Barriers to Green Living: Insights from 2018 and 2021 Toronto Climate Perception Surveys*

Uncovering What Stops Sustainable Behaviors and How Communities Can Overcome Them

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This study examines the relationship between demographic factors—age, education, and self-reported knowledge of climate change—and individuals' likelihood of engaging in climate-friendly behaviors. The analysis reveals that younger people and those with higher levels of education are more likely to adopt sustainable actions such as reducing car use and purchasing electric vehicles. However, the study also highlights that financial barriers and limited access to resources remain significant obstacles for broader climate action. These findings underscore the importance of tailoring policies and interventions to make sustainable behaviors more accessible to diverse demographic groups, promoting wider participation in efforts to combat climate change.

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*Code and data are available at: https://github.com/LexiKnight/toronto_climate/tree/main.

1 Introduction

Climate change is one of the most urgent challenges we face today. From rising temperatures to extreme weather events, the planet is already feeling the consequences of human-driven environmental change (Intergovernmental Panel on Climate Change (IPCC) 2023). Yet, despite widespread awareness of these risks, many people still struggle to adopt behaviors that could help mitigate climate damage (Gifford 2011). This gap between knowledge and action is a central puzzle that governments, communities, and organizations are trying to solve (Kollmuss and Agyeman 2002). If we are to tackle this crisis effectively, we need to better understand what stops people from acting, and how we can motivate change (Steg 2014).

This paper examines how specific factors—such as age, education, and self-reported knowledge of climate change—shape people's willingness to engage in climate-friendly actions (Schultz 2002). By analyzing data from a 2018 survey (City of Toronto 2024), we explore the connection between demographic characteristics and behaviors like reducing energy consumption, using greener transportation, and lowering waste. The survey also delves into what prevents people from adopting these behaviors, uncovering obstacles like cost, convenience, and skepticism about the power of individual actions (Gifford 2011). With this analysis, we aim to uncover how these factors interact and what they mean for efforts to encourage sustainable choices (Stern 2000).

The heart of this study is to measure how age, education, and knowledge of climate change influence the likelihood of adopting certain behaviors. We found that younger individuals and those with higher education levels are more likely to engage in actions like reducing car usage and adopting plant-based diets (Fulton 2022). However, older individuals are more inclined to take steps like cutting down on household energy use (Lee 2019). Beyond these demographic trends, we also discovered that barriers such as financial cost and doubts about the effectiveness of individual efforts often hold people back from taking action (Kollmuss and Agyeman 2002). These findings suggest that a "one-size-fits-all" approach to climate communication won't work. Instead, targeted strategies that consider demographic differences are essential for driving meaningful engagement (Steg 2014).

Understanding these patterns is crucial for crafting effective climate policies. By identifying which groups are more likely to act and which face significant barriers, we can better design interventions that speak to people's concerns and motivations (Stern 2000). The implications of this study go beyond simply knowing what people think about climate change—they offer a roadmap for shaping messages and policies that could shift behavior on a larger scale (Fulton 2022).

The remainder of this paper is structured as follows: Section 2 details the data and methods used in our analysis. Section 3 describes how we assess the factors influencing climate-friendly behaviors across demographic groups. **?@sec-results** highlights key differences in behavior based on age, education, and knowledge of climate change. **?@sec-discussion** discusses the findings, addresses the study's limitations, and suggests directions for future research. Section 6 concludes with a summary of the key takeaways and actionable recommendations for enhancing climate action engagement. Finally, Section A contains supplementary material.

2 Data

The primary data source for this project is the Climate Perception Study dataset, provided by the City of Toronto via the Open Data Toronto platform (City of Toronto 2024). This dataset offers insights into public perceptions of climate change in Toronto and was accessed from Open Data Toronto ("Open Data Toronto" 2024) on 6 November 2024. ## Software and R-packages This project was conducted using the statistical software `R` (R Core Team 2023). Data cleaning and manipulation were primarily facilitated by the `tidyverse` package (Wickham, Averick, et al. 2024), which encompasses various essential tools. Within this suite, `dplyr` (Wickham, François, et al. 2024) was employed for data manipulation tasks such as filtering, summarizing, and joining datasets, while `readr` (Wickham, Hester, et al. 2024) provided efficient functionality for reading and writing rectangular text data. Specifically, the `write_csv` function from `tidyverse` was used to save the raw 2018 dataset. To handle Excel files, we incorporated the `httr` package for downloading files directly from online sources and `readxl` (Wickham and Bryan 2024), which enabled us to read Excel files seamlessly. Additionally, the `openxlsx` package was utilized to create a new Excel workbook with multiple sheets, allowing us to store the 2021 dataset in a structured format.

The `arrow` package was employed to handle large datasets efficiently, ensuring smooth data processing, while `forcats` was used for reordering factor levels to facilitate more insightful analyses and visualizations. In terms of data tidying, the `tidyr` and `stringr` packages allowed us to reshape and clean the data by managing character strings and handling missing values. For the final documentation and report generation, the `knitr` package was instrumental in integrating R code and outputs into a cohesive and reproducible report format. This suite of R packages collectively enabled us to conduct thorough data management, manipulation, and analysis, ultimately contributing to the successful completion of the project.

2.1 Methodology

2.1.1 Data Collection

The data for this analysis comes from two surveys commissioned by the City of Toronto to assess residents' perceptions of climate change and their willingness to take community action. In 2018, Environics Research conducted n=404 online interviews with Toronto residents aged 18 and older between October 11 and October 18. Each interview lasted approximately 10 minutes. The sample was drawn from an online panel, with quotas set by region, age, and gender to reflect the city's population based on the 2016 Census, and minor weighting was applied. Due to the non-random nature of the online survey, no margin of error was assigned, though a random sample of this size would typically have a margin of ± 4.9 percentage points, 19 times out of 20.

In 2021, a second survey was conducted by Ipsos, a global market research company. This survey included n=1,400 Toronto residents aged 18 and older and used a mixed-method approach. The sample consisted of 1,000 respondents from an online panel, 300 recruited via cell phone and landline, and 100 online interviews conducted in Mandarin, Cantonese, and Punjabi. This combination of methods aimed to enhance the survey's representativeness. For analysis, Version 2 of the 2021 dataset, which presents responses in a numeric format, was used.

2.1.2 Data Analysis

The primary focus of this analysis was the 2018 dataset, examining six key variables: age, education, extent informed, likelihood to take action, reasons for not taking action, and the best method for delivering information regarding climate change action. I analyzed these variables at the individual level in the 2018 dataset by calculating the percentages within each category, which provided a clear understanding of the distribution and trends within the population.

In addition, I compared the 2018 dataset to the 2021 summary data to assess changes over the years. By calculating the percentage distribution for each variable in both years, I was able to identify any shifts in public awareness, engagement, and preferences regarding climate change action. This comparison revealed whether there have been notable changes in factors like the public's level of information about climate change, their likelihood to take action, and their preferred communication methods.

This two-step approach allowed for a comprehensive understanding: a detailed exploration of the 2018 data combined with a broader comparison of trends between 2018 and 2021.

2.2 Features

2.2.1 Age

2.2.1.1 Individual 2018

Figure 1 illustrates the age distribution of survey respondents in 2018. The histogram displays the frequency of respondents across different age groups, with the x-axis representing age intervals and the y-axis indicating the number of respondents within each interval. The distribution is relatively balanced, with two noticeable peaks around the 30–40 and 50–60 age ranges, suggesting these age groups are the most represented in the survey.

The vertical dotted lines in the figure highlight key statistical measures: the green dotted line represents the median age, while the blue dashed line indicates the mean age of the respondents. Both measures fall near the center of the distribution, reinforcing the observation that the sample is primarily composed of middle-aged individuals. Although the distribution appears fairly symmetrical, there is a gradual decline in respondent frequency after the age of 60, with fewer participants aged 90 and above, indicating a smaller representation of older individuals.

Overall, Figure 1 provides valuable context for understanding the demographic composition of the survey sample. The predominance of middle-aged respondents may influence the interpretation of survey results, particularly if age is a factor in attitudes, behaviors, or preferences related to the study.

2.2.1.2 Comparison 2018 to 2021

(**table-one?**) illustrates the different age ditribution for 2018 and 2021 surveys. The major difference is that there was greater representation of younger inviduals ranging from 18 to 23 in 2021 compared to 2018. The remaining age groups were not very different.

This table highlights the age distribution of survey respondents in 2018 and 2021.

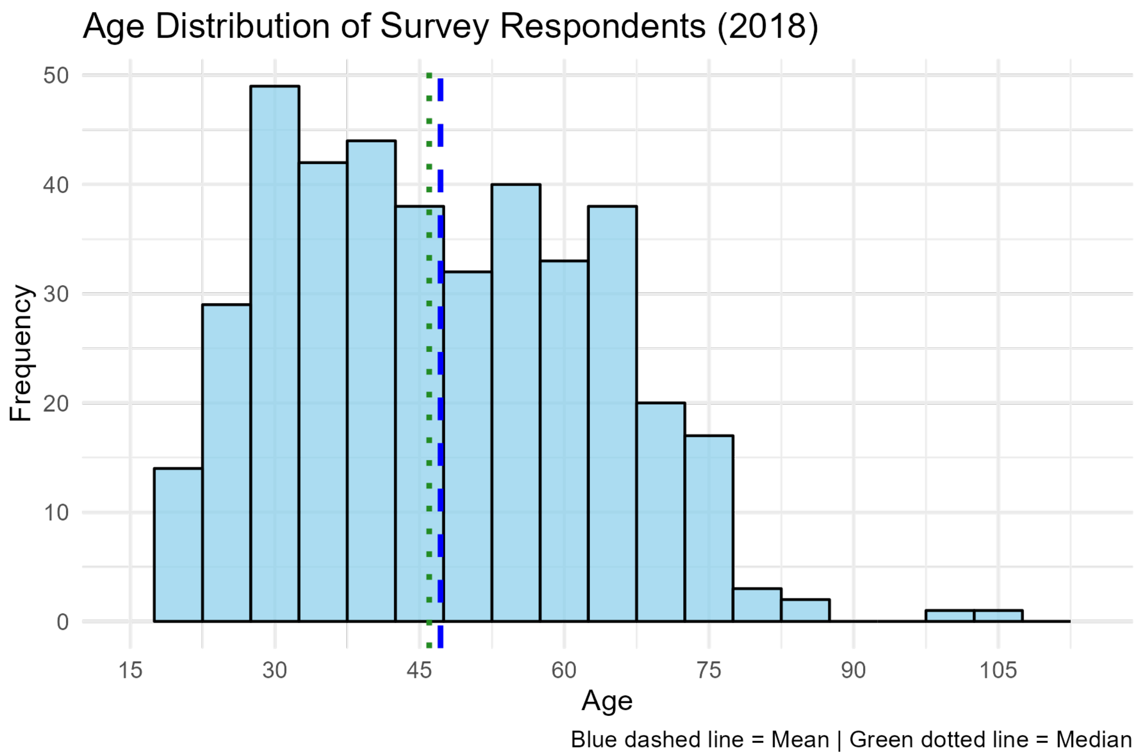

Figure 1: The histogram shows the distribution of age given the 2018 survey respondents.

Age Group	2018 Percentage	2021 Percentage
18-23	4	11
24-39	33	30
40-55	30	26
56+	33	33

2.2.2 Highest Level of Education Completed

2.2.2.1 Individual 2018

Figure 2 illustrates the distribution of survey respondents by their highest level of education attained. The most frequently reported education levels are "Completed undergraduate degree" and "Post graduate/professional school," with both categories having a noticeably higher frequency compared to others, indicating a well-educated respondent population. In contrast, fewer respondents reported "Some community college, vocational, trade school" and "Completed community college, vocational, trade school," suggesting these levels are less common among participants. Additionally, a small portion of respondents preferred not to disclose their education level. This distribution highlights a skew toward higher educational attainment within the sample, which may influence responses related to socio-economic factors and other survey topics.

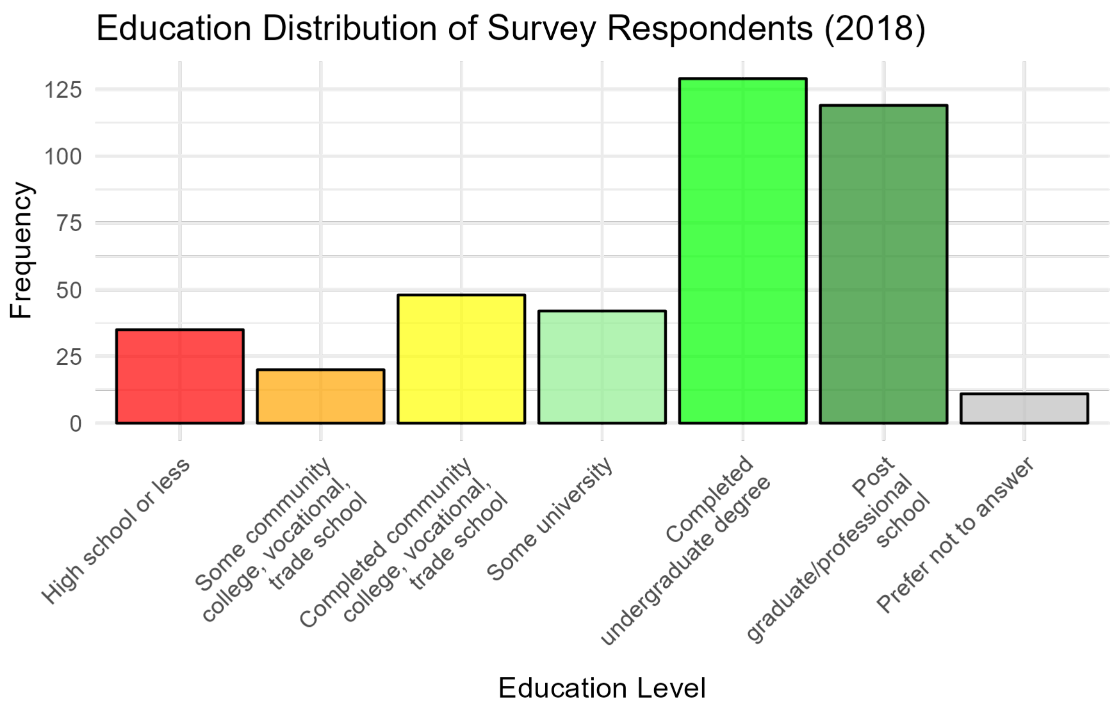

Figure 2: The histogram shows the distribution of education levels of 2018 survey respondents.

2.2.2.2 Comparison 2018 to 2021

(**table-two?**) illustrates respondant education level in 2018 and 2021 respectively. Please note, the categories of education level are different for 2018 and 2021 as these were different surveys

Education Level	2018 Percentage	Education Level
High school or less	9	Less than high school
Some community college, vocational, trade school	5	High School or equivalent
Completed community college, vocational, trade school	12	Degree or diploma from a college
Some university	10	Graduate or professional degree (
Completed undergraduate degree	32	Prefer not to answer
Post graduate/professional school	29	DK/NS
Prefer not to answer	3	

and categories were updated in 2021. Despite this, we are still able to make comparisons. Individuals with high school diplomas or less account for 9 for 2018 and 38 for 2021 (addition of less than highs school and high school or equivalent categories). This could indicate that the younger population was included more in the 2021 suvey or that less education individuals were surveyed. Additionally, its not super clear howver those with a post graduate or professional degree accounted for 29 percent in 2018 and 35 percent in 2021. This illustrates that more educated inviduals responded to the 2021 survey.

This table highlights the education distribution of survey respondents in 2018 and 2021."

2.2.3 Extent Feel Informed

2.2.3.1 Individual 2018

Figure 3 depicts the distribution of self-reported climate change knowledge among survey respondents in 2018. The majority of participants identified as "Very informed," making this the most prevalent category by a significant margin. A moderate number of respondents reported being "Not very informed," while a smaller yet noticeable group described themselves as "Extremely informed." In contrast, the categories "Not at all informed" and "Not very informed" have the lowest frequencies, with "Not at all informed" being particularly rare. This distribution suggests that most respondents possess a relatively high level of awareness about climate change, with very few indicating a lack of knowledge on the topic.

2.2.3.2 Comparison 2018 to 2021

(**table-three?**) illustrates the self-reported level of extent inviduals feel informed about climate change and climate action for 2018 and 2021. In 2018, the large marjority of individuals say they are very informed with 60 percent and the follwoign category is not very informed with 27 percent. In 2021, The majority of inividuals also say they are very informed but to a lesser degree with 48 percent and this is closely followed by only a little informed with 37 percent. There is a trend that invidiusls in 2018 reported greater levels of knowldege about

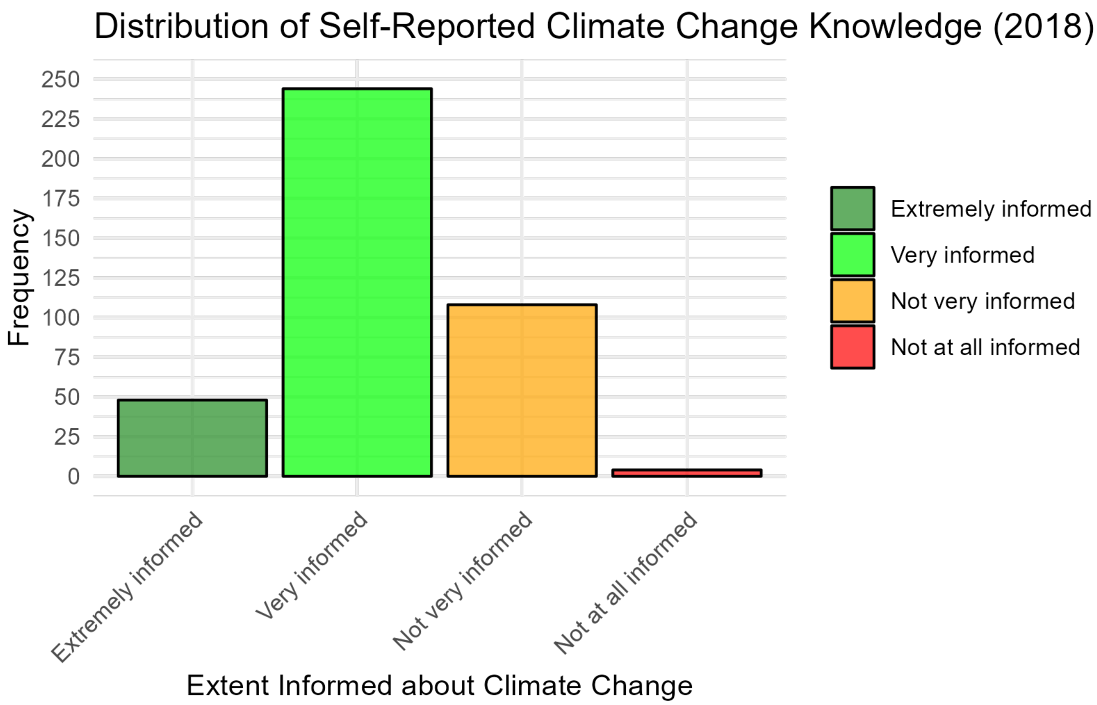

Figure 3: The histogram shows the distribution of self-reported climate change knowledge among 2018 survey respondents.

Extent Informed	2018 Percentage	Extent Informed	2021 Percentage
Extremely informed	12	Extremely informed	13
Very informed	60	Very informed	48
Not very informed	27	Only a little informed	37
Not at all informed	1	Not at all informed	2

climate change whereas 2021 illstrates a more even split between very informed and only little informed, portraying that fewer individuals have adequate knowledge about climate change.

This table highlights the extent feel informed distribution of survey respondents in 2018 and 2021.

2.2.4 Best Mode of Delivery

2.2.4.1 Individual 2018

The analysis of the best method for delivering climate change information portrayed in Figure 4 revealed that the majority of individuals in the 2018 dataset preferred receiving information firstly from advertising campaigns with about 55 percent, newsletters with about 52 percent, followed by the toronto website wiht about 46 percent. On the other side of the spectrum, few said they were uninterested in receiving climate action information with about 5 percent, about 12 percent indicated twitter and then 17 percent mentioned instagram. Overall social media platforms Facebook, Instagram and Twtitter were less popular methods of communciation. This could be because the survey only included individals over the age of 18. Moreover, the median sample was in the 40s.

2.2.4.2 Comparison 2018 to 2021

(**table-four?**) compares responses from 2018 and 2021 surverys regarding the best method of delivering information on climate change and climate action. Aside from the additon of four options to the 2021 survey, both surveys questions are the same. The leading category for 2018 is advertising campaigns with 55 percent, closely followed by newsletter emails with 52 percent and the Toronto website with 46. The 2021 survey illustrates a consistent trend with the same platforms as the top method of delivering information, specifically the Toronto website with 44 percent, then enewsletter emails with 43 percent and advertising campains at 42 percent. These top methods of communciation are more evenly spread out than the 2018 survey results. Social media platforms namely twitter, facebook and instagram all increased in the 2021 survey. Notable decreases in term of percentage from 2018 to 2021 include events, enewsletter emails, advertising campaigns, brochures and pamphlets. The new category of BetterHomesTO.ca webiste accounts for 15 percent of votes for the 2021 survey.

This table highlights the prefered method of communication of survey respondents in 2018 and 2021.

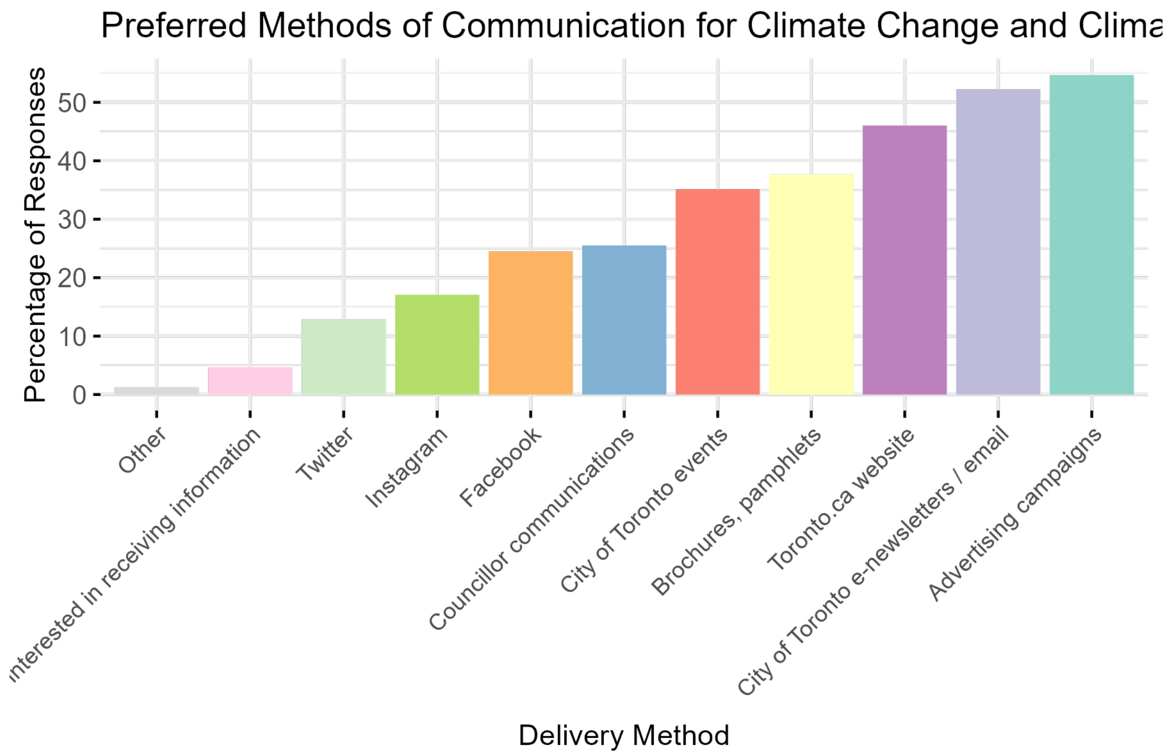

Figure 4: The stacked bar plot illustrates the preferred methods of communication for receiving information about climate change and climate action.

Communication Method	2018 Percentage	Communication Method	2021 Percentage
Toronto.ca website	46	Toronto.ca website	44
Events	35	City of Toronto events	31
Twitter	13	Twitter	17
Facebook	25	Facebook	26
Instagram	17	Instagram	25
Enewsletter / email	52	City of Toronto e-newsletters / email	43
Councillor communication	25	Councillor e-newsletters	24
Advertising campaigns	55	Advertising campaigns	42
Brochures / Pamphlets	38	Printed or online brochures, pamphlets	31
Other	1	BetterHomesTO.ca website	15
Not interested	5	Not interested in receiving information	8
		Mail/ letter	1
		Nothing	1
		Other	0
		Don't know	0

2.2.5 Likelihood Taking Action

2.2.5.1 Individual 2018

The likelihood of taking action against climate change was explored by assessing individuals' intentions and behaviors. Figure 5 illustrates self-reported likelihood of taking certain actions that minimize climate change effects. On the x-axis, we have the nine different climate actions and on the y-axis is the percentage. The stacked bar chart allows understanding of how likely individuals are to take part in the given actions. Sorting waste into the correct bins is the action that most individuals are doing right now, accounting for 60 percent whith 24 percent saying they are very likely to take part in this action. The next most prominent actions are walking or cycling short distances, reduce hydro usage, reduce waste and home improvements. 40 percent of invidiuals report walking or cycling when traveling shorter distances in the city with 22 percent reporting they are very likely. However, 7 percent say they are very unlikely to change their method of transportation. Reducing the amount of energy and water use is already done by 36 percent and very likely for 29 percent only a mere 3 percent is very unlikely. Reducing personal waste such as contributing to repurposing used products has similar percentages to responses for reducing hydro but even fewer individuals that report they are very unlikely to take action. Similarly, the likelihoods for making home improvements for energy efficiency such as energy-efficient appliances, programmable thermostat, LED lightbulbs, green or cool roof. In contrast, the action where the least number of individuals are contributing to is the investment of an electric or hybrid vehicle over gas-powered vehicles with only 8 percent who currently have an energy efficient vehicle. While 19 percetn are very likely to make this switch, 14 percent say they are very unlikely. This illustrates that buying an electric or hybrid vehicle is action the least number of individuals are willing to invest in despite gas-powered vehicles being a major contributor to greenhouse gases. This action has a huge impact on the environment and yet 41 percent of this sample say they are unlikely to change! The second action that individuals are most unlikely to engage in is eat less meat by incorporating more plant-based foods in their diet with 12 percent very unlikely and 23 percent somewhat unlikely. Only 23 percent are already consuming meat alternatives. Vegans greenhosue gas emissions are on average 37% lower than those who eat meat frequently.

3 Model

The goal of our modelling strategy is twofold. Firstly, we aim to predict the likelihood of individuals engaging in climate-friendly actions based on demographic variables, specifically age and education. The actions considered include investing in electric or hybrid vehicles, making home improvements (such as using LED lightbulbs), adopting meat alternatives, minimizing car use, purchasing green products, reducing hydro usage, reducing waste, sorting waste correctly, and walking or cycling shorter distances. Secondly, we aim to understand how these demographic characteristics influence individuals' likelihood of adopting these behaviors.Here

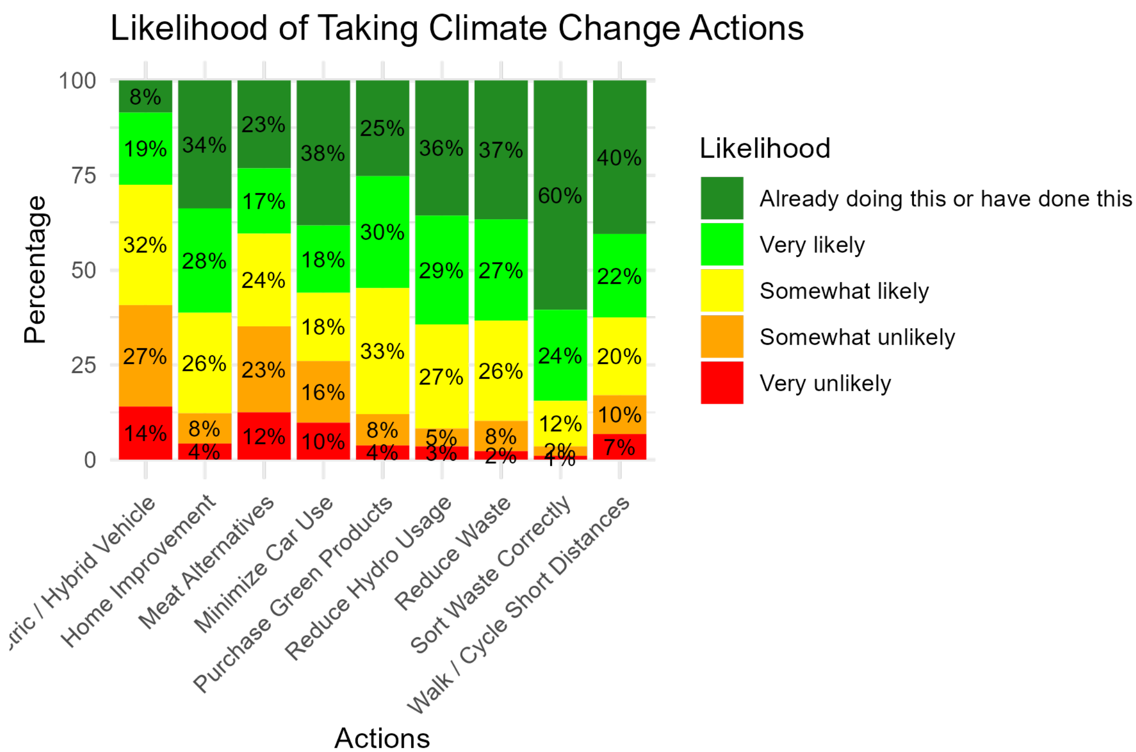

Figure 5: The stacked bar plot shows the likelihood of survey respondents taking various actions to address climate change.

we describe the probability tree model used to investigate the relationship between likelihood and the demographic factors of age and education.

3.1 Model set-up

In this analysis, we focus on predicting the likelihood of taking climate-friendly actions based on the demographic variables of age and education. The likelihood is measured on a five-point Likert scale, ranging from "Very unlikely" to "Already doing this or have done this."

3.1.1 Model Specifications

We use a probability tree model to predict the likelihood of individuals engaging in climate-friendly actions based on two key demographic variables: age and education.

The general form of the model is:

\begin{align} y_i = _0 + _1 * Age_i + _2 * Education_i + _i \end{align*} where:

- y_i represents the likelihood of individual i engaging in a climate-friendly actin, measured on a five point Likert scale:

1. "Very unlikely"
2. "Somewhat unlikely"
3. "Somewhat likely"
4. "Very likely"
5. "Already doing this or have done this"

- β_0 is the intercept, representing the baseline likelihood of taking action when all predictors are zero.
- β_1 is the coefficient for Age, representing how a one-year increase affects the likelihood of taking action.
- β_2 is the coefficient for Education, a categorical variable that is dummy-coded.
- ϵ_i is the error term, accounting for unexplained variation.

This model focuses on the direct effect of age and education on the likelihood of taking climate-friendly actions, assuming a linear relationship between these demographic variables and the outcome variable (the likelihood of action).

3.1.2 Model Justification

This model was developed to explore how demographic factors such as age and education influence individuals' likelihood of engaging in climate-friendly behaviors. By focusing on specific climate actions like reducing energy consumption, adopting sustainable practices, and investing in green technologies, the model aims to provide actionable insights for climate change interventions.

3.1.2.1 Response Variable

The response variable in this analysis is the likelihood of taking climate-friendly actions, measured using a Likert scale (1 = "Very unlikely" to 5 = "Already doing this or have done this"). This scale captures the respondent's perceived likelihood of engaging in various climate-friendly behaviors

3.1.2.2 Input Variabless

The input variables (predictors) include:

- **Age**: Previous research indicates that younger individuals may be more inclined to adopt climate-friendly behaviors due to increased environmental awareness (Leiserowitz et al., 2010; Gifford, 2013).
- **Education**: Higher levels of education are often linked to greater awareness of environmental issues and a higher likelihood of adopting sustainable behaviors (Kollmuss & Agyeman, 2002). Education is treated as a categorical variable and dummy-coded for analysis.

3.1.2.3 Model Structure

This model assumes a linear relationship between the predictors (age and education) and the likelihood of taking action. Specifically, the likelihood of taking climate-friendly actions is modeled as a function of age and education, with coefficients representing the change in the likelihood of action associated with a unit change in each predictor.

There are no interaction terms in this model, meaning we assume that the effects of age and education on the likelihood of taking action are independent of each other. This simplicity ensures clear interpretation of each predictor's individual effect on the likelihood of taking climate-friendly actions.

3.2 Nine Models

We fit nine separate probability tree models, one for each climate-friendly action we are predicting. Each model uses age and education as the predictors to estimate the likelihood of the corresponding action. These actions are:

1. Likelihood of investing in an electric or hybrid vehicle
2. Likelihood of making home improvements (e.g., using LED lightbulbs)
3. Likelihood of adopting meat alternatives
4. Likelihood of minimizing car use
5. Likelihood of purchasing green products 6 Likelihood of reducing hydro usage
6. Likelihood of reducing waste by repurposing used products
7. Likelihood of sorting waste correctly
8. Likelihood of walking or cycling shorter distances

Each model is built using the same structure but predicts a different outcome variable. This approach allows us to analyze the specific impact of age and education on each climate-friendly action.

3.2.1 Likelihood of investing in an electric or hybrid vehicle

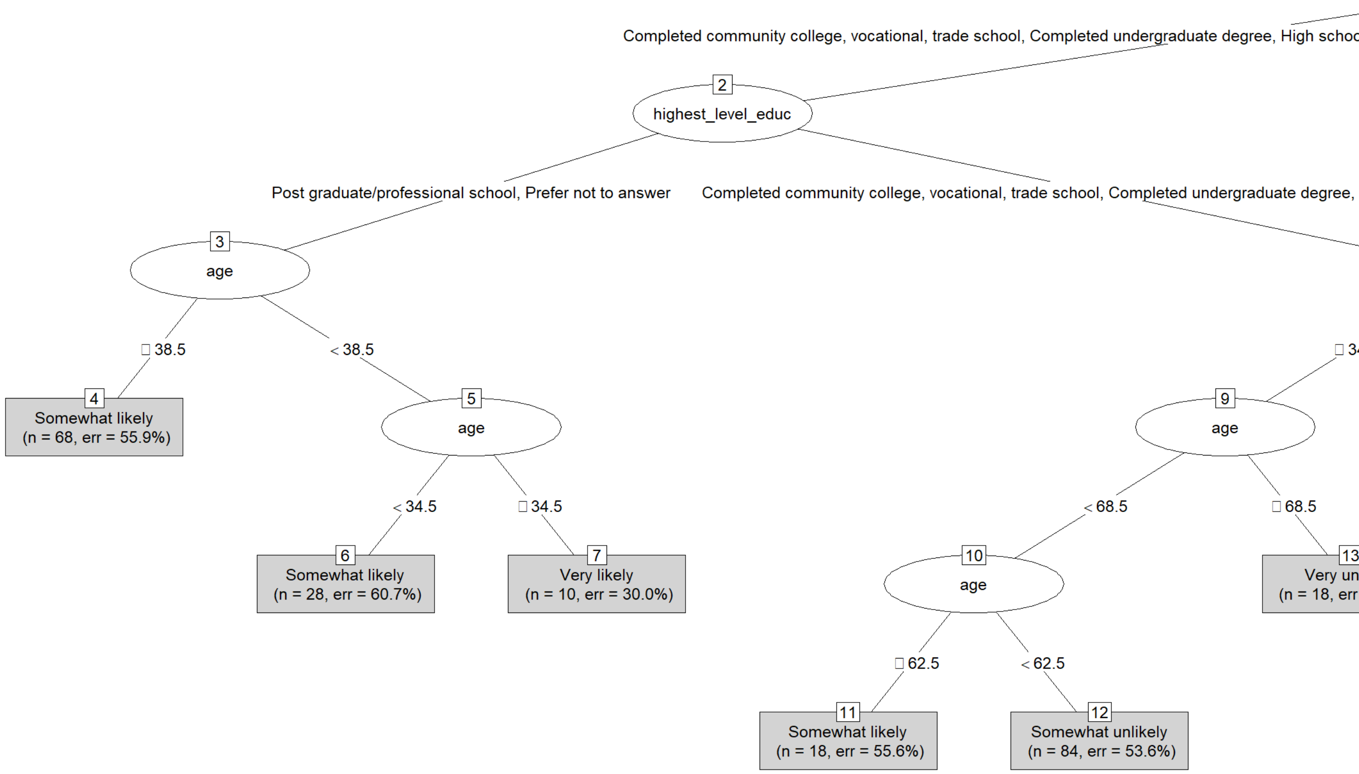

Figure 6: Probability tree for likelihood of investing in an electric or hybrid vehicle, predicted by age and education.

3.2.2 Likelihood of making home improvements

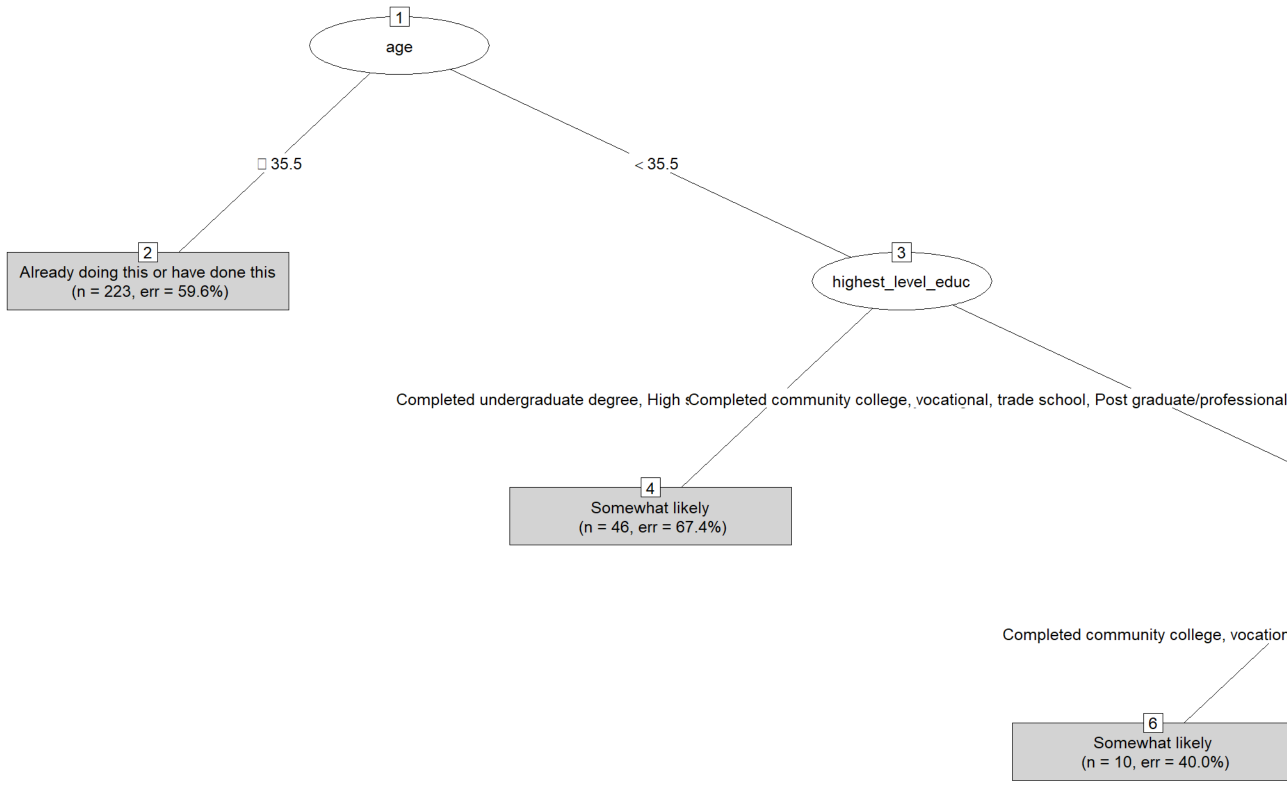

Figure 7: Probability tree for likelihood of making home improvements predicted by age and education.

3.2.3 Likelihood of adopting meat alternatives

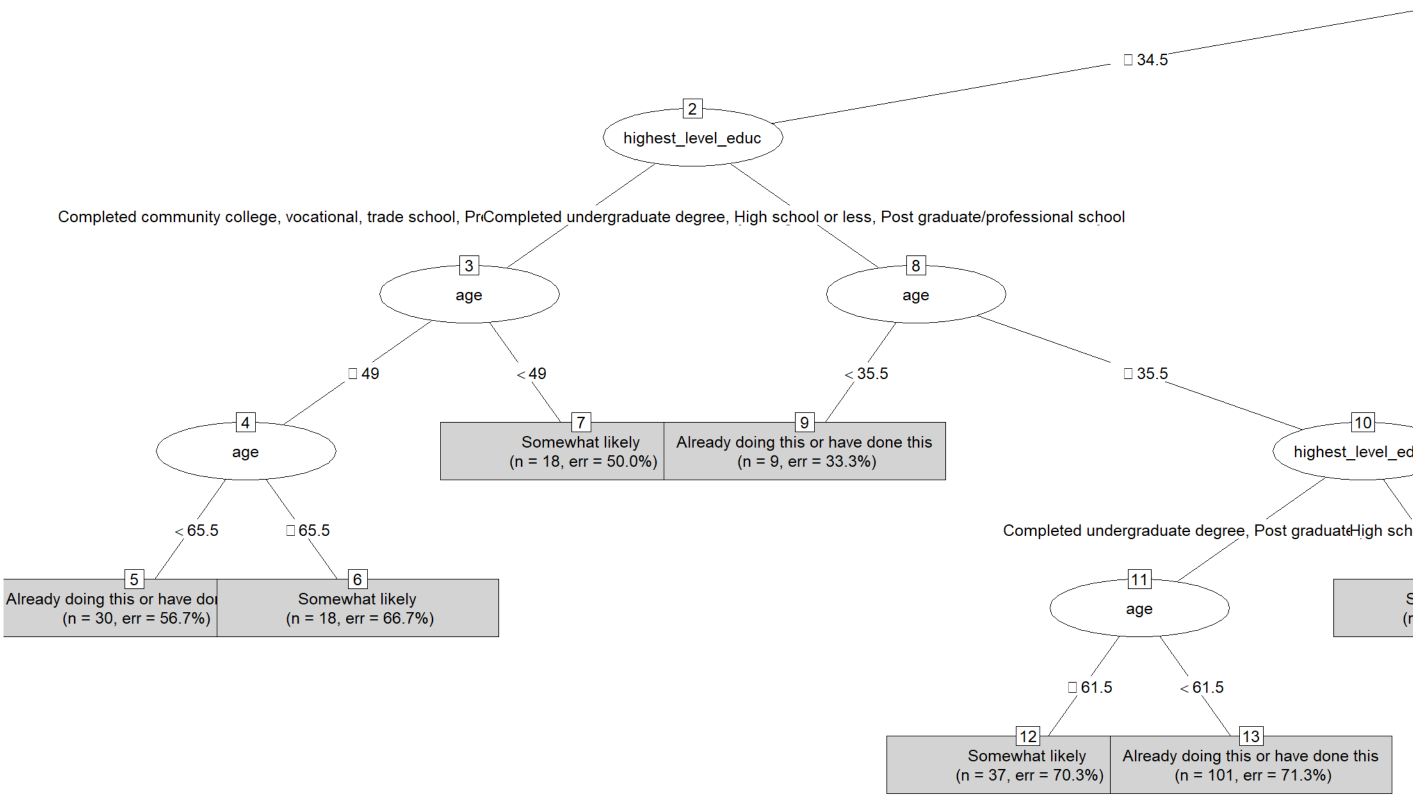

Figure 8: Probability tree for likelihood of adopting meat alternatives, predicted by age and education.

3.2.4 Likelihood of minimizing car use

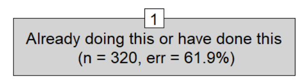

Figure 9: Probability tree for likelihood of minimizing car use, predicted by age and education.

3.2.5 Likelihood of purchasing green products

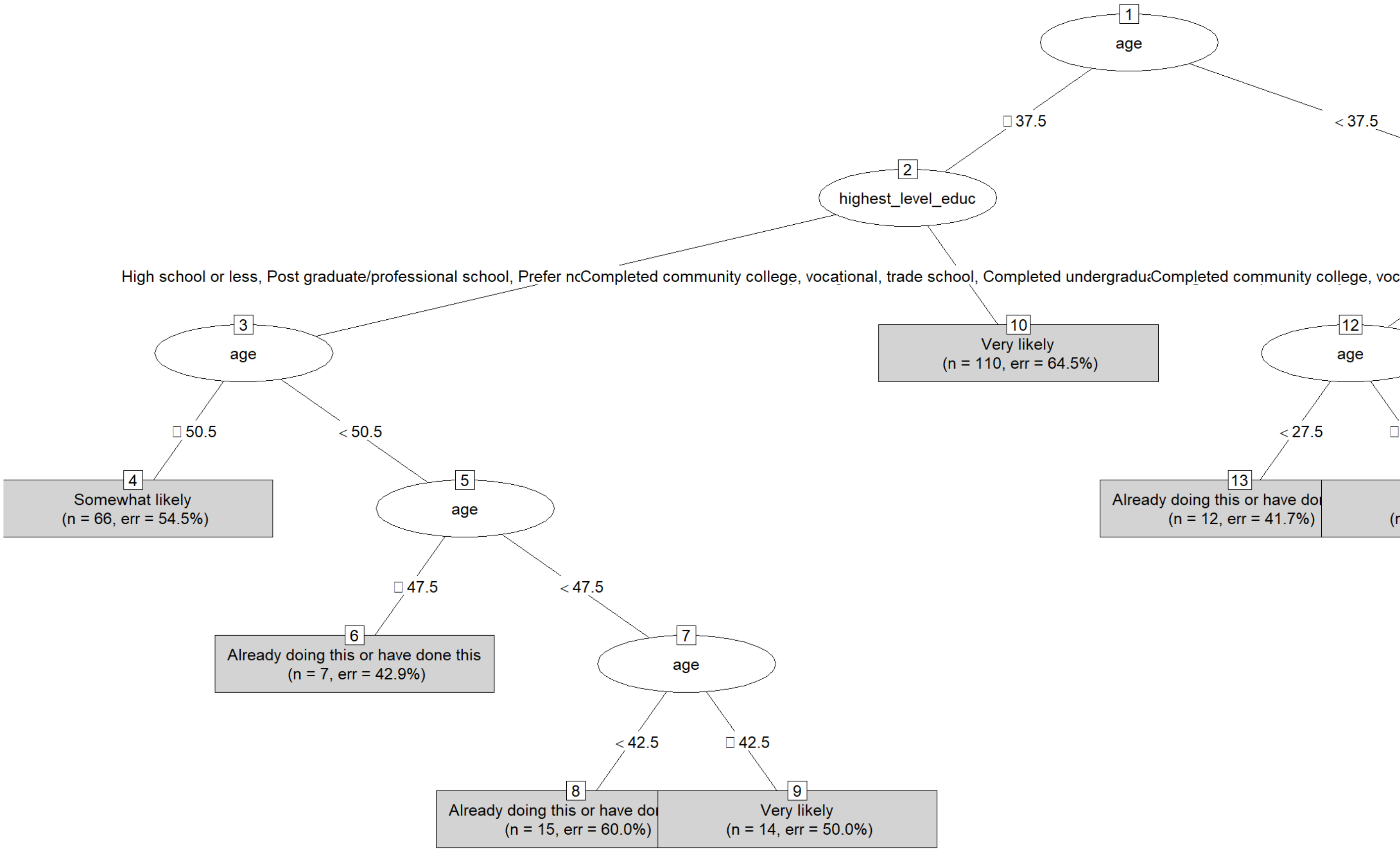

Figure 10: Probability tree for likelihood of purchasing green products, predicted by age and education.

3.2.6 Likelihood of reducing hydro usage

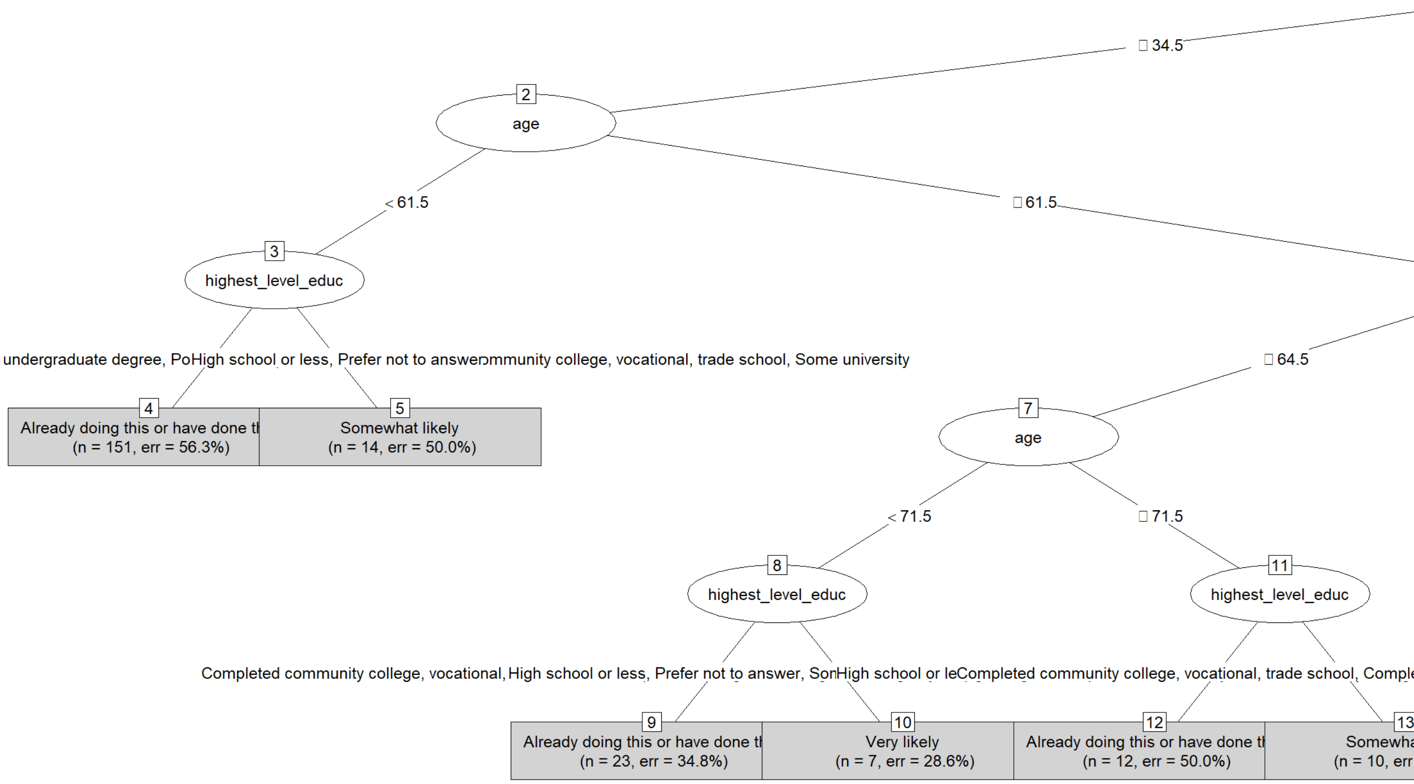

Figure 11: Probability tree for likelihood of reducing hydro usage, predicted by age and education.

3.2.7 Likelihood of reducing waste

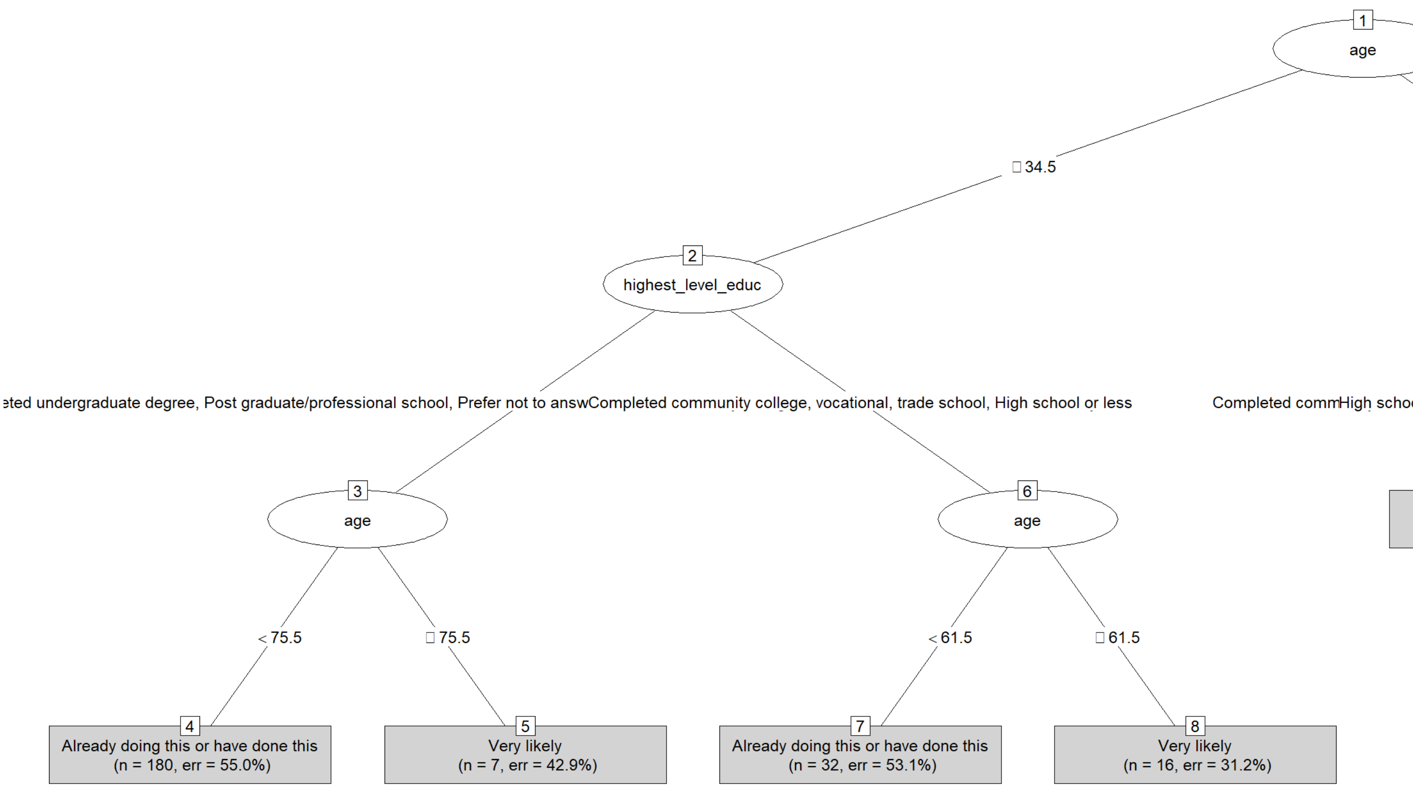

Figure 12: Probability tree for likelihood of reducing waste, predicted by age and education.

3.2.8 Likelihood of sorting waste correctly

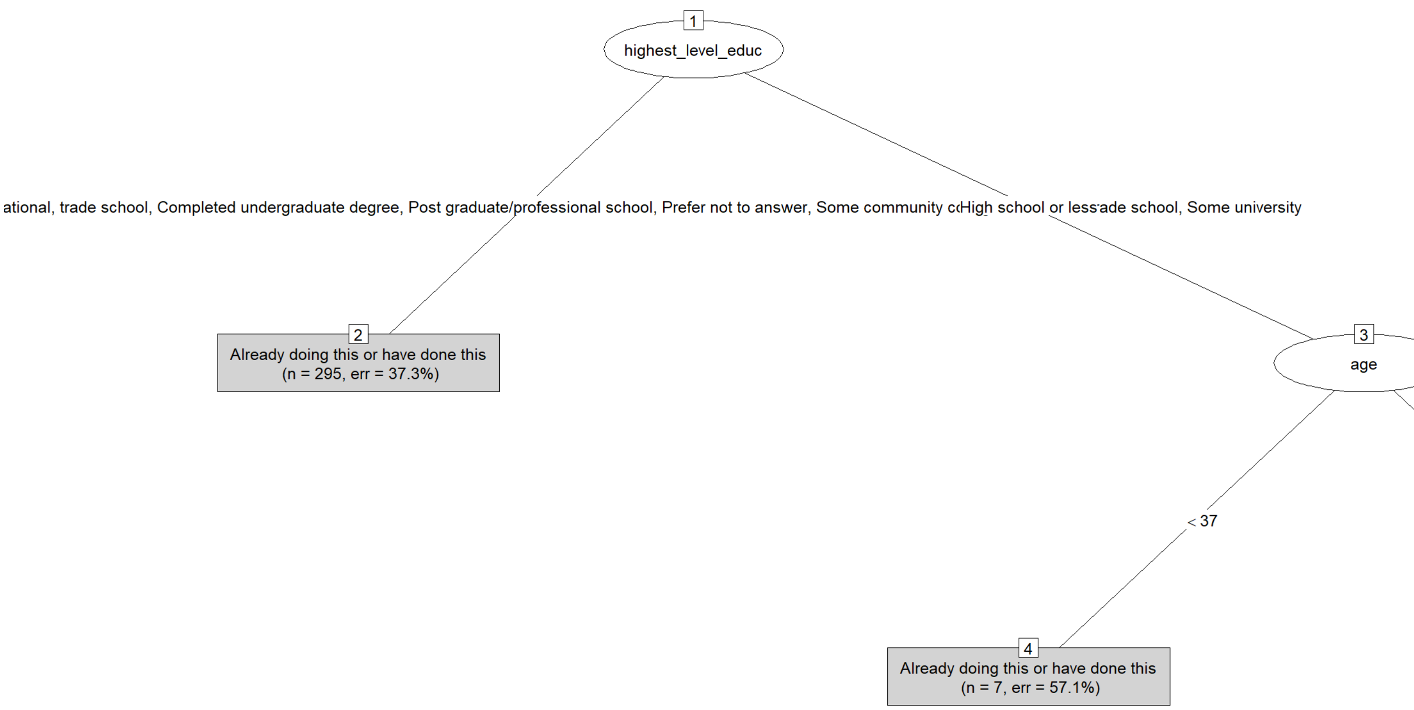

Figure 13: Probability tree for likelihood of sorting waste correctly, predicted by age and education.

3.2.9 Likelihood of walking or cycling shorter distances

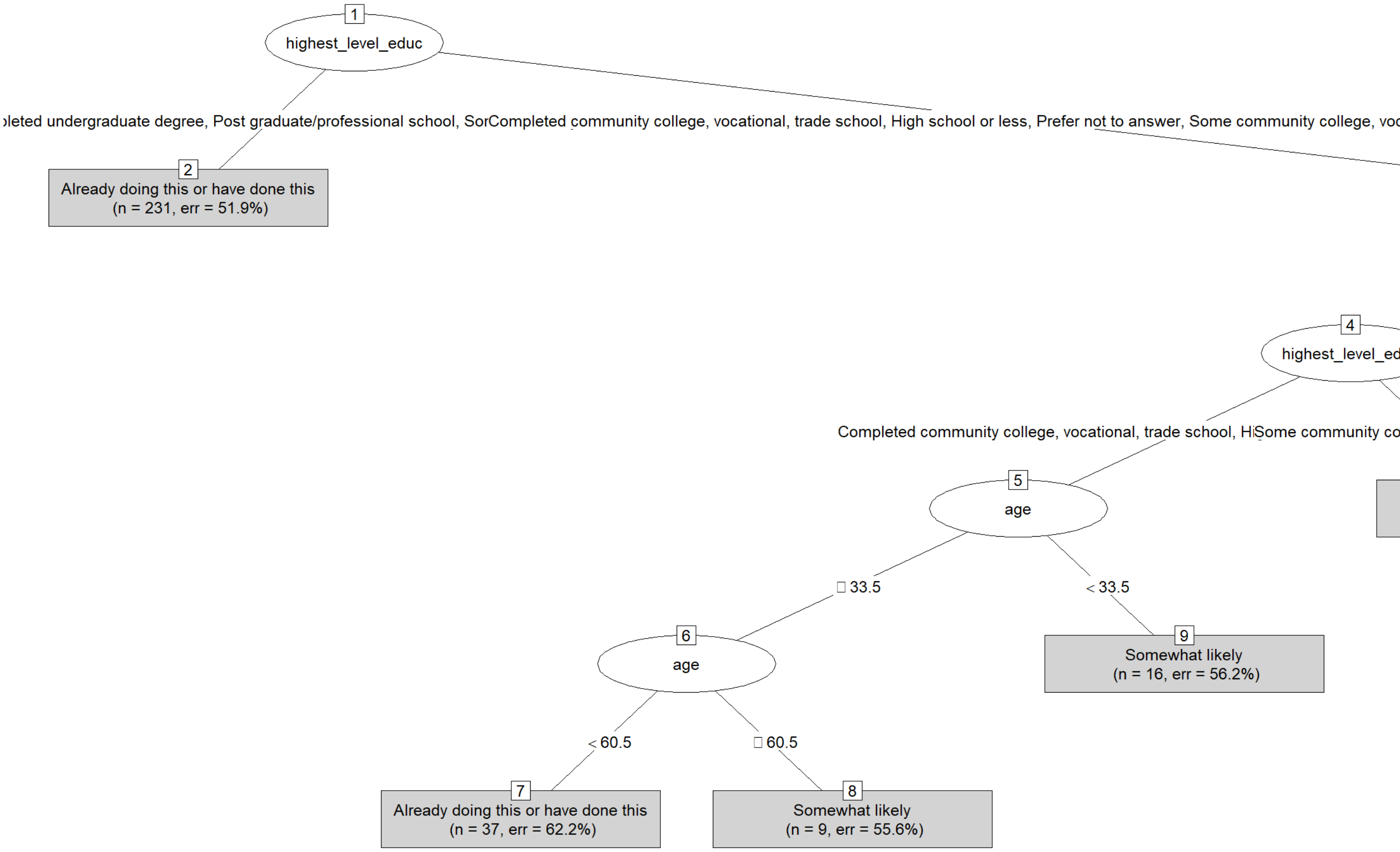

Figure 14: Probability tree for likelihood of walking or cycling shorter distances, predicted by age and education.

3.3 Model Estimation and Interpretation

The probability tree model estimates how the predictors age and education influence the likelihood of adopting climate-friendly behaviors. By splitting the data into branches based on these variables, the model helps identify decision rules that predict individuals' likelihood of taking actions such as reducing waste or investing in green products. We anticipate that younger individuals, due to greater environmental awareness, are more likely to engage in climate-positive actions, while those with higher levels of education may also be more inclined to adopt such behaviors, given their increased awareness of climate change and sustainable practices. The model estimates the parameters for age and education using regression techniques, providing coefficients that indicate how each factor influences the likelihood of taking climate-friendly actions.

4 Results

4.1 Model Summary Table

The table presents the accuracy of models predicting the likelihood of various climate-friendly actions based on demographic factors such as age and education. Each row represents a different climate action (e.g., home improvement, reducing hydro, minimizing car use), with the corresponding accuracy of the model's predictions. The accuracy values reflect how well the models, which use age and education as predictors, align with the actual data. An accuracy of 33 percent for home improvement" indicates that the model correctly predicted the outcome 33% of the time for this action. These accuracy values help evaluate the effectiveness of age and education as predictors for each specific climate action.

```
                Model Accuracy
1    home_improvement       33
2         reduce_hydro       28
3         minimize_car       39
4    vehicle_electric       25
5 protein_alternative       25
6         reduce_waste       39
```

4.2 Likelihood taking action by age

Figure 15 shows the relationship between age and the likelihood of engaging in various climate-related actions. The x-axis represents the age groups, and the y-axis indicates the percentage of respondents reporting different likelihood levels, from "Already doing this" to "Very unlikely." The trend lines across each action show how engagement varies by age.

4.2.1 Electric / Hybrid Vehicle Adoption

Younger respondents (15-24, 25-34) are less likely to adopt electric or hybrid vehicles, with only a small proportion already using or considering them. Adoption rates increase slightly in the 55-64 age group, then decline again in the 65+ group. This suggests that older individuals may have more resources or stability to invest in electric vehicles.

4.2.2 Home Improvement for Energy Efficiency

Middle-aged individuals (35-54) are the most likely to engage in home improvement actions aimed at increasing energy efficiency. Younger age groups (15-24, 25-34) report lower likelihoods, likely due to barriers such as homeownership and disposable income.

4.2.3 Consumption of Meat Alternatives

Younger age groups, especially 15-24 and 25-34, are more likely to adopt meat alternatives. As age increases, the likelihood of doing so decreases, possibly due to established dietary habits in older generations.

4.2.4 Minimizing Car Use

A trend similar to that of meat alternatives is observed, with younger individuals more likely to minimize car use. Older respondents, particularly those 65 and older, show less inclination to reduce car usage, possibly due to mobility needs or lifestyle factors like suburban living.

4.2.5 Purchasing Green Products

The likelihood of purchasing green products is relatively uniform across age groups. Middle-aged and older demographics show a slight increase in engagement, but the trend line remains mostly flat, indicating that this behavior is more influenced by factors such as income or environmental awareness rather than age.

4.2.6 Reducing Hydro Usage

Older respondents (55-64 and 65+) are the most likely to reduce hydro usage, likely driven by cost-saving measures or environmental concerns. The trend line shows a steady increase with age.

4.2.7 Reducing and Sorting Waste

Both reducing and sorting waste are more commonly reported by middle-aged and older groups (45-64). This may reflect increased awareness or resources for waste management.

4.2.8 Walking / Cycling Short Distances

Younger respondents (15-34) are more likely to engage in walking or cycling short distances. As age increases, the likelihood of walking or cycling decreases, possibly due to physical limitations or differing lifestyle needs.

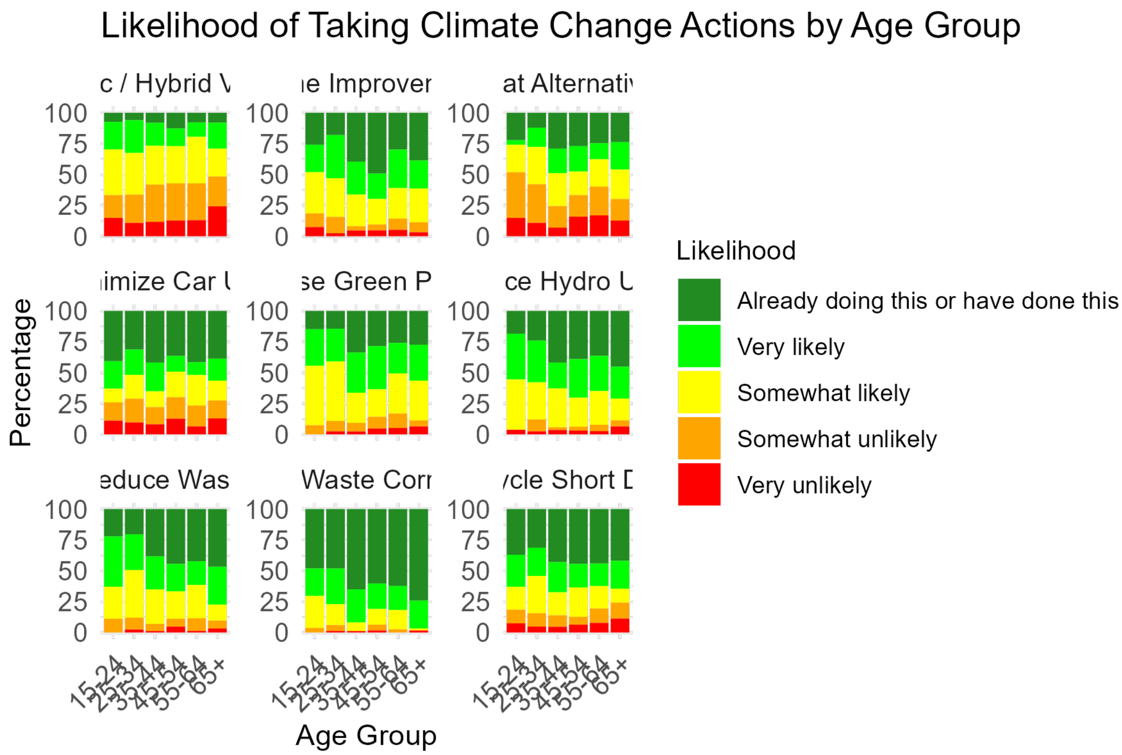

Figure 15: Likelihood of Taking Climate Change Actions by Age Group. The stacked bar chart illustrates the percentage of respondents across six age groups (15-24, 25-34, 35-44, 45-54, 55-64, 65+) in terms of their self-reported likelihood to engage in nine distinct climate-related actions. Each color represents a different level of likelihood, from "Already doing this or have done this" to "Very unlikely." The black dashed trend line highlights how the likelihood of action changes across age groups, providing insights into generational differences in climate-related behavior.

4.3 Likelihood taking action by education

Figure 16 displays how the likelihood of engaging in climate-friendly actions varies by educational attainment. The x-axis represents the proportion of respondents in each education category, while the y-axis lists the educational levels, from "Prefer not to answer" to "Postgrad." Each action is shown across separate facets, revealing how education level correlates with engagement in each behavior.

4.3.1 Trends in Education Attainment and Climate-Friendly Actions

Individuals with higher education levels generally show a higher likelihood of engaging in climate-friendly actions. This trend is evident across all behaviors, with respondents possessing undergraduate or postgraduate degrees more likely to adopt electric vehicles or purchase green products.

4.3.1.1 Electric/Hybrid Vehicle Adoption

Postgraduate degree holders are the most likely to have adopted or consider adopting electric or hybrid vehicles. In contrast, respondents with lower education levels, such as those with high school or less, are more likely to report being "Very unlikely" or "Somewhat unlikely" to adopt these vehicles.

4.3.1.2 Minimizing Car Use

Higher education levels correlate with a greater likelihood of minimizing car use, though the trend is less pronounced for individuals with lower education levels.

4.3.1.3 Reducing Hydro Usage

While education has a smaller impact on reducing hydro usage compared to other actions, those with higher education levels are still more likely to engage in this behavior.

4.3.1.4 Purchasing Green Products and Reducing Waste

Purchasing green products and reducing waste are more common among individuals with postsecondary education, especially those with undergraduate or postgraduate degrees. In contrast, individuals with lower education levels report more moderate engagement with these actions.

4.3.2 Adopting Meat Alternatives

Higher education is associated with greater adoption of meat alternatives. This is particularly true for those with undergraduate or postgraduate education, while fewer respondents with lower education levels report engaging in this behavior.

4.3.3 Walking or Cycling Short Distances

Walking or cycling short distances is a behavior that is relatively common across all education levels, though individuals with higher education levels show slightly higher engagement.

4.3.4 Sorting Waste Correctly

Sorting waste correctly is one of the most consistently adopted behaviors across all education levels, with a relatively small proportion of respondents indicating they are unlikely to engage in this action. However, individuals with higher education are still more likely to fall in the "Already doing this" category.

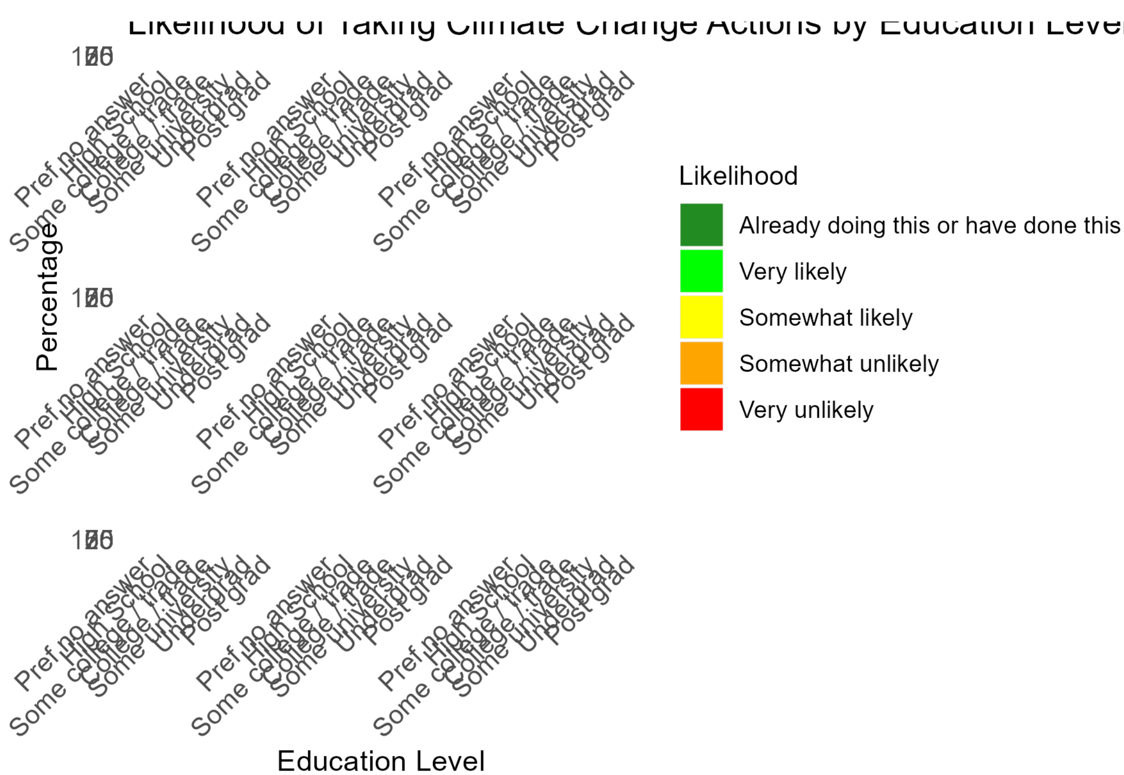

Figure 16

4.4 Overall Summary of Results:

The results indicate that both age and education significantly influence the likelihood of engaging in climate-related actions. Younger respondents tend to be more likely to adopt behaviors such as consuming meat alternatives and minimizing car use, while older individuals are more inclined to engage in actions that require larger investments or long-term commitments, such as reducing hydro usage and investing in energy-efficient home improvements. Higher educational attainment is also strongly linked to a greater likelihood of engaging in climate-friendly behaviors, particularly those that involve financial investment, like adopting electric vehicles and consuming meat alternatives. However, simpler actions such as sorting waste correctly are more widely reported across all education levels. These generational and educational differences highlight the importance of factors such as income, lifestyle, and environmental awareness in shaping individuals' climate-related behaviors. In light of these findings, it is crucial to consider demographic factors when designing policies or campaigns aimed at encouraging climate action, as different age and education groups exhibit varied levels of engagement with both simple and more complex sustainable practices.

5 Discussion

5.1 Age and Climate-Friendly Behaviors

The findings indicate that younger individuals are more likely to engage in climate-friendly actions perceived as low-cost and easier to implement, such as consuming meat alternatives and reducing car usage. The model results show that these behaviors have relatively higher predicted likelihoods among younger participants, aligning with existing research on generational differences in environmental attitudes. This trend may be driven by heightened environmental awareness and increased exposure to climate change discussions among younger generations, often through social media and educational initiatives. These results suggest that lifestyle factors and generational attitudes significantly shape behavioral patterns, with younger individuals gravitating toward actions that are both socially encouraged and accessible.

5.2 The Role of Education in Sustainable Actions

Education significantly influences individuals' likelihood of engaging in more substantial climate-friendly behaviors. Our models demonstrate that individuals with higher educational attainment are more likely to adopt behaviors requiring greater financial or logistical investment, such as purchasing electric vehicles or making energy-efficient home improvements. The accuracy of the models predicting these behaviors is relatively lower than for simpler actions, suggesting that education is an important but not sole determinant. This relationship between education and sustainability underscores the importance of knowledge and informed decision-making in supporting climate-friendly actions, particularly those with long-term environmental benefits. The data suggests that higher education increases both environmental awareness and the capacity to implement financially demanding sustainable practices, which are often inaccessible to those with lower educational levels.

5.3 The Influence of Climate Change Knowledge

Self-reported knowledge of climate change also plays a role in the likelihood of adopting sustainable behaviors. Our analysis shows that individuals with greater awareness are more proactive in making environmentally conscious choices, particularly for actions like reducing waste and conserving energy. However, the model accuracy for some knowledge-based behaviors remains moderate, highlighting a gap between awareness and action. This suggests that while raising awareness is critical, it must be paired with policies that reduce structural barriers to adopting more expensive or long-term sustainable actions. For example, financial incentives or subsidies for purchasing energy-efficient appliances could bridge this gap, ensuring individuals are both informed and able to make practical changes.

5.4 Limitations

One significant limitation of this study is its reliance on self-reported survey data, which is inherently prone to biases such as social desirability bias and recall errors. Respondents may overestimate their environmental knowledge or exaggerate their participation in climate-friendly behaviors to present themselves in a favorable light. This introduces uncertainty into the accuracy of the models, as the input data may not fully reflect actual behaviors or knowledge levels. Additionally, self-reported data often lacks the granularity needed to explore complex interactions between socio-economic factors, such as income and household size, which can significantly influence sustainable actions.

Another limitation arises from the use of summary data from the 2018 and 2021 surveys instead of individual-level data. While the summary statistics provided valuable insights into broad demographic trends, they limited the study's ability to explore more nuanced patterns and interactions. For example, the summary data showed differences in education and age trends between 2018 and 2021, but without individual-level data, it was difficult to determine the direct effect of socio-economic factors on climate action likelihood. Future studies with access to raw, individual-level data could offer more precise estimates and a deeper understanding of these dynamics.

5.5 Challenges with Survey Data

Survey data presents additional challenges, such as non-response bias, where certain demographic groups may be underrepresented, leading to skewed results. Additionally, the framing of survey questions can influence how respondents perceive and answer them, introducing further variability in the data. The inability to verify self-reported behaviors also limits the reliability of the conclusions drawn from such datasets. Despite these challenges, surveys remain a valuable tool for capturing perceptions and self-reported behaviors, but their findings should be interpreted with caution and, when possible, supplemented with objective data sources.

5.6 Future Directions

Future research should aim to identify the specific barriers preventing certain demographic groups from adopting climate-friendly behaviors. This could involve examining factors such as income, access to resources, and perceived obstacles to sustainable practices. Additionally, targeted interventions, such as financial subsidies, public awareness campaigns, or infrastructure improvements, could make sustainable actions more accessible and affordable. Longitudinal studies would be particularly valuable for tracking how awareness of climate change influences sustained behavioral changes over time. Comparing individual-level data across different years could also provide insights into the long-term impact of educational and policy interventions on climate-friendly behaviors.

Lastly, integrating objective data, such as energy consumption records or transportation usage statistics, could validate and enhance the accuracy of survey-based findings. This combined approach would offer a more comprehensive understanding of how demographic and socioeconomic factors influence the adoption of sustainable actions, ultimately informing more effective climate policies and interventions.

6 Conclusion

This study provides valuable insights into the demographic factors that influence individuals' likelihood to engage in climate-friendly behaviors, particularly age, education, and climate change knowledge. Younger individuals and those with higher levels of education are more likely to adopt sustainable behaviors, particularly those that require greater financial investment or long-term commitment. However, barriers such as financial constraints and access to resources remain significant challenges. Addressing these barriers through targeted policies and interventions could help make sustainable behaviors more accessible and the norm across all demographic groups. Future research should explore the underlying reasons for resistance to adopting climate-friendly behaviors and how external factors can help overcome these challenges to achieve widespread climate action.

A Appendix

B Idealized methodology

B.1 Survey objectives

The primary objective of this study is to explore the factors influencing the likelihood of individuals engaging in climate-friendly behaviors. Specifically, the study aims to identify the age groups that are least likely to participate in sustainable actions and investigate how education levels impact climate-friendly behaviors. The research also seeks to determine whether individuals who report being relatively informed about climate change causes are more likely to take action to mitigate it. The underlying assumption is that individuals with greater knowledge of climate change should be more inclined to adopt behaviors that reduce its impact. Additionally, the study will examine the barriers that prevent people from engaging in sustainable behaviors, with the goal of identifying strategies to make these actions more accessible, affordable, and easy to adopt. The overarching aim is to develop solutions to increase the likelihood of participation in climate-friendly behaviors by removing existing barriers and promoting sustainability across different demographic groups. Part of this involves determining the most effective platforms for disseminating information about climate change, specifically by identifying which communication methods resonate most with different age groups. The research will also explore the role of education systems in fostering climate awareness and encouraging sustainable actions from a young age. Ultimately, the findings aim to provide actionable solutions to promote wider participation in climate-friendly actions, contributing to the fight against climate change.

B.2 Sampling approach

This study will target a diverse set of respondents across various age groups and demographic characteristics to gain a comprehensive understanding of climate-friendly behaviors and their drivers. The sample will be stratified to ensure representation across youth and adult demographics, enabling a comparison of climate knowledge and behaviors between generations. The study will start by sampling youth as young as age 12. This age group is chosen because children are old enough to understand the basics of climate change and the actions required to address it but still impressionable enough for their behaviors to be influenced by education and social interventions. By including participants starting at age 12, we aim to assess how effective climate change education in schools is and whether it is shaping climate-friendly behaviors in the younger generation.

In addition to youth, adults aged 18 and older will also be included to provide insight into longer-term behavioral trends, which may have been shaped by earlier education or a lack of education on the subject. The sampling will be stratified according to age, education level, income, and geographic location to capture a broad spectrum of experiences and perspectives on climate change and sustainability. Age groups will be divided into the following ranges: 12-17, 18-24, 25-34, 35-44, 45-54, 55-64, and 65+, while education levels will range from middle school to postgraduate education. Income will be categorized as low (<$30,000), middle ($30,000–$99,999), and high (>$100,000), and participants will also be grouped based on urban, suburban, or rural geographic locations. This stratified sampling approach ensures a diverse representation of individuals, allowing for meaningful comparisons of climate knowledge and behaviors across different demographic groups.

B.3 Respondant recruitment

Participants will be recruited using a multi-channel approach to ensure broad representation across various age groups and geographic locations. For youth aged 12-17, recruitment will occur through schools, with cooperation from middle and high schools. District educational boards or individual teachers will be approached to distribute information about the survey, and parental consent will be obtained before participation. To recruit adults, online surveys will be distributed via social media, email lists, and relevant climate-focused online communities. Additionally, outreach will be conducted in community centers and public spaces to capture respondents from rural or underserved areas. Flyers, local advertisements, and community events will help ensure that the sample is representative of both urban and rural populations.

Incentives such as gift cards or a donation to a climate-focused charity will be offered to participants to encourage engagement and improve response rates, especially among younger participants who may be less inclined to participate without an incentive.

B.4 Data Validation

To ensure the validity and reliability of the data, several validation mechanisms will be employed. Responses will be reviewed for internal consistency, such as cross-checking whether respondents who claim high levels of climate change knowledge also report engaging in corresponding climate-friendly behaviors. Participants who provide inconsistent answers or fail to complete the survey will be excluded from the analysis. Additionally, respondents may be contacted for clarification if their answers are ambiguous or incomplete. This will ensure that the data accurately reflects the participant's true attitudes and behaviors.

C Weighting and Data adjustments

The data collected will be weighted to account for any imbalances in demographic representation within the sample. Statistical weighting will adjust for factors such as age, education level, income, and geographic location to ensure the sample accurately reflects the broader population. Weighting will correct for any over- or under-representation of specific demographic groups, allowing for more generalizable findings. Additionally, data will be adjusted for non-response bias, with greater weight given to underrepresented groups (e.g., certain age groups or income levels) to correct for gaps in participation.

C.1 Budget

The budget for this study will cover several key areas essential for effective data collection and analysis. A portion of the budget will be allocated to the survey platform and software tools needed for data collection, such as online survey tools and platforms for both youth and adult respondents. Since incentives are critical to encouraging participation, especially from younger individuals, funds will also be used to provide gift cards or donations to climate-related charities as incentives. To reach a diverse demographic, outreach costs will also be factored in, including the production and distribution of flyers, local advertisements, and outreach at community centers or schools. Lastly, resources will be dedicated to data analysis, including the purchase of statistical software like SPSS or R for cleaning, coding, and analyzing the responses. The final portion of the budget will cover any miscellaneous costs such as obtaining parental consent forms, printing, and mailing physical surveys or communication materials.

C.2 Survey design

The survey design will be structured to capture a range of demographic and behavioral data in order to address the research objectives. The survey will begin with demographic questions to capture essential background information, including age, education level, income, and geographic location. These variables will allow the analysis to identify how climate-friendly behaviors and knowledge vary across different groups. The primary focus will be on participants' climate change knowledge, specifically assessing their awareness of its causes, impacts, and potential solutions. Respondents will be asked to rate their perceived level of knowledge about climate change on a Likert scale, ranging from "not informed" to "very informed." They will also be prompted to identify key contributors to climate change, as well as actions individuals can take to mitigate its effects.

The next section of the survey will focus on climate-friendly behaviors, asking respondents to self-report on their engagement in specific actions such as reducing car use, purchasing electric vehicles, eating plant-based meals, recycling, and reducing household energy consumption. These behaviors will help determine the extent to which knowledge of climate change is translating into actions, as well as highlight potential gaps in engagement.

Following this, the survey will include a section on barriers to sustainable behaviors, exploring factors that may be preventing individuals from adopting more climate-friendly actions. Participants will be asked to identify reasons such as cost, convenience, lack of knowledge, or skepticism. This will allow the study to pinpoint the most significant obstacles to widespread adoption of sustainable practices and provide insight into potential solutions.

The final section will focus on how respondents prefer to receive information about climate change. Given the varying effectiveness of different communication channels for different age groups, the survey will include questions on the most effective platforms for disseminating climate change education, such as social media, school programs, TV ads, and email. By identifying these preferences, the study will be able to recommend the most suitable methods for spreading climate change awareness tailored to specific demographics.

Each section of the survey will include a combination of multiple-choice, Likert scale, and open-ended questions to capture both quantitative and qualitative data. The open-ended responses will allow for more nuanced insights into the reasons behind individuals' climate-related behaviors and barriers. The design will aim to balance simplicity with comprehensiveness to ensure that the survey is engaging and easy to complete while still gathering sufficient data to answer the research questions effectively.

C.3 Tradeoffs and limitations

While this methodology is designed to be comprehensive, there are inherent trade-offs and limitations that must be considered. One key limitation is the reliance on self-reported data. Since participants will be answering questions based on their own recollections and perceptions, there is the potential for bias, such as over-reporting sustainable behaviors or under-reporting barriers to climate action. This could skew the findings, particularly if individuals respond in a socially desirable manner. Additionally, while efforts will be made to capture a representative sample, there is a possibility of sampling bias, especially in rural areas or among specific income groups who may have limited access to the survey. This could affect the generalizability of the results. Further, survey fatigue is a potential issue, particularly with younger participants who may lose focus or fail to complete longer surveys. To mitigate this, the survey will be kept concise, though the breadth of questions may still pose challenges. Finally, while statistical weighting and adjustments for non-response bias will be implemented, there is always some degree of uncertainty regarding the effectiveness of these methods in fully correcting for bias or imbalances in the sample. These limitations must be taken into account when interpreting the findings of this study.

C.4 Idealized survey questions

Thank you for your participation in the 2024 Climate Change Survey. This survey aims to gather information about public attitudes and behaviors related to climate change, with a focus on understanding the factors that influence people's engagement in climate-friendly actions. Your participation is entirely voluntary, and you may withdraw at any time, for any reason, with no questions asked.

This survey collects data regarding your awareness of climate change, the actions you take to mitigate it, and the barriers that may prevent you from engaging in more sustainable behaviors. The data you provide will be kept confidential and will be used solely for research purposes. This survey is anonymous, and your responses will not be traceable back to you. The goal of this survey is to better understand the motivations, challenges, and opportunities related to climate action, with a view to improving strategies for promoting sustainability.

If you have any questions or concerns about this survey or its methodology, please feel free to contact Lexi Knight via email at lexi.knight@mail.utoronto.ca. Any correspondence will remain confidential and will not be shared with any external parties.

Screening and Consent:

By checking this box, I consent to this survey collecting information about my awareness of climate change, the actions I take to address it, and the factors that influence my behavior for research

Correspondence will not be shared with any external parties. - I consent.

Demographic Information: 1. Whats your age? 12-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65+, Prefer not to say 2. What is the highest level of education that you've completed? Some high school, High school diploma, Diploma / post secondary certificate (college, trade school). Bachelor's degree, Master's degree, Doctorate degree.

Climate Change knowledge and Awareness: 3. How would you rate your knowledge of the causes of climate change? Very informed, Somewhat informed, Neutral, Somewhat Uninformed, Very uninformed. 4. How confident are you in your understanding of how to mitigate climate change through individual actions? Very confident, Confident, Neutral, Somewhat confident, Not confident.

Climate-Friendly Action: 5. Which of the following climate-friendly actions do you regularly engage in? (Select all that apply). Reduce personal vehicle use (e.g., carpooling, using public transport, biking or walking shorter distances), Use / install energy-efficient appliances / devices (e.g., LED bulbs, smart thermostats), Eat a plant-based diet or reduce meat consumption, Recycle and compost, Purchase eco-friendly products (e.g., sustainable clothing, eco-conscious brands), Use renewable energy sources (e.g., solar panels, wind energy), None of the above, Other. 6. How often do you consider the environmental impact of your purchases? Always, Often, Sometimes, Rarely, Never

Barriers to Sustainable Actions: 7. What factors prevent you from engaging in more climate-friendly behaviors? (Select all that apply) Cost of sustainable products or services, Lack of time, Lack of knowledge about how to make sustainable choices, Convenience (e.g., environmentally harmful options are more accessible), Skepticism about the effectiveness of individual actions, No barriers (I already engage in sustainable behaviors), Other (please specify) 8. Do you feel that climate-friendly behaviors are affordable for people in your community? Yes, No, Not sure 9. Which of the following reasons best describe why you do not participate in more climate-friendly actions? (Select all that apply) I do not believe my individual actions will make a difference, I find it too difficult to make sustainable choices in my daily life, It is too expensive to adopt sustainable behaviors, I don't know where to start or how to make a meaningful impact, Sustainable products or services are not easily available in my area, I do not feel that climate change directly affects me or my community, I am unsure about what actions are most effective in reducing climate change, I am not sure how to balance sustainable actions with my current lifestyle 10. If you have avoided taking climate-friendly actions, what do you believe would make it easier for you to participate in these behaviors? (Select up to three) Lower cost of sustainable products or services, More convenient access to sustainable options, Clearer information on how individual actions can make a difference, More education or awareness about climate change, Incentives (e.g., government subsidies, rewards) to take action, More social pressure or norms encouraging sustainable behavior, Other (please specify) 11. How much do you trust the information provided by the following groups on climate change? Government, Environmental NGOs, Local community organizations, Media (TV, online news), Social media influencers/bloggers, Scientists, I do not trust any of these sources 12. If the government provided more support for individuals to take climate-friendly actions, would this lead you to taking more environmentally friendly actions (e.g., incentives, education programs, reduced cost)? Yes, No, Not sure 13. How strongly do you agree with the following statement: "Taking climate-friendly actions is a personal responsibility." Strongly disagree, Disagree, Neutral, Agree, Strongly agree 14. How strongly do you agree with the following statement: "The government or businesses should take more responsibility for addressing climate change than individuals." Strongly disagree, Disagree, Neutral, Agree, Strongly agree 15. Do you think the reluctance to take action against climate change more due to a lack of knowledge about how to get involved, or is it primarily because sustainable actions are inconvenient for people? Lack of knowledge about how to take action, Inconvenience of sustainable actions, Both, Neither, Unsure

Education and Information: 16. How effective do you think current school programs are in educating students about climate change? Very ineffective, Somewhat ineffective, Neutral, Somewhat effective, Very effective 17. Which platforms do you find most effective for receiving information about climate change? Social media (e.g., Instgram, Facebook, Twitter, TikTok), School programs, TV/Youtube, News articles, Websites, Podcasts, Community events, Email newsletters.

General Perception: 18. Do you believe that individual actions can make a significant difference in combating climate change? Yes, No, Not sure

19. In your opinion, which of the following should be prioritized to encourage more sustainable behaviors? (Select up to two), Making sustainable actions more affordable, Providing more education and awareness about climate change, Improving the accessibility of sustainable options, Encouraging government policies and incentives for sustainable behaviors, Creating a societal norm where sustainable actions are expected and practiced

Confirmation Message

Thank you for your response. We greatly appreciate the time, effort, and honesty you dedicated to completing this survey. Your answers have been successfully recorded and will contribute significantly to our research!

D Additional data details

After data collection, the responses will be cleaned, coded, and analyzed using appropriate statistical methods. Analysis will focus on identifying correlations between demographic factors (age, education, income, geography) and engagement in climate-friendly behaviors. The data will also be examined for patterns in barriers to participation and preferences for information delivery. These findings will provide the basis for actionable recommendations to improve climate change education and encourage greater participation in sustainable behaviors.

D.1 Simlation Process {sec-simulation-process}

For the purposes of this study, I simulated data to investigate various factors related to climate change behaviors, including demographics, education levels, awareness of climate change causes, and preferences for communication methods. The simulated dataset consists of 404 entries, each representing an individual. To create this dataset, I used the `tidyverse` and `arrow` packages in R and set a seed value `(set.seed(853))` to ensure the results were reproducible. I generated the following variables:

The age variable was sampled randomly from a range between 18 and 100 years old. For education, I created several categories, such as "high school or less," "some community college/trade school," and "postgraduate/professional school," with an option for "prefer not to answer." The informed variable was categorized into four levels, from "extremely informed" to "not at all informed," reflecting the extent to which individuals felt knowledgeable about climate change causes. To capture the likelihood of engaging in climate-friendly actions, I simulated the likelihood of taking action variable, with responses ranging from "already doing this or have done this" to "very unlikely." Finally, the communication method variable explored how individuals preferred to receive climate-related information, with options such as "Toronto.ca website," "social media platforms," and "advertising campaigns," among others.

I used random sampling to generate values for each of these variables, ensuring a broad range of responses. After generating the data, I summarized it to verify its structure and consistency. The dataset was then saved as a `.parquet` file for further analysis. This approach allowed me to simulate a diverse set of responses and explore potential relationships between demographic factors, climate awareness, and willingness to engage in climate-friendly behaviors, all while maintaining the flexibility of synthetic data.

D.2 Data cleaning

D.2.1 2018 Individual Data

The cleaning process for the 2018 individual data began with selecting six key questions from the survey, focusing on variables that would provide insights into individual perceptions and behaviors regarding climate change. The corresponding columns were extracted and renamed with meaningful, descriptive names for clarity. The selected variables included age, the extent to which individuals consider themselves informed about the causes of climate change, the likelihood of taking specific climate actions, reasons for inaction (if they indicated they were unlikely to act), the highest level of education completed, and preferred methods for the city to deliver information about climate change and climate action.

After selecting and renaming the columns, minor formatting inconsistencies were addressed. For instance, a missing space in the "verylikely" response category was corrected to "very likely." Additionally, certain values were reformatted to ensure compatibility with visualization tools, making the dataset easier to plot later. Unlike other datasets that often contain missing values or duplicate entries, this dataset was notably clean. There were no missing responses, and all questions were answered, allowing for a comprehensive analysis of survey participants' perceptions and behaviors. The dataset offered valuable insights into individuals' likelihood of engaging in climate actions and their preferred communication channels for climate information.

Throughout the cleaning process, no observations were removed, as every response was preserved to accurately represent the survey data. Despite encountering a few incorrect variable formats, these were easily corrected without data loss. The dataset provided a rare opportunity to analyze a complete and consistent set of individual responses, enabling a thorough exploration of both demographic characteristics and personal perceptions related to climate change.

D.2.2 2018 Summary Data

Cleaning Process for the 2018 Summary Data To create the 2018 summary data, I built off the cleaned 2018 individual data. This approach was necessary because the 2021 data was only available in summarized form, not at the individual level. By summarizing the 2018 data in a comparable format, I could facilitate a meaningful comparison between the two years. The first step involved loading the cleaned 2018 individual dataset and mimicking the structure of the 2021 summary data as closely as possible.

For age, I created the same age categories used in the 2021 dataset to ensure consistency between the two datasets. I then calculated the percentage of individuals within each age group and created a table summarizing this information. Similarly, I summarized the highest level of education completed by respondents, presenting it as a percentage of the total. However, a slight inconsistency emerged during this process, as the education levels and their descriptions differed between 2018 and 2021. Despite this discrepancy, I aligned the categories as closely as possible to maintain comparability.

Next, I calculated the percentage of respondents who reported feeling informed about the causes of climate change and summarized the likelihood of taking various climate actions. This step was somewhat more complex, as the dataset contained nine different actions, each rated on a five-point scale of likelihood. I created a table showing the percentage likelihood of taking each specific action. Additionally, I analyzed the reasons respondents provided for being unlikely to take certain actions, which were only collected if they had indicated "unlikely" in the previous question. These reasons were summarized as counts rather than percentages, reflecting the conditional nature of the responses.

Finally, I summarized the preferred methods for receiving climate-related information from the city, presenting this data as a percentage. This comprehensive summarization of the 2018 individual data provided a consistent and comparable dataset for analyzing trends and changes in perceptions and behaviors between 2018 and 2021.

D.2.3 2021 Summary Data

The cleaning process for the 2021 summary data focuses on ensuring consistency and accuracy for six specific variables: age, education, extent informed, likelihood to take action, and reasons for not taking action. I first extracted data from the relevant sheets and columns in the 2021 raw dataset using read_excel from the tidyverse. For each category, I selected specific rows and converted raw data into percentages. The age and education data were cleaned and saved into separate data frames (age_summary_21 and education_summary_21), while other categories like "extent informed" and "likelihood to take action" required cleaning across multiple columns, with data transformation into percentages. Missing values and outliers were handled by filtering invalid entries and ensuring all values were consistent.

Instead of merging datasets for 2018 and 2021, I aligned the 2018 summary data to match the structure and categories of the 2021 data to facilitate comparison. This alignment was necessary because the categories and structure of the two datasets differed, and I modified the 2018 dataset to resemble the 2021 format as closely as possible, allowing for a more direct comparison. By focusing on ensuring that categories and percentages were comparable between years, I preserved the integrity of both datasets.

Finally, I saved each cleaned dataset into formatted tables using tinytable for LaTeX compatibility. These cleaned datasets were essential for analysis, ensuring that all variables were represented as percentages without any missing or erroneous data. This process also ensured that the dataset was ready for comparison with the 2018 data, with clear, consistent categories across both years.

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