVID-19) records indicate that over 271 million individuals have been infected,

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and over 5.31 million have died. Effective vaccinations against SARS-CoV-2, the virus that caused the worldwide COVID-19 epidemic, are urgently needed. Numerous candidate vaccines have demonstrated robust immune responses and acceptable safety profiles, propelling them into large-scale Phase 3 studies. 1–8 As of September 22, 2020, a total of 13 Phase 3 studies evaluating a few candidate vaccines had been initiated worldwide.[2] Several vaccines have advanced to the final rounds of clinical trials, including mRNA vaccines, the Moderna vaccine, and the Pfizer/BioNTech vaccine, which had effectiveness rates of 94 percent and 95 percentage, respectively. Novavax is a protein-based vaccine; Sinovac, Wuhan vaccine, and Covaxin are inactivated or attenuated vaccines; and repurposed vaccines such as the Bacillus Calmette-Guerin vaccine are reused vaccinations. Additionally, AstraZeneca and the University of Oxford's viral vector vaccine, ChAdOx1, successfully completed phase II/III studies and was demonstrated to be safe and immunogenic with no significant adverse effects. However, more research on its efficacy in ethnically and geographically varied populations with long-term follow-up is necessary, as are investigations on its effectiveness in children.[7] The Coronavirus Efficacy (COVE) experiment estimated that the mRNA-1273 vaccine was 94 percent effective against coronavirus disease-19 (COVID-19). Antibodies against SARS-CoV-2 were evaluated as predictors of COVID-19 risk and protection. [3] By conducting a comprehensive review of the relevant literature and qualitative analysis of the published COVID-19 vaccine clinical trial findings, this study assessed the efficacy and adverse effects of covid-19 vaccines. The paper is divided as follows: The first section deals with the origin of the covid and the preliminary discussion of the vaccine. The second section discusses research methodology. Research question and article Selection have been discussed. Section 3 discusses research questions and reference paper data. Section 4 combines future research and its methods. Section 5 discusses validity, and section 6 discusses an overview of the full report.

2 RESEARCH METHODOLOGY

A systematic literature review can be defined as a research method and process for identifying and critically evaluating related research, as well as collecting and analyzing data from existing research.Fig 1 describes the process of a systematic literature review.[10]

2.1 Research Objective

We want to know about the effectiveness and adverse effects of the Covid-19 vaccine through this review. By this review, people will be able to understand and be aware of the efficacy and adverse effects of the vaccine, which will remove the ignorance in the way of receiving the vaccine. A systematic review of the literature is an excellent method for this aim, as it assures that researchers are not biased. Another reason for this review is to determine what research has been conducted in this domain, what methodologies were used, what conclusions were drawn, and what additional research should be conducted.

2.2 Research Questions

The research questions are designed to know all the facts of both the effectiveness and risk rate of the COVID-19 vaccine. It is also designed to determine which vaccine is effective or ineffective for which variant in the region. These questions directly relate to the study's objectives, methodology, data sources, analysis, and acceptance for the selected research papers.The Table 1 represent the questions:

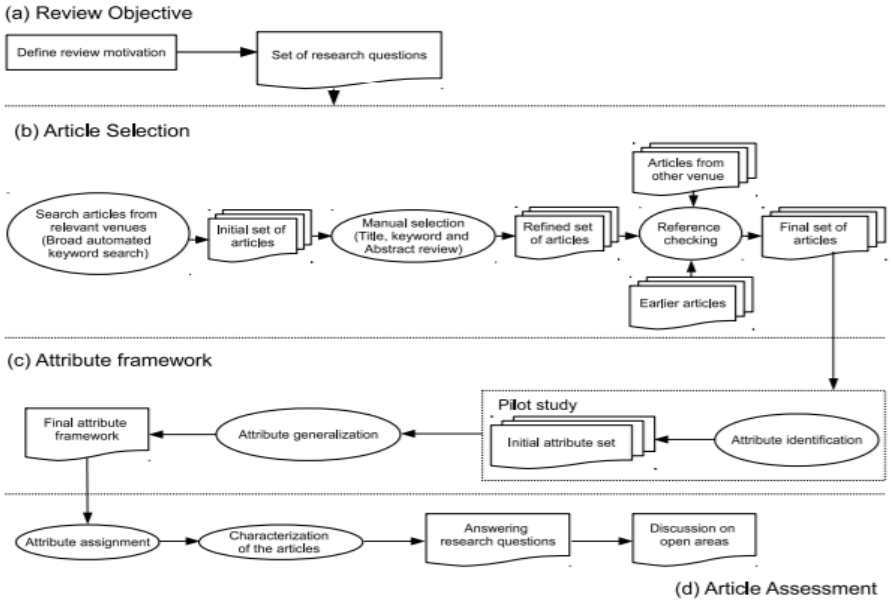


Fig. 1. The Outline of Systematic Literature Review

Table 1.
Research Questions

Category	Research Questions	Motivation
Target	Which reasons behind knowing the rate of efficacy and adverse effects of covid vaccines? Which Vaccines are more effective in a specific geographic area? Which vaccines are more effective in a particular geographical region?	To know the effectiveness of vaccines will motivate people to give effective vaccines for them.
Approach	Which methods of research are used in the investigations? What data collection techniques are used?	To learn about the articles' use of public and institutional data. Discover the data collection platform, analysis matrices, and tools used in the articles.
Outcome	What contributions has the literature made to the study of COVID-19 vaccination progress? How are the paper's methods and findings validated?	From Literature Review to learn about Different approaches and strategies how collecting and analyzing data which contributes to a predetermined outcome

2.3 Article Selection

This section is determined in some way for the article writing process. First, conduct a search of multiple digital libraries, including Google Scholar, Researchgate, and ACM Digital. The most important is to choose articles that are more

relevant and have a sufficient amount of data in those libraries. Another method is to automate the selection of related terms from the digital library.

2.3.1 ***Keywords and Search String:*** In a library database or search engine, a search string is a collection of keywords, truncation symbols, and boolean operators that you enter into the database or search engine's search box. During studying in the section automated keyword search, the following keywords were used: COVID-19, SARS-CoV-2, the efficacy of the covid-19 vaccine, the adverse impact of covid 19 vaccine, geographical influence on covid 19 vaccine, vaccines safety, systematic literature review, clinical trial on covid19 vaccine. Additionally, this article contains the following keywords: Variants, Vaccinations, Mutations, Double mutant variant, Triple mutant variant, Vaccine breakthrough cases, safety, effectiveness, vaccines, Moderna, Vaccine, Pfizer/BioNTech vaccine, mRNA vaccines, Protein-based vaccine, antibody, Pandemic, Clinical study, the efficacy of the covid-19 vaccine. This article will be shown if these keywords or strings are searched.

2.3.2 ***Digital Libraries to Search:*** This system or process is very dynamic, allowing for the easy development of any specific document. Due to its adaptability, it is the most frequently employed method. To do an automated keyword search, pick one or more digital libraries, such as Google Scholar, ACM digital libraries, or Research Gate. Following that, you must provide a keyword that is pertinent to the domain. All searches are conducted using a title, keyword, and abstract information. This search took place between January 2020 and August 2021. Two distinct digital libraries were utilized to pick the journals for this evaluation. Numerous keywords were searched, including COVID-19 vaccine, COVID-19 vaccination effectiveness, COVID-19 vaccine adverse impact, and geographical influence on covid-19. Almost 165 conference paper and 7480 journal papers had been found in ACM digital libraries. 9 papers had been selected for this systematic literature review.

2.3.3 ***Keyword search and Manual Selection:*** So many papers have been discovered via keyword searches. Following that, visitors must conduct a manual search for the desired appropriate documents. Rather than using the automatic search method, it is possible to select a specific number of papers consistent with the research topic at this stage by reading the abstract or a particular section of the report, which can ensure a large volume of work that is free of corruption, informative, and of decent quality.

2.3.4 ***Final set of Articles:*** Following the article selection, 15 articles were found with more data that relate to the domain for systematic review; by sorting from these 15 papers, 10 qualitative and quantitative papers have been selected.

3 DISCUSSION

In order to review the correct and beautiful systematic literature, the questions mentioned in the research paper need to be presented analytically. In this part of the research paper, an attempt has been made to discuss the seven questions of the three sections presented earlier in an accurate and detailed manner.

3.1 RQ1. Which reasons behind knowing the rate of efficacy and adverse effects of covid vaccines?

Coronavirus is a novel type of infectious disease that was first discovered in 2019. This category requires enhanced sequence surveillance, laboratory capabilities, and epidemiological analysis to determine disease severity and severity, risk of re-infection, and immunity to vaccination. This category encompasses variants associated with increased morbidity, increased disease severity, including hospitalization and death, a significant decrease in antibody neutralization,

decreased treatment efficacy, and diagnostic failure.[8] After long research in this situation, researchers discovered the vaccine with multiple phase trials in specific regions. Information on vaccine trials is presented in the Table 2.[4]

Numerous unanswered questions remain regarding the COVID-19 vaccine effort, both in the context of this pandemic and future pandemics. Do vaccines only protect against disease, or can they also protect against transmission and even asymptomatic infection? While vaccination has been shown to reduce symptomatic COVID-19 cases, direct evidence for vaccine-mediated transmission reduction is sparse. Individuals vaccinated with BNT162b2 had a lower viral load, as determined by the PCR Ct value27. Given that a lower viral load has been linked to a decrease in onward transmission93, these data suggest that vaccination may help reduce transmission.[6] Due to the fact that the world is only now becoming acquainted with this virus and these emergency vaccines are also new, their effectiveness and mild or moderate adverse reactions have been observed. As a result, numerous myths exist that discourage people from receiving vaccinations. As a result, widespread health risks and death are unavoidable. This research is to raise public awareness of the issue while demonstrating its regional utility. Trial vaccines according to regions are shown in the table 2:

Table 2.
Region base vaccine type and trial

Variant name	Region	Trial vaccines	Trial vaccines
B.1.351 or 20H/501Y.V2	South Africa	Novavax, Janssen, and Astra-Zeneca	October 2020 in Nelson Mandela Bay
P.1 or 20J/501Y.V3/ B.1.1.28	Brazil	CoronoVac	December 2020 in the city of Manaus in the Amazonas
B.1.617(double mutant) / Triple mutant variant (B.1.618)	India	COVEXIN	April 20 2021 in Maharashtra, Delhi, West Bengal and Chhattisgarh, India.
N440K	India	COVEXIN	Andhra Pradesh, India

3.2 RQ2. Which Vaccines are more effective with fewer adverse effects?

According to World Health Organization data, many vaccinations are presently in use (WHO). The first mass immunization campaign began in early December 2020, and as of February 15, 2021, 175.3 million vaccine doses had been delivered. At least seven different vaccinations have been distributed (from three distinct platforms). On December 31, 2020, the World Health Organization (WHO) issued an Emergency Use List (EUL) for the Pfizer COVID-19 vaccine (BNT162b2). On February 15, 2021, the WHO issued another EUL for two variations of the AstraZeneca/Oxford COVID-19 vaccine made by the Serum Institute of India and SKBio. Other vaccines are on track to achieve EUL status by June 2021.[3] The followings are a study of the most effective vaccines:

SinoVac:A Chinese vaccine candidate that was just licensed and launched is an inactivated vaccine candidate. Phase one and phase two individuals were randomly assigned to vaccination cohorts of 0-14 days and 0-28 days in Figure 2.[3]

Moderna (Mrna-1273): The Moderna COVID-19 Vaccine is also approved for use as a heterologous single booster dose in adults 18 or older who have completed primary immunization with another COVID-19 vaccine. In the Figure 3,

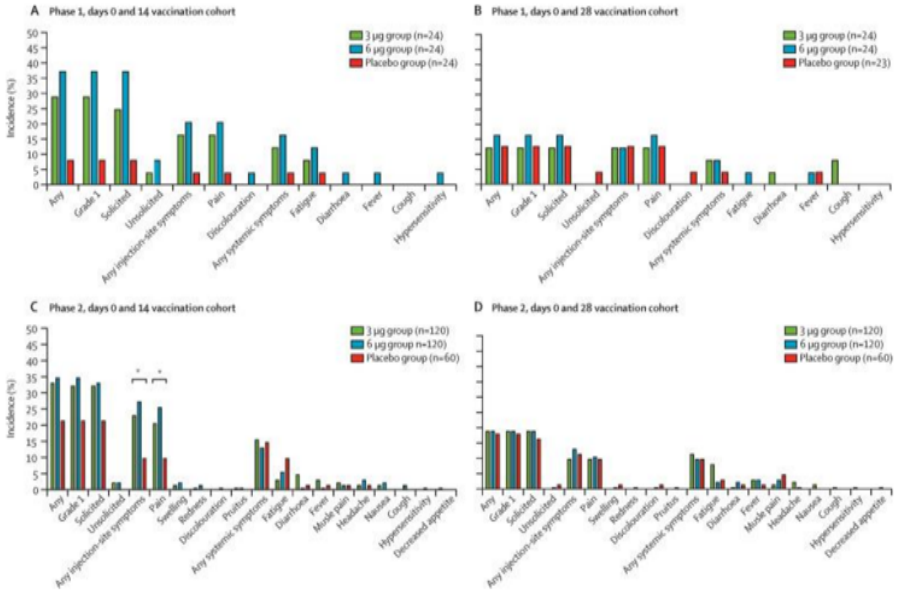


Fig. 2. Overview of SinoVac

an analytical summary of the moderna vaccine is presented.

AstraZeneca vaccine: The vaccination is delivered intramuscularly in two doses of 0.5 ml each, separated by 8–12 weeks (15-17). In the Figure 4, data came from four ongoing blinded, random, control studies involving adults.

Pfizer vaccine (BNT162b2): The vaccine is the first COVID19 vaccine to be approved for both emergency and regular usage. In Figure 5, an analytical summary of the Pfizer vaccine is presented.

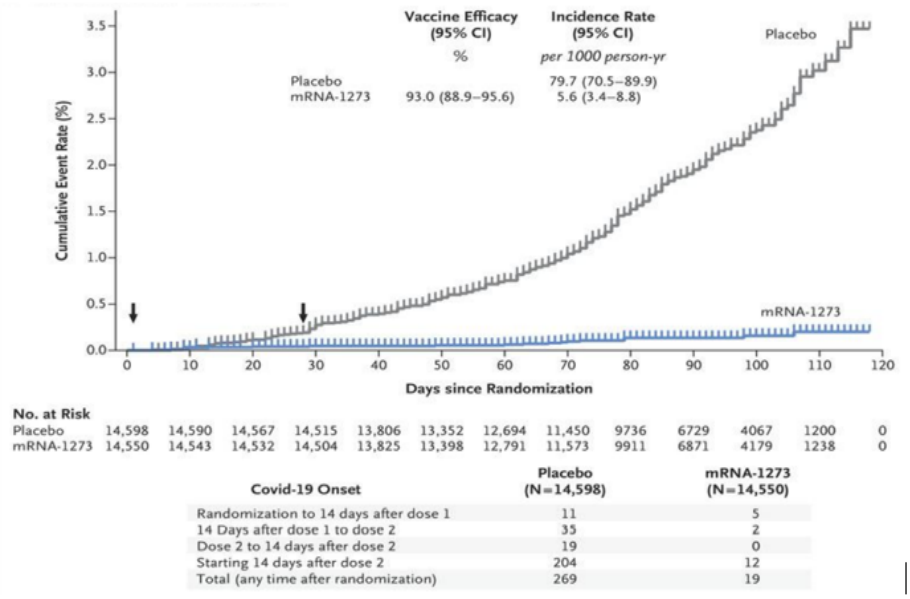
The vaccine effectiveness rate and probable side effects are shown in the Table 5:

3.3 RQ3.Which vaccines are more effective in a particular geographical region?

The effectiveness of vaccines varies from area to area. All effective vaccinations for specific locations are present in the Table 4

3.4 RQ4. Which methods of research are used in the investigations?

This question can be used to find out the method by which the articles are reviewed. Most research papers are made by observational data analysis.[2][3][6][4][5] Besides, analysis has also been done through the systematic review method.[1][6]



Covid-19 Onset	Placebo (N=14,598)	mRNA-1273 (N=14,550)
Randomization to 14 days after dose 1	11	5
14 Days after dose 1 to dose 2	35	2
Dose 2 to 14 days after dose 2	19	0
Starting 14 days after dose 2	204	12
Total (any time after randomization)	269	19

Fig. 3. Overview of Moderna (Mrna-1273)

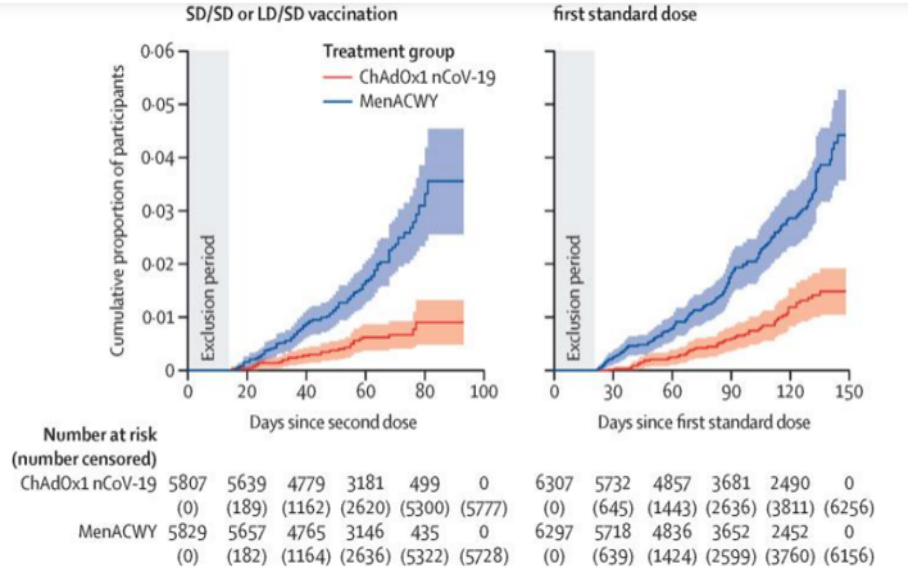


Fig. 4. Overview of AstraZeneca vaccine

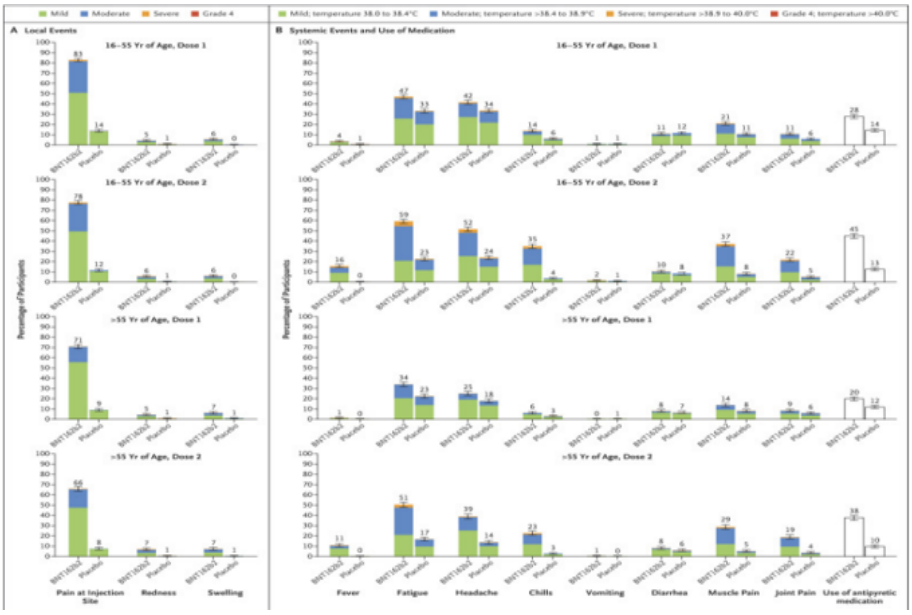


Fig. 5. Overview of Pfizer vaccine (BNT162b2)

Table 3.
Vaccine effectiveness rate and probable side effects

Vaccine	Efficiency rate(Under trial)	Side effects
BNT162b1	95%	Novavax, Janssen, and Astra-Zeneca
mRNA-1273 (Morderna)	94.1%	fatigue, chills, headache, myalgia, and pain to the injection site.
Oxford, AstraZeneca(AZD1222) / Triple mutant variant (B.1.618)	70.4 %	After 21 days, the control arm had ten COVID-19 hospitalizations, two severe cases and one death.
SinoVac	51 percent against SARS-CoV-2 symptoms, 100% against severe COVID-19, and 100% against hospitalization 14 days after the second dosage.	Pain at the injection site
rAd26 and rAd5	91.6%.	mild to moderate.

3.5 RQ5. What data collection techniques are used?

As far as the maximum article used primary data and secondary data such as survey methods for analytic data and collecting data, gathering information from journals, Audiences were directly questioned about the research questions. So, the data sets provided are the received responses, and the data sources are accessible.

Table 4.
Vaccine effective in a particular geographical region

Region	Effective Vaccine
U.S States	Pfizer and Moderna
Brazilian variant	Corona Vac vaccine
P.1 variant in Brazil	Corona Vac vaccine
B.1.351(South Africa)	Corona Vac vaccine
Indian all variants	COVEXIN

3.6 What contributions have the literature made to the study of COVID-19 vaccination progress?

Reviewing selected articles reveals the effectiveness and adverse effects of vaccines in different regions. It will also make an essential contribution to future research. This report will help raise awareness and knowledge about adverse conditions of the covid situation.

3.7 RQ7. How are the paper's methods and findings validated?

Each source of information has been validated for its publication date. After validating the original, the source's positivity or negativity is decided. After that, statements are authenticated. This section's references have been checked for bias. A significant study cannot be undertaken in the absence of professionals. Due to the researcher's lack of universal credibility, his institute or peer reviewer status has been manually validated. Except for the report's references, each article has been subjected to one kind of cross-check to ensure its legitimacy.

4 FUTURE RESEARCH DIRECTIONS

Future research directions point to further research related to this domain in the future. Since the Coronavirus is one of the major problems in the world today and it has not yet been possible to find a 100% effective vaccine against it, there is a lot of research to be done in this particular domain in the future.

4.1 In the medical field:

Especially in the medical field, there is extensive research in the pharmaceutical industry. No one knew the specifics of this virus prior to the outbreak. Through well-planned and reliable data collection and accurate analysis, it can be assumed that future generations will be able to cope with today's epidemic. There is a need for research on this in the medical field. And its continuous improvement is desirable.

4.2 In research method:

Method is very important in research. It is possible to produce high-quality research papers by following the correct and reliable method. All the data collected in this paper is collected from different papers, which, if wrong, will affect the research. It is possible to create a less or error-free paper by following the correct information and correct method.

4.3 To increase the effectiveness of vaccines:

It is reassuring to know that there are currently several vaccines available. But only a few vaccines are more than 90 percent effective. We must endeavor to develop vaccines that are completely effective in all of the world's cities. The stagnation that this parasitism has created in the world needs to be overcome through continuous research. Appropriate

research is efficient for any sector. One hundred percent coronavirus eradication antidote is now one of the major demands in the world. Appropriate and continuous research is the only way to get rid of this emerging situation.

5 VALIDITY THREAT

We had to read various reports to review the systematic literature. The data mentioned in the collected reports may have been collected in different ways. There has been researched on both primary and secondary types of data. It is not always possible to avoid biased or false data. However, in this research paper, we have honestly tried to analyze 100% accurately and verified data. We have tried to follow specific rules in every step of making this research paper.

6 CONCLUSION

This study reviews systematic literature on the topic of efficacy and adverse effects of covid vaccines. You have to search in the prescribed automated way as well as select the paper manually. At this stage, 10 articles are selected on the basis of which the entire work has been completed.

Our main goal in this research paper was to learn about the effectiveness of the Covid vaccine worldwide and its adverse effects. From the primary and secondary data of the collected papers, we are able to analyze them in a reliable and efficient manner.

This study proves that Pfizer – BioNTech (95%) is the most effective vaccine in different parts of the world. Moderna and Sputnik V are effective (94%) and (92%), respectively. There are also some effective vaccines that are approved by the World Health Organization. And in the review of the adverse effects, large-scale adverse effects are not common except for mild and moderate effects such as fever, headache, and muscle aches.[5]

The study seeks to inform the public about the effectiveness of vaccines by following the systematic approach of a systematic literature review. Since none of these vaccines are 100% effective and it is uncertain whether they are suitable for the next generation of the virus, further research is needed on this specific topic in the future.

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A CONTRIBUTION RECORD

Detail each group member contribution according to the following tables.

A.1 Paper Assessment

Student id & name	Paper No. from Ref	Paper Title
19-41168-2, MD. MEHEDI HASAN	[1], [2], [3]	A Report on COVID-19 Variants, COVID-19 Vaccines and the Impact of the Variants on the Efficacy of the Vaccines. The doubtful effectiveness of the COVID-19 vaccine. GSC Biological and Pharmaceutical Sciences. . Evaluating the Efficacy of COVID-19 Vaccines.
19-41192-2, MD. AL MAKSUD ALAM	[5], [6], [7]	Immune Correlates Analysis of the mRNA-1273 COVID-19 Vaccine Efficacy Trial. medRxiv : the preprint server for health sciences. Progress of the COVID-19 vaccine effort: viruses, vaccines and variants versus efficacy, effectiveness and escape Potential effectiveness and adverse implications of repurposing doxycycline in COVID-19 treatment, Expert Review of Anti-infective Therapy.
19-41212-2, MD. AHSAN NAYEM	[4], [8], [9]	Review of COVID-19 Variants and COVID-19 Vaccine Efficacy: What the Clinician Should Know? Mini-Review Discussing the Reliability and Efficiency of COVID-19 Vaccines. Efficacy and safety of COVID-19 vaccines: a systematic review

Table 5. Paper collected and read by the group member

A.2 Paper writing contribution

Student id & name	Section No	Section Title
19-41168-2, MD. MEHEDI HASAN	1 & 4 & 3	Introduction & Future Research Directions & Discussion
19-41192-2, MD. AL MAKSUD ALAM	3 & 5 & 2	Discussion & Validity Threat & Methodology
19-41212-2, MD. AHSAN NAYEM	2 & 6 & 3	Methodology & Conclusion & Discussion

Table 6. Section(J) Written in the paper by the group member