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A Review of Tobacco Control Program Economic Evaluations

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Abstract

In the United States, an estimated 443,000 individuals die each year from smoking-related diseases. Annually, cigarette smoking costs over $193 billion in medical expenditures and productivity losses. To help alleviate this burden, tobacco control initiatives and regulations are funded by several states, the federal government, and a number of national organisations. We analysed the current literature on economic analyses of tobacco control programmes for this paper. The most commonly studied smoking cessation strategies include Nicotine Replacement Therapy (NRT) and self-help. Other key interventions, such as price and tax increases, media campaigns, smoke-free air regulations and workplace smoking interventions, quitlines, youth access enforcement, school-based programmes, and community-based programmes, have significantly fewer research.

Keywords: Economic evaluation • Cost-effectiveness • Smoking • Tobacco use

Introduction

Cigarette smoking has a huge health and economic impact on the country. In the United States, an estimated 443,000 Americans die each year from a smoking-related disease [1]. At least 80% of deaths from Chronic Obstructive Pulmonary Disease (COPD) and early cardiovascular disease and mortality, as well as 30% of all cancer deaths, are caused by smoking [2]. Annually, cigarette smoking costs over $193 billion in medical expenditures and productivity losses [1]. States spent $12 billion in Medicaid money treating tobacco-related disorders in 2001 [3]. In 1997, the entire expenditures of smoking to the Medicare programme totaled $20.5 billion [4]. To help alleviate this burden, numerous states, the federal government, and a number of national organisations provide funding for tobacco prevention. States should spend an average of $5.98 per person on tobacco prevention programmes, according to the Centers for Disease Control and Prevention (CDC) [5]. States spent $538 million ($1.85 per person) on tobacco prevention programmes in fiscal year 2006, down from a high of $750 million ($2.51 per person) in fiscal year 2003 [6]. Tobacco control policies and programmes have been shown to reduce smoking initiation, increase smoking cessation, and reduce second hand smoke exposure [7-8]. Although the effectiveness of tobacco control strategies is well documented, less is known about their cost-efficiency. Economic evaluation is important for finding, evaluating, valuing, and comparing the costs and outcomes of different initiatives. We analysed the current literature on economic analyses of tobacco control programmes for this paper.

Despite significant gaps in the data, studies reveal that tobacco control programmes and policies are either cost-saving or extremely cost-effective when compared to other public health interventions in almost every scenario. We hope that this report will aid researchers, tobacco control advocates, and policymakers in developing an economic research agenda that will support the continuation of state tobacco control initiatives.

Economic evaluation elements

Cost analysis (CA), Cost-effectiveness Analysis (CEA), Cost-Utility Analysis (CUA), and Cost-Benefit Analysis (CBA) are the four primary approaches used in economic analyses.

Cost analysis: Cost assessments can be performed independently, but they are frequently included as part of a CEA, CBA, or CUA and cover the expenses of creating and executing an intervention. The cost of a programme is usually represented in total costs or dollars per person served [9]. Direct costs, indirect costs, and intangible costs are the three types of expenses. Direct costs can be medical or nonmedical in nature. Indirect costs (opportunity costs) are associated with the amount of time and productivity lost by people targeted by the intervention. Intangible costs, which assess the pain or suffering caused by a treatment, are difficult to quantify and are consequently rarely considered in economic analyses.

Analysis of Cost-Effectiveness: CEA correlates the cost of an intervention with the health benefits it provides [8]. Cases avoided, hospital days avoided, fatalities averted, and life years saved are all indicators of improved health. CEA is used to compare one intervention to no intervention or two or more interventions with varying levels of efficacy or cost. Each intervention's health benefits do not have to be identical, but they must be able to be converted to a common unit, such as life years saved. A cost-effectiveness ratio, which assesses the net cost of an intervention per unit of improved health, is often used to express the findings of a CEA.

Analysis of Cost-Utility: The cost of an intervention is compared to one specific measure of health improvement, the Quality Adjusted Life Year (QALY). To determine overall quality of life, QALY considers both mortality and morbidity. CUA results are often stated in terms of cost per QALY saved [9]. This method has the advantage of allowing different types of health gains to be compared [9]. The Disability-Adjusted Life Year (DALY) and the healthy life year are two other time-based health indicators frequently related with CUA.

Analysis of Cost-Benefit: The expenditures of the programme and the health benefits achieved are expressed in dollars, which are discounted to their current or present value. Discounting is a method of comparing the worth of expenditures and benefits regardless of their timing. When the interventions being compared have different or numerous outcomes, CBA is utilised. Net benefits (present value of benefits less harms, minus cost of prevention) and benefit–cost ratio (present value of benefits divided by present value of costs) is the two most widely used summary statistics for CBA [9]. Differences in expected interest rates will have a significant influence on the present value of future benefits streams. In general, if the benefits outweigh the costs, the programme is a good investment. Because of the difficulty and controversy that might surround putting monetary values on health outcomes, CBA is not as common in public health research as CEA and CUA.

The Importance of Perspective in Economic Analysis: Each of the aforementioned economic evaluation studies (CA, CEA, CUA, and CBA) can be conducted from the perspective of various intervention stakeholders, such as intervention participants, the funding agency, or society as a whole.

The end user of the study frequently dictates the perspective of an economic evaluation, and perspective decides which costs and benefits should be included in the study. As a result, defining the study's perspective before beginning data collecting or analysis is crucial. Private payers, government agencies, public payers, and society as a whole are all common perspectives.

When faced with a fixed budget, a set of options for how to spend it, and a number of other limitations (resource, ethical, or political), decision makers frequently seek evaluations that are extremely particular to their situation.

Insurance coverage: Only one study on the cost-effectiveness of workplace smoking treatments was discovered evaluated the cost-effectiveness of four employers' health-care plans and found that as many as 2.8% of employees would quit if both behavioural and nicotine-replacement approaches were completely covered. Employers would pay $2.10 to $6.48 per enrollee per year if they offered full coverage. The overall cost of quitting smoking ranged from $1,223 to $1,571.

Campaigns in the media: Two studies that looked at the cost-effectiveness of mass media campaigns were found. The costs and outcomes of Scotland's general public antismoking. The campaign included three primary components: (1) television, outdoor posters, and press advertising; (2) Smokeline, a telephone quitline for cessation support; and (3) You Can Stop Smoking, a handbook with practical information on quitting smoking. The average cost per quitter was $341 to $748. At a 6%discount rate, the cost per life year saved ranged from $617 to $1,330. The cost-effectiveness of a four-year mass media campaign that was found to prevent the onset of smoking in adolescents.

Discussion

The effects of tax and pricing policies, government laws, education, media campaigns, and cessation therapy on smoking prevalence and health outcomes were the focus of the articles evaluated in this research. The most thoroughly studied tobacco control methods appear to be smoking cessation therapies and group or individual counselling. Interventions for pregnant women that combine therapies with some sort of counselling are more cost-effective than standalone interventions. The cost of a cessation intervention for pregnant women is as low as $37 per participant, with a 15% cessation rate. As a result, small investments in pregnancy cessation programmes have a positive impact on pregnancy outcomes. Pregnant women's interventions reduce smoking prevalence while also lowering LBW and high infant mortality. The newborns born to experimental group participants were 57 grams larger on average, and the incidence of LBW was practically half in the experimental group compared to the control group. The experimental group's average cost per delivery was $1,767, whereas the control group's was $1,846. In terms of the number of quitters and life years gained indicated that interventions aimed at men were more cost-effective than those aimed at women. To reduce the burden of smoking, governments and non-governmental organisations fund a variety of tobacco control initiatives, which have proven to be effective in reducing smoking start, quitting, and second hand smoke exposure investigated the link between tobacco control spending and youth smoking. They discovered that spending on tobacco control lowered the prevalence of young smoking and the average number of cigarettes smoked.

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Whooping Cough: A Global Review of Disease

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Abstract

Pertussis is still a serious public-health concern. The pathogen's transmission has been slowed by high coverage rates, but the loss of immunity suggests that adolescents and adults play an important role in infective dynamics, since they may be a large source of infection for unvaccinated or partially immunise neonates. Many constraints impact the passive surveillance system. The lack of lab confirmation and unique clinical characteristics of patients contribute to underestimate of pertussis in adolescents, young adults, and adults. Because the true epidemiological impact of pertussis is not always apparent, the lack of comprehensive data should not hinder the use of active preventive treatments aimed at preventing the pertussis impact of declining immunity. In adolescents and adults, a booster dose of low-antigen content combination vaccine should be used to minimise a rise in the mean age of infection acquisition. The cocoon technique can reduce the chance of infection in neonates, while there is still controversy on this point, and more surveillance and research are needed to fine-tune the pertussis preventive strategy.

Keywords: Epidemiology • Disease • Review • Pertussis

Introduction

Bordetella pertussis causes pertussis, a human respiratory disease spread through Flügges droplets. The disease is extremely infectious, with a high basic Reproduction Number (Ro), which measures the number of secondary cases induced by each primary case in a population of fully susceptible people. The condition affects people of all ages, especially children, and is one of the leading causes of death in newborns under the age of one year. The incubation time is usually 7days-10 days (range 1week-3 weeks), and the clinical characteristics are linked to the age of infection, any accessible immunological status, and antibiotic therapy. Furthermore, the severity of the disease is inversely proportional to the patient's age; pertussis has a predictable course in unvaccinated youngsters and can result in severe symptoms and problems. The outlook is especially bad during the first and second years of life, when the incidence, hospitalizations, and mortality are all at their highest (case fatality rate: 0.2% and 4% in developed and developing countries). The disease may have a mild and atypical course in vaccinated children, adolescents, and adults [1-5], which is why it is rarely detected in these individuals [6]. These topics could be a source of infection for children, especially babies in their first year of life, when their immune systems are still developing [7]. Several seroepidemiological studies have found that the condition is very common in teenagers and adults.

Only by achieving high immunisation coverage in the community (>92%) can the illness be stopped from spreading. Immunity against pertussis, both natural and acquired through examine and review the pertussis epidemiology worldwide and in Italy, taking into account all of the preceding aspects.

Worldwide epidemiology

Pertussis is an endemic-epidemic infectious disease that occurs every 3years-5 years and has a summer−autumn seasonality. Both the incidence and case fatality ratio were high in the pre-antibiotic and pre-immunization era, and the sickness mostly affected children under the age of five. Antibiotic medication and immunisation have considerably reduced the number of cases and deaths. Pertussis vaccination (together with tetanus and diphtheria vaccination) was added to the WHO's Expanded Programme on Immunization (EPI) in 1974. According to 2008 data, the global rate of babies immunised with three doses was expected to be around 82%. Nonetheless, the WHO estimates that approximately 16 million cases and 195,000 deaths occurred in 2008, with 95% of these occurring in underdeveloped countries. Immunization prevented approximately 680,000 deaths in the same year. While data on the longevity of immunological protection in developing countries is scarce, several studies in industrialised nations have shown that protection fades after 4years-12 years. According to statistics published by Witt et al. in a recent publication, the existing schedule of acellular vaccine doses is insufficient to prevent pertussis outbreaks, with a considerably elevated rate of disease from ages 8years-12 years, proportional to the time since the last scheduled immunisation. Furthermore, as stated by Cherry, the fact that DTaP vaccines are less powerful than DTaP vaccines is of current concern. DTaP vaccines are more effective than DTaP vaccines, according to five studies published in the 1990s. In addition to low immunity causing an increase in pertussis cases in several countries, there are several other explanations for this rising trend, including increased awareness; increased use of PCR; use of DTaP vaccines, which are less effective than DTaP vaccines; and possible genetic changes in circulating Bordetella pertussis strains. Pertussis is a notifiable disease in the United States; data collected from 1990 to 2010 revealed that the incidence (per 100,000 populations) peaked in 2004 and has been growing since 2007, surpassing peak rates seen in 2004-2005. Infants younger than 6 months of age were substantially implicated between 1990 and 2010, with a 60% increase in incidence in this age group in 2008-2009. Adolescents and adults accounted for over 40% of notified cases in 2009, with children aged 7years-10 years accounting for an increasing proportion of cases in recent years (9%, 13%, 23.5% and 23% in 2006, 2007, 2008 and 2009, respectively). A pertussis outbreak has just been detected in the state of Washington. A total of 2,520 cases were reported from January to June 2012, with the highest frequency in infants under one-year-old and children aged 10, 13, and 14. The rate of hospitalised newborns aged one year was 21.9%, and the rate of hospitalised infants aged two months was 41.2%. Household members, particularly parents, were the source of infection for babies in the United States, Canada, France, Germany, Brazil, and Australia. From 1945 to 2005, the epidemiology of pertussis was studied in a number of Central and Eastern European nations as well as Turkey. Pertussis was common in the pre-vaccine era (180−651/100,000 cases), with the majority of cases occurring in pre-school children. During the period 1995−2005, when vaccine coverage was high (80%−98%), incidence dropped dramatically (3/100,000). In several countries (e.g., Poland, Estonia, and the Czech Republic), incidence rates for children aged 5years to 14 years old increased, while rates for children aged 1 year stayed stable. Despite high immunisation coverage, pertussis infection remains in Central and Eastern European countries, and the age distribution has shifted towards older children in comparison to the pre-vaccine era [9,10].

Conclusion

Pertussis remains a public-health concern, according to both national and international data.

The pathogen's transmission has undoubtedly been slowed by the high coverage rates obtained in developed countries; yet, the loss of immunity suggests that teenagers and adults play an important role undoubtedly been slowed by the high coverage rates obtained in developed countries; yet, the loss of immunity suggests that teenagers and adults play an important role in infective dynamics. For unvaccinated or incompletely immunised neonates, adolescents and adults may be a substantial source of infection. Limitations such as inadequate or delayed reporting and under-diagnosis influence the passive surveillance method based on notification. Furthermore, the underestimate of pertussis in adolescents, young adults, and adults is linked to atypical clinical features of cases and the lack of test confirmation.

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Medically Important Bacterial Infections Molecular Diagnostics

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Abstract

Infectious diseases are widespread over the globe. According to a recent World Health Organization report, infectious diseases are now the leading cause of death among children and young adults worldwide. In non-industrialized countries, infectious illnesses caused 45 percent of all deaths and 63% of deaths in early childhood. The development of novel, rare, or long-forgotten infectious diseases in affluent countries, such as HIV/AIDS, Lyme disease, and tuberculosis, has piqued public attention and sparked commitments to surveillance and control. According to recent reports, infectious diseases cause more than 17 million fatalities worldwide each year, the most of which are caused by bacterial infections. As a result, controlling infectious diseases remains a critical duty around the world. Diagnostic medical bacteriology is divided into two categories. There are two types of diagnostic medical bacteriology. Identification and type are two components. Medical bacteriology diagnostics is divided into two categories. Identification and type are the two components. Molecular biology has the capacity to transform the way we live. Diagnostic tests are performed in order to improve patient care. They occur in a hospital or in the neighbourhood. Since the invention of PCR in the 1970s, in the late 1980s, there was a huge amount of research was done that allowed for the introduction application of molecular assays to a variety of clinical scenarios microbiology. Molecular biology is still being used. Many people have found it difficult to keep up with the quick changes. Before deciding which test to use, technology will become obsolete.

Introduction

Following the cellular and protein period of the 1970s and 1980s, the last ten years of the twentieth century saw an exponential development in knowledge of molecular biology techniques. This technological explosion in molecular biology has had far-reaching repercussions, allowing significant advancements in a wide range of life sciences fields, including bacteriology. General molecular biology approaches are now being used by molecular bacteriologists to support their specific area of interest. This chapter examines the present state of molecular biology techniques in medical bacteriology, with a focus on the molecular identification of bacterial infection causative agents [1]. The chapter also seeks to provide a broad overview of current technology's applications so that the reader has a better understanding of the wide range of techniques accessible, both as research tools and in everyday situations. The managerial, financial, labour and space requirements of adopting molecular diagnostics will be examined. This chapter discusses the evolution of laboratory diagnosis of infectious diseases, as well as current understanding, literature, and recommendations. This review focuses on medically significant bacterial infections [2].

Historical considerations

In 1676, Anton van Leeuwenhoek, a Dutch cloth merchant and amateur lens grinder, used a rudimentary microscope to study living microorganisms, which he dubbed "animalcules." He looked for "animalcules" in many places, including pond water, sick individuals, and even his own mouth, and discovered that they were everywhere. In spherical, rod, and spiral forms, he described and recorded all of the primary types of microorganisms: protozoa, algae, yeast, fungi, and bacteria. His discoveries opened up a new realm, the microbial world, and this was the first milestone in diagnostic microbiology's history. Although the Roman physician Girolamo Fracastoro proposed in 1546 that disease was caused by invisible living creatures, people did not clearly recognise the role of microorganisms in diseases until 1876, 200 years after Leeuwenhoek discovered his little "animalcules," when German physician Robert Koch established his famous "Koch's postulates" based on the relationship between Bacillus anthracis and anthrax [3].

Koch's postulates include the following:

- To prove that a certain bacterium is the cause of a specific disease, the microbe must be discovered in all cases of the condition.
- This microorganism must then be entirely removed from the afflicted body and cultured in a pure culture outside of it.
- This pure culture must be capable of infecting healthy animals with the illness via inoculation.
- The identical microorganism should be extracted from the infected animals and cultured in a pure culture outside of the body.

Koch was a pioneer in medical microbiology, and his theories are still regarded foundational in bacteriology. Infectious diseases can spread through populations, causing epidemics or even pandemics. Some epidemic or pandemic diseases are so dangerous that they can kill hundreds of thousands, if not millions, of people. For example, bubonic plague, caused by Yersinia pestis, moved from Asia to Europe via the Black Sea ports, killing 42 million people, 25 million of them were in Europe, in just over four years between 1347 and 1352, decreasing Europe's population to 50 million people.

Tuberculosis was going to make an appearance. Bunyon's moniker, "The Captain of the Men of Death," expresses the enormous fear that the disease was linked with, even up to the present day. It was recognised and feared until the current age as one of life's most common and dangerous perils, from which escape was nearly impossible. During this period, Jean François Fernel, a well-known Renaissance physician, was conducting some groundbreaking research on the circulatory system. In his work Medicini, Fernel recounts a variety of clinical illnesses, including some of the earliest recorded examples of endocarditis [4]. When compared to traditional detection methods, which have been evolving for over a century, molecular detection technologies are very new, having only been around for about 20 years. Despite the fact that deoxyribonucleic acid, or DNA, was discovered in the late 1860s, it was not exploited until the 1970s, when restriction enzymes and recombinant DNA procedures were developed. Many scientists worked hard at this time to solve the profound enigma of DNA. We should remember certain pioneers and their findings to trace the history of molecular detection technologies. In the nuclei of human white blood cells, Johann Friedrich Miescher, a Swiss physician, discovered a mildly acidic substance of unclear purpose in 1869 [5]. This substance was eventually termed deoxyribonucleic acid, or DNA. For nearly a century, the material was generally neglected since it appeared to be too basic to serve any significant purpose. In 1949, a biochemist named Erwin Chargaff found that DNA composition was species specific, meaning that the amount of DNA and its nitrogenous bases differed from one species to the next.

Furthermore, Chargaff discovered that in DNA from all species, the amount of adenine equaled the amount of thymine, and the amount of guanine equaled the amount of cytosine. Scientists learned that chromosomes, which were previously thought to contain genetic information, were made up of DNA and proteins around this time. Franklin Griffth, a British medical officer, discovered how to transfer genetic material from heat-killed bacterium cells to live organisms in 1928 [6]. The first evidence that genetic material is a heat-stable chemical came from this event, known as transformation. Griffth's transforming agent was identified as DNA by Oswald Avery, a Canadian physician and bacteriologist, and his collaborators McCarty and Colin MacLeod in 1944. Experiments carried out in the 1940s revealed that DNA appeared to be the genetic material. However, until 1953, when James Watson and Francis Crick discovered the molecular structure of DNA, no one knew what the structure of DNA was or how such a molecule could hold all the information needed to develop a human being or other living species. The first proof that genetic material is a heat-stable chemical came from this event, known as transformation. Griffth's transforming agent was identified as DNA in 1944 by Oswald Avery, a Canadian bacteriologist, and his collaborators McCarty and Colin MacLeod. DNA appeared to be the genetic substance in experiments undertaken throughout the 1940s [7]. However, until 1953, when James Watson and Francis Crick discovered the chemical structure of DNA, no one knew what the structure of DNA was or how such a molecule could hold all the information required to build a human or other living entity. They deduced that it must take the twisted ladder shape of a double helix after developing various size models of probable DNA configurations. A "backbone" of sugar and phosphate molecules makes up the sides of the ladder. On the interior of the helix, the nitrogen-rich bases A, T, G, and C create the "rungs" of the ladder. Base A would only couple with T, while base G would only pair with C, the pair discovered. They shared the Nobel Prize in Physiology or Medicine in 1962 for their discovery, which they shared with Maurice Wilkins, whose work on Xray crystallography with Rosalind Franklin gave more critical evidence. François Jacob and Jacques Monod developed a hypothesis of genetic regulatory mechanisms in 1961, revealing how specific genes are activated and inhibited at the molecular level, and were given the Nobel Prize in Physiology or Medicine in 1962 for their contribution. Marshall Nirenberg, a young biochemist at the National Institute of Arthritis and Metabolic Diseases, discovered the first "triplet" in 1961, which is a sequence of three DNA bases that codes for one of the twenty amino acids that make up proteins [8]. Within four years, the full genetic code had been deciphered. Almost everything about DNA structures and functions was understood in theory by the end of the 1960s, but individuals couldn't get or edit any gene they wanted until the 1970s, when some essential enzymes were discovered [9]. In 1970, an American microbiologist named Hamilton Smith identified the first restriction enzyme, which breaks DNA at a particularly specific nucleotide sequence. Several other restriction enzymes were discovered over the next few years. In 1978, he and Werner Arber and Daniel Nathans shared the Nobel Prize in Physiology or Medicine for their discovery. Paul Berg created the first DNA molecules that integrated genes from many creatures in 1972. The findings of his investigations were essential in the later development of recombinant genetic engineering. Paul Berg, Walter Gilbert, and Frederick Sanger received the Nobel Prize in Chemistry in 1980 for "his foundational investigations of the biochemistry of nucleic acids, with particular relevance to recombinant DNA." Stanley Cohen and Herbert Boyer collaborated in 1973 to build functioning organisms that integrated and replicated genetic information from other species. Their experiments proved the enormous potential of DNA recombinant engineering in medicine and pharmacology, as well as in industry and agriculture. In 1977, Walter Gilbert and Frederick Sanger developed new techniques for rapid DNA sequencing while working separately in the United States and England. Sanger and Gilbert developed technologies that allowed them to read the nucleotide sequence of whole genes ranging in length from 1,000 to 30,000 bases.

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Knowledge, Awareness and Incidence of Adverse Events Following Immunization with Astrazeneca Covid-19 Vaccine among Healthcare Professionals in North Central Zone of Nigeria

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Abstract

Background: The Oxford-AstraZeneca COVID-19 vaccine was deployed in Nigeria on the 5th of March, 2021 with a goal of vaccinating 70% of the population by 2022. This goal is however being threatened by widespread vaccine hesitancy fueled by skepticism around vaccine safety. This study leverages on the clinical acumen of healthcare professionals to evaluate the occurrence of adverse events following immunization to the vaccine in tertiary hospitals in Nigeria.

Methods: It was a retrospective study conducted using a self-administered questionnaire from 25th May to 17th July 2021 in 4 tertiary hospitals across the north central zone of Nigeria. Participants were asked to report the type, intensity and duration of symptoms experienced following Oxford-AstraZeneca COVID-19 vaccine administration. Data was analyzed using SPSS version 22.0.

Result: Of the 295 vaccine recipients who took part in this study, around 71.1% of them reported experiencing at least one symptom with injection site pain (31.3%), fever (25.4%), tiredness (23.6%) and headache (22.9%) being the most commonly reported adverse events. Majority of the reported symptoms began within a day of vaccination; most had no impact on routine daily activities and almost two-thirds had resolved two days after their commencement. The frequency of reported symptoms was higher in: the younger (<40 years) age group, those who had taken two doses, and participants with a history of adverse reaction to a medicine/vaccine. These findings were consistent with those of clinical trials and similar studies in other regions.

Conclusion: As with other vaccines, some adverse events follow the administration of Oxford-AstraZeneca COVID-19 vaccine. Most of these events are short term, tolerable and similar to those reported in other parts of the world. Vaccine recipients should be informed about potential symptoms, how to handle them, and when and where to seek additional guidance if necessary. The findings in this study should help counter vaccine hesitancy by enhancing public confidence in Oxford-AstraZeneca COVID-19 vaccine safety.

Keywords: Nigeria • COVID-19 • Oxford-AstraZeneca • ChAdOx1 nCoV-19 • Adverse effects • Vaccine

Introduction

The widespread morbidity and mortality associated with the 2020 COVID-19 pandemic precipitated the most extensive and rapid global vaccine development program in history, culminating in several vaccine candidates attaining phase 3 efficacy milestones and receiving emergency use authorization by the end of the same year [1,2].

The AstraZeneca COVID-19 vaccine, codenamed ChAdOx1 nCoV-19, is a viral vector vaccine which uses the modified replication-deficient chimpanzee adenovirus, ChAdOx1 as a vector [3,4]. It was the first vaccine approved in Nigeria against COVID-19; it is stable at refrigerator temperatures making it more accessible to low- and middle-income countries with limited cold- chain capabilities [5]. It is administered as an intramuscular injection in a two-dose regimen with an interval of 12 weeks between doses [6]. Having demonstrated remarkable potency in clinical trials against the Wuhan strain [7-9] and new variants of SARS-CoV-2, the spotlight has been on the safety of ChAdOx1 nCoV-19. Nigerian Primary Healthcare Developmental Agency (NPHCDA) flagged off its nationwide deployment on the 5th of March 2021 to much fanfare and optimism. This optimism is however punctuated by lingering skepticism around vaccine safety due to widespread reports of thromboembolic events in some European countries and the conspiracy theories around the pandemic and vaccine. This negative spotlight has led to hesitancy in vaccine acceptance [10]. This survey leverages on the clinical acumen of Healthcare Professionals (HCPs) to facilitate formation of a national COVID-19 vaccine safety profile while also securing their buy-in to drive vaccine uptake by the general population.

The vaccine was shown to be safe and well tolerated in clinical trials [11]. Pain at injection site was the most commonly reported (58.5%) local Adverse Event Following Immunization (AEFI) during trials. The pain was mostly of mild intensity. Other local effects reported were redness, induration, and itching of site. Fatigue and headache were the most commonly reported systemic reactions. Other systemic effects were muscle aches, malaise, chills, and feeling feverish. This trend was similar across both the participants who took prophylactic paracetamol and those who didn't, although the overall incidence was lower in those who took paracetamol. Most of these events began within the first few days of vaccination and no serious adverse effects were observed in the participants. This pattern of adverse reaction was similar across different age groups although the incidence decreased as the age increased. These findings were consistent with trials of other viral-vectored COVID-19 vaccines [12-24].

There've also been several post-licensure cohort studies to assess the safety of ChAdOx1 nCoV-19. Youssef et al. assessed safety of the first dose of vaccine among HCPs in Ethiopia [24] and found that 75.8% of vaccine recipients had symptoms like pain and tenderness at site, tiredness, headache, myalgia, back pain, fever, chills, diarrhea, vomiting, and runny nose. Few (6.1%) participants reported severe symptoms like dypsnoea, chest pain, leg swelling, abdominal pain, and persistent cough. None of the participants were hospitalized, most of the symptoms began within 24 hours of vaccination and majority had resolved by the third day. In a similar study, majority (94.6%) of participants reported at least one symptom after receiving ChAdOx1 nCoV-19 [25]. The pattern of events was similar to that observed in Ethiopia [24]. Female gender and previous COVID-19 infection were associated with a higher incidence of symptoms, while chronic illnesses were associated with fewer symptoms. Some oral lesions including vesicles, blisters, ulcers, and bleeding gingiva were also reported from the study.

Studies from other regions also reveal a similar pattern of reported symptom only differing by occurrence of unique symptoms like sore throat, insomnia and impotence in Kabul, rash in Bangladesh, and a low incidence of fever in Republic of Korea [26-28].

Methodology

Study design

It is a randomized, retrospective, multi-center, cross-sectional exploratory study carried out in four tertiary hospitals across 3 states of the north central geopolitical zone of Nigeria.

Inclusion/Exclusion criteria

All adults (18 years and above) HCPs who consented to being part of the study were included. Healthcare professionals who are less than 18 years of age as of 31st March 2021 were excluded.

Sample size

By NPHCDA figures for 31st March 2021, 54708 individuals had been vaccinated with ChAdOx1 nCoV-19 in the North Central zone. This was our population size. Using a confidence interval of 95%, a 6% margin for error, and allowing for 10% no-response rate, the minimum sample size was determined to be 296 by Cochran formular.

Sampling technique

A two staged simple random sampling technique was used to determine the states and then hospitals in which the study was conducted. Proportionate allocation of study subjects to each state was done based on the total number of people vaccinated as of 31st March 2021.

Study instrument

A self-administered, 45 questions questionnaire developed from review of literature was used [29-34]. The questionnaire was validated by six selected HCPs, prior to being pretested among fifteen randomly selected HCPs for average time taken to complete, legibility, clarity, and understanding.

Data collection

The study observed ethical standards of all relevant institutional committees and the Declaration of Helsinki. Prior to administering the questionnaires, each participant was given a consent form to complete following a detailed explanation of the study protocol.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 22.0 was used to carry out all statistical tests. Descriptive statistics were executed for the demographic data, medical anamnesis, knowledge of COVID-19 vaccine, and the reported adverse events of ChAdOx1 nCoV-19.

Ethical approval

This study was approved by the Health Research Ethics Committee of Bingham University Teaching Hospital, Jos, Plateau State. The approval number is NHREC/21/05/2005/00781.

Result

295 HCPs participated in the study. There were slightly more male participants (50.8%) than females (49.2%). The mean age of the participants was 29.64 years with majority (61.7%) being in the 20-29 years age group (Table 1). Majority of the participants (96.9%) possessed tertiary level of education with over half being doctors (56.9%). Details regarding socio-demographics and medical anamnesis of the participants are provided in (Table 1).

Table 1: Demographic Characteristics of the Participants and Clinical History

Variable		Frequency	Percentage (%)
Gender	Male	150	50.8
	Female	145	49.2
Age group	18-19 years	4	1.4
	20-29 years	182	61.7
	30-39 years	73	24.7
	40-49 years	27	9.2
	50-59 years	9	3.1
Level of Education	Primary	4	1.4
	Secondary	5	1.7
	Tertiary	286	96.9
Profession	Doctor	168	56.9
	Nurse/Midwife	44	14.9
	Pharmacist	33	11.2
	Laboratory Scientist	39	13.2
	Other Allied Health Professional	11	3.7
State of Residence	Abuja	180	8.5
	Nassarawa	25	61
	Plateau	90	30.5
Comorbidities	Asthma	6	2
	Diabetes Mellitus (DM)	9	3.1
	Hypertension (HTN)	15	5.1
	HTN and DM	4	1.4
	Sickle Cell Disease	2	0.6
	None	255	86.4
Previous Drug/ Vaccine Reaction	Yes	40	13.7
	No	252	86.2
Food Allergies	Yes	49	16.6
	No	243	82.4

Despite majority of the participants (99.3%) reporting prior knowledge of ChAdOx1 nCoV-19, just over one-fifth of them (21.8 %) pinpointed the vaccine platform as viral vector (Figure 1). Most of the participants (98.0%) suggested there were adverse events associated with ChAdOx1 nCoV-19, and over two thirds (71.9%) that suggesting these events were common. Pain was postulated as the most common injection site symptom (81.4%), while headache (65.8%) and fever (65.8%) were the most common associated systemic symptom (figure 2).
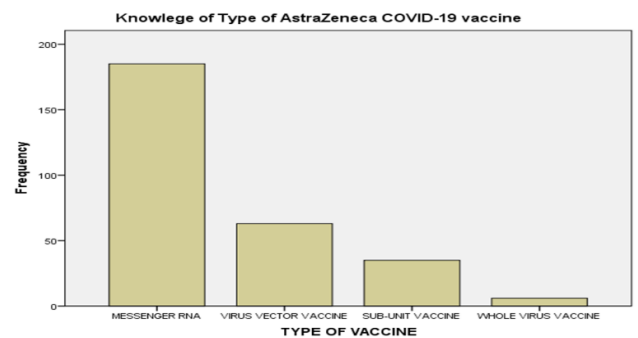

Figure 1: Knowledge of platform of the Oxford-AstraZeneca COVID-19 vaccine.
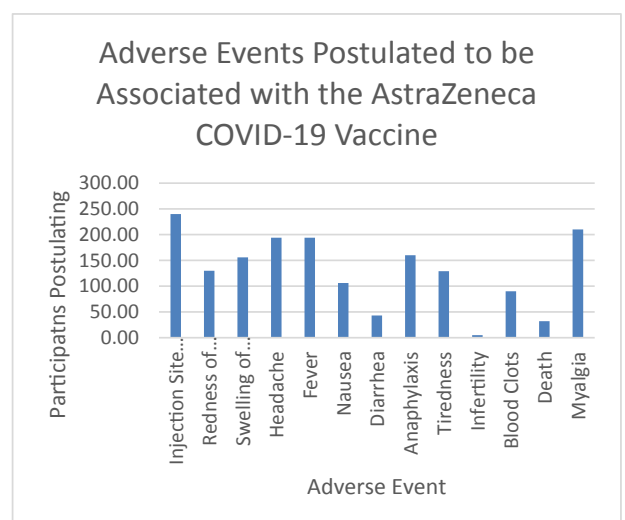

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Figure 2: Postulated adverse events associated with the Oxford-AstraZeneca COVID-19 vaccine.

Most (96.3%) of the participants had received at least one dose of ChAdOx1 nCoV-19, with a higher proportion having completed the two doses (65.8%). Over two-thirds (71.1%) of vaccine recipients reported experiencing at least one AEFI. The incidence of AEFI was higher in those who had completed their two doses (77%) compared to the one dose recipients (59.8%). More males (73.1%) reported experiencing adverse events than females (69.1%).

As illustrated in (Figure 3), all vaccine recipients in the 50-59 years age group reported a symptom while among the younger age groups (<40 years) the highest incidence was seen in the 20-29 years group (70.7%).
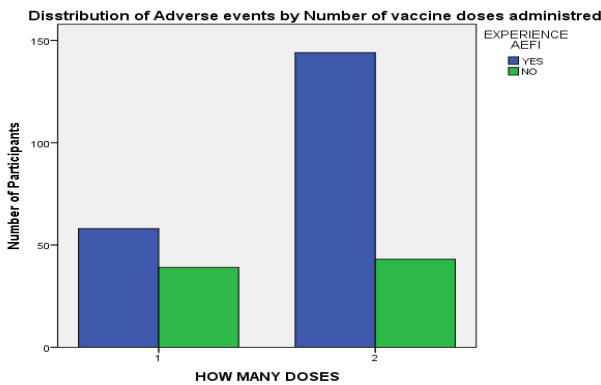

Figure 3: Distribution of reported adverse event by number of vaccine doses received.

A total of 391 AEFIs were reported by 202 (71.1%) vaccine recipients. Injection site pain (31.3%, 89) was the most commonly reported local AEFI (Figure 4 and Figure 5). Other local event reported was swelling of injection site (6%). Fever was experienced by about a quarter (25.4%) of vaccine recipients making it the most frequent systemic AEFI reported. Tiredness (23.6%) and headache (22.9%) followed closely. Other systemic AEFI reported were myalgia, nausea, and diarrhea. Chills and vomiting were reported by 2 participants each (Figure 5).
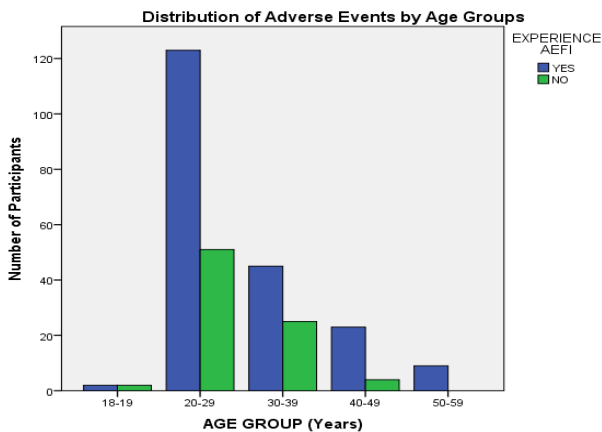

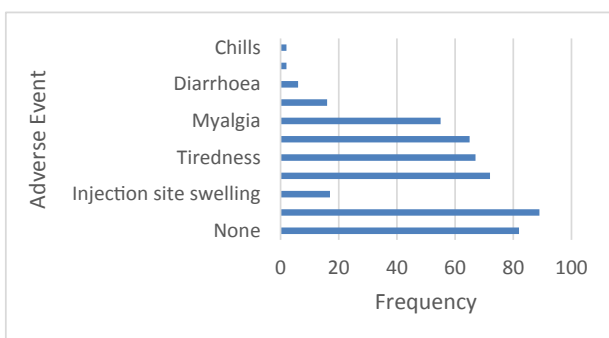**Figure 4:** Distribution of adverse events reported by age groups.

Figure 5: Reported adverse events following immunization with the AstraZeneca vaccine. Pain at the injection site was the most common local side effect, while feeling feverish or having a fever seemed to be the most common systemic side effects. 28.9% of participants reported having no side effects after their vaccination.

An overwhelming majority of the participants (96.3%) who reported having a food allergy also experienced an adverse event, while two-thirds of vaccine recipients who had experienced an adverse reaction to a medication or vaccine before reported an AEFI (65.8%). Most of the participants with chronic medical conditions also experienced an AEFI (72.2%). As shown in table 2, all the reported AEFIs began within two days of vaccination with majority (68.3%) starting on the day of vaccination. Only one AEFI began two days after vaccination.

Most of the reported AEFI were of mild to moderate severity with over half (51.2%) of them being negligible. Although some (18.8%) of the AEFIs required medical intervention mostly in the form of analgesics and antipyretics, they all improved within a few days (Table 2). Four of the participants required hospital admission for observation, they were discharged after a few days and recovered before the end of the week. An overwhelming majority (99.8%) of the AEFIs resolved within a week of their commencement with over two-thirds of them (71.7%) having resolved by the 3rd day. Only 1 AEFI extended into the second week (Table 2).

Table 2: Distribution of AEFI characteristics

Variable		Frequency	Percentage (%)
Onset of AEFI	The same day of vaccination	269	68.3
	1 day after vaccination	124	31.5
	2 days after vaccination	1	0.3
Severity of AEFI	Negligible	201	51.2
	Unable to complete normal activity	93	23.7
	Unable to perform normal activity	25	6.4
	Took medications	74	18.8
Resolution of AEFI	Same day AEFI began	32	8.1
	A day after AEFI began	134	34.1
	2 days after AEFI began	116	29.5
	3 days to 1 week after AEFI began	110	28
	Second week	1	0.2
Medications	Intravenous fluid	8	
	Analgesic	28	
	Paracetamol	45	

Discussion

Despite being HCPs, the participants' knowledge and awareness of ChAdOx1 nCoV-19 properties were inconsistent. While majority reported prior knowledge of the vaccine, just a handful accurately pinpointed the platform on which the vaccine was based. They however displayed commendable knowledge of the possible AEFIs with the vaccine though a handful associated the vaccine with infertility, blood clots, anaphylaxis and death, which was probably influenced by the sporadic reports of thromboembolic events in some European countries [7].

Majority of the participants reported experiencing at least one AEFI with pain at injection site, fever, tiredness, headache, and myalgia being the most commonly reported. Although the pattern of reported AEFIs was similar to that of the clinical trial of ChAdOx1 nCoV-19 [7], the frequency of these AEFIs was lower in our study. This could be due to differences in study sample demography, and psychological and race-based differences in symptom reporting behavior [35].

The distribution of reported AEFIs was also consistent with findings from other cohort post-licensure studies though there were some subtle differences observed. In the study among HCPs in Germany and Czech Republic [25], some oral lesions were reported as AEFIs while none of such

were reported in this study, most likely because they were unsolicited for in this study.

Most of the reported AEFIs were of mild to moderate severity with over half reported as having no negative impact on routine daily activities. Less than one-fifth of symptoms required medications mainly in the form of analgesics and antipyretics, and they all improved in the following days. Since identifying and managing AEFIs vital to sustain trust in vaccines, WHO recommends taking analgesics for AEFIs [36]. However, CDC warns against taking analgesics prophylactically since the interaction between them and the vaccines are not yet known [36].

Four participants required hospitalization including a young laboratory scientist with a history of hypersensitivity to metronidazole. All hospitalized participants improved in the following days and they were all discharged in good health. No death was reported among the participants.

Over half of the reported symptoms had resolved within two days of their commencement and all except one was gone by the end of the first week. The onset and duration of reported AEFIs were consistent with those of other post-licensure studies [24-28].

AEFIs were reported more among those who had received two doses of ChAdOx1 nCoV-19 than those who had gotten just a single dose, which was consistent with findings from the vaccine's clinical trials and a community-based study in Saudi Arabia.

Incidence of AEFIs was also higher in males than in females which was in contrast to observations from other cohort studies [25-27]. This might be attributed to the lower proportion of female participants in our study sample.

Although overall more AEFIs were reported by the younger participants (<40 years), the proportion of participants reporting AEFI was higher in the older age groups (>40 year). This was in sharp contrast with observations from both clinical trials and other studies [17-28]. This discrepancy could have resulted from differences in age distribution of sample populations (about 8.9% of participants in some clinical trials were aged 60 years and above whereas in this study the oldest age group [50-59 years] accounted for just 3.1% of participants) [16-17].

A higher incidence of AEFI was also seen in participants with a history of food allergy, and prior adverse reaction to a medication or vaccine. However, there wasn't much difference observed in incidence of AEFIs among those with chronic illnesses, which contrasts with observations by Raid et al [25].

Limitations and Recommendations

Although the small sample size of this study might make it difficult to generalize the findings, however, due to the lower coverage and relative shortage of vaccines in Nigeria, these findings could still shine some light on the situation and provide evidence against misunderstandings and conspiracy theories-backed beliefs driving vaccine hesitancy.

Also, the study instrument did not inquire about prior COVID-19 infection and its relationship with incidence of AEFIs. With several studies having shown a positive correlation between previous infection with SARS-CoV-2 and incidence of AEFIs, future studies should explore the role of prior infection and residual antibodies in the frequency and intensity of AEFIs.

Conclusion

As with other vaccines, some adverse events follow the administration of ChAdOx1 nCoV-19. The most common of these are injection site pain, headache, fever, tiredness and myalgia. Most of these events are short term, tolerable and similar to those reported by the manufacturing company. Within this study's limits, the frequency of these events was higher in participants who - had completed the two doses of the vaccine, were males, had prior history of reaction to a drug/vaccine, and had known food allergies. Further independent studies are required to evaluate ChAdOx1 nCoV-19 overall safety especially in the long term, and also to estimate more precisely the incidence of each AEFI.s

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The Future of Preventative Medicine: Health Promotion Programs as a Tool to Reduce Administrative Costs and Improve Health Outcomes

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Abstract

Patient-centered care evolves around proper coordination between healthcare providers in consultation with patient needs. Often times, children play a passive role in their health care because of the controversy around age and lack of consensual abilities. The impact of engaging children early on to empower decision-making skills has been proven to influence their ability to make informed and knowledgeable decisions. Consequently, if not provided with support, a child can make unwise decisions in the realm of their healthcare. In academia, children may develop the skills needed to make informed decisions with the adaption of inquiry-based and discovery learning methodologies. Particularly, science educators emphasize investigative skills using micro-science in the public-school curriculum. Generally, healthcare providers have relied on the traditional approach of intervention when treating conditions instead of engaging children early on with preventative approaches like the utilization of health promotion programs. As a result, healthcare systems are extremely strained due to higher rates of preventable conditions across Canada and the United States.

This literature review examines recent research on 1) inquiry-based learning, 2) micro-science outreach and 3) health promotion programs linked to the reduction of healthcare costs. Next, a case study of Dalhousie University's COVID-19 Vaccine Hesitancy Outreach Project is dissected to see its impact on children's overall scientific comprehension and health care decision-making procession. Subsequently, the exploration of micro-science combined with inquiry-based learning as a psychological tool to increase cognitive agility is debated. Upon conclusion, the synthesizes of recent research led to a proposal of how a healthcare administrator could utilize micro-science in health promotion programs to lower healthcare costs.

Keywords: Children • Informed decisions • Inquiry-based learning • Micro-science • Health promotions • Preventative care • Cognitive agility • Behavior change theory • Return on Investment (ROI)

Introduction

How we learn impacts our decision-making

Inquiry-based learning and discovery learning can be easily mistaken as the same learning methodology. The key differentiator is inquiry-based learning involves answering a series of questions or solving problems based on facts and observations, whereas discovery learning focuses on finding the concept through experimentation [1]. When adolescents take science classes with inquiry-based learning, they tend to acquire higher science achievements [2]. Though contrary, other studies have shown emotional intelligence has a heavier weight against learning methodologies on academic performance suggest that a student's quality of life and ability to overcome existing social problems could be attributed to taking science classes [3,4]. The effects of inquiry-based learning may trickle down to the progression throughout post-secondary studies and adulthood when making healthcare-related decisions.

Science literacy and comprehension can be attributed to the development of the ability to transfer knowledge from within the classroom in unknown situations [5]. A study conducted by Brickman reinforces that inquiry-based learning is best for deeper procession of material covered in class, leading to higher recognition and recollection during testing. However, inquiry-based learning may not be the best methodology to utilize if students experience the complexity and frustration associated with scientific inquiry beyond tolerance. The traditional approach to learning does not provide opportunities for deeper cognitive processes such as applying existing knowledge to the acquisition of new knowledge.

According to Burden and Burch, there are five definitive processes involved in inquiry-based learning: 1) Identifying and Formulating Problems, 2) Formulating Hypotheses, 3) Collecting Quantifiable and/or Qualitative Data, 4) Analyzing the Data to form Interpretations related to Hypotheses and 5) Drawing Conclusions. This process is very similar to the manner in which scientific phenomena are discovered by professionals [6].

Now, let's apply this learning methodology to making a healthcare decision. For instance, a child may receive unfortunate news that they have kidney stones. A decision on how to handle the situation can look like: 1) Finding out about Kidney Stones and its impact on you, 2) Weigh the treatment options, 3) Determining to undergo surgery with consultation of doctors and family, 4) Seeing how you feel compared to others who underwent the same surgery, and 5) Drawing your conclusions about that experience. In this example, the inquiry-based learning approach helped a child with deciding which treatment option to undergo and this process could improve their health outcomes. There may have been hurdles to overcome if stuck in the consultation phase with conflicting views between parties.

Healthcare decisions can exert the same frustration that a scientist would face in the field. Broadly speaking, it has been widely accepted practice for community-driven design and delivery of healthcare to reduce internal friction and tension that individuals face when making healthcare decisions [7]. A student's healthcare decision and educational progression are two separate realms in life to juggle. However, students can often use their knowledge obtained in academia to make informed healthcare decisions. Globally, the science educational curriculum reform has focused its efforts on teaching students to make informed and balanced decisions in their lives using their scientific knowledge acquired during instruction [8]. In the example above, the child could avoid the occurrence of kidney stones by applying their knowledge on nutrition, if previously educated on the role of diet before developing kidney stones.

Inquiry-based learning is deeply rooting in constructivism as learning occurs when one's own conceptions are constructed through intellectual activities. The decision-making process around your health should be as intellectually stimulating and provoke you to take an active role in your healthcare delivery. Even with limitations, inquiry-based learning is found to improve confidence with low ability students when it comes to making decisions in the context of solving problems [9,10].

The next section of this article will examine a particular case study of Dalhousie's Vaccine Hesitancy Outreach Project attempting to instill this decision-making process with the adaption of micro-science activities structured with inquiry-based learning methodologies [11]. Before diving into the case study, it is important to discuss preventative medicine and healthcare delivery, as the project's outcomes evolve around prevention of COVID-19 viral outbreaks.

Preventable conditions routed in poor decision-making

Preventative medicine is the application of medical sciences in the absence of disease or in an attempt to prevent the occurrence or halt the onset of a disease [12]. Health promotion is the profession evolving around preventative medicine that seeks to promote healthy living surrounding nutrition and hygienical care to individuals. The goal is to reduce the occurrence of preventable conditions by educating the general public on self-care and identifying the onset of symptoms and interventions to improve prognosis.

Health promotion programs should be evaluated to routinely determine their effectiveness for achieving the desired health outcome. Clarke noted a famous example of a health promotion program for anti-smoking propaganda

targeted at youth [12]. The following factors were compounding influences on the student's receptivity: 1) parental influence on smoking habits outweighing any impacts on the campaign and/or, 2) socio-economic status. Thus, this means health promotion programs require action to be taken from community members in the communities themselves to lead change initiatives. This involves all community members including the aging population to play a role in promoting change. So, what about the aging population? Do health promotion programs tailored to the aging population help with targeting youth?

In the United States, Goetzel et al. examined how health promotion programs in general with or without inquiry-based learning methodologies integrated, could potentially reduce the cost to Medicare [13]. The prevention of the onset of chronic disease for senior populations has become the increasing focal point to reduce suffering and aliment [14]. A summary of experimental and quasi-experimental studies suggests that health promotion programs using behavior change theory with tailored delivery may produce positive ROI outcomes for the target audience [15-17]. In fact, Aldana found in 28 studies reporting cost savings, with 7 studies showing expended calculations for cost-benefit ratios and financial returns averaging $3.48 for every dollar.

Notably, these studies were conducted by well-established companies such as Johnson & Johnson, Citibank, Bank of America, Duke University, Procter and Gamble, and more [18-22]. In addition, a RAND report concluded that health promotion programs using health risk assessments with ongoing tailored interventions have the potential to be cost-beneficial [23]. Table 1 summarizes two studies that found performing programs to slow the onset of developing preventable conditions in the aging population.

Developing and delivering health promotion programs in aging versus youth populations can vary in approach and tactics when conveying complex medical and scientific knowledge. After reviewing the literature, health promotion programs using inquiry-based learning methodologies or not, offer a promising approach to reducing healthcare costs. One could only ask if the influence of programming structure played a substantial role in cost reduction.

What if we can cut the costs drastically by reducing the demand and need for healthcare with health promotion programs? Although cutting the need for healthcare is not feasible, we can theoretically discuss how re-engineering the mindset of community health can reduce the higher admission rates to clinics of preventable conditions and the strain on the healthcare system.

Re-engineering healthcare delivery for reducing the need and demand

Health Promotion Practices: The traditional approach in healthcare is to diagnose and provide treatment to patients. The field of health promotion acts as an integral part focusing on self-management and behavior modification. Fries et al comprised 3 complementary models of health promotion programs to reduce the need for healthcare [24]. The factors affecting the need are composed of a conceptual base for need (Figure 1). This base includes specific factors involved in the decision-making process such as Compression of Morbidity, Self-Efficacy, Long-term/Short-term Outcomes, Nature of Need, Nature of Demand, Self-Management, End-of-Life Care, Health Outreach Programs, and Expanded Definition of Health Promotion [24].

Health Promotion should be defined to encompass all activities needed to educate, guide, and motivate the individual to take personal action to improve their likelihood of sustained good health and reduce the need to seek medical care unless needed [24]. A three complementary model was established to improve: 1) the long-term outcomes of healthcare delivery, 2) Complete Disease Management, and 3) Five Lines of Health Defense (Figure 2).

From the literature, the structure of health promotion programs should be deeply rooted in behavioral theory and applying learning methodologies. An approach using behavioral theory and learning methodologies would focus on changing the mindset of the target audience from a passive to an active role in their healthcare delivery. Our health can be thought of as being inseparable from our behavior. In the fifth edition of Health Behavior: Theory, Research, and Practice, it provides roadmaps in which conceptualization,
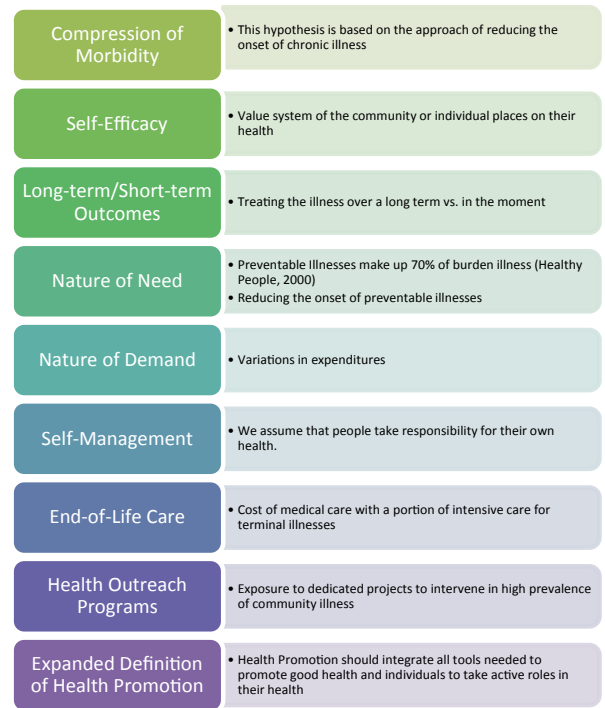
Table 1: Health Promotion Program Studies in Aging Populations

Health Promotion Studies	Summary of Findings	
	Expenditure Variable	ROI (USD)
Citibank (Ozminkowski et al, 1999)	Independent Variable (Controlled)	$4.70 for every dollar
Bank of America (Leigh et al, 1992)	Independent Variable (Controlled)	$5.00 for every dollar
General Motors (Goetzel et al, 2007)	Does not contain precise expenditure information (varies)	Does not contain ROI information but, it suggests $101 USD in savings

Figure 1: Conceptual Base of Need in Healthcare Organizations [24].
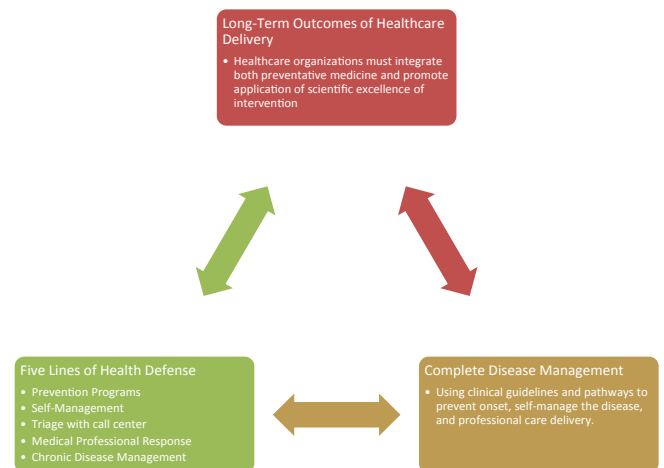

Figure 2: Three Complementary Model for Healthcare Organizations [24].

measurements, and alteration of health behaviors could positively impact health outcomes. Most systematic approaches using health behavior theory (i.e., encompasses behavioral theory and learning methodologies) produce more profound results than programs developed without [25]. While some studies have shown an improvement, others produced results to the contrary which suggest there is a heavier weight on delivery by individuals and dissemination of information in communities, among other social influences [26].

Health Promotion Programming Structure: A broader overview of health behavior entails the examination of health promotion and education programs that correlate to improving coping skills and enhanced quality of life. Up until this point, preventative health behavior with health promotion programs was discussed as an option for the reduction in administrative costs. Now, we will explore the origins of the theory, research, and practice and the tension arising when implementing effective strategies like health promotion programs to alter health behavior.

Aristotle defined theoria and praxis. Theoria signifying the science concerned with knowing for own sake whereas praxis means the application of science. Western society has propagated that the two: theory and practice, are opposites with no reconciliation [27]. Over the years, Dewy (2012) attempts to reconcile the differences with insights into "experiential and experimental knowing" emphasizing empirical investigation, and research, as the common ground for practice and theory. That brings us to the present day where the application of health promotion programs provides unique experiences to engage communities while experientially altering delivery based on the context [28].

Depending on the objective of the health promotion program, it should be deeply rooted in the theories developed from predecessors to achieve outcomes. Thus, the context involving the audience, medical condition, culture, and program delivery will be the determining factors for program outcomes. For example, if an organization's objective is to promote weight loss strategies to those at risk of becoming obese, it is essential to understand the theories of the Transtheoretical Model (i.e., Social Cognitive Theory) to structure the program, including efforts to understand the patient's upbringing and culture. Then, proceed with the delivery to optimize the patient's outcome. Wouldn't you take your weight more seriously if this preventative care approach was applied? In fact, this seems like the medical practitioners are going the extra mile to improve their patient outcomes. This should really be the way that patient-centered care is approached and not considered an extra stride. However, society follows the traditional approach to healthcare with no onus on innovation integrated into the thread of health policies and programs to enhance patient experience and quality of care [29-30].

Health promotion programs should be extensively researched by health scientists and clinicians for determining potential framework architecture. It is simply human nature to create correlations and generalizations to translate our knowledge into applications. We should thread with caution to not become over-reliant on correlational design models when determining programming demands [25]. There will always be difficulty in finding reliable ways to translate theory for applications in health promotion programs to improve patient health outcomes. As a result, clinicians should actively use innovative ways to disseminate information to communities with an eye for sampling pragmatic real-world case studies. Therefore, it is suggested that future health promotion programs should focus more on the translation of knowledge in communities to reduce the prevalence of preventable conditions, both in clinical and community settings (Rothwell, 2005; Rohrbach et al, 2006).

The case study of Dalhousie University's COVID-19 Outreach Project will serve as an example of an attempt to improve community health outcomes using a micro-science educational outreach project (interchangeably known as a health promotion project). In the next section, we will examine the details of this case study from inception to close out of the project and how it could have been improved to achieve objectives.

Case study: Encouraging vaccination confidence project

Background: COVID-19 Impact on Mental Health of Youth: Children can be malleable and shaped by their experiences in life. The need for stability is essential for them to master their environments [31]. As we age, cognitive functions and abilities become less malleable with time, making it essential to influence children early in their decision-making processes through support and guidance in a nurturing environment. The COVID-19 pandemic disrupted the stability of youth, making it difficult for them to adapt, thrive, and conquer their environments [32]. UNESCO estimated that 80% of children would be impacted by school closure globally [33]. This rate increased into the pandemic, and still, presently, more than half of schools are partially or fully closed [34]. In Canada, 5.7 million children and youth in elementary to secondary school have been impacted [35].

Although school closures were implemented to stop the spread, youth have suffered the burden after the lack of social interactions led to a deficit for cognitive development. These skills are fundamental to the growth, wellness, and overall development of a child. When deprived, the academic scholastic achievement is negatively affected, and less play-social interaction behavior with an immediate effect on their mental health [36,37]. Studies show that this type of trauma has a long-term negative effect on physical health, mental health, academic performance, and relationship formation [38-41].

With technological advancements, social media is used by youth to collect information and steer the social constructs of the next generation. It can be weaponized to disseminate misinformation around COVID-19 vaccines with the goal of increasing vaccine hesitancy. For example, TikTok is a well-established social media platform and there has been a high occurrence of memes dedicated to discouraging COVID-19 vaccination. A recent study by Basch et al, 2020 scanned TikTok using the #covidvaccine for videos, showing 38 videos discouraging the vaccine. Approximately, 25 (65.79%) showed a parody of an adverse reaction and 22 videos (57.89%) falsely conveyed that a vaccine was available, as they were not at the time of the study. Overall, this anti-vaccination propaganda may undermine efforts to ensure widespread uptake of the various COVID-19 vaccines, particularly for young people who are more likely than other age cohorts to use TikTok [42].

Strasser et al (2022) conducted an examination of 13 research studies with over 760, 474 participants between ages 10-29, across seven countries [43]. These studies collected data on how COVID-19 News on TV could lead to elevated distress levels in youth. There are several factors involved in creating distress such as information overload, negative content, and misinformation creation [44,45]. From these studies, assessments of depression, anxiety, and stress symptoms were carried out with self-reporting practices. Table 2 summarizes the findings of two studies: one in Canada and the United

States. Regardless of the context, COVID-19 news discouraging vaccination showed to elevate symptoms of depression, anxiety, and distress by creating a sense of false hopelessness in the target audience (Table 2epression, anxiety, and distress by creating a sense of false hopelessness in the target audience (Table 2).

Impaired mental health can impact decision-making abilities, resulting in poor judgment [46,47]. The Encouraging Vaccination Project was conceived to address misinformation circulation causing distress around COVID-19 vaccines in youth [11]. The objective was to provide information in an interactive format to youth for them to consider when making informed decisions related to vaccinations. This approach indirectly was thought to improve mental health through teaching valuable skills with identifying credible sources and improving confidence with instilling scientific inquiry abilities. This project ran between July 2021-March 2022 and it received a tremendous amount of publicity [48-51].

Design, development and delivery: The project was designed to deliver science activities about COVID-19 virology and vaccinations to African Canadian youth in Nova Scotia. After the realization, that public health initiatives need to engage all community members for optimal community outcomes pertaining to reducing viral outbreaks. Later, the reach expanded to an all-inclusive group representation of the general public.

The science activities were developed after conducting focus groups with 60 African Canadian students to determine comprehension of vaccinology, immunology, epidemiology, and sources of vaccine hesitancy. These focus groups were conducted with open-ended questioning and led by students in an informal discussion. The conductor asked 3 questions about the determination of how many students held misconceptions, felt confident about vaccines, and possessed basic knowledge around vaccinations.

The focus group students were composed of ages 6-18 from Halifax, Digby, and Cape Breton regions with 50 students English-Speaking and 10 French-Speaking. Approximately, 10% were already vaccinated but, may or may not recommend COVID-19 vaccines, and, 90% younger than 16 years old. The findings suggested that students lacked a rudimentary understanding of the fundamental concepts around vaccinology and epidemiology [11]. It was even more alarming when students indicated a lack of resources such as booklets, pamphlets, and dedicated personnel at their local clinics to help them with vaccination questions. Clearly, this created a void, resulting in misinformation circulation from social media becoming more prominent within this age group. Figures 3 and 4 show the findings broken down separately for English-Speaking and French-Speaking students.
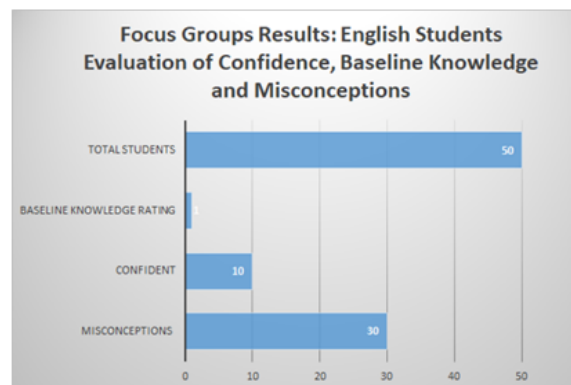
Figure 3: EVC Project: Focus Groups English-Speaking Results

Approximately, 2% of ANS students showed basic knowledge related to vaccinology and epidemiology, 20% of ANS students rated themselves as being confident in vaccine effectiveness and resources, and 60% were

Table 2: COVID-19 News Consumption and Mental Health Youth Studies in Canada and the United States

Country	Study Design	Sample Size	Summary
Canada (Gill, 2021)	Cross-sectional	84	Significant higher level of psychological distress and depression symptoms with daily-to-hourly use of social media to obtain COVID-19 news
United States (Kecojevic, 2020)	Cross-sectional	162	Significant higher positive association between time spent searching COVID-19 information with anxiety and somatization levels. Higher anxiety levels with longer time spent on social media platforms.

predisposed to misinformation via social media channels (e.g., Facebook, Instagram, Twitter, etc.) and believed the information they received. Baseline Knowledge Rating was calculated based on how many bullets points out of 10 were correctly identified from the fact sheet [11].
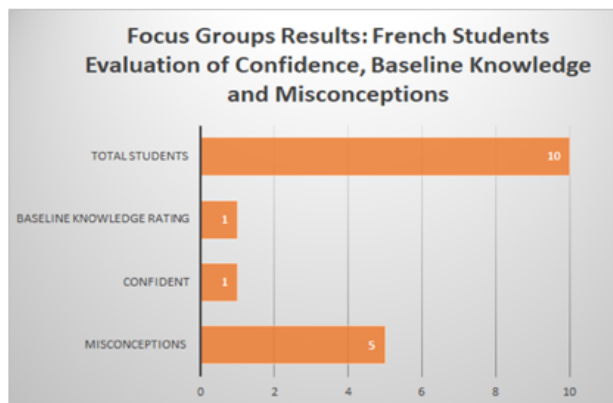

Figure 4: EVC Project: Focus Groups French-Speaking Results

Approximately, 10% of ANS students showed basic knowledge related to vaccinology and epidemiology, 10% of ANS students rated themselves as being confident in vaccine effectiveness and resources, and 50% were predisposed to misinformation via social media channels (e.g., Facebook, Instagram, Twitter, etc.) and believed the information they received. Baseline Knowledge Rating was calculated based on how many bullets points out of 10 were correctly identified from the fact sheet [11].

With this data, the developers created 8 science activities broken down into Grades 4-6, Grades 7-12, and All Grade Levels. In total, the breakdown of these activities shows: 3 explained vaccine mechanisms, 1 explained viral mutations, 2 explained how masking/social distancing worked, and 2 explained herd immunity. These science activities were conceived with the application of inquiry-based learning methodologies when presented to students. Thus, students played an active role in performing activities, developing, and testing hypotheses, and drawing conclusions based on their findings [11]. In a sense, these interactions promoted students' analytical thinking and taking active roles in making informed decisions around their vaccinations.

Even when training mentors, it was attempted to apply the testing effect. This theory was first coined by Edwina E. Abbott in 1909 [52]. The project manager/lead developer, Matthews, used roleplay techniques where trainee mentors acted as students during a mock session. Subsequently, the trainees attended a live session to observe how to engage students and observe first-hand what they could possibly encounter. Thereafter, the trainees were tested by taking on the role of presenter and the project manager/lead developer acted as an observer providing delayed feedback. The mentor's performance was determined by how many questions they could answer correctly, teacher affect, and ability to direct students to resources [53]. If the trainee's performance was satisfactory, they would be cleared to conduct sessions on their own without supervision. If not, they were retrained with the entire process.

Ultimately, it was determined the best delivery was to select 3 science activities, watching videos to reinforce learned concepts, and immediate testing in a discussion forum for a 1.5-hour session [54]. Additionally, the application of micro-science enabled efficient budgeting and expense adjustments since all science activities utilized common household commodities.

The use of micro-science to reduce costs is yet another administrative approach to being cost-effective in improving health outcomes. Ogunleye et al. (2019) explored the micro-science as a cost-effective way to reach more students in remote and impoverished areas. Experiences in developing countries and remote communities demonstrate that the quality of science education is often unsatisfactory, especially with respect to the use of imported equipment thereby draining limited foreign currency, without an apparent positive effect [55]. Therefore, the need to develop and curate science activities with affordable kits was essential for delivering high-quality sessions for the EVC project.

Outcomes, improving science comprehension: The EVC sessions concluded in March 2022. A total of 900 students were engaged with 78% identified as African Heritage. An optional follow-up survey was conducted to evaluate the changes in student science comprehension and confidence ratings related to vaccinations. Collectively, 60 surveys were returned, providing insights into the effects of the outreach initiative (Figure 5).

During sessions, mentors observed that African Heritage students tended to be less engaged in sessions and more likely to conform to group consensus due to polarization in multi-racial groups [11]. Applying the inquiry-based learning theory did not neutralize the effects of group polarization. Even once students drawn their own conclusion from the activities, they continued to proceed to agree verbally with other students about vaccinations. However, they are more likely to express a difference of opinion behind closed doors. This suggests that social influence plays a dynamic role in students' decision-making around vaccinations and may with other health-related decisions. In addition, there is a long history of medical racism and lack of access to proper healthcare in African Canadian communities [56]. African Canadian students highlighted the importance of family influence and perceived lack of trustworthiness in the scientific process behind vaccine development related to the historical medical racism events in the past.
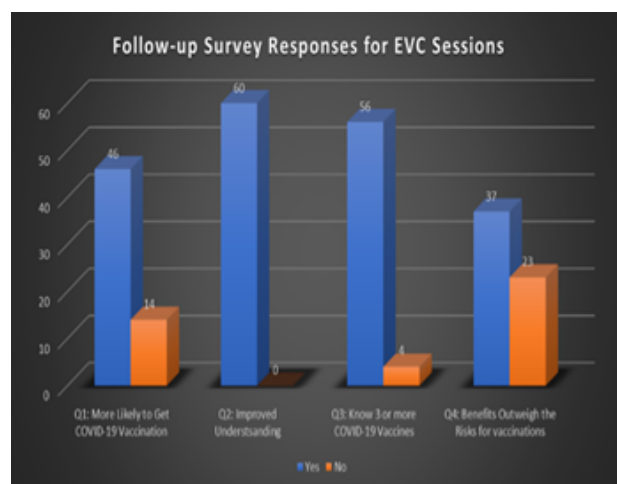

Figure 5: EVC Project: Post-Session Survey Responses

Follow-up Survey Results for Q1: more likely to get a COVID-19 vaccination, Q2: understanding of the science behind viruses and vaccines improved, Q3: know 3 or more vaccines available in Nova Scotia as of October 2021, and Q4: the benefits outweigh the risks of getting vaccinated [11].

The survey results show that students self-reported an increase in understanding and confidence ratings after the presentations (Figure 5). Despite the promising self-reporting of improvement in comprehension, there was no way to verify this as truce and students still provided lower ratings in benefits outweighing the risk of vaccinations.

Misconceptions about COVID-19 vaccines steam from the circulation of misinformation [57, 58]. In fact, some students apart of the EVC project were misled to believe that vaccines changed their DNA and caused blood clots, after viewing content on social media [11]. It was hypothesized through engaging students using inquiry-based learning methodologies (i.e., a type of experiential learning) in science activities would address the clarification of misinformation. The manner in which would be encouraging students to be analytical thinkers and question the credibility of information sources [11]. Through the advocacy of analytical and critical reasoning skills, students could become active agents in their vaccination decisions and acquire the skills necessary to make an informed decision. It is suggested that future research using experimental conditions and rigorous study design should be explored to investigate if this upholds a statistically robust evaluation.

Though the EVC project is not a research study, it did provide viable insights into what drives vaccine hesitancy in African Canadian communities in Nova Scotia. The students participating in the sessions expressed a variety of factors influencing their decision-making process for getting COVID-19 vaccines. Matthews et al (2022) synthesized the student feedback and formulated 5 standard questions, also known as the 5D's in decision-making around vaccine hesitancy which includes (Figure 6):

• Do I have confidence in the information provided?

• Do my family members have confidence in vaccines?

• Do I have confidence in healthcare providers throughout this process?

• Do I have confidence in the science behind making the vaccine?

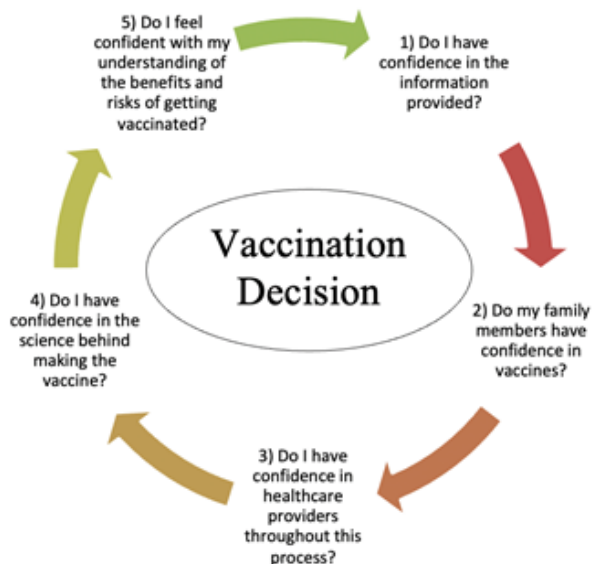• Do I feel confident with my understanding of the benefits and risks of getting vaccinated?

Figure 6: 5Ds of Decision-Making around Vaccine Hesitancy [11].

Upon the conclusion, the EVC project published a final project report detailing the findings from outreach efforts. In particular, the findings reinforce what we already know about the impact medical racism has on African Canadian communities, highlight how misinformation can impact health decisions, and emphasizes the discovery of a potential linkage between social influences on health decisions of African Canadian youth.

Opportunities for improvement: As noted, the EVC project was a science outreach project and only sought to see how science activities could improve comprehension. It was not developed as a research project, meaning there were holes in data collection and demographic information to draw conclusions. Also, there was no controlled conditions setup to separate students based on multi-racial or African Heritage groups to examine the potential effects of the project activities in different subgroups. Lastly, the survey results were based on self-reporting of students in surveys that their comprehension had increased. This may be an inaccurate read as there was no standardized test provided to score comprehension levels before and after sessions to see if the improvement correlates to attending the sessions.

An expansion of this project should be further pursued to examine the social influences (e.g., family members, peers, social media) in depth. An option explored by the EVC project was creating a spin-off program targeted at intermediate family members. The approach is simply to educate family members on vaccinology, virology, epidemiology, and related topics to make informed health decisions. It was noted that the art of persuasion for promoting vaccinations may actually deter community members by showcasing bias. In theory, this would encourage community members to stay on the fence or at worse, make a health decision that they later regret. In psychological terms, this is known as reverse psychology or reactance which is the main reason why outreach programs fail as they ignore the guideline to tread lightly and not present unbiased opinions to achieve their objectives.

Basch and Strasser conducted studies specifically looking at social media and news outlets, respectively [42,43]. From the literature review conducted, there are yet to date any studies being conducted to see how the combination of all social influences could play a role in vaccine hesitancy and particularly, youth making informed health decisions. Matthews hypothesized the possibility that integrating cross-provincial educational pandemic preparedness programs structured with learning theories in mind may improve pandemic preparedness before future outbreaks.

Discussion

Health promotion programs can serve as an innovative approach for preventative medicine. The research conducted by Clarke (1974) and Goetzel et al (2007) provides insights into youth and adult health promotion programs. From the literature review, social influences, and community dynamics impact healthcare decisions. Moreover, these programs must be structured to effectively convey medical information in communities to ensure that they have the right information to make informed decisions. Applying inquiry-based learning methodologies could help the target audience improve their comprehension of the subject area.

It can become overwhelming if we leave youth and community members at their own accord to make healthcare decisions. Often, they turn to social media outlets as information providers or scientific knowledge agents, leading

to the development of distortions, misconceptions, and the circulation of misinformation. The COVID-19 pandemic is one example of how youth could develop symptoms of distress, anxiety, and depression when bombarded with information from social media related to healthcare decisions around vaccinations. The long-lasting impacts on the mental health of the future generations due to COVID-19 may trickle down into impaired decision-making in their overall healthcare decision-making processes Georgiades et al. 2021.

The case study of Dalhousie University's Vaccine Hesitancy Outreach program serves as an attempt to investigate into an innovative approach to disseminate reliable and credible information around the COVID-19 pandemic for improving the healthcare decision-making process of African Canadian youth. From this case study, this project provided valuable insights into the complexity of the decision-making process for youth around their vaccinations and how innovative programming with learning methodologies can increase subject matter comprehension used in decision-making.

From a healthcare administrative standpoint, health promotion programs can require higher investment upfront for running initiatives. Ozwminkowski et al, 1999 and Goetzel et al (2007) ran health promotion programs showing an increase in ROI when programs have risk assessments with ongoing tailored interventions, leading to potential cost-beneficial incentives [13, 20]. Health promotion programs could reduce the occurrence of preventable conditions if structured to address communities using effective strategies. Healthcare Administrators could focus efforts on lowering the need and demand of healthcare services for preventable conditions to reduce administrative costs and strain on the overall healthcare system.

Historically, the evaluation and structuring of health promotion programs have been done poorly due to the lack of embedment of psychological theories and false belief of causality [59]. The most effective approach to evaluate a health promotion program is to measure the health outcomes in relation to the activities. This literature review produced a summary of the research studies on health promotion programs. These health promotion programs for preventative medicine have been fruitful for healthcare reduction in costs over time Ozwminkowski et al, 1999; and Goetzel et al, 2007 [13, 20]. It was challenging to locate studies providing standardized testing on study participants' decision-making process and changes in comprehension under controlled conditions.

Fries et al (1998) were amongst the first to hypothesize 3 complementary models with a conceptual base of need in healthcare organizations, using behavioral theories and learning methodologies to promote cognitive agility in patients making complex healthcare decisions. Through this understanding, we can theorize that educating and disseminating health information can be a tool used by administrators for the reduction of costs while staying true to the field of preventative medicine [60,61].

Conclusion

Several conclusions can be drawn from exploring the literature and examining the case study. Additional research is needed to explore the nature of health promotion program designs, implementation, and social influences on the decision-making process with a keen eye on examining their usage in the field of preventative medicine.

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Conflict of Interests

No conflicts of interest disclosed by the author. This article references the psychological theories applied in the development and conception of the Encouraging Vaccination Confidence (EVC) project conducted by Imhotep's Legacy Academy. The EVC project was not a research project and only serves as an example of a micro-science educational outreach project.

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