

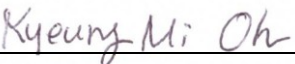





KNOWLEDGE, ATTITUDES, AND PRACTICES RELATED TO
ANTIMICROBIAL RESISTANCE AMONG UNDERGRADUATE STUDENTS
AT A LARGE PUBLIC UNIVERSITY IN 2020

by

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A Thesis
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of
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Knowledge, Attitudes, and Practices Related to Antimicrobial Resistance among
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LIST OF ABBREVIATIONS

Antimicrobial resistance	AMR
Centers for Disease Control and Prevention	CDC
George Mason University	GMU
Hospital-acquired infection.....	HAI
Institutional Review Board	IRB
Knowledge, attitudes, and practices.....	KAP
United States of America	U.S.
World Health Organization.....	WHO

ABSTRACT

KNOWLEDGE, ATTITUDES, AND PRACTICES RELATED TO ANTIMICROBIAL RESISTANCE AMONG UNDERGRADUATE STUDENTS AT A LARGE PUBLIC UNIVERSITY IN 2020

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George Mason University, 2020

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One of the major contributors to antimicrobial resistance (AMR) is human misuse of antibiotics. The goal of this research project was to understand knowledge, attitudes, and practices (KAP) related to antibiotic use and AMR among undergraduate students at a large public university. A total of 527 undergraduate students at George Mason University completed an online KAP survey about AMR, holistic health, and climate change in January and February 2020. The participants were reasonably representative of the university's undergraduate student population. While 92% of the participants knew that antibiotics could be used to cure bacterial infections and 82% knew that resistant pathogens can be contagious, 47% incorrectly thought that antibiotics can cure viral infections, 42% believed that AMR was a problem only for people who take antibiotics often, and 38% believed that antibiotics weaken the immune system. Students with more knowledge about antibiotics and AMR were less likely to participate in the types of

behaviors that generate AMR, such as taking antibiotics that were not prescribed to them, sharing their antibiotics with other people, and stopping antibiotics before the full course has been completed. The percentage of students who reported being worried about AMR (57%) was significantly lower than the percentage who were worried about climate changes (88%, $p < 0.001$). Increasing knowledge about AMR among college students may contribute to raising their concern about AMR and encouraging them to adopt behaviors that help prevent AMR.

INTRODUCTION

Antimicrobial resistance (AMR) is a burgeoning threat that knows no borders. AMR occurs when microorganisms are not killed by the antimicrobials used against them, which include antibiotics, antivirals, and antimalarials.¹ Antibiotic resistance can occur in numerous ways, such as through bacterial mutation or antibiotic misuse.² Bacteria experience selective pressure to survive, and they mutate to gain resistance when faced with antibiotics.² When new antibiotics are created to combat the antibiotic resistant bacteria, some bacteria gain resistance to the new drugs, thereby perpetuating a vicious cycle.² Most of the concern about AMR pertains to antibiotic resistance because this is the most prevalent form of AMR (more prevalent than antivirals and antimalarials).¹

Antibiotics are hailed as one of the greatest inventions in the history of medicine.³ From the beginning of the 20th century, antibiotics have saved countless lives and have helped to curb the spread of infectious diseases that, in the past, contributed immensely to human morbidity.³ The use of antibiotics is not limited to the modern 21st century however. Traces of antibiotics, such as tetracycline, have been found in human skeletal remains in Sudanese Nubia that date back to 350-550 CE.³

The modern age of antimicrobial therapy came about when Paul Ehrlich began his study on the antibacterial effects of dyes on tissues.⁴ Ehrlich observed that some stains were toxic against the bacteria and discovered salvarsan, an arsenic-based chemical.⁴ Salvarsan was an effective therapy against syphilis and was likely the first genuine

modern antimicrobial agent, although it was not an exact antibiotic.⁴ Penicillin, an antibiotic administered against various types of bacterial infections, was first identified in 1928 by Alexander Fleming and was the first commercialized antibiotic.⁴

AMR does not confine itself to a particular population or age; it can affect anyone, anywhere. AMR can also affect the healthcare, veterinary, and agricultural industries, cementing it as a pressing public health concern for the world.⁵ More than 2.8 million antibiotic-resistant infections occur each year in the United States, with over 35,000 resulting in death.¹

AMR is a global concern due to its current and potential impact on the health of the global population, costs to healthcare systems and societies, and the risk that uncontrolled spread of bacteria that cannot be killed with antibiotics could adversely affect economic growth and stability.⁶ If new therapeutics are not developed, extensively resistant bacteria may become more prevalent.⁷ By 2050, there may be as many as 10 million deaths each year worldwide due to AMR, and that could cost health systems up to \$100 trillion.⁸

Annually, roughly two million Americans develop a hospital-acquired infection (HAI), resulting in about 100,000 deaths, most of which were due to antibiotic resistant bacteria rather than other types of pathogens.⁹ AMR infections can lead to sepsis (blood poisoning), pneumonia, and death.¹ Treatment and hospitalizations prior to death may cost more than \$8 billion annually in the United States alone.¹⁰ Because patients with antibiotic resistant infections often required lengthy hospital stays, even when they ultimately recover, eight million additional hospital days per year are due to AMR.¹¹

AMR infections are expensive to patients, health systems, and society. In 2009, the average medical cost for a patient with an antibiotic resistant infection ranged from \$18,500 to \$29,000, but could run into the millions.¹² This cost society \$10.7 million to \$15.0 million in 2008 dollars.¹² According to the U.S. Centers for Disease Control and Prevention (CDC) in 2013, AMR added an excess \$20 billion in direct healthcare costs and approximately \$35 billion in productivity loss per year.¹³

Of all the antibiotics sold in the United States, 80% were sold for use in animal agriculture (it should be noted that there are many more animals than humans).¹⁴ These antibiotics are given to the livestock to promote growth and prevent disease in the animals.¹⁵ Antibiotics used in this situation have been linked to high frequencies of resistant bacteria in the gut flora of chickens, swine, and other food-producing animals.¹⁵ This practice is projected to increase exponentially around the world in the next ten years.¹⁵ Growing evidence has shown that antibiotic resistance in humans has advanced due to the use of antibiotics in livestock and other animals.¹⁶ Antibiotic resistant bacteria can be transmitted to humans through direct contact with the animals, exposure to animal manure, through the intake of undercooked meat, and through contact with uncooked meat or surfaces the meat has touched.¹⁶ Without regulation, it is believed that resistant bacteria and genes could spread and emerge in the human population.¹⁷ However, the biggest driver of AMR is human behavior, especially the behavior of individual patients.

There are several human behaviors related to antibiotic use and misuse that can contribute to bacterial strains becoming drug resistant. Some individuals may take antibiotics when they are not needed. Sometimes physicians prescribe antibiotics that are

not truly necessary, and sometimes patients do not follow the orders from doctors and pharmacists.¹⁸ Patients may share their prescribed antibiotics with others who may not need them, or the shared medications may harm the recipient because they are the wrong dose or type of antibiotic for an existing infection.¹⁹ When someone else uses the prescribed medications, the patient the antibiotics were intended for does not get the full dose and duration of the prescribed therapy.²⁰ Discontinuing antibiotics early due to unpleasant side effects or feeling better can have the same outcome of bacteria within the patient becoming resistant to the drug.²⁰

The overuse and abuse of antibiotics has led to rise of AMR.¹⁸ In 2016, 270 million oral antibiotic prescriptions were written in the United States.²¹ This equates to enough antibiotic courses for five out of every six Americans to receive an antibiotic prescription.²¹ The CDC estimates that at least 30% of antibiotics prescribed are not necessary.²¹ Urgent care centers are stand-alone clinics that treat patients with acute illnesses or injuries that do not warrant the use of an emergency room or trauma center. Urgent care centers have the highest percentage of all visits that result in an antibiotic prescription. The CDC estimates that 46% of antibiotics prescribed in urgent care settings are not needed compared to 25% of prescriptions written in emergency departments, 17% in medical offices, and 14% in retail health clinics such as those housed within pharmacies like Rite Aid and Walgreens.²²

Colleges and universities are crucial sites for promoting community health and disease prevention activities. Those who pursue a postsecondary education are more likely to be receptive to health education and adopting healthier behaviors and practices.

In addition to the individual benefits resulting from said behaviors, students may share information with family and friends not enrolled in higher education. From there, knowledge, attitudes, and behaviors can spread into the communities of which they are a part.

Nearly 20 million students were enrolled in postsecondary education in the United States during the 2019–2020 academic year.²³ Roughly 48% of 18- to 24-year-olds in the U.S. were enrolled in postsecondary educational programs in 2017.²³ George Mason University (GMU) in Fairfax, Virginia, is the largest public university in the state, with approximately 37,800 students enrolled.²⁴ Students in college may participate in behaviors and practices that increase the possibility of AMR developing. This thesis examines the knowledge, attitudes, and behaviors related to AMR among undergraduate students at GMU.

METHODS

Eligibility Criteria

The eligibility criteria for this study included: (1) being enrolled as an undergraduate student at George Mason University; (2) being at least 18 years old; and (3) consenting to participate. A total of 670 individuals began the survey, 546 met all of the eligibility criteria, and 517 completed the full survey instrument.

Recruiting

Recruitment of participants was done through multiple methods. First, flyers with detailed information about the survey and the raffle, including pull-off tabs with the survey's web address, were posted in university-approved locations around campus. Second, these same flyers sans pull-off tabs were handed out in high trafficked areas around campus. Third, these flyers were posted on social media, such as Facebook and Reddit. Fourth, the survey was added to the list of activities that students enrolled in COMM 100 (Public Speaking) or COMM 101 (Fundamentals of Communication) could participate in to fulfill a research engagement requirement.

Those who fully completed the survey were offered a chance to enter a drawing for a \$50 Amazon gift card. To enter the drawing, participants clicked on a link at the end of the first survey that opened a second survey form where they could enter a university email address. The second survey containing the email addresses could not be linked to the original AMR survey. 477 email addresses were collected, with only 16

duplicate email addresses, which suggests that few students attempted to take the survey more than one time.

Survey instrument

The survey instrument included questions about demographics, health history, perceptions, knowledge, and attitudes concerning AMR, holistic health, and climate change. Six of the questions about AMR knowledge were adapted from the World Health Organization's (WHO) Antibiotic Resistance: Multi-Country Public Awareness Survey.²⁵ Five of the questions regarding climate change were adapted from a survey conducted by the research firm Ipsos.²⁶ Two of the questions about holistic health were adapted from a survey on natural remedies and homeopathy.²⁷ Prior to deployment of the survey instrument, master's student classmates were asked to review the questionnaire as part of a "pilot test."

Response options comprised of true/false questions, a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree), and "I have done this" to "I have not done this, and I would never do this." Answers were dichotomized into strongly agree and agree versus other answer choices. The full survey instrument is attached as an appendix.

Data Collection

Qualtrics, a quantitative online survey software program, was used to gather data. Participants could access the link by typing in the link, clicking on the link within social media posts and emails, or scanning the QR code. The survey was available online from January 22 to February 29, 2020.

Analysis

All analyses were done using STATA I/C 16 software. Bivariate analyses were conducted using Chi-square tests to test for differences in responses to antimicrobial resistance knowledge and behaviors by antimicrobial resistance practices.

Ethical Considerations

All study protocols were approved by the George Mason University Institutional Review Board (IRB). Because the IRB deemed this to be a low-risk study and there was therefore no need to collect any personally identifying information, participants were not required to sign a consent form. Instead, respondents must click “I agree” on the first page of the survey, which outlined the research procedures, risks, benefits, confidentiality, participation, and contact information for the study, to be allowed to continue with the survey.

A drawing for a \$50 Amazon gift card was held, with participants were invited to submit their email addresses to enter the drawing. The survey for email addresses was not linked to the study survey to keep responses completely anonymous. The winner was selected by random drawing at the end of the data collection period.

RESULTS

A total of 670 students began the survey. 546 students met all of the eligibility criteria (enrolled as an undergraduate at GMU and at least 18 years old), 527 completed over 90% of the questionnaire items, and 517 fully completed the survey. Among the 546 eligible participants, the age group with the highest number of students was 18-20 years old (n=330). The majority was female (n=320, 58.6%). In terms of race, 247 (45.3%) respondents identified as white, 146 (26.8%) Asian, 56 (10.3%) black or African American, and 46 (8.4%) other. 89 (16.3%) considered themselves Hispanic or Latino. Most were born in the United States (n=440, 80.6%). The majority were full-time students who are taking 12+ credits this term (n=509, 93.2%).

The respondents were similar to the student population that they were intended to represent. The university's undergraduate student population during the spring 2020 term (n = 25,697 degree-seeking undergraduate students) was 49.5% female; 37.9% white, 11.0% black, 15.6% Hispanic, and 20.9% Asian. 79.3% were full-time students. The study population was generally reflective of the diversity of the university's undergraduate student population, although the study sample included a higher representation of female, white and Asian, and full-time students.

The survey included three questions about AMR knowledge (Table 1). In total 432 respondents (82.0%) believed that antibiotic-resistant pathogens (germs) can be spread from person to person. The statement "antibiotic resistance is only a problem for people who take antibiotics often" is false, and 359 (68.1%) respondents provided the

correct answer. The statement “antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans” is true, and 314 (59.6%) answered correctly.

Table 1. Responses to questions about antimicrobial resistance and climate change knowledge, attitudes, and practices among undergraduate students at a large public university in the United States in February 2020.

Theme	Question (Number of respondents)	Response	Number with response	Percentage of respondents with response
AMR knowledge	Antibiotic-resistant pathogens (germs) can be spread from person to person (n=527)	True	432	82.0
	Antibiotic resistance is only a problem for people who take antibiotics often (n=527)	False	359	68.1
	Antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans (n=527)	True	314	59.6
Antibiotic knowledge	Antibiotics can cure most bacterial infections (n=527)	True	486	92.2
	Antibiotics can cure most viral infections (n=527)	False	277	52.6
	Antibiotics weaken a person’s immune system (n=527)	False	329	62.4
AMR practices	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had unpleasant side effects (n=527)	I have done this / I would consider doing it	231	43.9
	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better (n=527)	I have done this / I would consider doing it	200	38.0
	I have taken antibiotics that were not prescribed to me (n=527)	I have done this / I would consider doing it	122	23.2
	I have shared my prescription antibiotics with other people (n=527)	I have done this / I would	68	12.9

		consider doing it		
Attitudes	I am worried about antimicrobial resistance (n=517)	Agree / strongly agree	296	57.3
	I am worried about global climate change (n=517)	Agree / strongly agree	454	87.8
	Climate change is occurring (n=517)	Agree / strongly agree	487	94.2
	Global climate change is mostly due to human activity rather than natural causes (n=517)	Agree / strongly agree	467	90.3
	I am optimistic that we can address climate change if we take action now (n=510)	Agree / strongly agree	460	90.2
	I feel a personal responsibility to help do something about climate change, even if it is in a small way (n=510)	Agree / strongly agree	434	85.1
	I have taken steps to reduce the ways that my actions contribute to global climate change (n=527)	I have done this / I would consider doing it	468	88.8

Participants were asked three statements about their antibiotic knowledge. 486 (92.2%) correctly answered that “antibiotics can cure most bacterial infections.” The statement “antibiotics can cure most viral infections” is false, because for most viral infections there is no medication that suppresses or kills the agent. Of the participants in our study, 277 (52.6%) were aware that this was a false statement. The statement “antibiotics weaken a person’s immune system” is false. 329 (62.4%) participants correctly indicated that antibiotics are not harmful to the immune system.

Participants were also surveyed about their AMR practices. 231 (43.9%) of participants have stopped, or would consider stopping, antibiotics after a few days rather than the full course prescribed due to unpleasant side effects from the medication. 200 (38.0%) have stopped, or would consider stopping, antibiotics after a few days rather than the full course prescribed because they started feeling better. 122 (23.2%) have taken, or would consider taking, antibiotics that were not prescribed to them. 68 (12.9%) have shared, or would consider sharing, antibiotics with other people.

Students were asked about their attitudes regarding AMR and climate change. 296 (57.3%) of participants responded that they were worried about AMR. A much higher number, 454 (87.8%) were worried about global climate change. In total, 487 (94.2%) agreed that climate change is occurring, 467 (90.3%) agreed that global climate change is mostly due to human activity, 460 (90.2%) were optimistic that climate change could be addressed if action was taken now, 434 (85.1%) feel a personal responsibility to do something about climate change, even if it is in a small way, and 468 (88.8%) have taken steps to reduce how their actions contribute to global climate change. These types of attitudes were not exhibited in relation to AMR.

Respondents' answers were split into those who were worried about AMR and those who were not worried about AMR (Table 2). 296 respondents answered that they were worried about AMR; 221 of them were not.

Table 2. Responses to questions about antimicrobial resistance and climate change knowledge, attitudes, and practices among undergraduate students who are worried and not worried about antimicrobial resistance at a large public university in the United States in February 2020.

Theme	Question	Response	Population Sample (number of respondents)	Number with response	Percentage of respondents with response	p-value
AMR knowledge	Antibiotic-resistant pathogens (germs) can be spread from person to person	True	Worried about antimicrobial resistance (n=296)	254	85.8	0.009
			Not worried about antimicrobial resistance (n=221)	170	76.9	
	Antibiotic resistance is only a problem for people who take antibiotics often	False	Worried about antimicrobial resistance (n=296)	212	71.6	0.036
			Not worried about antimicrobial resistance (n=221)	139	62.9	
	Antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans	True	Worried about antimicrobial resistance (n=296)	201	67.9	< 0.001
			Not worried about antimicrobial resistance (n=221)	107	48.4	
Antibiotic knowledge	Antibiotics can cure most bacterial infections	True	Worried about antimicrobial resistance (n=296)	270	91.2	0.406
			Not worried about antimicrobial resistance (n=221)	206	93.2	
	Antibiotics can cure most viral infections	False	Worried about antimicrobial resistance (n=296)	115	38.9	< 0.001
			Not worried about antimicrobial resistance (n=221)	91	41.2	

	Antibiotics weaken a person's immune system	False	Worried about antimicrobial resistance (n=296)	170	57.4	0.006
			Not worried about antimicrobial resistance (n=221)	153	69.2	
AMR practices	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had unpleasant side effects	I have done this / I would consider doing it	Worried about antimicrobial resistance (n=296)	126	42.6	0.478
			Not worried about antimicrobial resistance (n=221)	101	45.7	
	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better	I have done this / I would consider doing it	Worried about antimicrobial resistance (n=296)	116	39.2	0.488
			Not worried about antimicrobial resistance (n=221)	80	36.2	
	I have taken antibiotics that were not prescribed to me	I have done this / I would consider doing it	Worried about antimicrobial resistance (n=296)	72	24.3	0.652
			Not worried about antimicrobial resistance (n=221)	50	22.6	
	I have shared my prescription antibiotics with other people	I have done this / I would consider doing it	Worried about antimicrobial resistance (n=296)	40	13.5	0.779
			Not worried about antimicrobial	28	12.7	

			resistance (n=221)			
Attitudes	I am worried about global climate change	Agree / strongly agree	Worried about antimicrobial resistance (n=296)	287	97.0	< 0.001
			Not worried about antimicrobial resistance (n=221)	200	90.5	
	Climate change is occurring	Agree / strongly agree	Worried about antimicrobial resistance (n=296)	278	93.9	0.002
			Not worried about antimicrobial resistance (n=221)	189	85.5	
	Global climate change is mostly due to human activity rather than natural causes	Agree / strongly agree	Worried about antimicrobial resistance (n=293)	269	91.8	0.001
			Not worried about antimicrobial resistance (n=217)	191	88.0	
	I am optimistic that we can address climate change if we take action now	Agree / strongly agree	Worried about antimicrobial resistance (n=293)	260	88.7	0.155
			Not worried about antimicrobial resistance (n=217)	174	80.2	
	I feel a personal responsibility to help do something about climate change, even if it is in a small way	Agree / strongly agree	Worried about antimicrobial resistance (n=296)	273	92.2	0.007
			Not worried about antimicrobial resistance (n=221)	187	84.6	
I have taken steps to reduce the ways that my actions	I have done this / I would	Worried about antimicrobial resistance (n=296)	279	94.3	0.006	

	contribute to global climate change	consider doing it	Not worried about antimicrobial resistance (n=221)	175	79.2	
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The statement, “antibiotic-resistant pathogens (germs) can be spread from person to person,” is true, and 254 (85.8%) of the respondents who were worried about AMR supplied the correct answer, compared to the 170 (76.9%) participants who were not worried about AMR who also gave the correct answer. The statement, “antibiotic resistance is only a problem for people who take antibiotics often,” is false, and 212 (71.6%) of the students who were worried about AMR provided the correct answer. 139 (62.9%) of those who were not worried about AMR also answered correctly. The statement “antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans” is true, and 201 (67.9%) of participants who were worried about AMR answered correctly, compared to the 107 (48.4%) of respondents who were not worried about AMR. Students who were more knowledgeable about AMR were also more worried about it.

270 (91.2%) and 206 (93.2%) of those worried and not worried about AMR, respectively, correctly answered the statement “antibiotics can cure most bacterial infections.” The statement “antibiotics can cure most viral infections” is false, and 115 (38.9%) of the respondents who were worried about AMR provided the correct answer, compared to 91 (41.2%) participants who were not worried about AMR who also gave the correct answer.

The statement “antibiotics weaken a person’s immune system” is false. Of the respondents who were worried about AMR, 170 (57.4%) gave the correct answer, along with 153 (69.4%) of respondents who were not worried about AMR.

Both groups were surveyed about their AMR practices. 126 (42.6%) and 101 (45.7%) of those worried and not worried about AMR, respectively, answered that they have stopped, or would consider stopping, antibiotics after a few days rather than take the full course prescribed due to unpleasant side effects from the medication. 116 (39.2%) and 80 (36.2%) of those worried and not worried about AMR, respectively, have stopped, or would consider stopping, antibiotics after a few days rather than take the full course prescribed because they started feeling better. 72 (24.3%) of those worried about AMR have taken or would consider taking antibiotics that were not prescribed to them; 50 (22.6%) of those not worried about AMR would do the same. 40 (13.5%) of those worried about AMR have shared or would consider sharing their prescription antibiotics with other people; 28 (12.7%) of those not worried about AMR would do the same.

287 (97.0%) of those worried about AMR are worried about global climate change; 200 (90.5%) of those not worried about AMR are also worried about global climate change. 278 (93.9%) and 189 (85.5%) of those worried and not worried about AMR, respectively, agree that climate change is occurring. 269 (91.8%) of those worried about AMR agree that climate change is mostly due to human activities rather than natural causes; 191 (88.0%) of those who are not worried about AMR agree with that statement. Both participants who are worried about AMR and those who are not worried are optimistic that climate change can be addressed if action is taken now, at 260 (88.7%)

and 174 (80.2%), respectively. 273 (92.2%) of those worried about AMR feel a personal responsibility to do something about climate change, even if it is in a small way; 187 (84.6%) of those not worried about AMR feel the same. 279 (94.3%) of those concerned about AMR have taken steps, or would consider taking steps, to reduce how their actions contribute to global climate change, with 175 (79.2%) of those not concerned about AMR doing the same.

Students were asked four questions concerning their AMR practices.

Respondents' answers were split into those who believe AMR is only a problem for frequent antibiotic users and those who do not believe that AMR is only a problem for frequent antibiotic users (Table 3). 168 participants answered that AMR is only a problem for frequent antibiotic users, and 359 disagreed.

Table 3. Responses from those who believe AMR is only a problem for those who take antibiotics frequently to questions about antimicrobial resistance practices among undergraduate students at a large public university in the United States in February 2020 (n=168).

Theme	Question	Response	Population Sample (number of respondents)	Number with response	Percentage of respondents with response	p-value
AMR practices	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had unpleasant side effects	I have done this / I would consider doing it	AMR is only a problem for frequent antibiotic users (n=168)	83	49.4	0.078
			AMR is not only a problem for frequent antibiotic users (n=359)	148	41.2	

	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better	I have done this / I would consider doing it	AMR is only a problem for frequent antibiotic users (n=168)	70	41.7	0.229
			AMR is not only a problem for frequent antibiotic users (n=359)	130	36.2	
	I have taken antibiotics that were not prescribed to me	I have done this / I would consider doing it	AMR is only a problem for frequent antibiotic users (n=168)	48	28.6	0.044
			AMR is not only a problem for frequent antibiotic users (n=359)	74	20.6	
	I have shared my prescription antibiotics with other people	I have done this / I would consider doing it	AMR is only a problem for frequent antibiotic users (n=168)	30	17.9	0.02
			AMR is not only a problem for frequent antibiotic users (n=359)	38	10.6	

Of this population, 83 (49.4%) of students have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because the medication had unpleasant side effects. 70 (41.7%) of respondents in this population have stopped, or would consider stopping, taking antibiotics after a few days rather than

finishing the full course because they started feeling better. 48 (28.6%) of the population have taken, or would consider taking, antibiotics that were not prescribed to them. 30 (17.9%) of the population have shared, or would consider sharing, their antibiotics with other people.

Students were asked four questions concerning their AMR practices.

Respondents' answers were split into those who answered "true" and "false" to the statement "antibiotics can cure viral infections" (Table 4). It is false that antibiotics can cure viral infections. 277 respondents provided the correct answer.

Table 4. Responses from those who believe antibiotics cure viral infections to questions about antimicrobial resistance practices among undergraduate students at a large public university in the United States in February 2020 (n=250).

Theme	Question	Response	Population Sample (number of respondents)	Number with response	Percentage of respondents with response	p-value
AMR practices	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had unpleasant side effects	I have done this / I would consider doing it	Antibiotics can cure viral infections (n=250)	113	45.2	0.548
			Antibiotics cannot cure viral infections (n=277)	118	42.6	
	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better	I have done this / I would consider doing it	Antibiotics can cure viral infections (n=250)	114	45.6	0.001
			Antibiotics cannot cure viral infections (n=277)	86	31.0	
I have taken antibiotics that	I have done this /	Antibiotics can cure viral	61	24.4	0.518	

	were not prescribed to me	I would consider doing it	infections (n=250)			0.044
			Antibiotics cannot cure viral infections (n=277)	61	22.0	
	I have shared my prescription antibiotics with other people	I have done this / I would consider doing it	Antibiotics can cure viral infections (n=250)	40	16.0	
			Antibiotics cannot cure viral infections (n=277)	28	10.1	

Of those who believe that antibiotics can cure viral infections, 113 (45.2%) of students have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because the medication had unpleasant side effects. 114 (45.6%) of respondents in this population have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because they started feeling better. 61 (24.4%) of those who believe that antibiotics can cure viral infections have taken, or would consider taking, antibiotics that were not prescribed to them. 40 (16.0%) of the same population have shared, or would consider sharing, their antibiotics with other people.

Students were asked four questions concerning their AMR practices. Respondents' answers were split into those who answered "true" and "false" to the statement "antibiotics weaken the immune system" (Table 5). It is false that antibiotics weaken the immune system. 329 participants provided the correct answer.

Table 5. Responses from those who believe antibiotics weaken the immune system to questions about antimicrobial resistance practices among undergraduate students at a large public university in the United States in February 2020 (n=198).

Theme	Question	Response	Population Sample (number of respondents)	Number with response	Percentage of respondents with response	p-value
AMR practices	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had unpleasant side effects	I have done this / I would consider doing it	Antibiotics weaken the immune system (n=198)	103	52.0	0.003
			Antibiotics do not weaken the immune system (n=329)	128	38.9	
	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better	I have done this / I would consider doing it	Antibiotics weaken the immune system (n=198)	95	48.0	< 0.001
			Antibiotics do not weaken the immune system (n=329)	105	31.9	
	I have taken antibiotics that were not prescribed to me	I have done this / I would consider doing it	Antibiotics weaken the immune system (n=198)	53	26.8	0.127
			Antibiotics do not weaken the immune system (n=329)	69	21.0	
	I have shared my prescription antibiotics with other people	I have done this / I would consider doing it	Antibiotics weaken the immune system (n=198)	30	15.2	0.232
			Antibiotics do not weaken the immune system (n=329)	38	11.6	

Of those who believe antibiotics weaken the immune system, 103 (52.0%) of students have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because the medication had unpleasant side effects. 95 (48.0%) of respondents in the same population have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because they started feeling better. 53 (26.8%) of those who believe antibiotics weaken the immune system have taken, or would consider taking, antibiotics that were not prescribed to them. 30 (15.2%) of the same population have shared, or would consider sharing, their antibiotics with other people.

Students were asked four questions concerning their AMR practices.

Respondents' answers were split into those who answered "true" and "false" to the statement "antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans" (Table 6). The statement is true. 314 respondents provided the correct answer.

Table 6. Responses from those who do not believe antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans to questions about antimicrobial resistance practices among undergraduate students at a large public university in the United States in February 2020 (n=213).

Theme	Question	Response	Population Sample (number of respondents)	Number with response	Percentage of respondents with response	p-value
AMR practices	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had	I have done this / I would consider doing it	Antibiotics given to livestock/other animals cannot reduce antibiotic effectiveness for humans (n=213)	101	30.7	0.172

	unpleasant side effects		Antibiotics given to livestock/other animals can reduce antibiotic effectiveness for humans (n=314)	130	65.7	
	I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better	I have done this / I would consider doing it	Antibiotics given to livestock/other animals cannot reduce antibiotic effectiveness for humans (n=213)	75	22.8	0.286
			Antibiotics given to livestock/other animals can reduce antibiotic effectiveness for humans (n=314)	125	63.1	
	I have taken antibiotics that were not prescribed to me	I have done this / I would consider doing it	Antibiotics given to livestock/other animals cannot reduce antibiotic effectiveness for humans (n=213)	53	16.1	0.437
			Antibiotics given to livestock/other animals can reduce antibiotic effectiveness for humans (n=314)	69	34.8	
	I have shared my prescription antibiotics with other people	I have done this / I would consider doing it	Antibiotics given to livestock/other animals cannot reduce antibiotic effectiveness	26	7.9	0.694

			for humans (n=213)			
			Antibiotics given to livestock/other animals can reduce antibiotic effectiveness for humans (n=314)	42	21.2	

Of those who do not believe antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans, 101 (30.7%) of students have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because the medication had unpleasant side effects. 75 (22.8%) of respondents in the same population have stopped, or would consider stopping, taking antibiotics after a few days rather than finishing the full course because they started feeling better. 53 (16.1%) of this population have taken, or would consider taking, antibiotics that were not prescribed to them. 26 (7.9%) of those who do not believe antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans have shared, or would consider sharing, their antibiotics with other people.

DISCUSSION

More than half of the participants in this study understood at least some of the science of AMR, such as the idea that AMR strains can be transmitted, that AMR is a problem for everyone, and that antibiotics given to livestock decrease the efficacy in humans. However, there were some critical knowledge gaps. Almost half of the students believed that antibiotics can cure viral infections, which they cannot. Roughly 40% had the impression that antibiotics can weaken the immune system. Those who were more knowledgeable about AMR were more concerned about it and more likely to act to prevent it.

Many participants had either engaged in or would consider engaging in bad practices that can further problems with AMR, such as stopping prescriptions early, taking antibiotics without a prescription, and sharing their own prescription antibiotics with other people. Misuse of antibiotics was more common among those who believed that AMR was only a problem for those who frequently use antibiotics and those who believed that antibiotics could weaken the immune system. Misperceptions may lead to further emergence and spread of AMR.

A significant proportion of participants were more worried about climate change than AMR. Most students agreed that climate change was occurring and that humans were responsible. However, they were optimistic that humans could address climate change, if they started now. A majority felt a personal responsibility to do something about climate change, even if it was in a small way. Many have already taken steps to

reduce their contribution to global climate change. Climate change may offer a model for how to improve knowledge and practices in regard to AMR. If there is more awareness about AMR and how to prevent and combat it, that might be an approach to empower people to personally take steps to decrease their contribution to AMR.

Though there are many policies and programs already in place that address AMR, more must be done to mitigate the problem. Governments should focus their efforts on preventing the spread of resistant bacteria and AMR, along with slowing down the rise of AMR. Implementing antimicrobial stewardship programs to guarantee the proper use and prescription of antibiotics would help in decreasing the abuse of antibiotics.²⁸

While the most important role for individuals is to avoid overuse and misuse themselves, individuals who are concerned about AMR can also help advocate for other policies that will slow the spread of AMR. For example, decreasing the use of antibiotics in livestock and other animals could help curb the spread of AMR, as a majority of the antibiotics consumed are not required. It would cost next to nothing to pass a law banning the use of excessive antibiotics in livestock and other animals.²⁹ This type of law is most likely to pass when lawmakers have evidence that their constituents care about AMR and will support elected officials who enact and enforce AMR stewardship programs.

Strengths and Limitations

This study had several limitations. A convenience population is not ideal, but the participants were reasonably representative of the student population at GMU. Although there were few significant differences in responses for males and females, the study

results may be slightly skewed due to higher participation rates from females. Second, the survey was administered at a single university within the Northern Virginia area, so results may not be generalizable to a larger population or another region. Finally, due to lack of proctoring, participants may have searched for answers to the knowledge questions while taking the survey.

The data were collected before the coronavirus (SARS-CoV-2) began circulating in the U.S. As a result, some of the attitudes about health and the environment may have changed due to school closures and disruptions to daily routine. An unforeseen strength is that this new awareness of the threat that infectious diseases pose to human health may invigorate more people to invest in combatting AMR.

Conclusion

AMR is a problem that necessitates cooperation from countries around the world to solve. This study shows how a lack of knowledge of antibiotics and AMR is associated with behaviors that could promote the spread of AMR. Increasing knowledge among college students and others about the science of AMR and how it occurs is an important part of the process of improving AMR awareness and promoting antimicrobial stewardship.

APPENDIX

Sustainability and Well-being Survey of Undergraduate Students

George Mason University

January–February 2020

Each of the areas under one header will be presented as one “page” in the online survey form. Clicking “next” will advance the survey to the next section.

STUDY INFORMATION / CONSENT

{See the informed consent statement in a separate file.}

Clicking ‘I agree’ below indicates your consent to participate in this survey.

ELIGIBILITY

1. Are you currently enrolled as an undergraduate student at Mason?
 - Yes
 - No
2. Are you at least 18 years old?
 - Yes
 - No

If the answer to either question is no, end survey after this question. When clicking “Next” to advance to the next set of questions, the individual will see a screen that says “Thank you for your interest in contributing to research. However, only current George

Mason University undergraduate students ages 18+ are eligible to participate in this study.”

DEMOGRAPHICS

1. Are you currently enrolled as an undergraduate student at Mason?

- Yes
- No

If no, end survey after this question.

2. Are you attending Mason as a full-time or part-time student?

- Full-time (12+ credits this term)
- Part-time (1-11 credits this term)

3. What is your class level?

- First-year student (<30 credits earned)
- Sophomore (30-59 credits earned)
- Junior (60-89 credits earned)
- Senior (90+ credits earned)

4. What is your age (in years)?

- Less than 18
- 18-20
- 21-25
- 26-30
- Over 30
- Prefer not to answer

5. Sex

- Female
- Male
- Other
- Prefer not to answer

6. Race

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or other Pacific Islander
- 2 or more categories
- Other
- Prefer not to answer

7. Ethnicity

- Hispanic or Latino
- Not Hispanic or Latino
- Prefer not to answer

8. Were you born in the United States?

- Yes
- No

9. Have you ever lived for 1 year or more in a country other than the United States?

- Yes
- No

10. Are you pursuing a major or minor that focuses on health?

- Yes
- No

11. Are you pursuing a major or minor that focuses on sciences?

- Yes
- No

12. Do you expect to earn a graduate degree (a master's degree or doctorate) at some point in the future?

- Definitely
- Highly likely
- Likely
- Unlikely
- Highly unlikely
- Definitely not

13. Do you plan on pursuing a clinical health profession (such as medicine, nursing, dentistry, or physical therapy) in the future?

- Definitely
- Highly likely
- Likely
- Unlikely

- Highly unlikely
- Definitely not

AREAS OF STUDY AT MASON

1. What is your major (check all that apply)?

Health

- Community Health
- Health Administration
- Health, Fitness, and Recreation Resources
- Human Development and Family Science
- Kinesiology
- Medical Laboratory Science
- Nursing
- Physical Education
- Psychology
- Rehabilitation Science

Science

- Astronomy
- Atmospheric Sciences
- Biology
- Chemistry
- Earth Science
- Environmental and Sustainability Studies

- Environmental Science
- Forensic Science
- Geography
- Geology
- Mathematics
- Neuroscience
- Physics
- Statistics

Education, Law, and Social Services

- Conflict Analysis and Resolution
- Criminology, Law, and Society
- Early Childhood Education
- Elementary Education
- Global Affairs
- Government and International Politics
- Public Administration
- Special Education
- Social Work
- Tourism and Events Management

Humanities and Social Sciences

- Anthropology
- Communication

- Economics
- English
- Foreign Languages
- History
- Philosophy
- Religious Studies
- Russian and Eurasian Studies
- Sociology

Business

- Accounting
- Business
- Finance
- Management
- Marketing

Engineering and Computer Sciences

- Applied Computer Science
- Bioengineering
- Civil and Infrastructure Engineering
- Computational and Data Sciences
- Computer Engineering
- Computer Game Design
- Computer Science

- Cyber Security Engineering
- Electrical Engineering
- Information Systems and Operations Management
- Information Technology
- Mechanical Engineering
- Systems Engineering

Art

- Art and Visual Technology
- Art History
- Creative Writing
- Dance
- Film and Video Studies
- Music
- Theater

Other

- Applied Science
- Individualized Study
- Integrative Studies
- Undecided

2. Do you consider your major to be related to health?

- Yes
- No

3. Are you pursuing a minor in addition to a major?

- Yes
- No

If yes, then show the follow-up questions.

3a. Do you consider your minor to be related to health?

- *Yes*
- *No*
- *I have no minor*

3b. Do you consider your minor to be related to science?

- *Yes*
- *No*
- *I have no minor*

4. Have you already completed your Mason Core requirement in Global Understanding?

- Yes
- No, but I am taking a global understanding course this semester
- No, I will complete this requirement later
- I'm not sure

5. Have you already completed your Mason Core requirement in Natural Science?

- Yes
- No, but I am taking a natural science course this semester
- No, I will complete this requirement later
- I'm not sure

6. Have you already completed ENGH 302 (Advanced Composition)?

- Yes
- No, but I am taking ENGH 302 this semester
- No, I will complete ENGH 302 later
- I'm not sure

7. Starting in Fall 2016, entering Mason student had the option of participating in the Mason Core Engagement Series (ENCORE). Are you completing one of the two optional Engagement Series pathways?

- I am completing the Engagement Series in Sustainability.
- I am completing the Engagement Series in Well-Being.
- I am not in an ENCORE program.

EXPERIENCE QUESTIONS

These questions and answers will be presented in a grid.

1. When did you most recently receive health services from a conventional healthcare provider, such as a physician or nurse practitioner?

- Within the past 1 year
- 1 to 3 years
- More than 3 years
- Never

2. When did you most recently receive chiropractic care or massage therapy?

- Within the past 1 year
- 1 to 3 years

- More than 3 years
 - Never
3. When did you most recently receive services from a complementary / alternative healthcare provider, such as an acupuncturist, homeopath, or naturopath?
- Within the past 1 year
 - 1 to 3 years
 - More than 3 years
 - Never
4. When did you most recently receive services from a mental healthcare provider, such as a psychologist or counselor?
- Within the past 1 year
 - 1 to 3 years
 - More than 3 years
 - Never
5. When did you most recently take prescription antibiotics for an infection?
- Within the past 1 year
 - 1 to 3 years
 - More than 3 years
 - Never
6. When did you most recently take prescription medication for pain management?
- Within the past 1 year
 - 1 to 3 years

- More than 3 years
 - Never
7. When did you most recently receive a vaccination?
- Within the past 1 year
 - 1 to 3 years
 - More than 3 years
 - Never
8. When did you most recently take a vitamin or mineral supplement (such as a daily multivitamin pill or a vitamin C tablet)?
- Within the past 1 year
 - 1 to 3 years
 - More than 3 years
 - Never
9. When did you most recently take an herbal remedy, herbal supplement, or other botanical medication (such as ginseng, echinacea, or detox teas) for health purposes?
- Within the past 1 year
 - 1 to 3 years
 - More than 3 years
 - Never
10. When did you most recently engage in a holistic health practice such as yoga or meditation for health purposes?
- Within the past 1 year

- 1 to 3 years
- More than 3 years
- Never

11. When did you most recently spend time in nature, such as taking a hike in a wooded area?

- Within the past 1 year
- 1 to 3 years
- More than 3 years
- Never

HYPOTHETICAL QUESTIONS

These questions and answers will be presented in a grid.

1. I have taken antibiotics that were not prescribed to me.

- I have done this
- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

2. I have shared my prescription antibiotics with other people.

- I have done this
- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

3. I have recommended holistic health practices such as yoga or meditation to other people.

- I have done this

- I have not done this, but I would consider doing it
 - I have not done this, and I would never do this
4. I have recommended herbal remedies or other types of natural medicines (other than vitamins or minerals) to other people.
- I have done this
 - I have not done this, but I would consider doing it
 - I have not done this, and I would never do this
5. I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because I started feeling better.
- I have done this
 - I have not done this, but I would consider doing it
 - I have not done this, and I would never do this
6. I have stopped taking antibiotics after a few days rather than taking the full course prescribed by my doctor because the medication had unpleasant side effects.
- I have done this
 - I have not done this, but I would consider doing it
 - I have not done this, and I would never do this
7. I have tried using complementary / alternative medicine for an illness before seeking conventional medical care.
- I have done this
 - I have not done this, but I would consider doing it
 - I have not done this, and I would never do this

8. I have used natural / holistic remedies for an illness at the same time as prescription medication.

- I have done this
- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

9. I have used complementary / alternative medicine to restore my health after taking antibiotics for an infection.

- I have done this
- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

10. I have taken steps to reduce the ways that my actions contribute to global climate change.

- I have done this
- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

11. I have participated in a march, rally, or other form of collective activism for an issue I care about (such as reducing gun violence or supporting Earth Day).

- I have done this
- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

12. I have voted in a local or national election.

- I have done this

- I have not done this, but I would consider doing it
- I have not done this, and I would never do this

TRUE/FALSE QUESTIONS

These questions and answers will be presented in a grid.

This instruction will be presented to participants:

Use “true” to indicate answers that are always, mostly, or usually true and “false” to indicate answers that are always, mostly, or usually false.

1. Antibiotics can cure most bacterial infections.

- True
- False

2. Herbal remedies can cure most bacterial infections.

- True
- False

3. Antibiotics can cure most viral infections.

- True
- False

4. Herbal remedies can cure most viral infections.

- True
- False

5. Antibiotics weaken a person’s immune system.

- True
- False

6. Herbal remedies strengthen a person's immune system.
- True
 - False
7. People should stop taking antibiotics as soon as the symptoms of an infection go away.
- True
 - False
8. People should stop taking herbal remedies as soon as the symptoms of an illness go away.
- True
 - False
9. Antibiotic resistance is only a problem for people who take antibiotics often.
- True
 - False
10. People can develop resistance to herbal remedies, and the natural products will not work as well for those people as they did before.
- True
 - False
11. Antibiotic-resistant pathogens (germs) can be spread from person to person.
- True
 - False

12. Antibiotics given to livestock and other animals can reduce the effectiveness of antibiotics for humans.

- True
- False

13. Most scientists agree that global warming is happening.

- True
- False

14. Stress contributes to many physical and mental health problems.

- True
- False

ATTITUDES AND PERCEPTIONS 1

These questions and answers will be presented in a grid.

1. When I have a mild illness, I prefer to use holistic health practices (such as herbal remedies and massage) rather than conventional medicine (such as antibiotics and pain medication).

- Strongly agree
- Agree
- Disagree
- Strongly disagree

2. When I have a severe illness, I prefer to use holistic health practices (such as herbal remedies and massage) rather than conventional medicine (such as antibiotics and pain medication).

- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
3. Positive thinking can prevent mild illnesses.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
4. Positive thinking can prevent severe illnesses.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
5. Positive thinking can help people recover from mild illnesses.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
6. Positive thinking can help people recover from severe illnesses.
- Strongly agree
 - Agree

- Disagree
 - Strongly disagree
7. I am worried about antimicrobial resistance.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
8. I am worried about global climate change.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
9. Climate change is occurring.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree
10. Climate change is causing more droughts and water shortages.
- Strongly agree
 - Agree
 - Disagree
 - Strongly disagree

11. Climate change is causing storms to become more severe.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

12. Climate change is harming animal wildlife and their habitats.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

13. Global climate change is mostly due to human activity rather than natural causes.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

ATTITUDES AND PERCEPTIONS 2

These questions and answers will be presented in a grid.

1. Living a healthy lifestyle is important to me.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

2. A healthy diet will prevent most illnesses.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

3. Daily exercise will prevent most illnesses.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

4. I am hopeful about life in general.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

5. I feel optimistic about my future.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

6. I typically use alternative / complementary medicine or holistic approaches to health rather than conventional medicine.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

7. My siblings / cousins (family members in my generation) typically use alternative / complementary medicine or holistic approaches to health rather than conventional medicine.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

8. My parents / aunts / uncles (family members 1 generation older than me) typically use alternative / complementary medicine or holistic approaches to health rather than conventional medicine.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

9. My grandparents / great aunts / great uncles (family members 2 generations older than me) typically use (or used) alternative / complementary medicine or holistic approaches to health rather than conventional medicine.

- Strongly agree

- Agree
- Disagree
- Strongly disagree

10. I feel a personal responsibility to help do something about climate change, even if it is in a small way.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

11. New technology will solve most of the problems associated with climate change.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

12. It is too late to stop climate change, so there is no point in trying.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

13. I am optimistic that we can address climate change if we take action now.

- Strongly agree
- Agree

- Disagree
- Strongly disagree

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