

Visualization of Smoking and its Impact on Lung Cancers by Country

COS30045 Data Visualization

Group - CL02_T07

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Mercury Web Page Link:

<https://mercury.swin.edu.au/cos30045/s103609316/assignment/>

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Introduction

Background and Motivation

Smoking is a prevalent behavior with deep-rooted cultural, economic, and social foundations that vary significantly across global regions. In many Asian societies, smoking is intricately intertwined with societal norms and business customs, contrasting with Western cultures where it is often portrayed as a symbol of defiance and autonomy. Our initiative focuses on healthcare professionals and current smokers to offer a comprehensive visualization of smoking data, aiming to explore these subtleties. By gaining insights into regional smoking practices, healthcare providers can better tailor smoking cessation programs to address distinct cultural and socioeconomic influences. (Loddenkemper, 2015)

The act of smoking involves inhaling smoke produced by burning tobacco, mostly through cigarettes but also through cigars, pipes, and increasingly, e-cigarettes. Throughout history, smoking has been a common practice with strong cultural, economic, and social roots all throughout the world.

The primary goal of the website is to help to inform visitors of the negative health impacts of smoking by presenting the data in an understandable and easily digestible context for the viewer; this will be done by allowing for the dataset to be interactive and for the viewer to specify their own regions of interest.

Related Data in OECD

According to the OECD's latest data in 2022, about 15.9% of individuals aged 15 and above in OECD nations smoke tobacco daily. The prevalence varies notably among countries, exceeding 25% in places like France and Türkiye but falling below 10% in countries such as Iceland and Norway. This disparity underscores the widespread issue of tobacco use and the differing effectiveness of public health interventions globally.

The OECD statistics also indicate that men tend to smoke more than women in nearly all countries, with an average daily smoking rate of 19.9% for men compared to 12.3% for women across OECD member states.

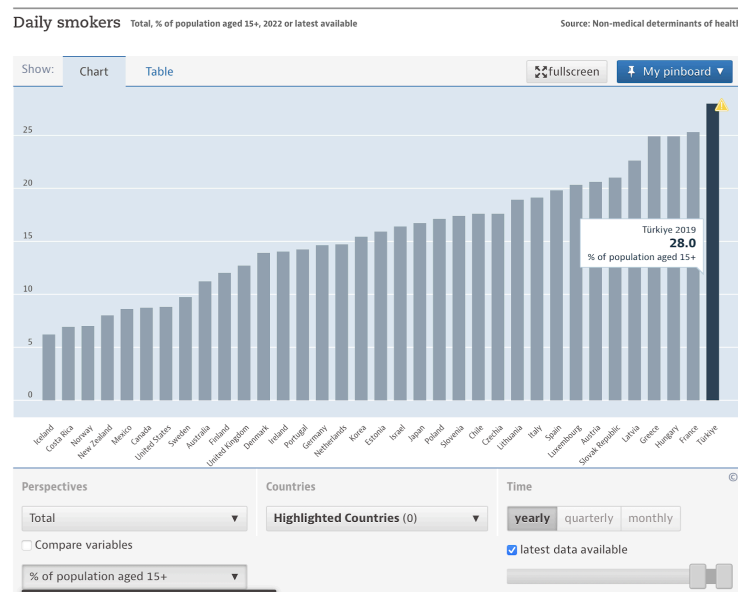


Figure 1: Daily smokers across regions

New challenges:

New obstacles have emerged for those attempting to stop smoking due to the rising popularity of e-cigarettes and other alternative smoking products, particularly among younger people. The potency of tobacco promotion and the creation of alluring tobacco product tastes make public health activities more challenging.

Our audience**1) Current/daily smokers**

It is assumed that the audience's awareness of smoking's dangers varies significantly. Many smokers may not fully understand the specific risks or the benefits of cessation.

2) Health care workers & providers

Healthcare providers are generally well-informed but may lack the latest data on intervention strategies.

We have targeted our audience more in depth as defined in further stages.

The continuing burden of cancer

Cancer remains a significant healthcare concern across all OECD nations, with nearly 5 million new cancer cases diagnosed annually or an average of 261 cases per 100,000 individuals. Cancer poses a greater burden in terms of potential years lost than heart attacks and strokes for both genders, constituting over a quarter of all fatalities.

The economic burden linked to cancer is mounting steadily. Expenditure on cancer currently represents around 5% of total medical costs and is projected to rise due to increasing incidence rates, longer survival periods, and the high expenses associated with advanced treatments and technologies. Cancer patients and their caregivers bear substantial financial and social costs; factoring these in reveals that the global economic impact of cancer-related premature death and disability surpasses that of heart disease at approximately USD 900 billion.

Health systems needs to do better

Efforts against cancer are not meeting their full potential. An estimated one-third of cases could be cured through timely detection and appropriate treatment while another third could be preventable with more extensive public health strategies in place. Although cancer mortality rates have slightly decreased in most OECD nations since 1995, the decline has been less pronounced than that observed for heart disease and stroke; some countries have not witnessed any reduction in cancer-related deaths either. Additionally, there exists nearly a fourfold variance in cancer survival rates across OECD countries, particularly lower rates persisting in Eastern European nations compared to other OECD regions.

Visualization Purpose

The website is intended to serve as a thorough resource for both medical experts and those who are thinking about giving up smoking. Through the platform's interactive and data-driven insights into global smoking habits, numerous important public health questions are addressed:

1. How common is smoking in different countries?

- With the help of our visualization, the users can quickly identify the regions with greater smoking rates and compare those from region-to-region.
- The public health experts can efficiently pinpoint the regions and can distribute their resources of smoking cessation programs through our visualization.

2. How has tobacco consumption trended upward or downward in the past?

- Our dynamic timeline feature allows users to follow historical tobacco usage data. It helps in forecasting future patterns and demonstrates the efficacy of earlier anti-smoking initiatives.
- This longitudinal data can be essential for assessing health policy's long-term effects.

3. How does tobacco consumption impact cancer rates?

- Our application provides a clear visual representation of the health effects of smoking by correlating data on tobacco intake with lung cancer rates. This feature is specifically designed to inform smokers about the dangers and give medical professionals information that can help in promoting education and advocacy.

Benefits to the Target Audience:

- **For Medical Professionals:** It would help doctors to make more educated decisions and offer patients counseling by giving users access to up-to-date, dependable data on smoking's consequences.
- **For Smokers:** Persuades people to change their behavior by providing compelling, demographic-specific visual proof of the health dangers linked with smoking.
- **For Health Policy Makers:** It would provide useful information about smoking patterns and the health effects of smoking, which may be used to improve the effectiveness of anti-smoking laws.

(Park, 2019)

The main purpose of our visualization is to clarify the global smoking pattern and how it relates to lung cancer incidence.

Healthcare professionals can track changes over time and spot patterns with the help of this interactive tool that incorporates features like a timeline and geographic comparisons. This could play a key role in creating focused public health initiatives and giving smokers convincing, individualized data to support their quit. (Park, 2019)

Data

Data Source

Our primary data source is the **OECD's data on tobacco consumption per capita by country** (OECD, 2023), with supporting data from the **OECD's cancer rates per capita by country**. (OECD, 2024)

In the data on tobacco consumption data, we have the following data values:

- The country the data represents, which is categorical data, and;
- The percentage of the population who smoke daily, which is quantifiable data, and;
- The sex of the people being represented, which is categorical data.

In the data on cancer rates per capita, we also have the following data values:

- The country the data represents, which is categorical data, and;
- The number of cancer cases for 100,000 people, which is quantifiable data, and;
- The sex of the people being represented; which is categorical data.

We also chose to keep the “measure” of both datasets as a personal reminder of what the datasets value's represent as it is simply a test description of the unit the OBS_VALUE field represents.

Data Processing

The dataset on cancers contains information about lots of different types of cancer, such as malignant cancers in various different areas other than those more closely related to smoking such as that of the lungs, trachea, and bronchus.

To process the data we developed a simple python script which would allow for different modifications to be applied to the dataset before saving the modified .csv file.

Tobacco Consumption Dataset

The first change made to the tobacco dataset was the removal of fields which were irrelevant to our needs. These fields were either related to specifying the data structures for more complex programming needs or reiterating existing data fields in a more codified way.

The rows which were removed were:

- STRUCTURE
- STRUCTURE_ID
- STRUCTURE_NAME
- ACTION
- REF_AREA
 - Represents shortened value of “Reference area” field.
- FREQ
- Frequency
 - Both FREQ and Frequency are all “A” or “annual”
- MEASURE
 - Represents shortened value of “Measure” field
 - Additionally two measures exist:
 - “Share of population who are daily smokers”
 - “Tobacco Consumption

- AGE
 - Represents shortened value of “Age” field
- SEX
 - Represents shortened value of “Sex” field
- UNIT_MEASURE
 - Always “Percentage of population” for “Share of population who are daily smokers”
 - Always “Grammes per person” for “Tobacco consumption”
- METHODOLOGY
- Measurement method
- Time period
 - Which is always blank
- Observation value
 - Which is always blank
- OBS_STATUS
- Observation status
- UNIT_MULT
- Unit multiplier
- Decimals
 - Which is always blank
- DECIMALS
 - Which is always blank

Finally once all the unneeded fields were removed the dataset was split into two subsets based on the value of MEASURE and two csv files created:

- DS_Tobacco - containing the “daily smokers”
- TBC_Tobacco - containing the “tobacco consumption”

Cancer Rate Dataset

Again the OECD’s raw data on cancer rates contained lots of empty data fields or other fields which were unnecessary for our purposes. Again we began by removing the unnecessary data fields from the dataset.

The following fields were removed:

- STRUCTURE
- STRUCTURE_ID
- STRUCTURE_NAME
- ACTION
- REF_AREA
 - Represents shortened “Reference area” field
- FREQ
- Frequency
 - FREQ and Frequency are always “A” or “Annual”
- MEASURE
- Measure
 - MEASURE and Measure are always “CNCR” or “Cancer incident”
- UNIT_MEASURE
 - Represents shortened “Unit measure” field
- AGE

- Always total
- SEX
 - Represents shortened “Sex” field
- SOCIO_ECON_STATUS
- Socio-economic status
 - Always “_Z” or “Not applicable”
- DEATH_CAUSE
- Cause of death
 - Always “_Z” or “Not applicable”
- CALC_METHODODOLOGY
- Calculation methodology
 - Always “_Z” or “Not applicable”
- GESTATION_THRESHOLD
- Gestation period threshold
 - Always “_Z” or “Not applicable”
- HEALTH_STATUS
- Health status
 - Always “_Z” or “Not applicable”
- DISEASE
- Disease
 - Always “_Z” or “Not applicable”
- CANCER_SITE
 - Represents shortened “Cancer site” field

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- Time period
 - Always blank
- Observation Value
 - Always blank
- DECIMALS
 - Always blank
- Decimals
 - Always blank
- OBS_STATUS
 - Always blank
- Observation status
 - Always blank
- OBS_STATUS2
 - Always blank
- Observation status 2
 - Always blank
- OBS_STATUS3
 - Always blank
- Observation status 3
 - Always blank
- UNIT_MULT
 - Always blank
- Unit multiplier

- Always blank

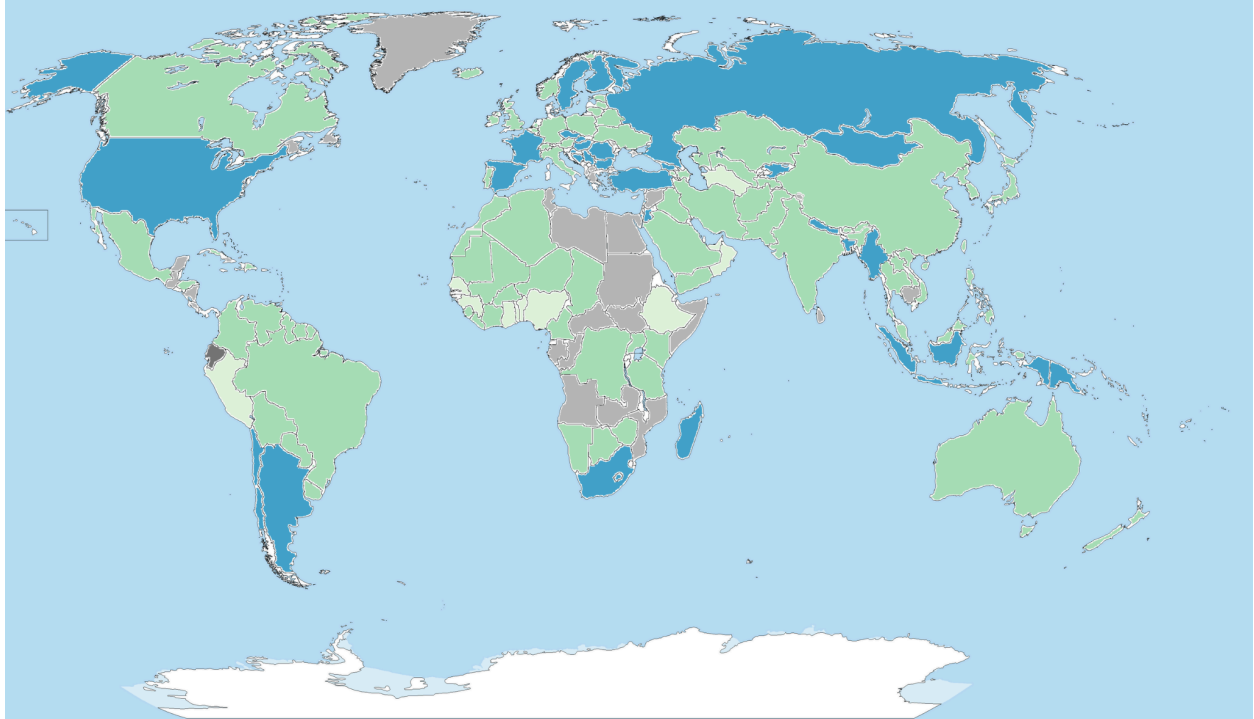
Next we removed all data values which were not respiratory cancers as those were the only data values we were interested in for the visualizations.

Finally we had our final dataset.

Visualisation Design

Preliminary Designs

1 - Daily Smokers Globe Choropleth 1



Design Description

This design depicts a choropleth of the globe with a measure of what percentage of the population of each country is a daily smoker utilizing a color channel to represent the data.

This design's strength is that it allows for the viewer to contextualize the data in an easily readable format as well as to distinguish what portion of the datasets relate to them specifically through their own country of residence and cultural background.

User Interaction

Users can hover or click on a country to see detailed statistics, such as the percentage of daily smokers, trends over the years, and comparisons with global averages. Tooltips or a side panel

can be used to display this information, enhancing user engagement and providing immediate insights.

Additionally the inclusion of a draggable timeline from the years of 2010 to 2022 can be implemented to help show trends in data visually.

2 - Daily Smokers Globe Choropleth 2



Design Description

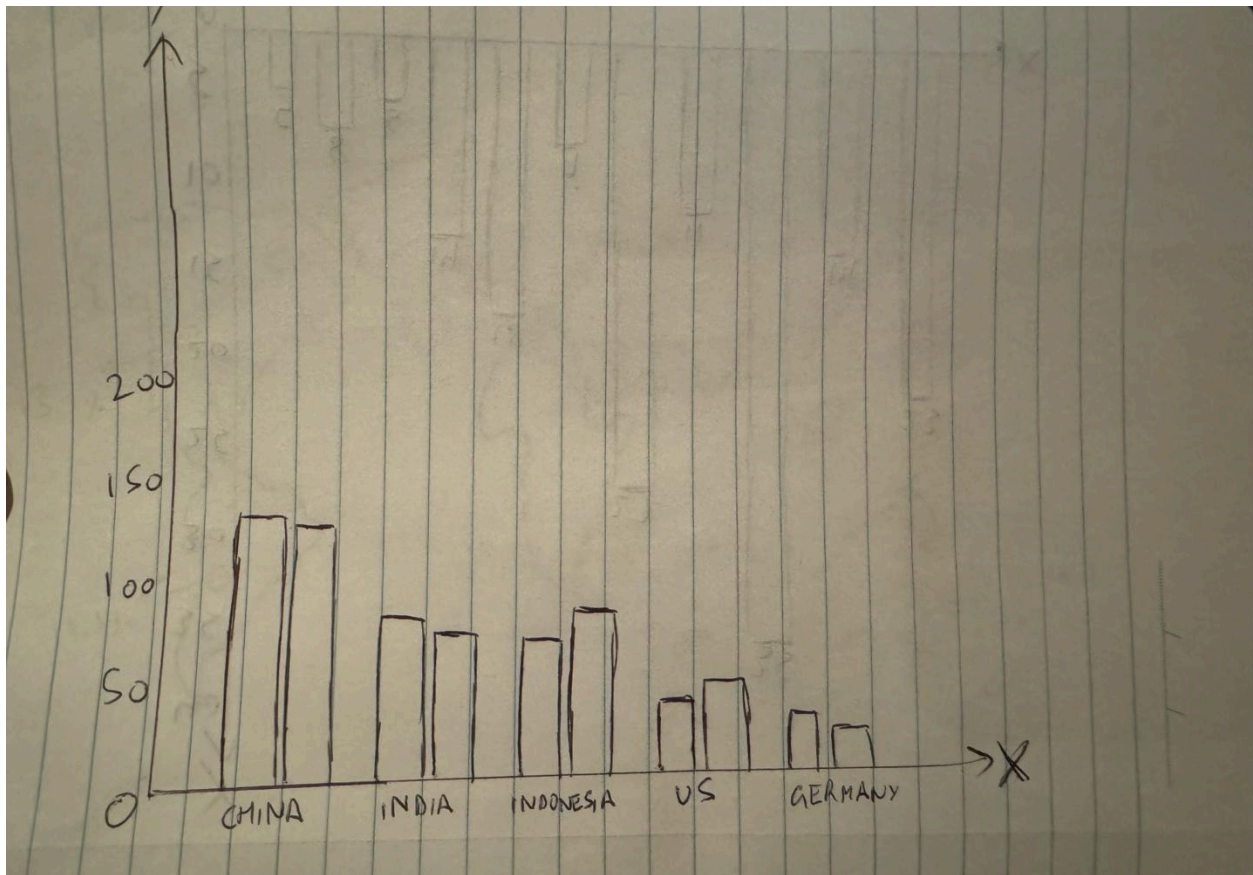
This design is another choropleth, again the data being represented is percentage of the population who are daily smokers; although unlike the previous design data is represented through text measurements for each area with the use of various marks to help distinguish different data points in the dataset.

This can aid in the accessibility by placing less importance on the color selection, the concern of color blindness impacting the designs effectiveness is reduced.

User Interaction

Similar to design 1, a scroll bar could be used to enhance the design by again allowing for viewers to adjust the point in time the data shown is a part of. Similarly to help prevent too much data being shown to the viewer at a single time the design could make use of contextual information such as where the mouse is hovering to show expanded information on specific countries.

3 - Daily Smokers vs Predictions Bar Graph



Design Description

This design shows a grouped bar chart, where each group of bars is the current rates of smoking alongside the predicted increase or decrease.

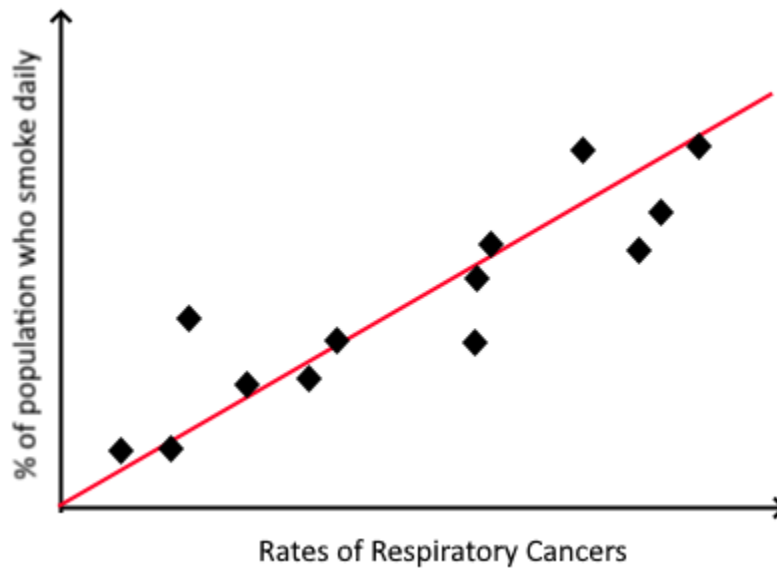
This visualization is useful as it can quickly show the viewer if smoking is becoming more or less popular in their own context.

User Interaction

User interaction can be added to this visualization in several different ways such as:

- By allowing the user to specify what time frame the predicted growth is over.
- By allowing the user to specify which countries they are most interested in.
- By showing the user more detailed information by hovering their mouse over a specific bar.

4 - Daily Smokers - Respiratory cancer rate correlation graph



Design Description

This graph shows the positive correlation between rates of respiratory cancers and the percentage of the population to smoke daily.

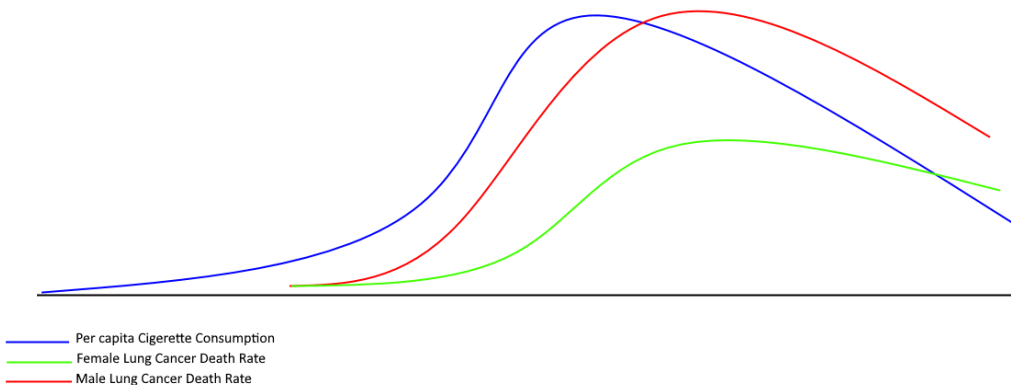
A line of best fit is also included to help with the readability of the design.

User Interaction

Some of the ways which user interaction can improve the visualization is as follows:

- Presenting the user with more information on mouse hover of discrete units.
- Presenting the user with the value of the line of best fit at the mouse location.

5 - Cancer Rates & Cigarette Consumption over Time Combined Line Graph



Design Description

This chart shows the cigarette consumption of a given country as well as the rates of respiratory cancers. By showing the two values on a time scale any rise in cigarette consumption is also followed by a rise in respiratory cancers soon after, which also begins to decline following a decline in cigarette consumption.

This is a useful description as it can help to visually demonstrate the close correlation between rates of smoking and cancers.

User Interactivity

User interactivity for this designed could be included in two primary ways:

One method is allowing the user to “zoom in” to a specific time frame, either through a slider or click and drag controls.

Another method is to find the data point closest to the user’s cursor position and show specific data from this data point or otherwise interpolate between the available data.

Design Iteration

Globe Choropleth

For the primary visualization we liked aspects of both of our preliminary choropleth designs and decided that we wished to combine aspects of the two for the actual visualization.

From Choropleth 1 we incorporated the color scale to depict the % of population in each country which were daily smokers, as well as the pop out text from choropleth 2 detailing the exact data values.

To combine the two in an understandable way we decided that the aspects of choropleth 2 would be shown only when the user moves the mouse over a country with data instead of showing all the information at all times.

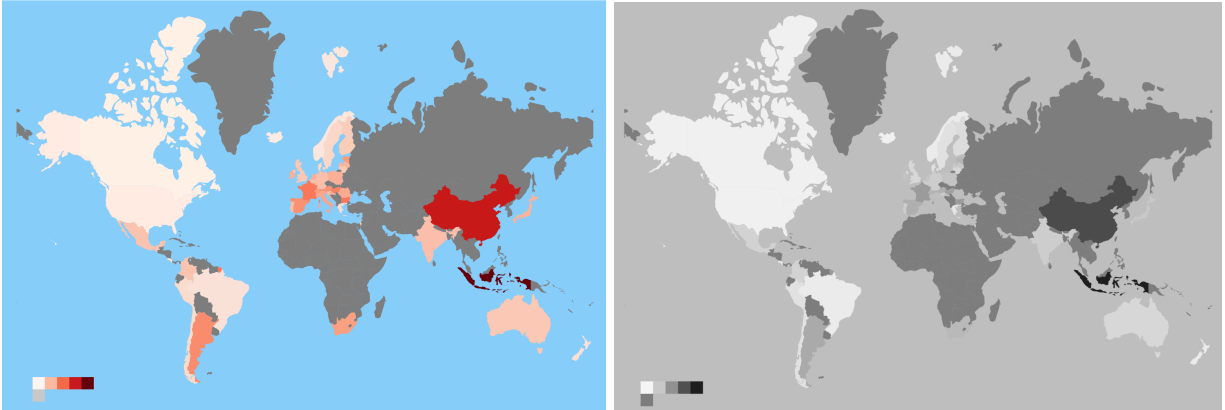
Our goal for this visualization is for it to show the user how smoking rates are in their own countries of interest and the surrounding areas, as well as to act as an interface for the user to select which country to view more in depth.

Initial Implementation

After getting an initial prototype of the choropleth working on the website with all the desired functionality it was important that we iterated on the visualization to ensure that the scale was clear and readable.

In order to get the color scale to function correctly we made use of the d3 “scale chromatic” library extension which adds functionality for linear color scales.

The initial color scheme had some issues in that some parts of the color scale were difficult to discern from countries which we did not have data from when viewed in black and white.

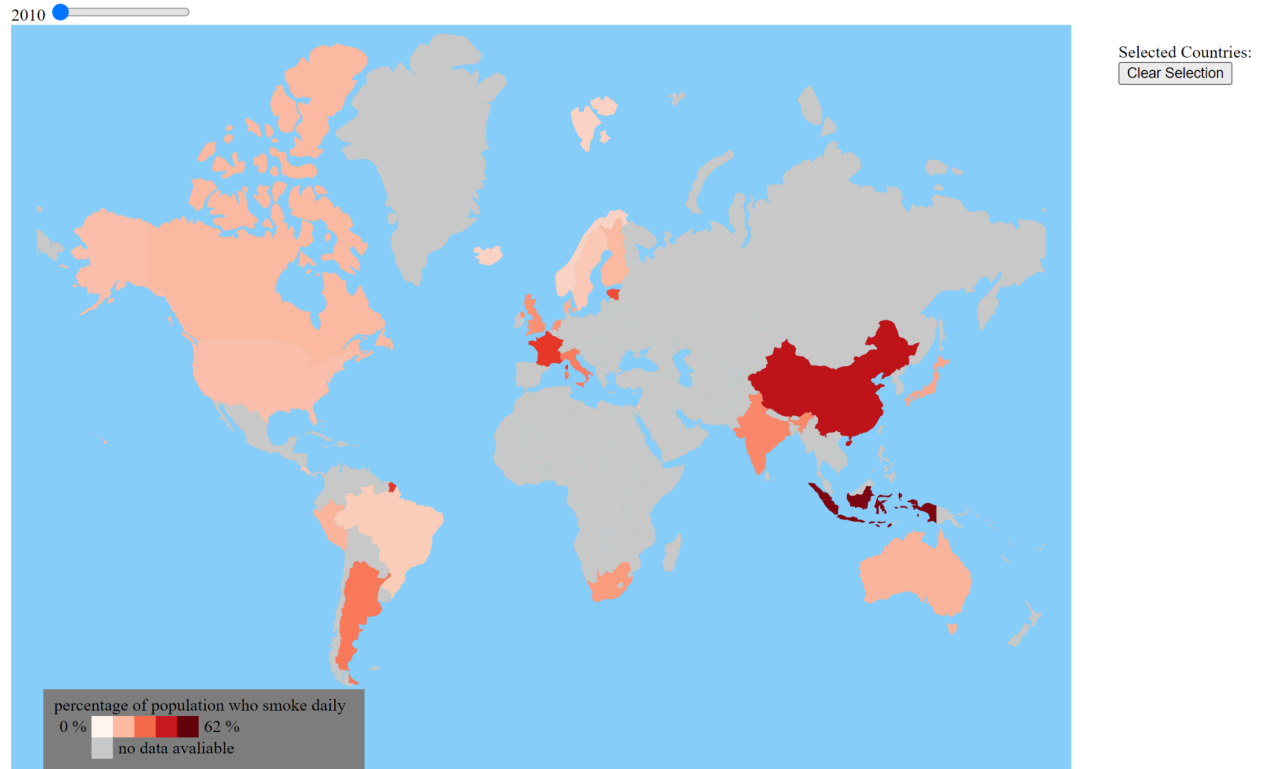


This can be seen especially clearly in the above photos where the color being used for countries missing any data points is very similar to part of the color gradient used to quantify the data.

Another issue of the current iteration is that the borders of countries are difficult to discern both with and without color.

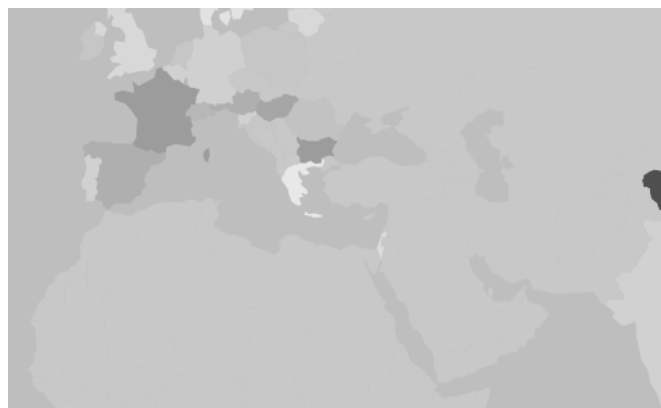
Reviewed Implementation

After further work on the implementation this is what the design looked like:



Firstly a key was added to the visualization to aid in the visualizations readability by showing the data range as well as which color was the “high end” of the data.

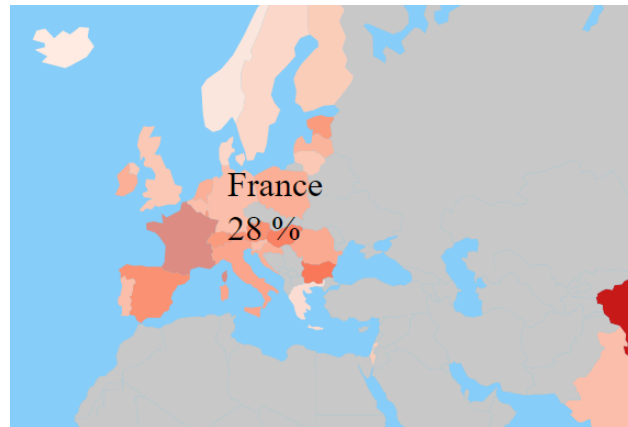
Then, to correct the discussed issue with the color selection of the visualization the color of the areas with missing data was replaced with a lighter shade of gray.



User interaction was added in the form of a slider which allows the user to select a specific point in time for the choropleth to display within the data range (2010-2022).



Another added feature of user interaction was that by hovering the mouse over a country the opacity of that country is decreased to help show its area, as well as a text popup will appear showing the name of the country and the data value.



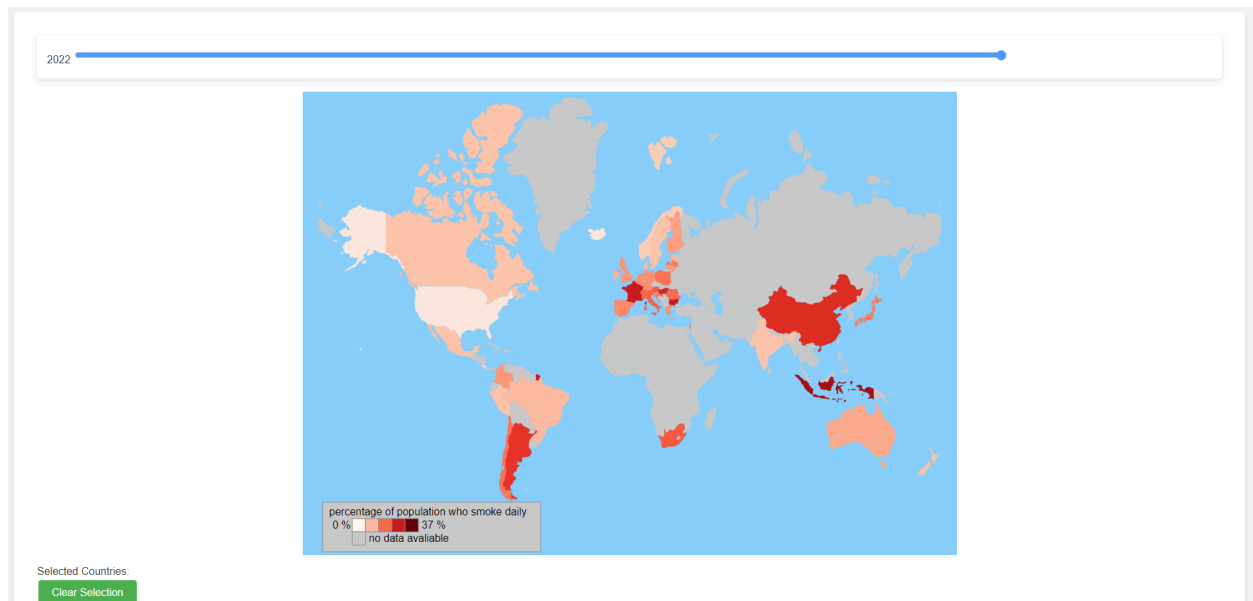
Finally a list of selected countries was added as well as a “clear selection” button to show the user what countries they have selected.



Further Changes

Finally a CSS style sheet was created to make the design more appealing as well as functionality allowing the user to click the listed countries to remove them from the list of selected items.

The color of the background of the key was changed to a lighter shade of gray to help with the visibility of the text, and a thin, darker border placed around it and its color scale.



Finally we added the ability to click on the listed names of countries to remove them from the selected list, as making the background color of the background darken when the mouse moves over it to help indicate that the text is interactable.

Visualization Reflection

We feel as though our choropleth achieves its goals presenting more personal data to the user. Additionally we feel as though our visualization acts well as an interactive element to further enhance the second visualization.

Smoking & Cancer Rates Graph

After the interactive elements of the globe choropleth work began on the line graph.

A large contributing factor for our decision to use this design was that we thought it most clearly shows the correlation between smoking and cancer rates although we would change this.

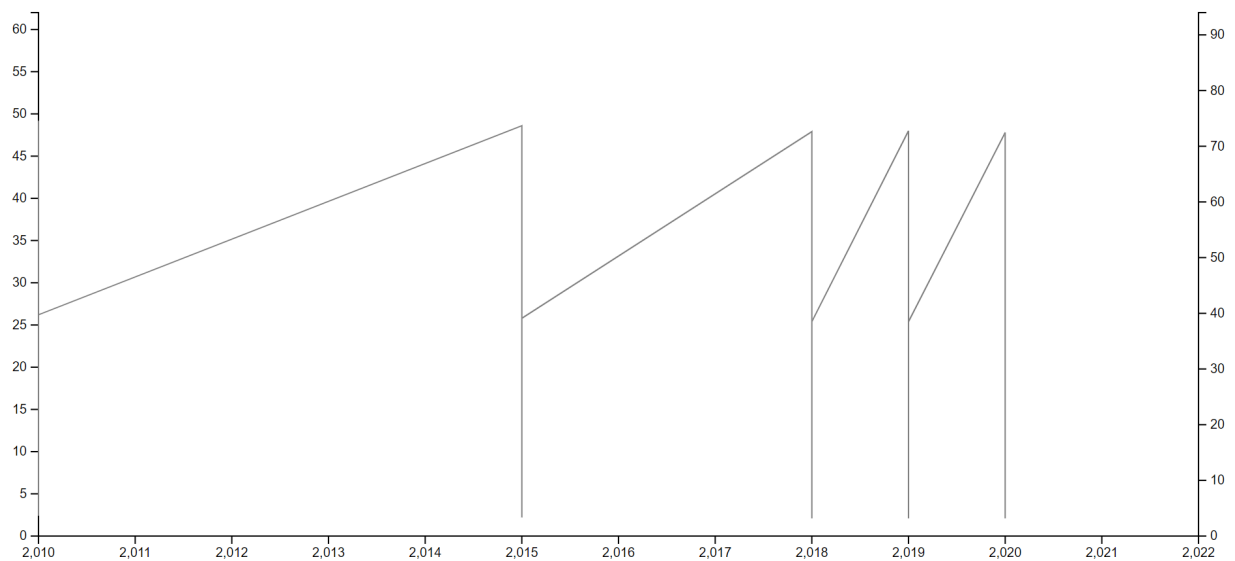
The graph would be primary based on preliminary design 5, although with added features for enhanced user interaction.

The specific data shown would be based on selections made by the user by clicking on the choropleth.

The goals of this visualization is for it to help to show the viewer the correlation of smoking and lung cancers as well as to show the viewer whether smoking rates are trending up or down.

Initial Implementation

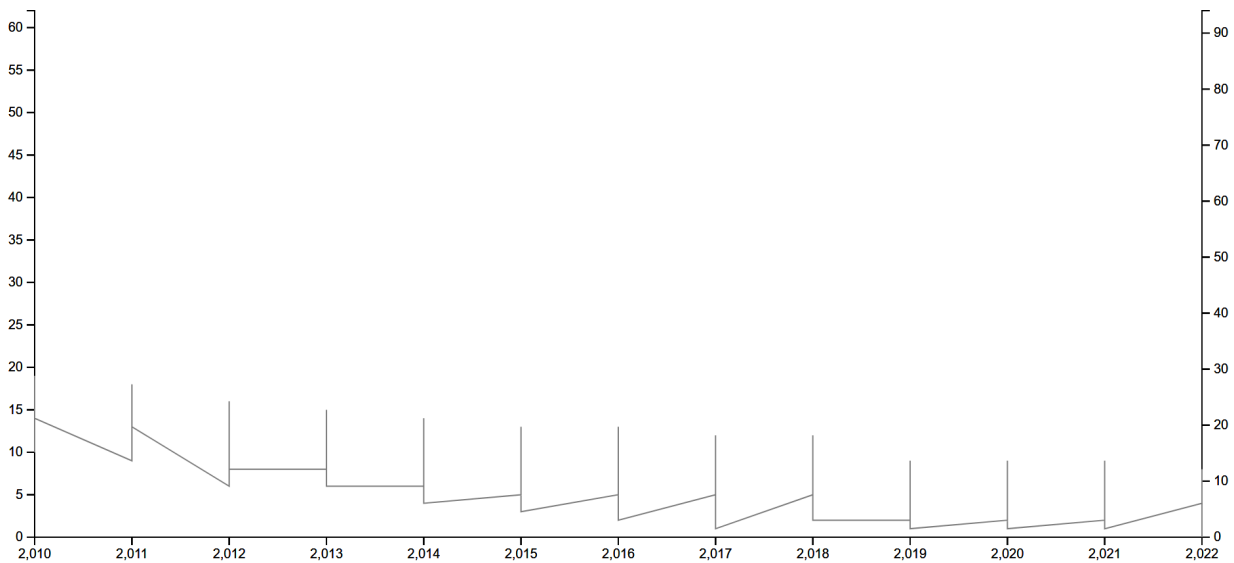
The initial focus at this time was primarily on passing the information from the choropleth's selected countries to the line graph and as such the implementation is rather primitive from the final goal, as such currently only the data of daily smokers is shown on the graph and not the number of respiratory cancer cases, although that data is being loaded.



The cause for the seemingly large points of variance is that this current implementation does not distinguish between female, male, and total populations, as such for each time frame where a data value exists (above in 2010, 2015, 2018, 2019 and 2020 for China), there are three data points being represented in one line. This will be solved by placing each category on its own dataline, in differing stroke styles, and providing toggle buttons to show or hide the desired data.

Showing further countries will be distinguished by color.

Another needed improvement is making the scale's domains adjustable based on the country selected as well as removing the “,” character from the year scale.



Implementing this will aid with readability as it will ensure that datasets with less variability or low magnitude data values (such as Norway pictured above) take up very little of the space of the visualization.

Axis labels are also needed to be added as currently it is difficult to tell what each axis represents; currently the left axis is the value of % of daily smokers, and the right axis is the number of cancer cases per 100,000 people.

Consideration of changing graph type

After discussing with our tutor we agreed with her opinion that a proper correlation graph is inline with our preliminary design 4 would be a better way to represent our data; however this is something we were unable to accomplish with the dataset which we had. This was because unfortunately both datasets did not always have the same data points.

For Example, the data on lung cancers only went until the year 2012, where the daily smokers went until 2022.

Another similar issue was that neither dataset was actually properly “annual”; meaning that both datasets had gaps, and this meant that when joining the two datasets the final values were not always valid.

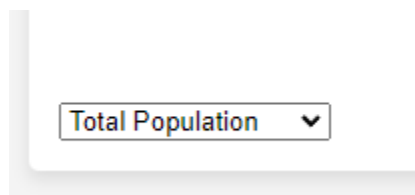
We did consider that one solution to this was to simply join the data sets at the times when each data point is closest to its counterpart from the other dataset, however in the interest of ensuring that our visualization was true to the data being represented we decided that this wasn't a good solution. Especially since in some cases, such as that of China, the only data point we have regarding lung cancer rates is in 2012 which would result in every data point having that same value.

Because of these reasons we returned to focusing on implementing the combined line graph.

Reviewed Implementation

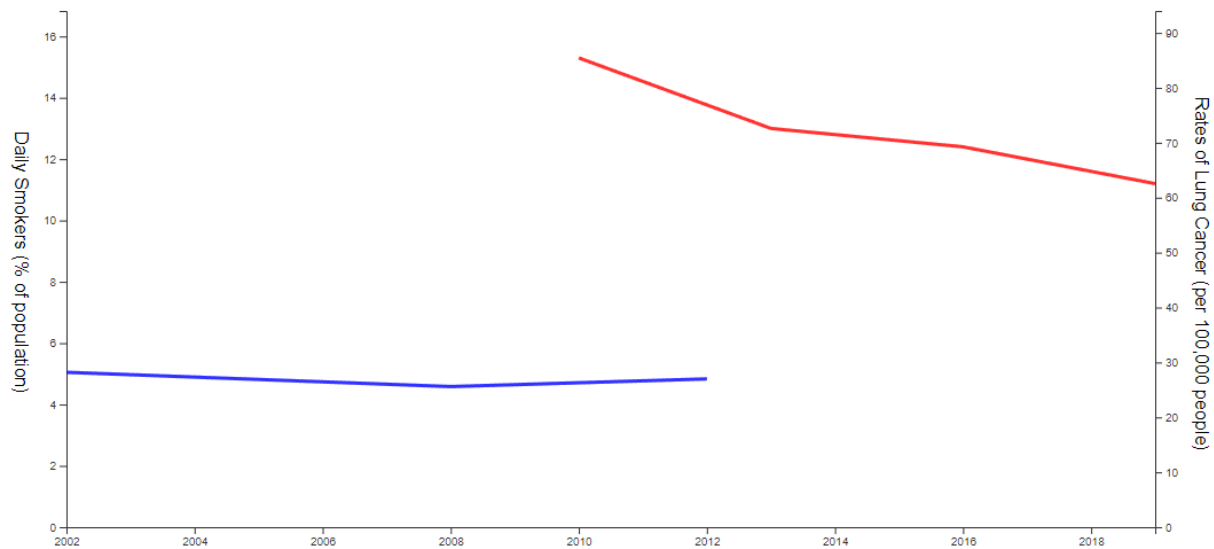
After getting both the dataset on cancers and the dataset on smoking rates to both load we began to split the dataset based on the selected sex of the viewer.

To allow the user to interact with the visualization we made a selection drop down box with three values: Total Population, Male Population and Female Population.

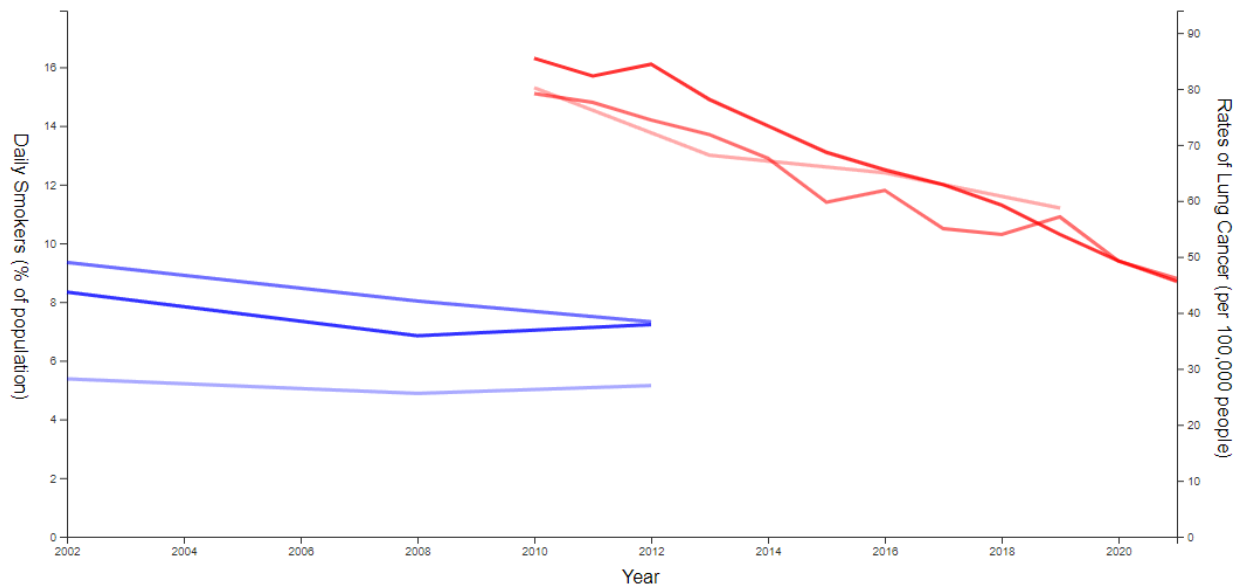


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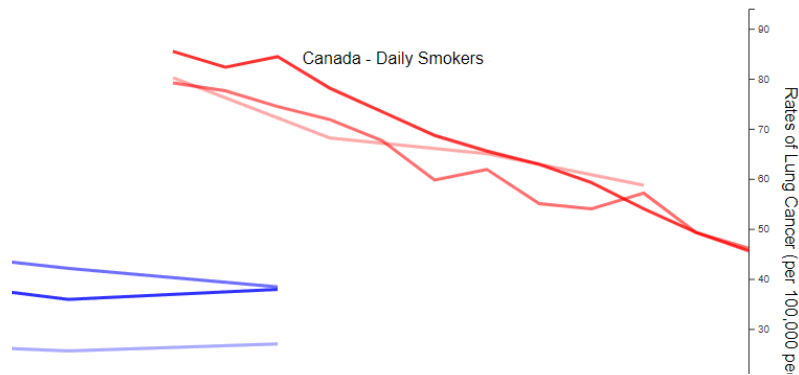
With this working and the two datasets being loaded we then made it so that when a change is made to the list of selected countries the data values of that country are added to the chart.



The next challenge was making the chart display multiple different countries on different lines. To do this we made use of the opacity of the line and set it to a range based on the number of countries selected.



Finally to add clarity to the design we added the feature of the country and data being shown by each line to appear when the mouse is hovered over the line.



Visualization Reflection

Sadly we feel as though this visualization failed to achieve some of its goals. The primary reason we believe this to be issues with our selection of data.

The OECD's data for daily smokers is fairly consistent from when it began being recorded, although still missing some annual data points for certain countries.

The OECD data for cancer rates however is not actually annually recorded and only goes up to 2012, and similarly less OECD member countries have their cancer rates recorded.

This could have been solved if we caught the issue earlier and searched for more supporting data from other credible sources.

Validation

In order to ensure that the interactive world map and timeline depiction meets user needs and upholds tight usability standards, user testing was conducted. This section explains how the results were obtained and shows the results according to the defined requirements.

Preparation Phase

Informed Consent

- **What We Did:** Every participant was made aware of the objectives of the study and the intended use of the data. We gave them the assurance that their answers would be kept private and that they might discontinue at any moment if they want to.
- **Why It Matters:** This process ensured participants were fully informed about what their involvement entailed and reassured them about the security and privacy of their data.

Demographic Questionnaire

- **What We Asked:** Before starting, everyone filled out their form with some basic info like age, gender, job, smoking status, and how much they've worked with data visualizations before.
- **Why It Matters:** This allowed us to see whether different types of users interacted with the visualization in different ways, which may have an impact on how they perceive and utilize the data.

Testing Phase

User Tasks

- **Tasks Given:** A series of tasks was distributed utilizing visualization, including the comparison of smoking rates and identification of the country with the highest prevalence of smokers. No guidelines were given on operating the features to showcase the ease of self-navigation.

- **Goal:** This allowed us to determine whether or not users found the timeline and map difficult to use.

Questionnaire

- Question 1: How user-friendly did you find the world map's navigation to be? (Exceptionally intuitive, Fairly intuitive, Lacking intuition)
- Question 2: How easy was it to use the timeline slider? (Very Easy, Somewhat Easy, Not Easy)
- Question 3: Was the information presented clearly and understandably? (Yes, No)
- Question 4: How satisfied are you with the ability to compare data across different countries? (Very Satisfied, Somewhat Satisfied, Not Satisfied)
- Question 5: Did you encounter any issues while using the visualization? If yes, please describe.
- Question 6: Do you have any suggestions for improving this visualization?

Participant 1

Age 23, Male, Software engineer, has never smoked

- **Q1: Exceptionally Intuitive**
 - Found the map easy to navigate without needing extra guidance.
- **Q2: Very Easy**
 - Had no trouble using the timeline slider to select years.

- **Q3: Yes**
 - The level of information clarity was great, and the data was easily comprehensible.
- **Q4: Very Satisfied**
 - Really pleased with how simple it was to compare smoking rates between nations.
- **Q5: No issues.**
 - Experienced a smooth interaction with no technical problems.
- **Q6: Maybe add more demographic details in the tooltip.**
 - Suggests including age and gender breakdowns in tooltips for richer insights.

Participant 2

Age 21, Male, Aditya Bajaj, Student, partially smoked

Q1: Somewhat Intuitive

- Generally found the map easy to use but needed some time to familiarize.
- **Q2: Somewhat Easy**
 - Found the timeline slider usable but felt it could be improved for finer control.
- **Q3: Yes**
 - Recognized the information provided, but feels it could have been delivered in a more interesting way.
- **Q4: Somewhat Satisfied**
 - Thought the experience could be more interactive, overall, I'm happy with the usefulness.

- **Q5: Sometimes the slider jumps too far with a small movement.**
 - Reported that small movements on the slider resulted in large changes in the year selection.
- **Q6: Improve the sensitivity of the timeline slider.**
 - Recommends making the slider less sensitive to ensure more accurate selections.

Participant 3

Age 49, Male, Businessman, never smoked

- **Q1: Somewhat Intuitive**
 - Found the map fairly easy to use but noted some initial confusion.
- **Q2: Very Easy**
 - Had no issues with using the timeline slider to choose different years.
- **Q3: Yes**
 - Information was clear and well-presented, making it easy to digest.
- **Q4: Very Satisfied**
 - Highly satisfied with the ability to easily compare smoking rates across countries.
- **Q5: No significant issues.**
 - Did not encounter any major problems while using the visualization.
- **Q6: Adding a feature to view trends over time for a selected country directly on the map would be great.**
 - Would appreciate a feature that allows direct viewing of time trends for selected countries on the map itself.

Participant 4

Age 22, Male, Software Engineer, smokes regularly

- **Q1: Very Intuitive**
 - Found the map straightforward and simple to interact with.
- **Q2: Not Easy**
 - Experienced difficulty with the timeline slider, finding it hard to control precisely.
- **Q3: Yes**
 - The information was clear, but the physical presentation could be improved.
- **Q4: Somewhat Satisfied**
 - Satisfied with the functionality but felt that the visual experience could be enhanced.
- **Q5: The text is a bit small on my device.**
 - Found the text size too small to read comfortably on their device.
- **Q6: Increase font size and maybe make the website more mobile-friendly.**
 - Suggests larger text and a design that is more responsive on mobile devices for better accessibility.

Participant 5

(Survey conducted initially modifying our visualization)

- **Q1: Not Intuitive**
 - Struggled to navigate the map and understand how to interact with it.
- **Q2: Not Easy**
 - Found the timeline slider difficult to manipulate, affecting their ability to view data.

- **Q3: No**
 - Faced challenges in understanding the data due to unclear visual representations.
- **Q4: Not Satisfied**
 - Unhappy with how hard it was to make comparisons due to usability issues.
- **Q5: It's difficult to understand the color scale for smoking rates.**
 - Had trouble interpreting the color scale used to denote different smoking rates.
- **Q6: Use a clearer legend and maybe interactive tutorials.**
 - Suggests a more detailed legend and tutorials to help users understand how to read the map.

These thorough answers provide a thorough picture of each user's experience, highlighting both their strong points and their potential for development. To improve usability and better satisfy user needs, the visualization tool must be refined with the help of this organized feedback.

Analysis of Responses

- **Intuitiveness and Ease of Use:** The majority of participants appreciated the map's user-friendly interface, although views on its practicality differed. While the overall design is considered simple to navigate, some users could benefit from additional navigational aids or resources.
- **Clarity of Information:** One participant found it difficult to comprehend the visual data display because the visual scales were not clear. This emphasizes the need for more understandable legends and maybe interactive tools to support users in making better sense of the data.

- **Comparison Feature Satisfaction:** Most participants were happy with global data comparison. But the user feedback also indicates that what consumers actually want is greater gamification in the comparative research tools.
- **Technical Issues and Improvements:** Text should be easier to read, and information more interesting to consume, are two very common requests. The participants instead expressed that they would have liked to have had a great many more features to build out the data and make it easier to consume and visually more appealing.

Recommendations for Improvement

1. Enhance Information Clarity:

- **Action:** We updated the legends with active tooltips that provide a deeper explanation of the data points and made them more logical. Users will have a better understanding of the data metrics and color scales as a result.

2. Improve Text Readability:

- **Action:** In order to improve readability through CSS and make the tool more accessible and user-friendly, we increased the font size and adjusted the contrast. This will guarantee that all users can easily read the content.

2. Mobile-Friendly Design Enhancements:

- **Action:** The entire graphic is well-optimized for portable use. To ensure a consistent user experience across all platforms, responsive design features adapt layout and interactivity dependent on the device being used.

Conclusions

Our entire project is constructed to create an interactive visualization tool to help better understand worldwide smoking trends and their health consequences. Our visualization, combining dynamic global maps, timeline sliders and detailed demographic breakdown, reveals important characteristics about the habits of smoking in different geographies and over time.

Achievements:

- **Enhanced Data Accessibility:** This enabled a broad audience that included researchers, health professionals and the general public to quickly access and interpret complex data. This is now made possible to communicate with data through graphical ways and it facilitates the understanding of the pace of smoking.
- **Informed Decision-Making:** Overall, our visualization has shown to be quite helpful for medical professionals in determining regions with high smoking prevalence and examining patterns over time. This data is essential for creating focused health programs and informing communities about the dangers of smoking.
- **Public Health Impact:** Additionally, our visualization serves as a great tool for educators and motivation of persons thinking about quitting by simply using the interactivity of the data to bring the real impact of smoking on a daily basis. It highlights the tangible benefits of quitting smoking for better health of the individual.

Future Directions:

Looking ahead, there are several enhancements that could be made to increase the tool's effectiveness and reach:

- **Expansion to Other Risk Factors:** Adding more risk factors linked to smoking, such heart disease and long-term respiratory disorders, to the graphic could give an improved understanding of the negative effects smoking has on one's health.

- **Mobile Optimization and Accessibility:** Improving the tool's accessibility and compatibility for mobile devices would guarantee that a larger user base can utilize it, especially in areas where mobile internet connection is widespread.

In conclusion, this visualization tool can provide richer insights into the global trends in smoking, making it a valuable resource for the general population and public health professionals alike. Through its interactive design, it has stimulated more intelligent debates and decision-making that influence the anti-smoking health regulations as well as hundreds of thought processes that help individual choices about health.

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