Measles Awareness: The Public's Knowledge and Immunity Regarding the Disease

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ABSTRACT

Background
Measles is a highly contagious disease which has been the cause of numerous epidemics and outbreaks worldwide. The introduction of the two-dose Mumps, Measles and Rubella (MMR) vaccine helped to reduce and eliminate the disease in various places and continues to be the most effective method of developing immunity against measles. However, due to high non-vaccination rates and low herd immunity, measles is becoming a serious public health issue again. Additionally, those born between 1970 to 1994 are more at risk of contracting measles because they may have only received one-dose of the MMR vaccine during that time, which is not sufficient to develop immunity. Due to the recent measles outbreaks in Vancouver, B.C, this project surveyed the public regarding their knowledge of measles and the MMR vaccination to determine if they are able to protect themselves from this disease.

Methods
An in-person survey was conducted at three institutions: British Columbia Institute of Technology (BCIT), University of British Columbia (UBC) and Douglas College. The first section of the survey gathered general information from the participant such as year of birth, country of birth, area of study and municipality of dwelling. The second section of the survey included various true or false and yes or no questions regarding measles, MMR vaccination and recent outbreaks.

Results
Thirty-four people participated in the study. Four factors were analyzed using the chi-square. There was no statistically significant association found between any of the factors, including, country of birth vs. vaccination status ($p=0.3952$), year of birth vs. vaccination status ($p=0.2563$), country of birth vs. knowledge of MMR ($p=0.7903$) and area of study vs. knowledge of MMR ($p=0.9875$). It is possible that due to small sample size, there was insufficient power to detect any associations.

Conclusions
Out of the 34 participants, 21 were vaccinated, 4 were not vaccinated and 9 had an unknown vaccination status. Although the chi-square tests showed no association between any of the factors, the descriptive data still shows that we've only achieved a herd immunity of slightly over 50% was achieved within our survey population, which is not high enough to protect against measles. This can be a great opportunity for health authorities to educate individuals who are vaccine hesitant or refuse to immunize, particularly at the current time where there is considerable momentum in the anti-vaxxers camps.

Keywords: measles, mumps, measles and rubella (MMR) vaccine, immunization, vaccination, outbreaks, vaccine hesitancy, MMR knowledge, vaccine education

INTRODUCTION

Measles is a highly contagious disease, responsible for many past major epidemics. To this day, outbreaks still occur in parts of the world and cases arise in certain areas. Beginning with fever, cough, runny nose, and watery eyes (1), the infection develops into rashes which spread from the face to the rest of the body (1). In rare cases, the virus causes ear infection, pneumonia, neurological damage or even death (1). The mode of transmission is spread directly by droplets when the infected individual coughs or sneezes or when contact is made with infected secretions (1). It is also spread indirectly because the infected droplets remain airborne for several hours (1). In general, the period of communicability (POC) is indicated as 4 days before rash onset and 4 days after (2,3). Therefore, taking simple preventative measures such as handwashing, treating fever, limiting sharing between people and staying home after exposure will help to reduce the risk. However, the most effective method of prevention remains to be receiving a full two doses of the Measles, Mumps and Rubella (MMR) vaccine to achieve immunity (1).

Measles in British Columbia:

As a goal of the Pan American Health Organization (PAHO), the province of British Columbia (BC) initiated a two-dose measles vaccine for children in 1996 (4). In 1998, Canada was deemed free of endemic measles and in 2002, the virus was completely eliminated in the Americas (4). The rate of measles has been low for both Canada and British Columbia from the years of 2003 to 2016. As for BC, there were two peaks in this time period; one in 2010 and another in 2014. These include the 2010 Winter Olympic Games outbreak, with 82 confirmed and probable cases, and the larger 2014 outbreak associated with the Netherlands Reformed Orthodox Protestant community (4). Both cases were caused by importation, which is the cause for many existing cases in developed countries. The 2014 outbreak resulted in 433 cases (325 confirmed and 108 probable) and occurred as the community refused to receive vaccination due to their religious beliefs (4).

In the 2016 Measles Surveillance in Canada, the incidence rate for Canada was 0.3/100,000, while the incidence rate for measles in B.C. was 0.4/100,000; ranking second highest out of four provinces (5). As for Canada, the age range for the cases was between 4 months to 40 years, with the majority of cases occurring in ages under one year (5). No cases were reported for those in the 5-19, 25-39, and 60+ age groups (5). In terms of vaccination, 9 out of 11 measles cases were unvaccinated and 2 out of 11 cases had an unknown vaccination status (5). Although the 2018 Measles Surveillance in Canada has not been published, the Public Health Agency of Canada (PHAC) compiles weekly Measles cases in the Measles and

Rubella Weekly Monitoring Reports. In 2018, there were 29 cases of Measles in Canada and out of those, 10 cases have occurred in BC (6). A large majority of the cases are due to importation; involving individuals who have travelled to endemic countries such as India, Ukraine, Uganda, Romania, Pakistan, Brazil, Philippines and Southeast Asia (6).

The most recent outbreak of measles in Vancouver occurred in the months of February and March of 2019 (7). The outbreak began among three French language schools in Vancouver and began to spread as infected individuals travelled across the lower mainland (7). As of April 22nd, 2019, 26 individuals have been infected with measles (7). Meanwhile, measles cases in the United States have also reached an all-time high, with record number of cases being reported ever since the disease has been eliminated in the United States (8). As of April 19, 2019, there have been 626 confirmed cases of measles across 22 states, with most cases occurring among unvaccinated communities (8).

Due to the highly contagious nature of Measles, only those who have the full immunization (2 doses) are immune to the disease. Individuals who were born before January 1, 1970 are more likely to be naturally immune to the virus because they have lived through the era where measles prevailed (9). In the early 1970's, a one dose measles program was implemented, however overtime, it failed to develop immunity in a few individuals. As of 1995, a two-dose vaccination program began, and the two-dose vaccination was adopted across the country. Therefore, those born between 1970 and 1994 or from out of B.C may only have one dose, or not be vaccinated at all (9). In light of the recent measles cases in Vancouver, it is important to determine the public's awareness of the measles virus and the MMR vaccine. The feedback from a survey of persons born between 1970 to 1994 asking about vaccination status, will help the health departments obtain a better understanding of the epidemiology of Measles, public perception and where their target population should be.

British Columbia Vaccination Schedules:

Currently, the MMR vaccine is publicly funded, and a part of the routine immunization schedule in B.C. Infants and children receive the first dose of MMR at 12 months and the second dose at the age of 4 or kindergarten entry (10). For those who were not immunized at childhood or moved from another country, they can receive the MMR vaccine as provided by the B.C. government. The first dose will be administered at their first visit, and the second dose will follow 4 weeks after (10).

Outbreak Response:

The general response to measles outbreaks includes a few basic components. The main priority is to identify the risk of transmission and those who may be at a greater risk. These include infants, unvaccinated pregnant woman and immunocompromised individuals (2). Active surveillance is also needed to recognize suspected or confirmed cases. This way, vaccines or immunoglobulins may be offered to those who have been exposed, because individuals may still develop immunity if they receive the multi-dose vaccine within 72 hours of exposure (2). Additionally, the health departments may want to issue a public alert addressing the outbreak, similar to how Vancouver Coastal Health issued a public alert for the recent September 2018 measles case (2,9). As for the healthcare workers, all should be fully vaccinated, lest they risk transmission to susceptible populations. Regarding the confirmed cases of measles, the infected individual should be educated on the general characteristics of the virus, such as, symptoms, treatment methods and most importantly, the mode of transmission. Once they understand the mode of transmission, it would help in preventing the spread of the virus. Isolation of the infected individual is also effective in preventing the transmission of the virus, however, as you may already be contagious before symptoms appear, there is a chance that you have already spread the disease before the confirmation of the case (2). This concept of outbreak control has remained the same from the past until now. In 1999, the World Health Organization (WHO) released the "WHO Guidelines for Epidemic Preparedness and Response to Measles Outbreaks". The method of controlling a measles outbreak was to increase and maintain immunization coverage; lowering the incidence and mortality of the virus (11). It was also stated that once adequate vaccination levels are attained, it would double the length in years between outbreaks occurring. Fast forward 19 years, the method of measles control has remained the same. As mentioned above, a few methods of preventing the virus include: washing your hands, treating the fever and limiting the sharing of utensils (1). Vaccination with the MMR vaccine remains one of the most effective methods of preventing the emergence and spread of diseases (12, 1). This in turn would increase the number of people who are immune to the disease and increase the herd immunity. Herd immunity is when enough vaccinated individuals exist in a given population, reducing the number of reservoirs and making it harder for transmission between individuals (11).

Unvaccinated individuals decrease the herd immunity and as a result, increase the risk of transmission. There are often groups of individuals who are not willing to receive vaccination. These include, and are not limited to, faith-based groups, ethnic groups, certain age

groups or those part of a socioeconomic strata (2,4). As mentioned earlier, this was the case for one of the larger outbreaks in BC, when members of the Netherlands Reformed Orthodox Protestant community refused to receive vaccination due to their religious beliefs (4). Since the majority of measles cases which occur in BC or other developed countries are due to importation, it is important that the herd immunity is well maintained (2). In the past year alone, approximately eight cases of measles which occurred in BC have involved people who have not received immunization, have only received one dose or travelled to an endemic country (6).

Effectiveness of Measles Vaccine:

The MMR vaccine comes in 2 doses. The first dose is often received by children at 12-15 months. The second dose, often received when the children are in preschool, is to ensure immunity in the case that it did not develop after the first dose (14). The vaccine is 95% effective in preventing the development of measles and 92% effective in preventing the spread of measles to others (14). A study done by the Department of Public Health and Infectious Diseases at the University of Rome found that the use of the MMR vaccine decreases the rate of hospital admittances. Out of the 11,400 children analyzed, only 12 were hospitalized for measles. Out of the 12 admittances, 9 were unvaccinated and 3 had only received one vaccination dose. All who were vaccinated with two doses were not admitted (12).

Although the virus could still be preventable with a vaccine up to 72 hours after exposure, it is still more effective to receive the vaccination before exposure. In the study done by P.A. Gastañaduy and others, it was found that during an outbreak, vaccines distributed before exposure were more effective than those given after exposure. As for children, it was found that vaccinating 14 days before exposure decreased the rate of illness (2). These studies continue to show and prove that vaccination with the MMR vaccine is indeed effective, and the consequences of contracting the disease is completely preventable (15).

Perception of the MMR Vaccine:

However, throughout the course of recent history, the MMR vaccine has often been involved in controversy, as an article by former British doctor, Andrew Wakefield linked the vaccine with the development of autism in children (14). Although the controversial article has already been proven as false, its repercussions continue to have an effect on people's perception of the vaccination (14).

Following a Measles outbreak in Glamorgan in 1995, a catch-up immunization schedule was held at schools for those who have not yet received the MMR vaccination. A questionnaire

regarding parent's opinions on the MMR vaccine was given out during a Measles outbreak in Glamorgan, parents were asked to answer why they had refused their children to be vaccinated (16). Since this was a catch-up immunization schedule, the majority of responses were that the children had already been infected with Measles before, or that the children had received the vaccination already.

Effect of Education on Vaccination Coverage:

As many factors come into play with unvaccinated populations, it is important to have the opportunity to educate them on the Measles virus and MMR vaccine. Bangladesh has conducted several Measles and Rubella education campaigns, occurring in 2005, 2006, 2010 and the largest one in 2014 (17). Results were successful, with a >20% increase in vaccination rate from 2005-2006 and a 90% vaccination rate in 2014 (17). Additionally, campaigns held and delivered in educational institutions had a higher success rate in delivery, in comparison to those held at vaccination centers (17). As Bangladesh has many rural areas, the campaign did not reach many in those areas who were unaware of the ongoing campaign. Post-campaign surveys also found that a percentage of the population did not receive vaccination, despite the ongoing campaign. Several reasons for non-vaccination include child sickness during the campaign and fear of adverse effects following immunization (AEFI) (17).

The fears and concerns which individuals have towards the MMR vaccine is a major obstacle on the path to complete elimination of Measles. During the 2011 Measles outbreak in Quebec, a total of 678 cases of Measles were confirmed (18). In order to prevent the spread of the virus, a province wide school-based vaccination campaign was conducted, targeting all elementary and high schools (18). The study of the outbreak, done by M.N Billard and others, estimated the impact which the campaign had on the immunity of the school population. The results showed that the Measles vaccination campaign had only increased the school population's immunity to measles by 1.5% (18). The study pointed out that a few reasons for non-vaccination among individuals is simply due to missing out on the vaccine. However, a large majority of the non-vaccination cases are due to families who are against vaccination. Therefore, although some of the unvaccinated population were able to become vaccinated in this outbreak, the individuals who are against vaccination are still decreasing the herd immunity (18).

In some situations, it may not be effective to conduct a nation-wide immunization, especially in areas where vaccination rates are high, as mentioned in a study done by P.A. Gastañaduy and others. Distribution of vaccines in outbreak settings are a costly measure to take, therefore in

certain situations, it may be more efficient and effective to have targeted campaigns aimed at smaller groups when dealing with high vaccinated areas (E.g. Unvaccinated people, people in poverty etc.) (2).

Importance to Public Health:

The Canada Communicable Disease Report (CCDR) regarding prevention and control methods of Measles outbreaks in Canada introduce a set of guidelines which help to prevent the occurrence of Measles (19). Since Measles is already considered to be eliminated from the Americas, the Public Health Agency of Canada (PHAC) is extremely cautious when it comes to control measures, and active surveillance (19). In fact, a joint national surveillance called the Canadian Measles and Rubella Surveillance System (CMRSS) conducts continuous surveillance of the disease to ensure of its containment (19). Additionally, the report emphasizes that public health interventions greatly reduce the risk of Measles outbreaks (19). Public health initiatives to increase MMR vaccination, for example, increased educational campaigns and providing booster shots, all contribute to the goal of eliminating Measles for good (19). Research regarding the public's perception of Measles and the vaccine would benefit health authorities in the knowledge of these individuals (those born between 1970 and 1994) and aid in their public health initiatives. Since these individuals only have one dose of the MMR vaccine, or even none at all, they are considered to be susceptible in an outbreak situation. Better understanding of the public and their knowledge can help to determine if public health awareness campaigns are required.

Conclusion:

As the world continues to strive for the complete eradication of measles, cases will continue to arise, due to importation. The goal to keeping the incidence rate of measles low is to keep a high herd immunity within the population by the MMR vaccine. However, due to numerous factors such as, fear of adverse effects following immunization, religious beliefs and socioeconomic status, there are holes in the immunity of the population, resulting in a decrease of herd immunity and increase in the risk of transmission. In Vancouver, BC, dozens of cases arise each year; often occurring among the unvaccinated population. After the recent measles cases of measles in Vancouver, the question remains as to what the public's understanding of the virus and its method of prevention is. Does the public understand the high infectious nature of the virus, or how one requires two full doses of the MMR vaccine to achieve immunity? A better knowledge from the public will help health authorities achieve a clearer understanding of the current herd immunity and vaccination status in Vancouver and B.C.

METHODOLOGY

To assess the knowledge of the public regarding measles and the MMR vaccine, an in-person survey was conducted at three post-secondary institutions across the lower mainland; British Columbia Institute of Technology (BCIT), University of British Columbia (UBC) and Douglas College. The survey included two sections which collected nominal data. The first section comprised of general questions asking about the participants year of birth, country of birth, municipality of dwelling and educational background. The second section included dichotomous questions (yes or no, true or false) regarding measles, recent outbreaks and the MMR vaccine. An in-person survey was chosen over an online survey because it may yield a higher response rate (20), since it is often more difficult to reject an in-person survey. The method of sampling involved surveying every 7th person who passed the researcher and the randomized approach was chosen in order to reduce as much bias as possible. The data was gathered on Microsoft Excel 2018 and the nominal data was analyzed using the Chi-Squared Test on Minitab Express (21).

Inclusion and Exclusion Criteria

The survey focused on those born between 1970 to 1994, and in order to survey that specific age range, surveys were conducted at later hours to target night school students. Targeting night school students was justified by three reasons; age, diversity of background and ease of delivery. Firstly, the assumption was that the age demographic of night school students would more likely fit the criteria, in comparison to day-time school, where the age demographic is generally younger. Secondly, the background of night school students is usually more diverse. The students are commonly working adults, international students or people who wish to receive an extra credential, and the diversity may provide a better representation of the larger population. Lastly, the survey was not conducted on a big scale as a census is. Therefore, solely focusing on night school helps narrow down the target and may help health authorities with the ease of delivery. In other words, the health authorities may evaluate if they need to increase educational campaigns or advertisements at schools. Having said that, the survey was still opened to all ages. Additionally, as the survey was conducted, more responses were collected from individuals who were born after 1994. Therefore, the original target group of individuals born between 1970 to 1994 could not be properly analyzed.

Ethical Considerations

The survey questions, consent form, cover letter and script were approved by the BCIT Research Ethics Board (REB) before it was distributed. Approval was also obtained from the REB at

UBC and Douglas College to conduct the survey
at the institutions.

RESULTS

Descriptive Data: General questions

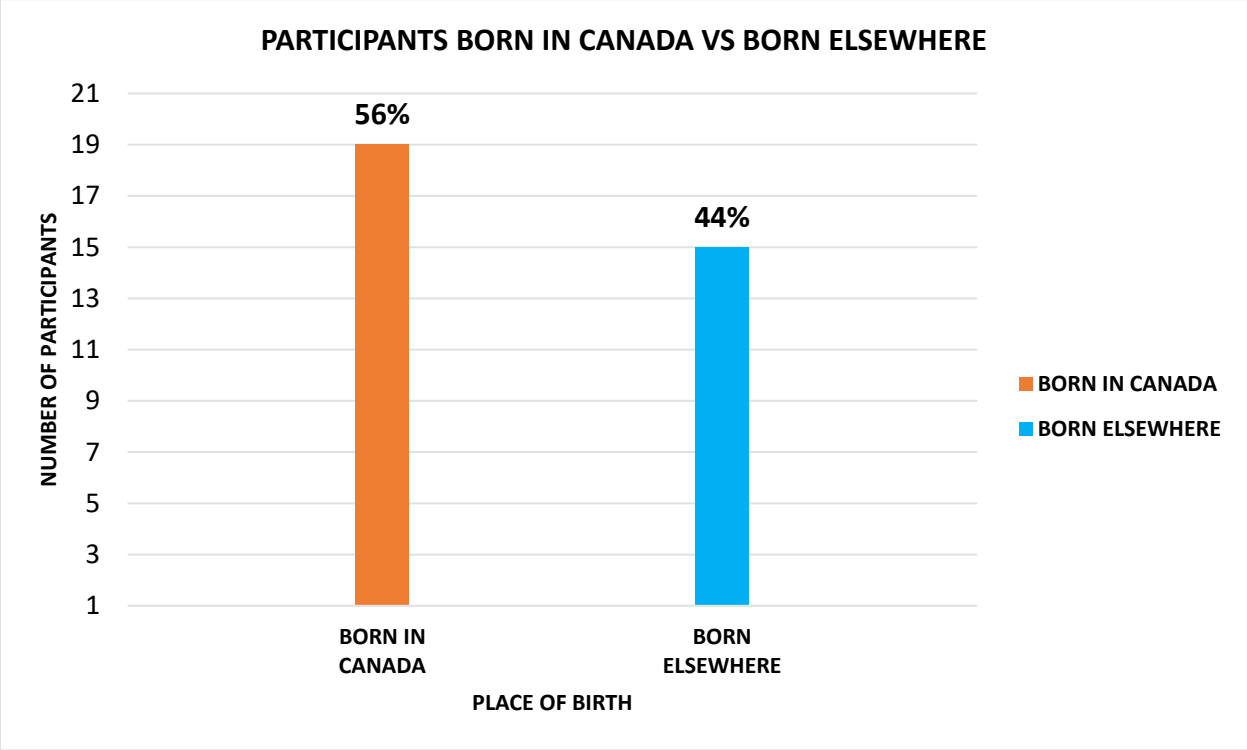

Figure 1. Participants born in Canada vs. born elsewhere

Out of the 34 participants, 19 (56%) were born in Canada and 15 (44%) were born elsewhere.

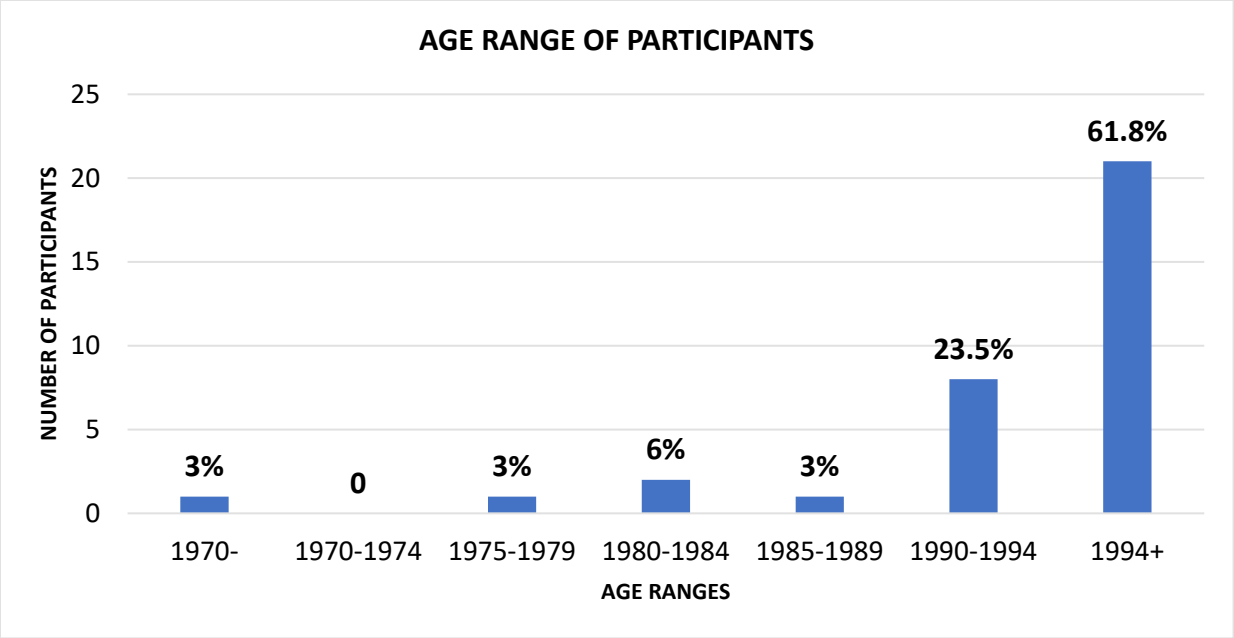

Figure 2. Age range of participants

Out of the 34 participants, 13 were born within the target age range of 1970 to 1994, and 21 were born outside the age range. As for those born between the target age range of 1970 to 1994, the largest age range were those born between 1990 to 1994 (23.5%).

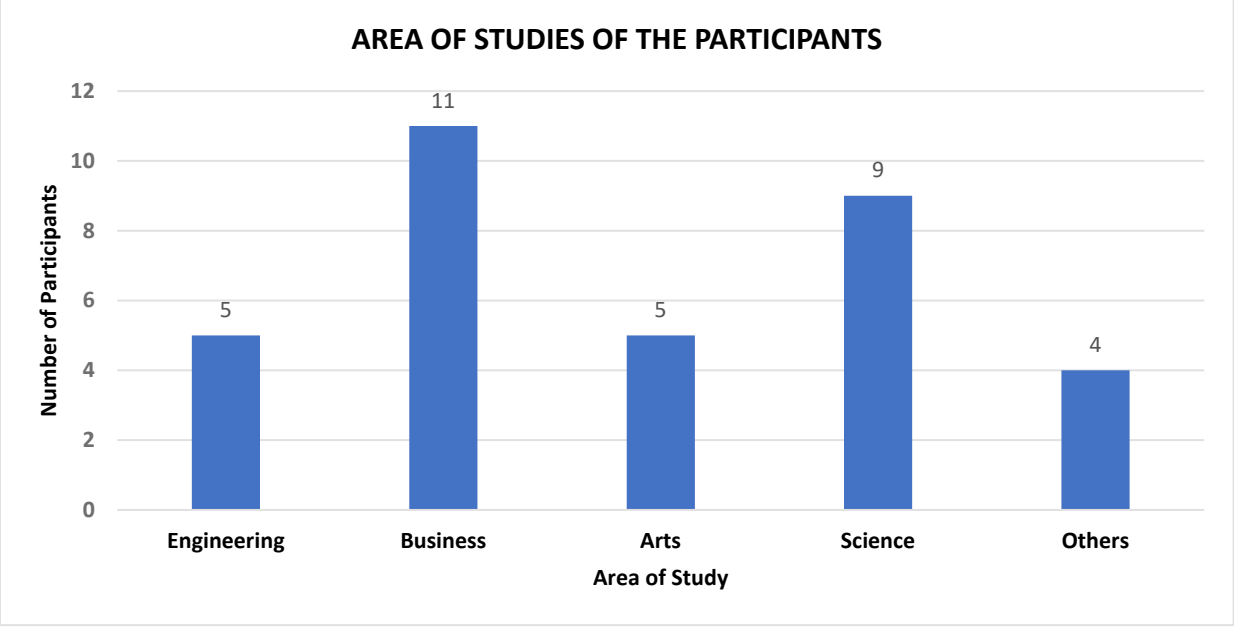

Figure 3. Area of studies of the participants

The areas of studies for the participants were grouped into 5 general areas: Engineering, business, arts, science and others. Majority of the participants were studying business.

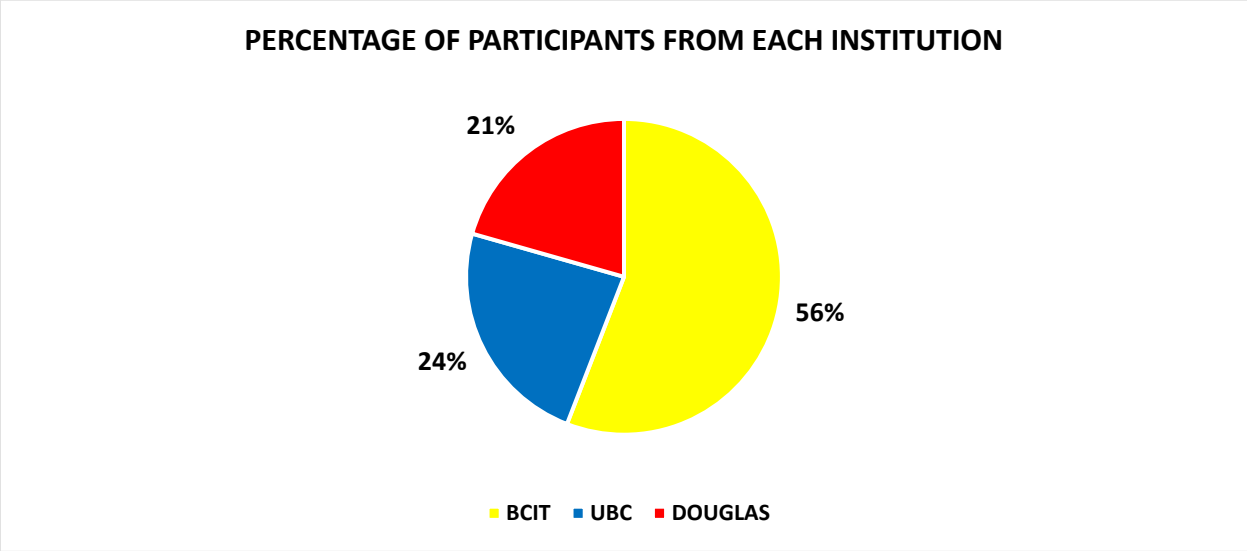

Figure 4. Participants from each institution

The majority of the participants were from BCIT (56%). There were 8 participants (24%) from UBC and 7 participants from Douglas College (21%).

Descriptive Data: Measles related questions

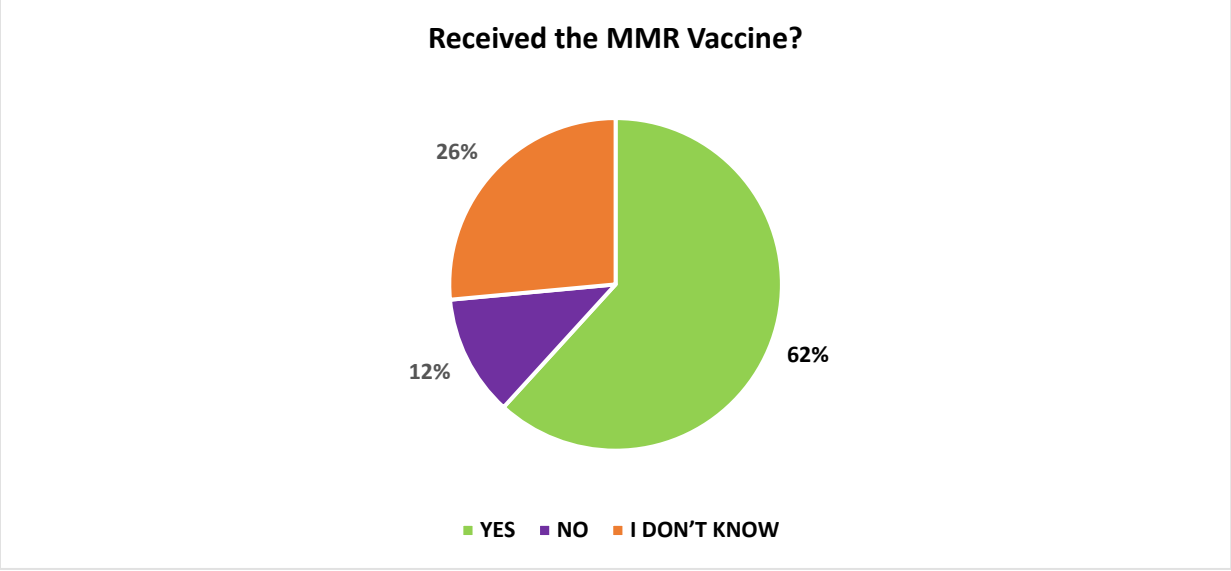

Figure 5. Vaccination status of participants

Out of the 34 participants, 21 (62%) received the MMR vaccination, 4 (12%) have not receive the MMR vaccination and 9 (26%) did not know their vaccination status. More than half of our survey population have achieved herd immunity, however, 38% of our population is still not protected against measles.

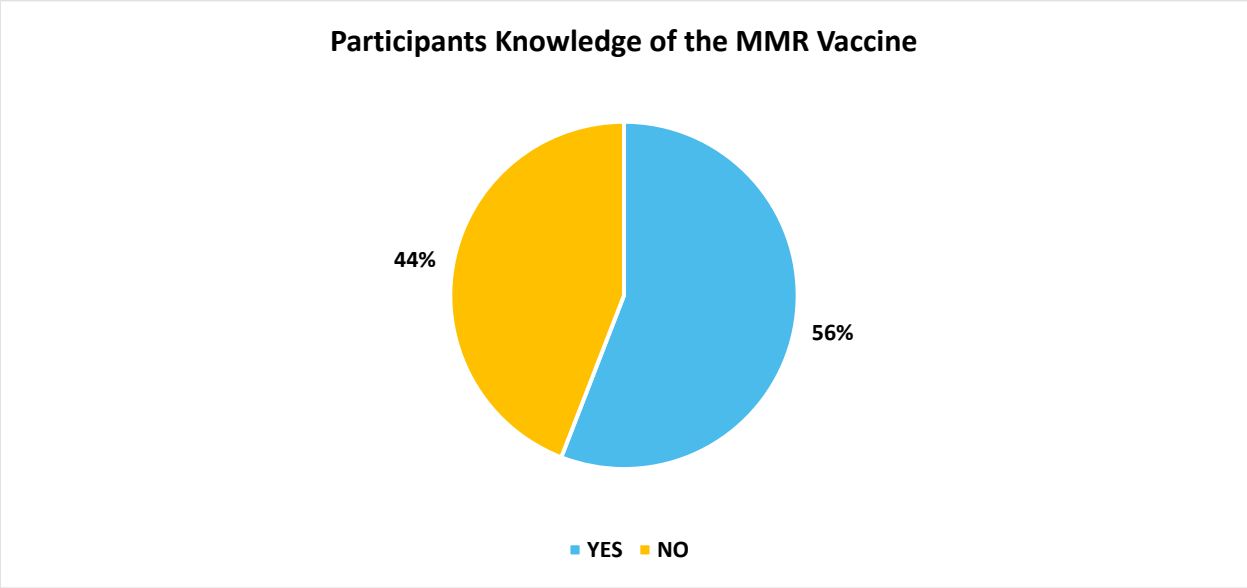

Figure 6. Participants knowledge of the MMR vaccine

19 participants (56%) knew what the MMR vaccine was, which is over 50% of our population. 15 participants (44%) did not know what the MMR vaccine was.

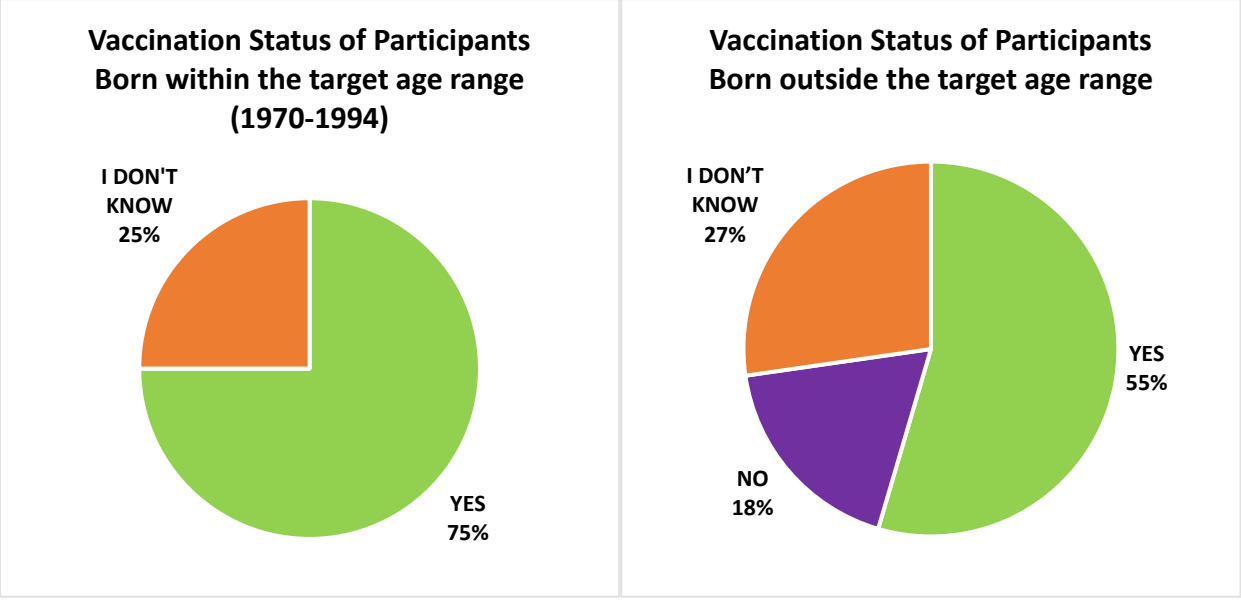

Figure 7. Vaccination status of participants born within the target age range vs. outside the target age range

Among the 12 participants born within the target age range of 1970 to 1994, 9 were vaccinated and 3 were did not know their vaccination status. There were no participants who were non-immunized. As for the 22 participants born outside the target age range, 12 participants have received the MMR vaccination, 6 participants did not know their vaccination status, and 4 participants were non-immunized.

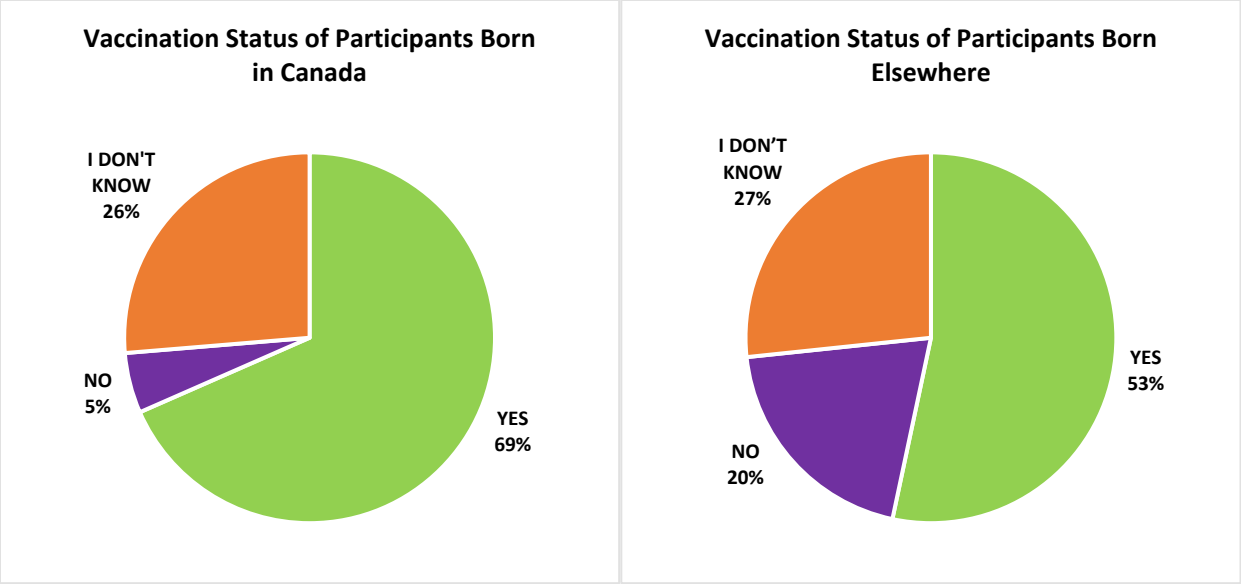

Figure 8. Vaccination status of participants born in Canada vs. born elsewhere

Among the 19 participants born in Canada, 13 were vaccinated, 1 was unvaccinated and 5 had an unknown vaccination status. Among the 15 participants born elsewhere, 8 were vaccinated, 3 were unvaccinated and 4 had an unknown vaccination status.

Inferential Data

H_0 and H_A	Result (p-value)	Conclusion
H_O: There is no association between country of birth and vaccination **H_A:** There is an association between country of birth and vaccination	P = 0.3952	Do not reject the H_o and conclude that there is no association between individual's country of birth and vaccination with MMR. We can further conclude that individuals born inside Canada are not more likely to be vaccinated than those born outside of Canada.
H_O: There is no association between those born between 1970-1994 and those born other times in terms of status of vaccination **H_A:** There is an association between those born between	P = 0.2563	Do not reject the H_o and conclude that there is no association between individual's birth year and vaccination with MMR. We can further conclude that individuals born within the target age range of 1970-1994 are not less likely to be vaccinated in comparison to those born before 1970 or after 1994.

1970-1994 and those born other times in terms of status of vaccination		
H_O: There is no association between country of birth and knowledge of MMR **H_A:** There is an association between country of birth and knowledge of MMR	P = 0.7903	Do not reject the H_o and conclude that there is no association between country of birth and knowledge of MMR. We can further conclude that individuals born inside of Canada are not more likely to have more knowledge about MMR than those born outside of Canada.
H_O: There is no association between area of study and knowledge of MMR **H_A:** There is an association between area of study and knowledge of MMR	P = 0.9875	Do not reject the H_o and conclude that there is no association between area of study and knowledge of MMR. We can further conclude that knowledge of MMR is not more/less known between area of studies.

Table 1. Results of Inferential Data analysis using chi-squared

DISCUSSION

Based on the results of the survey, the general knowledge of measles was medium to low. Participants were generally split into two categories: either having no previous knowledge of measles or solely understanding the basics of the disease. Only a handful of participants understood measles thoroughly, regarding its virulence factors, vaccination and other characteristics. Brieger and others conducted a similar survey which assessed the knowledge, attitudes and opinions towards measles and the MMR vaccine. Their results also showed that majority of the participants could accurately identify “non-specific symptoms” of measles such as fever and rash. Only a few of their participants could describe its virulence factors, characteristics or possible complications regarding the disease. However, due to a small sample size, their results also found no statistically significance difference between immunizers and non-immunizers (22).

The results of the 4 true or false questions showed that 29 participants scored 100%, 4 scored 75% and 1 scored 50%. However, it was later discovered that the survey questions did not accurately assess the Measles knowledge of the participants. Many who had no previous knowledge of Measles scored 100% on the true or false questions, simply by guessing the answers. The presentation and wording of the questions did not accurately assess if their knowledge of Measles was enough to protect themselves from the disease. Due to this potential limitation, the questionnaire scores were not statistically analyzed. Additionally, 56% of the participants answered YES to knowing what the MMR vaccine was. They understood that the vaccine is used to build immunity against Measles, and many knew that

two doses were required for full immunity. It is important to note that many of the participants who answered YES to knowing what the vaccine was did not recognize the abbreviated name of the vaccine “MMR”, but recognized the full name “mumps, measles and rubella vaccine”. On the other hand, 44% of the participants did not know what the MMR vaccine was.

When asked regarding their awareness of recent cases of Measles in Vancouver, 11 of the participants answered YES to knowing the occurrence of Measles in Vancouver. Cases mentioned included the Maple Ridge Secondary case in September 2018, Fleetwood Park Secondary case in November 2018 and the Vancouver International Airport case in July/August 2018. In terms of describing the cases, most participants did not know any details, but only knew of its occurrence. Many also mentioned the 2019 Measles outbreak in Washington State which was ongoing during the time which the survey was conducted. Since the survey was conducted in early February 2019, the project was not able to cover the Vancouver Measles outbreak which occurred in the second half of February 2019. A total of 23 participants answered NO to knowing the occurrence of Measles in Vancouver and were unaware of any of the recent cases.

Among the total number of participants, 62% received the vaccination, which is more than 50% of the survey population. However, this is not enough to achieve herd immunity as there was still 38% of our population which was unvaccinated or had an unknown vaccination status. According to the World Health Organization, countries should achieve a minimum 95% vaccination coverage in order to get closer to the goal of measles elimination (23). The majority of the 21 vaccinated participants received the 2-full doses of the vaccine, with only 1 participant not knowing how many doses he/she had received and 1 participant only receiving one dose. As of 2015, the global vaccination percentage for the two doses of MMR were 85% and 61%, respectively (23). Those who did not know their vaccination status were asked if they knew where to access vaccination records or resources for vaccination. Common answers from participants included family doctor, hospitals and clinics, schools and online. An area of improvement can be to make immunization records more accessible to the public. For example, records could be made electronically and stored on mobile devices, therefore it is easier to access when needed. However, this would require security so that only the health care providers and the patient could access the data. Shortly after the early 2019 measles outbreak in Vancouver, health officials urged the public to visit community pharmacies and their family doctors to check up on vaccination status’ or to receive vaccination because these were the best sources to go to in this situation (24).

As measles was previously considered to be eliminated in the America's, the discussion of measles has become a rare topic. This caused measles to be forgotten as an issue among the public (22). This was true among a few of our participants who stated that "they were unaware that measles was an existing issue" and they thought "measles only occurred among children and did not pose a risk to adults". One of the participants also shared their thoughts of non-vaccination as a parent, stating that some parents have a misunderstanding that as long as others vaccinate their children, the herd-immunity will remain high and their children will be protected. These misunderstandings along with others are common among the public as measles has been associated with false claims in the past (22). Additionally, due to how convenient social media and the internet is nowadays, it is easier for individuals to access blogs, forums and posts which may spread false information. A quick search of "MMR causes" into the google search bar shows the most common questions individuals have. These included MMR causes measles, seizures, diabetes, death, deafness, arthritis, epilepsy and brain damage. Therefore, the issue may be that majority of anti-vaxxers know that measles does not cause autism or bring extremely negative effects, however, they are hesitant or refuse to receive vaccination because they believe that the risk of vaccines heavily outweighs the benefits of receiving them (22). Other literature also suggests that due to the doubt and questions over the safety and benefits of vaccines, it drives individuals in the direction of vaccine hesitancy which ultimately ends in vaccine refusal (25).

In terms of vaccine hesitancy and refusal, other literature has often split them into two groups; conscientious objectors and families experiencing barriers to access (26). Conscientious objectors are parents/individuals who refuse vaccination due to their concerns regarding immunization. Individuals in this group are usually highly educated or well off (26). Families experiencing barriers to access are parents/individuals who do not have access to immunization due to barriers in wealth, status, and clinic accessibility. (26). As for British Columbia, all childhood recommended vaccines and the majority of adult recommended vaccines are publicly funded and freely available (27). The MMR vaccination is included in the list of recommended vaccines in BC; therefore, all individuals are provided the access to them, removing possible barriers which may hinder them from becoming immunized.

Country of Birth and Vaccination Status:

As Canada implemented a vaccination program for MMR in 1994, the vaccination rate for Canadian born citizens should be fairly high. Therefore, the two factors of Country of Birth and Vaccination Status were compared. According to Figure 8 (results section), vaccination with MMR appears to be higher

among those born in Canada, while non-vaccination looks higher among those born elsewhere. However, after statistical analyses, the chi-squared test determined that there was no association between the two factors (p=0.3952); concluding that there is no indication that those born in Canada are more or less likely to be vaccinated in comparison to those born elsewhere. The results are inconsistent with information suggesting that those born in Canada are more likely to be vaccinated with the MMR vaccine in comparison to those born in other countries (28). According to the Canadian Immunization Guide on measles, one-third of new immigrants/refugees (particularly woman) were more susceptible to measles due to its prevalence in other countries (28). Additionally, other countries may not offer the MMR vaccine as a widely available, publicly funded vaccine. This statement held true for a lot of our participants who did not know their vaccination status as the reasons for not-knowing varied between those born in Canada and those born elsewhere. Participants born in Canada knew of the existing MMR vaccination program in Canada but did not know if they had received the vaccination or not. While those born elsewhere did not know if their country had any existing MMR vaccination programs, and therefore, did not know if the vaccine was provided to them. Due to this reason, the Canadian government has made recommendations to those travelling to other countries to fully vaccinate themselves before departure; especially for those born between 1970 to 1994 (28).

Country of Birth and Knowledge of MMR:

Since not all countries have existing MMR vaccination programs or education regarding measles, the two factors were compared to determine if country of birth affects the individual's knowledge of the MMR vaccine.

58% of the participants born in Canada knew about the MMR vaccine and 42% had no knowledge. 53% of the participants born elsewhere knew about the MMR vaccine and 47% had no knowledge. However, after statistical analyses, there was no association between the two factors (p=0.7903); concluding that those born in Canada are not more or less knowledgeable about the MMR vaccine than those born elsewhere. As mentioned above, many countries may not have a publicly funded vaccination program or provide education regarding the MMR vaccine (28). However, existing literature suggest that receiving proper education regarding measles or the MMR vaccine may not necessarily increase the immunization rates of the public. Historically, health officials believed that delivering the proper information and debunking any misinformation regarding measles and the MMR vaccine would turn individuals from the direction of vaccine hesitancy/refusal. However, it was later discovered that only relying on

education is not effective because there are other emotional, cultural, social, religious and political factors which affect the decision to immunize (29).

Year of Birth and Vaccination Status:

These factors were the most important to analyze as it answered one of the main questions; determining if those born between 1970 to 1994 are at a higher risk of contracting Measles. This is because those born before 1970 have most likely developed natural immunity and those born after 1994 would have received the two doses as a part of the mandatory vaccination in B.C. However, those born between would have only received one dose of the vaccine or none at all. Out of the participants born within the target age range, there was only one who was sure that they had only received 1 shot and needed to receive a booster shot. Another participant received the vaccination after contracting the disease at a later age. After analyzing the data, there was no association between the two factors ($p=0.2563$); concluding that those born within the target age are not less likely to be vaccinated in comparison to those born outside the target age range.

The results did not agree with recommendations which suggests that those born between 1970 to 1994 are less vaccinated. It is important to note that due to methodological limitations, it was difficult to find individuals born between 1970 to 1994, resulting in a smaller sample size and inadequate power. However, there is a chance that there is actually no difference between those born within the target age range and those born outside the target age range. Data provided by Vancouver Coastal Health shows that the current vaccination rate for kindergarten students was only 83.1%; falling short of the 95% herd immunity which is ideal to achieve (30). Additionally, a recent news article published by CBC states that over 20 million children worldwide miss out on measles vaccines annually (31). Therefore, those born after 1994 may also experience the same risk of non-vaccination. Measles is definitely not a virus that is foreign to the public, and through the constant education provided by health authorities and exposure on the news, many have taken the precaution to ensure that they are vaccinated. The message is also always the same; to check your vaccination status and take extra precaution. Not only for those born between 1970 to 1994, but for everyone to double check their vaccination status. Therefore, the public is often reminded, and pushes people to check their own immunity. Just looking at the recent 2019 February outbreak in Vancouver, the MMR vaccination rates in B.C. have doubled, or even tripled in some regions due to the constant exposure in the news (30).

Area of Study and Knowledge of MMR:

After compiling the areas of studies from

participants, the studies were organized into 5 categories: arts, business, engineering, science and others. More than half of the participants were enrolled in business or engineering. According to the chi-squared test, no association was found between the different areas of study ($p=0.9875$); concluding that what a person studies has nothing to do with their knowledge regarding the MMR vaccine. Therefore, a targeted approach to a specific field/study is not necessarily the best method of education.

Addressing Vaccine Hesitancy:

The exposure of measles in the news has indeed increased the vaccination rate in B.C. after the recent outbreak in Vancouver (30). However, those who are hesitant to vaccinate or outright refuse to vaccinate still remain stalwart. As mentioned above, simply relying on knowledge-based education proves to be ineffective in changing the minds of these individuals as many other factors come into play when regarding immunization (29). In fact, studies have shown that some methods of education may even be counterproductive and cause those who are already hesitant to be even more hesitant (29). Additionally, educational tools such as brochures and pamphlets may be effective in spreading information but has little to no effect on those who are vaccine hesitant (29). Instead, studies have recommended the use of social media or the internet as a method to deliver information (29). Positives to using the social media platform is that it is very influential and able to have the potential to positively affect the public (29). However, it is also a tool used by anti-vaxxers to spread false information or their own opinions on the internet. Negatives to using social media/internet is that not everybody has access to the internet, therefore it limits some of the audience which we could reach. However, using social media would still reach majority of the public as a large percentage uses the internet or social media these days. Another recommendation to prevent vaccine hesitancy is to educate children at young ages (elementary schools) regarding vaccine knowledge (29). The idea is to educate them while they are young and use this opportunity as a way to have vaccine acceptance among the future generations. Through all the various intervention methods, one of the most important factors when dealing with vaccine hesitancy or refusal is the interaction between the healthcare provider and the patient (29). Many who are anti-vaxxers refuse to believe correct information even if it is from a health authority or another credited source. However, studies have found that if a certain level of trust or reassurance is achieved between the healthcare provider and the patient, it would have more of an impact on their decisions (29).

Validity of Results:

There were definitely methodological limitations which existed. The survey did not accurately

assess the knowledge of the participants. As mentioned above, the T/F questionnaire showed to be an inaccurate representation of their knowledge as many participants guessed the answers. Individuals who have no existing knowledge of measles could get all the answers correct on the questionnaire. Additionally, participants who were in a rush or non-focused could have answered untruthfully.

LIMITATIONS

1. Due to the limited time and resources, the survey was only conducted a few times. If more time was available, multiple rounds of survey could be conducted, resulting in a larger sample size. The survey also coincided with exam season/reading breaks during the month of February, which may have also contributed to the low participation rate. Additionally, as each institution was located in different districts, more responses were collected at BCIT due to convenience.
2. Since the target audience was night school students, surveys were carried out at later hours. However, there was a lower response rate for night time as many students were either in class or rushing to return home. Additionally, it was difficult to find the 1970 to 1994 age range at institutions because many have already graduated.
3. As more surveys were conducted, more issues arose such as questions which did not accurately represent the knowledge of the participants. Due to the ethics review and approval process, the survey could not have been edited during the period of surveying. Therefore, this shows the importance of creating survey questions which accurately assess knowledge of participants. And if the project was done again, the survey questions require amending.

RECOMMENDATIONS

1. Redo the survey and include more questions which may more accurately assess the knowledge of the public. True or false questions are not accurate as it is just a 50/50 guess. Below are a few suggestions of questions which could be added to the survey:
    a. How many doses of the MMR are required to achieve immunity?
    b. If you have already contracted Measles before, are you immune forever?
    c. At what ages do you receive the MMR vaccination?
    d. What are the signs and symptoms of measles?
2. Distribute the survey online to reach a larger audience and potentially get a

larger sample size. The responses received online may be more diverse, including different religious groups, anti-vaxxers, parents, students, etc. However, it is important to note that responses received online may not be as genuine as in person surveys. Additionally, participants can look up answers online.

3. Allow for more time to conduct the survey. It was disappointing to have such a small sample size for this project because it would be very interesting to see more responses. It would also be interesting to conduct the survey on other populations. This project focused on school students because it was not able to cover larger populations such as those identified in a census. However, if more time and resources were available, it would be interesting to see the responses from a larger, more diverse sample.

KNOWLEDGE TRANSLATION

The main goal of the project was to obtain results from three institutions to assess their knowledge of measles and to see if those born between 1970 to 1994 were at a higher risk of contracting measles. However, since the sample size was so small, the collected data could not be generalized for the rest of the population. However, the collected information can still allow health authorities to understand the public's knowledge of measles, the MMR vaccine and awareness. The collected information allows health authorities to know more regarding the public such as, common misunderstandings and reasons for non-vaccination. Additionally, by comparing different factors (country of birth vs vaccination, area of study vs knowledge of MMR, etc.), it allows the health authorities to determine if education needs to be targeted at certain populations or groups. Although the statistical analysis showed no association between any of the factors, figure 5 (results section) stills shows a fraction of our participants who either did not know their vaccination status or has not received the MMR vaccination. Therefore, this suggests that education is still needed to increase the herd immunity of the population. If a larger sample size is obtained and a deeper analysis is conducted, health authorities may use this information to create more educational programs and tools to educate the public regarding measles. This is extremely important, especially after the recent measles outbreak in Vancouver, and around the world.

FUTURE RESEARCH

The same exact project could be carried out, analyzing the same question, except with a few changes:

1. Try to target other populations to assess their knowledge. It would be interesting to assess the rest of the public, especially after the recent cases of Measles in Vancouver.

2. Try to conduct the survey online. It would reach more of the public and have a broader, more diverse audience. However, doing this online could be an issue because respondents may look up the correct answers to the questions before answering them.
3. Design the questions to better assess the knowledge of participants regarding measles and the MMR vaccine.

CONCLUSION

Out of the 34 participants, 21 were vaccinated, 4 were not vaccinated and 9 did not know their vaccination status. Although no association was found between any of the compared factors, the results still suggest an educational opportunity to increase the herd immunity of the public. Due to time and methodological limitations, the collected data may not accurately represent the public's knowledge and the target population of those born between 1970 to 1994 may not have been properly assessed. Having said that, the information collected could still allow health authorities to understand the population's perception and understanding of the disease and the MMR vaccination. The knowledge can be translated into education programs and tools to further educate the public with the goal of getting rid of Measles once again.

ACKNOWLEDGMENTS

I would like to express my greatest appreciation to Helen Heacock, my project supervisor for her advice, suggestions and continuous support throughout this project. I would also like to take this opportunity to thank Jeffrey Ma for presenting me with such a wonderful project idea. Finally, I would like to thank my dearest family who provided for my needs and supported me in every way they could, and to my friends who helped to cheer me on as well.

COMPETING INTERESTS

The author declares that they have no competing interests.

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