REPOSITORY OF ACTIVITIES

Repository of activities

Below is a table outlining the proposed activities designed to explore each factor in the citizen science on vaccination. Each activity is briefly described to provide an overview of its purpose and implementation.

Activity 1: Vaccine research
Through two videos featuring research groups, students will explore the scientific process behind vaccine development.
Activity 2: Approve a new vaccine
Through a virtual experiment, students will engage in a series of activities designed to help them explore and understand the key phases involved in evaluating and approving a vaccine.
Activity 2.1: Introduction and assignment
Students will define essential immune system concepts to understand vaccine development.
Activity 2.2: Vaccine effectiveness experiment
A virtual experiment and reflection activities will help students explore laboratory research methods used to assess vaccine effectiveness and how scientific evidence is communicated.
Activity 2.3: Weighing Risks and Benefits
Through activities from the Clinical Trials Unit in the virtual resource, students will examine the clinical trial phases of vaccine development and reflect on the risks and benefits of vaccination.
Activity 2.4: Vaccination strategies
A video, a classroom simulation of disease transmission under different vaccination levels, and news analysis will help students understand vaccination strategies and their impact.
Activity 3: To get vaccinated or not, that's the question
Activities designed to explore the debate surrounding vaccination.
Activity 3.1: Watch and decide
A video and guided questions introduce students to the controversy and various perspectives on vaccination.
Activity 3.2: Play and decide
Two debate games, *Discussion Continuum* and *Play Decide*, will allow students to discuss the ethical, legal, and social aspects of vaccination.
Activity 4: The impact of ethical, legal and social factors on research
A video and case study of a vaccination campaign will help students reflect on sociocultural, economic, legal, genetic, and biological factors influencing vaccination efforts.
Activity 5: Overcoming Needle Phobia
Through reflection, relaxation techniques, and awareness exercises, students will explore strategies for managing a fear of needles.
Activity 6: Gender barriers to vaccination
Students explore gender-related barriers to vaccination and develop potential solutions in small groups. They analyse real-world challenges, propose strategies, and present their findings in a class discussion.
Activity 7: Exploring the influence of age and education level on vaccination decisions
Students analyse survey data to explore how age and education level impact vaccination decisions, comparing results with their hypotheses.

Activity 1: Vaccine research

Objective	Time: 1h
• Understand the research process involved in developing new vaccines.	**Materials:** video player and video quiz

Development of the activity

Students will watch two videos showcasing research groups dedicated to vaccine development. After viewing, they will answer a set of guided questions designed to help them analyse and reflect on the content.

(20 min) Watch the videos

a. A new technology for making more efficient vaccines
b. The microorganisms' police

(40 min) Video quiz

After watching the videos, carefully answer the following questions based on the information presented.

Questions about the video a)
1. What advantages do Virus-Like Particles (VLPs) offer compared to traditional vaccines? What diseases can they help prevent? What potential do they hold for cancer treatment?
2. Describe the process of obtaining VLPs as described by the researcher. For an HIV vaccine, which parts of the virus would be selected to generate the VLPs and why?
3. How long does it typically take for a vaccine to reach the market? At what stage of development is the research group in the video? What are the subsequent stages in the vaccine development process?
Questions about the video b)
4. What are the objectives of the research conducted by the group led by the researcher in the video?
5. What contribution has the research group did to improve pneumococcal prevention? What methods did they use to evaluate whether the vaccine provides protection against different pneumococcal strains?

6. **In the paediatrician's comparison between children's nasopharyngeal microbiota to a social network, which elements are identified as good and bad influencers for health? Explain the reasoning behind each classification.**

Good influencers	Bad influencers

7. **Why are massive sequencing devices valuable to their research? What example is provided to illustrate their usefulness?**

Solutions to activity 1

Questions about the video a)

1. What advantages do Virus-Like Particles (VLPs) offer compared to traditional vaccines? What diseases can they help prevent? What potential do they hold for cancer treatment?
   Possible answer:
   - Virus-Like Particles (VLPs) offer several advantages compared to traditional vaccines. They help spark a stronger, quicker, and more specific immune response, making them more effective in protecting against pathogens.
   - VLPs can help prevent infection diseases, such as HIV, TB, malaria and others.
   - VLPs hold great potential for cancer treatment as cancer vaccine. By incorporating specific proteins from tumor cells into VLP-based vaccines, it is possible to generate an immune response against cancer cells. This approach could significantly enhance existing immunotherapies, providing a powerful tool to improve cancer treatment outcomes.

2. Describe the process of obtaining VLPs as described by the researcher. For an HIV vaccine, which parts of the virus would be selected to generate the VLPs and why?
   Possible answer:
   - The process of obtaining VLPs: (1) Generate the coding DNA for the conserved part of the target proteins (e.g., gp41 from HIV) (2) Transfect this DNA into cultured cells in the laboratory (3) The cells express large amount of protein, which self-assemble into VLPs.
   - For an HIV vaccine, it's beneficial to select the conserved parts of virus (antigens) with the aim of protecting against different variants.

3. How long does it typically take for a vaccine to reach the market? At what stage of development is the research group in the video? What are the subsequent stages in the vaccine development process?
   Possible answers:
   - The development process up to the last stage of bringing the vaccine to market could take at least 10 years, probably no more than 15.
   - The research group in the video is conducting the first tests with small laboratory animals to determine if the vaccines generate the expected response. The initial data confirms that the VLPs work, and now they plan to move on to an animal model that will provide more information.

Questions about the video b)

4. What are the objectives of the research conducted by the group led by the researcher in the video?
   Possible answer:
   - The objectives of this research group are (1) to monitor microbes' genetic changes, as they adapt and mutate in the environment, since these mutations can sometimes cause vaccines to become less effective, and (2) to ensure that vaccines remain effective over time.

5. What contribution has the research group did to improve pneumococcal prevention? What methods did they use to evaluate whether the vaccine provides protection against different pneumococcal strains?
   Possible answer:

- The research group contributed to improving pneumococcal prevention by identifying gaps in vaccine coverage. They discovered that certain pneumococcal strains were not covered by the existing vaccine, leading to the development of a more comprehensive one.
- To evaluate whether the vaccine provides protection against different pneumococcal strains, the research team compared samples from sick children with healthy children of the same age and sex. They isolated pneumococcus from nasopharyngeal samples, broke down its cells, extracted and amplified its DNA using thermocyclers, and sequenced it. The DNA sequencing helped determine if the strains were protected by the vaccine, identify virulent clones with higher international spread potential, and assess their resistance profiles. This data helps ensure vaccines remain effective against the most harmful strains.

6. In the paediatrician's comparison between children's nasopharyngeal microbiota to a social network, which elements are identified as good and bad influencers for health? Explain the reasoning behind each classification.
   Possible answer:

Good influencers	Bad influencers
1) Bacteria *Dolosigranulum* because it is more frequently found in association with *Streptococcus pneumoniae* in healthy children. 2) Good nutrition habits 3) Good oral hygiene 4) Vaccination is the favorite good influencer because it is the most effective way to prevent infection	1) Measles virus is a "heater" microorganism that, whatever it is, always causing an infection. 2) Respiratory viruses because they are usually associated with *Streptococcus pneumoniae* in patients with disease. 3) Bad nutrition habits 4) Tobacco exposure in children 5) Antibiotic misuse

7. Why are massive sequencing devices valuable to their research? What example is provided to illustrate their usefulness?
   Possible answer:
   - Massive sequencing devices are valuable because they allow the team to deeply analyse microorganisms through their DNA. This helps them identify microbes related to various diseases (infectious, oncological, metabolic and mental illnesses)
   - An example provided is the discovery of the relationship between the HPV and cervical cancer, leading to the development of a vaccine.

Activity 2: Approve a new vaccine

Objectives	Time: Varies depending on the number of sub-activities you choose to complete.
• Learn about the process of designing and approving a new vaccine (specific objectives in each sub-activity). • Reflect on vaccination strategies	**Materials:** Multimedia resource **Link** and material specified in each of the sub-activities

Development of the activity

The activity **"Approve a Vaccine"** is a virtual experiment that guides participants through the essential phases of evaluating and deciding whether to approve a vaccine. The experiment is divided into sub-activities to help illustrate the complexity of the process. Depending on the factors you wish to explore, you can choose to complete all the sub-activities or focus on specific ones.

Activity 2.1: Introduction and assignment

Objective	**Time:** 40 min
• Define key concepts related to the immune system and vaccines	**Materials:** Multimedia resource **Link**

Development of the activity

To carry out this activity, it will be necessary to give the following instructions to the students and provide them with a tool so that they can collect the information that is requested, such as the table that is proposed for example.

1. Activate the virtual experiment at this link and access the **National Medicines Agency**. There they will give you the basic information to understand the different phases you will have to go through to decide whether to approve the new vaccine. You can do the experiment in pairs or individually.
2. Based on the information you will be given at the first meeting at the Public Health Agency, define the following concepts:

Term	**Definition**
Vaccine	
Immune system	
Lymphocytes	
B cells	
T cells	
Memory cells	
In *vitro design* of the vaccine	

Solutions to activity 2.1

Possible answers:

Term	Definition
Vaccine	A vaccine trains the immune system to recognize and fight harmful viruses or bacteria. It introduces harmless components of a pathogen, allowing the immune system to identify them as foreign and remember them. This prepares the body to mount a fast, protective response if exposed to the real pathogen in the future.
Immune system	The immune system is the body's defence against infections. When a microorganism enters, the immune system responds to eliminate it, but this process takes time, during which we may feel sick. After overcoming the infection, the immune system remembers the pathogen, allowing for a faster and more effective response if exposed again, often preventing illness.
Lymphocytes	Lymphocytes are white blood cells essential for the immune response, recognizing and fighting infections. The two main types are **B cells**, which produce antibodies, and **T cells**, which help destroy infected cells and coordinate the immune response.
B cells	**B cells** are a type of lymphocyte that produce antibodies, which bind to microorganisms and mark them for destruction by other white blood cells.
T cells	**T cells** are a type of lymphocyte that directly recognize and eliminate microorganisms without producing antibodies.
Memory cells	After an infection is resolved, some lymphocytes become **memory cells**. If the same microorganism enters the body again, these cells trigger a fast immune response, often stopping the illness before it starts.
In *vitro design* of the vaccine	This refers to the **design phase** of vaccine development. During this phase, scientists select the antigen that will trigger an immune response, determine how to obtain it, choose the best method of administration, and define the vaccine's composition.

Activity 2.2: Vaccine effectiveness experiment

Objective	Time: 1h 30 min
• Learn the types of experiments that are done to determine the effectiveness of a vaccine • Reflect on the experimental process • Reflect on the communication of the results of experimentation	**Materials:** Multimedia resource **Link**

Development of the activity

(5 min) Introduction to the activity

We begin by explaining that the process of developing a vaccine is very long. It involves multiple stages, starting from the identification of a potential vaccine candidate in a laboratory, through human clinical trials, until it is approved by a regulatory authority and its marketing is authorized.

3.2.1 Virtual experiment (45 min)

We propose to divide the students into groups of 4 or 5 to work on the virtual experiment. To guide them through the activity, Worksheet 1 is provided.

3.2.2 Complementary reflections (45 min)

Next, we suggest dividing students into 5 groups. Each group will focus on one of the proposed reflection activities. After completing the task, each group will share their reflections with the class. Worksheet 2 is available to support students during the activity.

In Solutions to Worksheet 2, you will find suggested answers for each reflection prompt.

Worksheet 1 for students: Experiment on the effectiveness of a vaccine

During the visit to the Biomedical Research Centre, a virtual experiment is conducted to test the effectiveness of the new vaccine candidate. As you progress through the experiment, please answer the following questions:

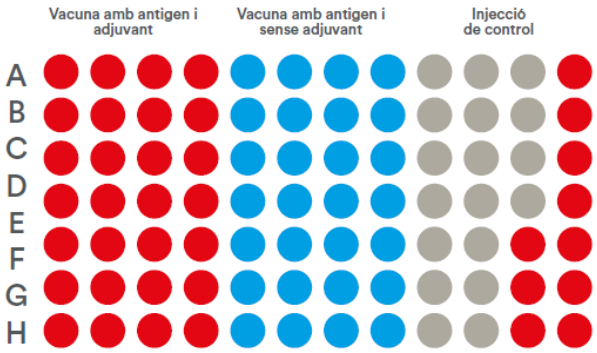
1. The research team that is hosting you has identified a fragment of the Y virus. What is the name of this fragment, and what do they want to verify to determine if it is a good candidate for the vaccine?	
2. What laboratory technique is used in this experiment, and what does it allow us to detect?	
3. Your study has been approved by the ethics committee because it adheres to the 3Rs principle in animal experimentation. Now that you understand how these principles are applied in research, how would you respond to the following statement: *"The pursuit of knowledge is not an end that justifies any means. Therefore, we denounce the use of experimental animals as if they were objects without rights, disregarding their suffering and the extent to which they are used."*	

Worksheet 2 for students: complementary reflections

We invite you to reflect on several aspects related to the virtual experiment you conducted at the Biomedical Research Centre. Work on the question assigned to your group, and brainstorm possible answers. Afterward, a representative from each group will present their answers to the rest of the class within three minutes, and together you will compare and discuss them.

Group 1: Error in the controls

Imagine that, after performing the ELISA, we observe that the wells containing the serum from one of the control mice show a shade like that of the wells containing vaccine serum. As a group, list possible causes that could explain these results. Provide at least three different reasons.



Group 2: Experiment without the ELISA

Imagine that the ELISA technique does not exist. As a group, discuss how you could prove that the vaccine is effective, and write down your conclusions below.

Group 3: Increased immunogenicity

At the Center for Biomedical Research we have learned that an adjuvant will be added to the vaccine because they have seen that this increases its immunogenicity in mice. However, when tested in humans, the vaccine may still not be sufficiently immunogenic. As a group, think of at least three strategies that could be explored to increase the vaccine's immunogenicity, propose them, and write them down below:

Group 4: Sample size

To determine the number of mice required for a valid experiment—that is, to calculate the appropriate sample size—researchers use various biostatistical tools. In the experiment you conducted, you were informed that nine mice were sufficient to measure the vaccine's effectiveness.

Now, consider this: If nine of your friends were vaccinated against the Y virus and none of them became infected, could you confidently conclude that the vaccine is 100% effective? Why or why not?

Group 5: Reliable sources of information

Biomedical research findings are typically published in scientific articles aimed at the scientific community. However, they are also communicated to the general public through media outlets. Click on the two links below and compare a scientific article with an informative publication. What differences do you notice in terms of language, structure, and style?

1. **Scientific article.** *Evaluation in Nonhuman Primates of Vaccines against Ebola Virus*: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3369765/
2. **Informative publication.** *Ebola vaccine tested in adults and children in Africa hailed a success*: https://www.sciencedaily.com/releases/2017/10/171006142352.htm

Fill in the table below with possible answers for each aspect of the publications.

	Scientific article	Informative publication
Language		
Structure and style		
Contents		

Solutions to Worksheet 1

Possible answers:

1. The research team that is hosting you has identified a fragment of the Y virus. What is the name of this fragment, and what do they want to verify to determine if it is a good candidate for the vaccine?	The fragment is called the **Y antigen**. The research team aims to test whether it can trigger an immune response in animals and determine if an adjuvant, an additional substance, is necessary to enhance this response.
2. What laboratory technique is used in this experiment, and what does it allow us to detect?	The laboratory technique used is **ELISA** (Enzyme-Linked Immunosorbent Assay), which detects the presence of specific antibodies against an antigen in a sample.
3. Your study has been approved by the ethics committee because it adheres to the 3Rs principle in animal experimentation. Now that you understand how these principles are applied in research, how would you respond to the following statement: *"The pursuit of knowledge is not an end that justifies any means. Therefore, we denounce the use of experimental animals as if they were objects without rights, disregarding their suffering and the extent to which they are used."*	By following the **3Rs principle** (Replacement, Reduction, and Refinement), researchers aim to balance the pursuit of knowledge with ethical considerations. This ensures that animals are treated with respect for their well-being and rights, rather than being viewed as mere subjects. Approval from the ethics committee demonstrates a commitment to the responsible and humane treatment of animals in scientific research.

Solutions to Worksheet 2

Group 1: Error in the controls

Possible answers:

- Studying two different animal populations in which the disease occurs, vaccinating one group and leaving the other unvaccinated. This could lead to cross-contamination or misinterpretation of the immune response.
- Exposing vaccinated and unvaccinated animals to the virus. If the control animals were inadvertently exposed to the virus, they may have developed an immune response similar to that of the vaccinated mice, resulting in a similar color change in the ELISA.
- Measuring antibody levels using a different technique. The method used to measure antibody levels might not be specific enough, leading to false positives or inaccurate results that appear similar across both the control and vaccinated groups.

Group 2: Experiment without the ELISA

Possible answers:

- Studying two different animal populations where the disease occurs, vaccinating one group and leaving the other unvaccinated. By comparing the incidence and severity of the disease between the two groups, we could assess whether vaccination provides protection.
- Exposing vaccinated and unvaccinated animals to the virus. After exposure, we would observe whether the vaccinated animals show fewer symptoms or a reduced viral load compared to the unvaccinated group, indicating the vaccine's effectiveness.
- Measuring the number of antibodies with another technique.

Group 3: Increased immunogenicity

Possible strategies to increase the immunogenicity of the vaccine:

- Use another adjuvant – Explore alternative adjuvants that may enhance the immune response more effectively.
- Combine multiple antigens into the vaccine – Similar to the Measles, Mumps and Rubella vaccine (MMR Vaccine), incorporating multiple antigens could provide broader and stronger immunity.
- Increase the number of doses administered – A multi-dose schedule or booster shots could improve long-term immunity.
- Strengthen the patient's immune system with drugs – Investigate whether certain immunostimulatory drugs could enhance the body's response to the vaccine.
- Consider virus variability and select a suitable antigen – Ensure the antigen used in the vaccine is relevant to the circulating virus strains to maximize effectiveness.
- Verify that the laboratory virus matches the one circulating in the population – Confirm that the virus strain used in research is representative of real-world infections to ensure vaccine efficacy.
- Identify a more suitable experimental animal model – Find an animal model whose immune response closely resembles that of humans for more accurate preclinical testing.

Group 4: Sample size

No, it would not be correct to conclude that the vaccine is 100% effective based on such a small group. Many variables could have influenced the fact that your friends did not get infected, including:

- Disease distribution – The virus may not have been circulating in their environment, meaning they were never exposed.
- Virus strain virulence – The severity and infectiousness of the virus strain can vary from year to year.
- Individual differences – Factors such as age, overall health, and immune system response can affect susceptibility to infection.
- Population variability – A small group does not represent the diversity of a larger population, where responses to the vaccine may differ.

Additionally, the experiment was conducted on mice using a laboratory virus. When tested in humans, results may differ due to biological differences or variations in the virus circulating in the real world. This is why large-scale clinical trials with diverse participants are essential before confirming a vaccine's effectiveness.

Group 5: Reliable sources of information

In this table, you have possible answers for each aspect of the publications.

	Scientific article	**Informative publication**
Language	Descriptive and specific, using technical or scientific terms. Concrete, precise, and brief, with minimal use of adjectives	More common and accessible language, designed to engage the reader. Often includes literary elements, opinion-based verbs, or references to future possibilities.
Structure and style	Follows a rigid structure: Title, Abstract, Introduction, Materials & Methods, Results, Conclusions, and References.	More flexible, structured like a journalistic article, presenting facts, ideas, concepts, and discoveries in an engaging and accessible way.
Contents	Based on scientific evidence, supported by objective data, and highly detailed in methodology. Includes images and graphs to summarize findings. Aimed at an academic and specialized audience.	Focuses on explaining scientific discoveries using simplified terminology, metaphors, or analogies for clarity. Often omits experimental details and includes illustrations or photographs to capture attention. Intended for the general public.

Activity 2.3: Weighing Risks and Benefits

Objective	Time: 30 min
• Reflect on the balance of risks and benefits of getting vaccinated. • Learn about the phases of vaccine development.	Materials: Multimedia resource Link

Development of the activity

Students open the educational resource "Approve a New Vaccine" and navigate to the Clinical Trials Unit. To access it, they must enter the name JAMES LIND—what a coincidence! This name belongs to a doctor who conducted one of the first clinical trials in history.

Students will then follow the steps outlined below and respond to the following questions:

1. Read the leaflet for the new vaccine and explain why it is described as immunogenic.
2. Access the app that Dr. James Lind has loaded onto your tablet. Using the information provided, complete the following sentences:
    a. According to the graph, the number of cases of _____ has decreased the most after the introduction of the vaccine.
    b. When a disease such as smallpox is completely eliminated worldwide, it is said to have _____.
    c. The likelihood of suffering serious complications due to measles is _____ if you're not vaccinated, whereas the likelihood of experiencing a severe reaction to the vaccine is _____.

Optional Activity: Learn More About Clinical Trials

Dr. James Lind mentioned that the unit has conducted Phase I, II, and III clinical trials in humans, but he did not go into detail about each phase. If you are curious and want to explore what these phases involve, click on the following link and take part in designing a new drug. In this interactive activity, you will conduct clinical trials with human volunteers:

🔗 Develop a Drug in This Race Against Time

After completing the activity, explain what each phase of a clinical trial consists of:

Solutions to activity 2.3

1. **Read the leaflet for the new vaccine and explain why it is described as immunogenic.**
   Possible answer: The vaccine is highly immunogenic because protective antibodies against Y virus infection were detected in 97% of the subjects who received the vaccine.

2. **Access the app that Dr. James Lind has loaded onto your tablet. Using the information provided, complete the following sentences:**
   a. According to the graph, the number of cases of **__measles____** has decreased the most after the introduction of the vaccine.
   b. When a disease such as smallpox is completely eliminated worldwide, it is said to have **___been eradicated_____**.
   c. The likelihood of suffering serious complications due to measles is **___1 in 1,000_____** if you're not vaccinated, whereas the likelihood of experiencing a severe reaction to the vaccine is **__1 in 1,000,000 (0,0001%)**.

Activity 2.4: Vaccination strategies

Objective	Time: 1h (parts a & b) + 1h (learn more)
• Know vaccination strategies • Learn what herd immunity is and how it works.	Materials: Multimedia resources: Link & follow this link

Development of the activity

To complete this activity, you can give the following instructions to the students.

Within the "Approve a Vaccine" educational resource, navigate to the Public Health Agency—this is the last center you will visit. Here, you will decide on the best vaccination strategy to follow.
Remember that the Wi-Fi password is "John Snow", an English doctor who is considered one of the fathers of modern epidemiology.

a) After watching the video in the app, define in your own words what herd immunity is.

b) Herd Immunity Class Simulation

This activity introduces students to the concept of vaccination by exploring its role in disease prevention, herd immunity, and public health. Through a simulation and interactive discussions, students analyse the importance of high vaccination rates.

This activity is hosted by **e-Bug**, a health education programme operated by the UK Health Security Agency. To access all the necessary materials, follow this link.

Learn more: Exploring Vaccination Strategies

To deepen their understanding of different vaccination strategies, students will read selected press articles and answer guiding questions.

Case Study 1: Measles and the Importance of High Vaccination Rates

Article: "'Concerning' measles rise prompts warning" (BBC)

Discussion Questions:

1. What is the current situation regarding measles cases in the southwest of England according to the article?
2. What are the possible consequences of the decline in vaccination rates mentioned in the article?
3. According to health authorities, what actions should parents take to protect their children and the wider community?
4. What connection does the article make between **low vaccination rates** and the **rise in measles cases**?

Case Study 2: Ring Vaccination as a Containment Strategy

Article: "Ring vaccination effective in containing Ebola" (Nature)

Discussion Questions:

1. What is **ring vaccination**, and how was it implemented during the Ebola outbreak?
2. What were the **key challenges or limitations** identified in the study regarding ring vaccination?
3. How might the findings of this study **influence future strategies** for controlling Ebola outbreaks or other infectious diseases?
4. In your own words, **define ring vaccination** and explain **why it would be appropriate** for controlling virus Y or a virus like **Ebola**.

Solutions to activity 2.4

a) After watching the video in the app, define in your own words what herd immunity is.

Possible answer: Herd immunity occurs when a large percentage of the population becomes immune to a disease through vaccination making it difficult for the disease to spread. This protects even those who are not immune, such as the elderly, infants, or immunocompromised individuals who cannot be vaccinated, as the chances of an outbreak decrease significantly.

Learn more: Exploring Vaccination Strategies

Case Study 1: Measles and the Importance of High Vaccination Rates

Possible answers:

1. **What is the current situation regarding measles in the southwest of England according to the article?**
   The southwest accounts for nearly half of all UK cases, with 26 out of 57 cases.
2. **What are the possible consequences of the decline in vaccination rates mentioned in the article?**
   The decline in vaccination rates can lead to more measles outbreaks. Since measles is highly contagious, more people could become seriously ill or, in rare cases, dies.
3. **According to health authorities, what actions should parents take to protect their children and the wider community?**
   Parents are urged to ensure their children are vaccinated against measles to protect and prevent further spread.
4. **What connection does the article make between low vaccination rates and the rise in measles cases**?
   The article links the rise in measles cases to the decline in vaccination rates, which is leading to more outbreaks in the region.

Case Study 2: Ring Vaccination as a Containment Strategy

Possible answers:

1. **What is ring vaccination, and how was it implemented during the Ebola outbreak?**
   Ring vaccination is a strategy where close contacts of an infected person are vaccinated to prevent disease spread. During the Ebola outbreak, it was implemented by vaccinating individuals close to confirmed cases, such as family and friends, creating a protective barrier that significantly reduced the spread.

2. **What were the key challenges or limitations identified in the study regarding ring vaccination?**
   One challenge is that the vaccine's effects take about 10 days to fully take hold, so most infections occurred within the first nine days before full protection.

3. **How might the findings of this study influence future strategies for controlling Ebola outbreaks or other infectious diseases?**
   The study demonstrates ring vaccination's effectiveness in rapidly containing outbreaks, suggesting it could be applied to similar diseases like Marburg or Lassa fever. It emphasizes the need for proactive planning and preparedness to respond swiftly.

4. **In your own words, define ring vaccination and explain why it would be appropriate for controlling virus Y or a virus like Ebola.**
   Ring vaccination involves vaccinating individuals who have close contact with an infected person, creating a barrier to prevent the disease from spreading. It's effective for controlling viruses like virus Y or Ebola, where transmission occurs through close contact, as it helps stop the spread before it becomes widespread.

Activity 3: To get vaccinated or not, that's the question

Objective	Time: 1h
• Reflect on the controversy surrounding vaccination	**Materials:** computer or tablet

Development of the activity

The activity "To Vaccinate or Not, That Is the Question" consists of two sub-activities that can be completed independently or consecutively. The goal is to open the debate about the controversy surrounding vaccination. Should individuals get vaccinated? What are the personal and community-wide implications of vaccination? What are the consequences of choosing not to vaccinate? And how should vaccination be regulated?

Activity 3.1: Watch and decide

Objective	Time: 30 min
• Reflect on the ethics of vaccination	Materials: computer or tablet

Development of the activity

In this activity, students will watch a video titled *"Is it ethical to be against vaccination?"* and answer the following questions to help them engage with the content. These questions will also be useful when preparing for the debate games in activity 3.2.

(10 min) Watch the video
Link: "Is it ethical to be against vaccination?"

(20 min) Questions for students
The answers to the following questions will guide students' understanding of the video's content.

3.1.a What three attitudes of families regarding vaccination that the nurse describes? What reasons does the nurse give parents to encourage them to vaccinate their children?

3.1.b Describe what bioethical principles in relation to vaccination.

3.1.c What adverse effects of vaccines are mentioned in the video? Has any proven connection been found between the MMR (Measles, Mumps, and Rubella) vaccine and autism?

Solutions to activity 2.4

Possible answers:

3.1.a) What three attitudes of families regarding vaccination that the nurse describes? What reasons does the nurse give parents to encourage them to vaccinate their children?

The three attitudes of families regarding vaccination mentioned by the nurse include:

- Families who are confident and supportive of vaccination.
- Families who have doubts, particularly about optional vaccines.
- Families who oppose vaccination altogether (anti-vaccine).

The nurse encourages parents by explaining that vaccines protect children from serious diseases and highlighting the importance of herd immunity. The risks of not vaccinating are much higher than any mild side effects.

3.1.b) Describe what bioethical principles in relation to vaccination.

The main bioethical principles related to vaccination include:

- **Beneficence**: Acting in the best interest of the child and the community by protecting them from serious diseases through immunization.
- **Non-maleficence**: Avoiding harm by minimizing the risks associated with vaccines and ensuring that the benefits outweigh any potential side effects.
- **Justice**: Ensuring fair and equitable access to vaccines for all families, regardless of their social or economic situation.
- **Autonomy**: Respecting families' decisions while guiding them with clear, evidence-based information so they can make informed choices.

3.1.c) What adverse effects of vaccines are mentioned in the video? Has any proven connection been found between the MMR (Measles, Mumps, and Rubella) vaccine and autism?

The video mentions mild adverse effects like fever and swelling at the injection site. It also addresses the misconception that the MMR vaccine causes autism, stating that no proven connection has been found between the vaccine and autism.

Activity 3.2: Play and decide

Objective	Time: 1 hour
• Reflect on the ethics of vaccination	Materials: computer or tablet

Development of the activity

In this activity, we propose two group games to explore ethical, legal and social issues surrounding vaccination. Before beginning, we recommend completing Activity 2.4 as an introduction. To play, divide the participants into groups: half will play *Discussion Continuum*, and the other half will play *Play Decide*.

3.2 a) Game Discussion Continuum

To begin, read the game instructions. Feel free to adjust the playing time by limiting the number of cards. We recommend selecting a maximum of 10 cards to simplify the game.
In this game, groups will discuss and order a set of cards based on their views on vaccination. After reaching a consensus within their group, they will compare their results with other groups and debate the placement of the cards. A photo of the final card order will be taken, and the most controversial cards will be discussed.

3.2b) Play Decide Game

Download the game from this link. Play Decide facilitates a respectful, fact-based discussion on controversial issues like vaccination. It helps players explore different perspectives, form or clarify their opinions, and examine whether they can reach a consensus as a group. The game concludes with a vote on proposed positions.
The goal is to understand vaccination from various viewpoints and develop an informed opinion or stance on the issue.

To complement the game, after the session, ask students to write an argumentative essay explaining which political position they agree with most and why. They should use arguments and controversies from the group discussion to support their position.

Game Discussion Continuum

This activity encourages dialogue on ethical, legal and social aspects of vaccination. Groups of 4 to 12 students will discuss various statements and place them between "Agree" and "Disagree" cards.

Content:

- One ***AGREE* card** and one ***DISAGREE* card**
- **15 discussion letters** with statements vaccination-related topics

Rules of the game:

1. Players form small groups (4 to 12 members). Each group receives an AGREE card, a DISAGREE card and the discussion cards.
2. The *AGREE* and *DISAGREE* cards are placed one meter apart, representing the two ends of a continuum. The discussion cards will be placed in between.
3. The first student reads the first discussion card to the group and ensures everyone understands it.
4. The student who read the factor decides where to place the factor card on the continuum (closer to AGREE or DISAGREE) based on her personal view, without debate. If possible, the student provides a justification for their choice.
5. Other students, in turns, read the other factors, ensuring everyone understands them, and individually placing them on the continuum and explaining the reasons why they placed them in the selected position.
6. After all cards are placed on the continuum, the group discusses where each card should be positioned. Students may suggest moving cards while justifying their reasoning. The final goal is to **reach a consensus** on the final order, with factors placed between the cards **AGREE and DISAGREE**.
7. If multiple groups are playing simultaneously, the teacher can compare results across the groups. Are the arrangements similar? Can a representative from each group explain their reasoning for a particular card? Were there any disagreements within groups? For what reasons?

Game adaptation:

If time is limited, you can reduce the number of discussion cards or use them only as starting points for discussion.

Agree

Disagree

Discussion Card 1 "The **eradication of diseases** through vaccination is only achievable when a significant majority of the population is vaccinated. To ensure this, governments should enforce **mandatory vaccination policies**"	**Discussion Card 2** "Health authorities should have the power to **mandate vaccinations for children** in communities experiencing an **outbreak** of an infection and, therefore, where herd immunity is at risk"
Discussion Card 3 "Vaccination against diseases that have been **eradicated** in our country should remain mandatory to **prevent their resurgence**. Families should not have the option to choose"	**Discussion Card 4** "When a high percentage of the population is vaccinated, **herd immunity** is established, protecting even those who choose not to be vaccinated. Is it fair for individuals who could be vaccinated but refuse to still benefit from this protection?"
Discussion Card 5 " Public health campaigns should highlight that vaccination not only protects the individual but also serves as an **act of solidarity**, helping to safeguard those who cannot be vaccinated "	**Discussion Card 6** " Given the significant benefits of vaccination for the overall health system, health authorities should cover the **cost of all vaccines**, not just those included in the standard vaccination schedule"
Discussion Card 7 "If the government allows families to decide whether or not to vaccinate their children, schools or kindergartens should not be permitted to require an **up-to-date vaccination card** as an admission criterion"	**Discussion Card 8** "When the paediatrician explains the vaccination schedule, they should outline both the **benefits and the potential side effects**, which, in extremely rare cases, could occur. This ensures that individuals can make a more informed decision about vaccination"

Discussion Card 9 "When considering the total **cost of suffering from a disease**, vaccines save more than 40 euros for every euro spent. Therefore, individuals who choose not to be vaccinated and later become infected should be responsible for covering the **costs of their treatment**"	**Discussion Card 10** "Some **alternative medicines** may create a false sense of protection against certain infectious diseases, leaving individuals vulnerable and putting both their own health and the health of their community at risk"
Discussion Card 11 " The health system includes numerous vaccines in **vaccination schedules**, partly due to pressure from private industry, which may influence decision-making and policies"	**Discussion Card 12** " The government should work to make all **vaccine-related information** more accessible and transparent. It is more effective to educate and convince families to vaccinate rather than forcing them to do so"
Discussion Card 13 "**Vaccination for health professionals** should be mandatory, given their potential role as carriers of diseases, such as influenza, to high-risk individuals, including the elderly and those with chronic illnesses"	**Discussion Card 14** "Since **children become immunized** after contracting a natural infection, administering certain vaccines is unnecessary"
Discussion Card 15 " When an outbreak of diphtheria occurred in Olot, individuals who were vaccinated but were carriers had to stay home to avoid putting **unvaccinated people at risk**. This was unfair"	

Activity 4: The impact of ethical, legal and social factors on research

Objective	Time: 1h
• Reflect on the ethical, legal and social factors involved in vaccination	Materials: video player

Development of the activity

For the development of this activity, two parts are proposed: the viewing of a video on the ethical aspects of malaria and the reflection on a specific situation in a vaccination campaign.

(5 min) Watch the video
Watch the video using the link provided.

(25-45 min) Reflection on a vaccination campaign
To carry out this activity, divide the students into small groups. Then, explain the following situation to the students:
"Although the development of many vaccines takes place in Europe, imagine that there is an outbreak in a country with low per capita incomes and that the vaccine is distributed there. After a few months, the number of infected people is not decreasing as expected and it seems that the vaccine is not as effective as anticipated"

Once the situation is explained, suggest that the students reflect as a group and write down one reason per sticky note that might interfere with the effectiveness of vaccination campaigns for each category listed in the table below. Each group should come up with at least one reason for each category. Afterward, a representative from each group will briefly explain their reasons and stick them under the corresponding category on the board.

Table: Categories for possible reasons affecting vaccine campaign effectiveness

Sociocultural reasons
Economic and legal reasons
Genetic and biological reasons

Solutions to activity 4

Possible answers:

Sociocultural reasons
- Low acceptance of vaccines within the community - People stop taking preventive measures, such as mosquito control, believing the vaccine is the sole solution - Lack of support for the vaccination initiative from political leaders, influencers, or local health professionals - Insufficient or ineffective public information campaigns - Misinformation and myths circulating - Language or literacy barriers that prevent understanding of vaccination benefits - Religious or cultural beliefs opposing vaccination
Economic and legal reasons
- Lack of funding to cover the costs of the vaccination campaign - People unable to afford the vaccine (if there is a cost associated) - Limited vaccine distribution centers, preventing access to the entire population - Lack of proper storage facilities, leading to spoilage of vaccine - Poor transportation infrastructure making it difficult to deliver vaccines to remote or rural areas
Genetic and biological reasons
- Variation in how individuals' immune systems respond to the vaccine, affecting its overall effectiveness - The presence of mutations in the virus that make the vaccine less effective - Incomplete or inconsistent vaccine doses, leading to inadequate immune response

Activity 5: Overcoming the fear of needles

Objective	Time: 50 min
• Recognize the existence of needle phobia • Learn techniques and tools to help overcome the fear of needles	**Materials:** none required

Development of the activity

This activity explores various techniques to help overcome the fear of needles and aims to help participants understand what happens to people who experience this phobia. The proposed methods can be practiced individually but can also be adapted to a group setting.

It has been adapted from: Needle phobia and overcoming your fear by the NHS Foundation Trust.

(5 min) Introduction

Start by explaining that for many people, the fear of needles often manifests as fainting or feeling dizzy. This is because when someone experiences a trigger (like seeing blood or thinking about an injection), their heart rate and blood pressure rise, and then drop suddenly. This rapid drop in blood pressure can lead to fainting.
Many individuals avoid confronting their fear due to embarrassment. While some may not faint or feel dizzy, they experience anxiety or panic when exposed to needle-related situations.

Ask students to share their thoughts on how they think the fear of needles could be overcome. Use the following prompts as a guide for brainstorming:

- Communicate your concerns to the person administering the injection or blood test. They can answer your questions and guide you through the procedure. For example, they may talk to you during the process to help distract you.
- Don't worry about others' reactions. The medical staff will not judge you for expressing your fear, and knowing about it will allow them to make the process easier for you.
- Reflect on past experiences. Have you found anything that has helped you manage the fear before? Can it be used again?
- If your fear is related to fainting, you can try an applied tension technique to keep your blood pressure stable.
- If you experience panic (racing heart, tight chest, shaky stomach), but don't feel faint, learning a breathing exercise can help you relax.

(10 min) Practice support techniques

Here, students will practice two effective techniques for managing their fear of needles.

1. **Applied Tension Technique**

This simple exercise can help raise blood pressure to prevent fainting.

1. Sit in a comfortable position.
2. Tense the muscles in your arms, upper body, and legs for 10–15 seconds or until you feel warmth in your face.
3. Release the tension and return to a relaxed sitting position.
4. After 20-30 seconds, repeat the tension exercise until you feel warmth in your face again.
5. Repeat this sequence 5 times.

For best results, practice this technique 3 times a day for about a week before attempting to face your fear. If you experience headaches, avoid tensing the muscles in your face and head. Take care if you have any health concerns and be careful when tightening any part of the body where you have health problems.

2. Breathing for relaxation

This technique helps you stay calm by focusing on deep, controlled breathing.

1. Sit comfortably with your back straight but relaxed. Let your shoulders and jaw soften.
2. Place one hand on your belly. Breathe in slowly, deeply, and gently through your nose, allowing your stomach to rise, then breathe out through your mouth.
3. Repeat this for 5 breaths, focusing on the sensation of breathing deeply into your stomach.

If possible, practice this exercise 3 times a day for a week to improve relaxation skills. Then you can try to face your fear.

(30 min) The scale of fear: climbing the ladder

Once students are familiar with the techniques, it's time to confront the fear of needles gradually.

a) **Creating a "Fear Scale"**

A "Fear Scale" helps students rate situations involving needles based on their anxiety levels, allowing them to face their fear step by step. The scale should be ordered from least to most anxiety-inducing situations.

Example of a Fear Scale:

Situations	Anxiety Rating (0-10)
Receiving an injection in the arm	10/10
Holding a needle	9/10
Touching a needle	8/10
Watching someone get an injection in real life	8/10
Seeing someone else get an injection on TV/online	7/10
Looking at pictures of needles or injections	6/10
Hearing someone talk about getting an injection	6/10
Thinking about getting an injection	5/10

Each student should create their own scale based on personal comfort levels, placing the easiest situations at the bottom of the ladder and the most difficult at the top.

b) Climbing the ladder of fear

Steps:

1. Begin with the least anxiety-provoking situation on the scale (e.g., thinking about getting an injection).
2. Stay in the situation long enough for anxiety to peak, remain steady for a while, and gradually subside. The goal is to experience that the fear doesn't last indefinitely and that it eventually fades. Even if your anxiety doesn't subside, it's important to stay in the situation long enough to prove that your fear is wrong (e.g., thinking you're going to faint).
3. Use the *applied tension* or *breathing* techniques as needed to manage the anxiety.
4. Once anxiety reduces, move to the next situation on the ladder. You may need to repeat a situation a few times before feeling ready to move on.
5. Celebrate small successes! Recognizing progress is key to overcoming fear.

(5 min) Conclusion

Overcoming fear takes time and practice. By gradually exposing yourself to anxiety-inducing situations and using relaxation techniques, the fear becomes more manageable. With consistent effort, you can build confidence and reduce the impact that fear has on your life.

Seeking Professional Support

If necessary, professional psychological support can be valuable in overcoming needle phobia. Encourage students to reach out to a healthcare provider or therapist if they feel their fear is significantly impacting their well-being.

Activity 6: Gender barriers to vaccination

Objective	Time: 50 min
• Explore existent gender-related barriers to vaccination • Develop and propose solutions to address those barriers	Materials: device with internet connection

Development of the activity

This activity will help students explore gender-related barriers to vaccination and encourage them to think critically about potential solutions.

(10 min) Brainstorming barriers

To begin, initiate a class discussion to introduce the topic and explore students' prior knowledge. Use the following guiding questions:

- Do you think gender influences a person's decision to get vaccinated?
- If yes, what do you think are the possible causes?
- If not, do you believe this is the case everywhere? Can you think of communities or countries where gender differences in vaccination decisions are more pronounced?

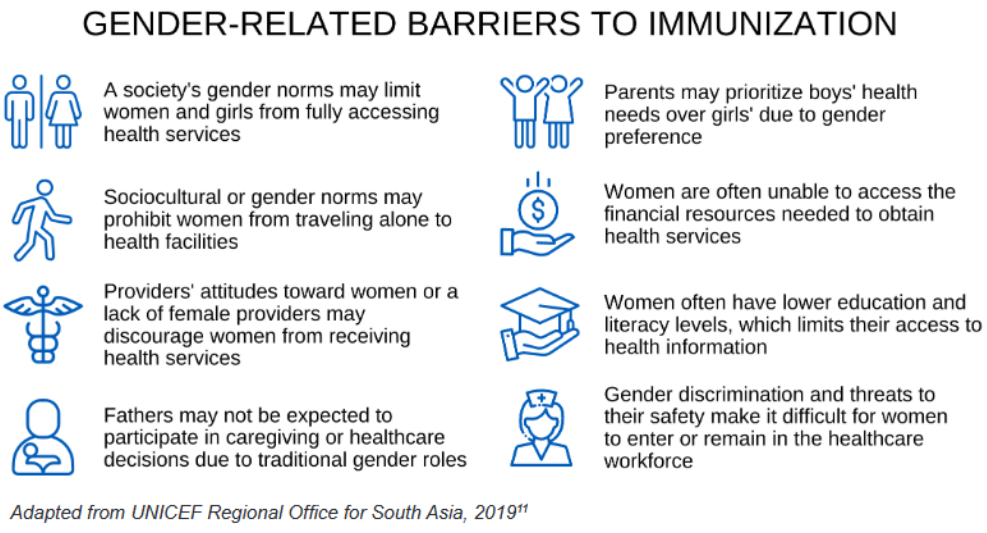
(15 min) Exploring Gender-Related Barriers

Divide the students into small groups, assigning each group to represent the gender committee of an organization that addresses gender barriers in vaccination:

- Group 1: **Global Polio Eradication Initiative (GPEI)**
- Group 2: **UNICEF**
- Group 3: **Gavi, the Vaccine Alliance**
- Group 4: **Bill & Melinda Gates Foundation**
- Group 5: **Global Health 50/50**
- Group 6: **Gender & Health Hub**

Each group has 5 minutes to research and summarize the mission of their assigned organization in two sentences.

Afterward, introduce the challenge: present the gender-related vaccination barriers identified by UNICEF.



Adapted from UNICEF Regional Office for South Asia, 2019[11]

(15 min) Proposing Solutions to Barriers

Once students understand the barriers, assign one or two to each group, ensuring all are covered. Their task is to develop a solution for each assigned barrier. To support their work, they can refer to resources such as

- **Article:** "Beyond Constructs and Principles: Addressing Gender-Related Barriers to High, Equitable Immunization Coverage" (*Front. Glob. Womens Health*, April 3, 2024) **Image link**
- **Advocacy Brief: "**Addressing Gender Inequities to Improve Immunization Coverage for Zero-Dose Children" **Read here**

(5 min) Conference on Eliminating Gender Barriers in Vaccination
Each group presents their proposed solution to the class.

If time allows, facilitate a reflection session:

- How challenging was it to come up with solutions?
- Do they seem feasible in the short term?
- How could these solutions be implemented, and which organizations or institutions would play a role?

Activity 7: Exploring the influence of age and education level on vaccination decisions

Objective	Time: 50 min
• Understand the impact of age and education level on vaccination decisions • Develop critical thinking and data interpretation skills by formulating hypotheses, testing them against empirical data, and discussing the findings as a class.	**Materials:** computer with internet connection

Development of the activity

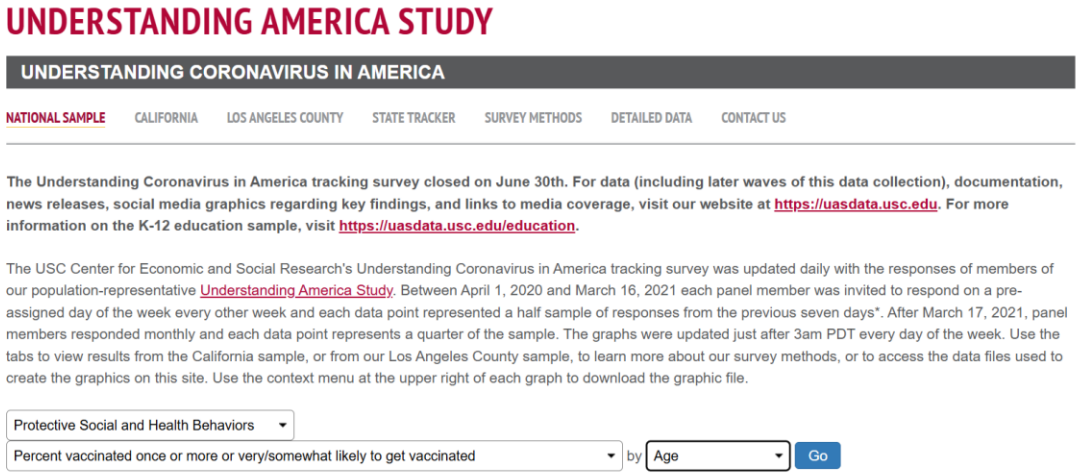
This activity aims to explore how age and education level influence the decision to get vaccinated. To do this, we will analyse data from the Understanding Coronavirus in America Tracking Survey conducted by the USC's Center for Social and Economic Research. This survey examines willingness to receive the COVID-19 vaccine based on various demographic factors, including race, ethnicity, age, education, income, and gender.
Specifically, we will focus on graphs generated from data collected between March 2020 and June 2021.

(10 min) Hypothesizing the influence of age and education
Divide the class into small groups and ask each group to formulate two hypotheses:
1. How do they think age influences vaccination uptake?
2. How do they think education level can influences vaccination uptake?

For example:
- People with higher education levels are more likely to get vaccinated than those with lower education levels.
- Older adults are more likely to receive the COVID-19 vaccine than young adults.

(30 min) Analysing the data
In this activity, the research has already been conducted, so we will go directly to the results to test whether our hypotheses are supported. Follow these steps:

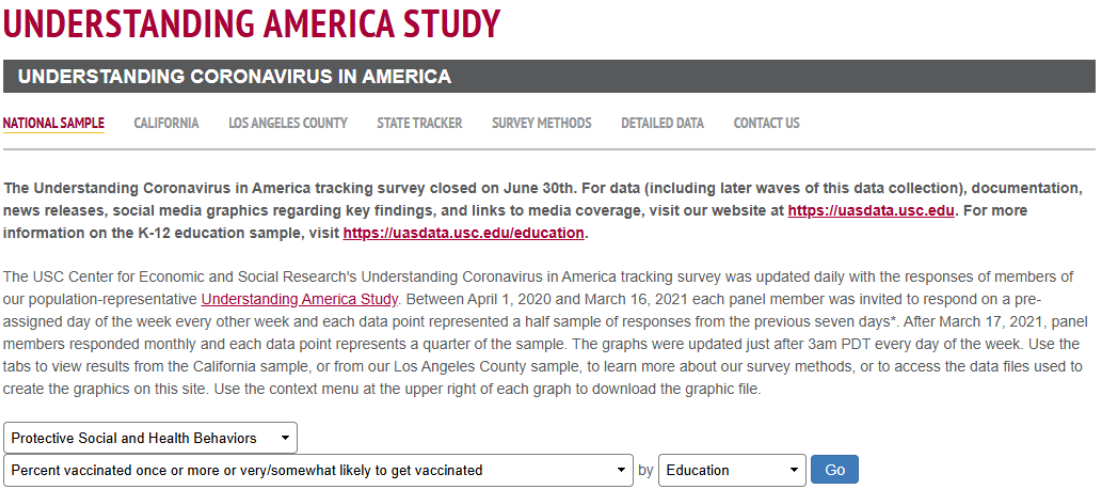
1. **Influence of age on vaccination**
   1) Go to the Understanding Coronavirus in America Tracking Survey
   2) In the graph's menu, select:
      a) *Protective Social and Health Behaviours*
      b) *Percent vaccinated once or more or very/somewhat likely to get vaccinated*
      c) *Age* → Click "GO!"



3) Answer the following questions:
   a) In general, which age group has the highest vaccination rate or intention to get vaccinated?
   b) Can we say that vaccination rates and willingness to get vaccinated are related to age? How are they connected?
   c) Do the results support your hypothesis?

2. Influence of education level on vaccination

1) Go to the Understanding Coronavirus in America Tracking Survey
2) In the graph's menu, select:
   d) *Protective Social and Health Behaviours*
   e) *Percent vaccinated once or more or very/somewhat likely to get vaccinated*
   f) *Education* → Click "GO!"



3) Answer the following questions
   a) In general, which education level has the highest vaccination rate or intention to get vaccinated?
   b) Can we say that vaccination rates and willingness to get vaccinated are related to education level? How are they connected?
   c) Do the results support your hypothesis?

(10 min) Sharing Results with the Class

Each group presents their findings, comparing their initial hypotheses with the actual data. As a class, discuss any trends, surprises, or insights gained from the activity.

Solutions to activity 7

Suggested answers:

1. Influence of age on vaccination

3) Answer the following questions:

a) In general, which age group has the highest vaccination rate or intention to get vaccinated?

The age group that has de highest vaccination rate or intention to get vaccinated is 65 and older.

b) Can we say that vaccination rates and willingness to get vaccinated are related to age? How are they connected?

It can be observed that the 65+ age group has the highest vaccination rate, followed by the 51 to 64 age group. The groups between 40-50 and those 39 or younger fluctuate, but there is no clear relationship. We could say that, in general, there is a positive correlation starting from age 50, where the older the age, the higher the percentage of people vaccinated or with a strong intention to get vaccinated against COVID-19.

2. Influence of education level on vaccination

3) Answer the following questions:

a) In general, which education level has the highest vaccination rate or intention to get vaccinated?

The group with the highest vaccination rate or intention to get vaccinated consists of individuals with a bachelor's degree or higher.

b) Can we say that vaccination rates and willingness to get vaccinated are related to education level? How are they connected?

There is a clear difference between people who have a bachelor's degree or higher, as they are generally much higher in vaccination rates or intention to get vaccinated. People who have studied some college seem to generally be slightly above those who completed their studies at the secondary level or below. However, the difference is not as significant as with the former. We could say that the higher the level of education, the higher the percentage of vaccinated people or those with the intention to get vaccinated.