Mindsets and Air Pollution in a Dynamic Urban Environment: How Attitudes and Behaviors May Aggravate Public Health Outcomes in Almaty, Kazakhstan

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Abstract

Using an original public opinion survey we study attitudes and behaviors toward air pollution in Almaty, Kazakhstan, a growing modern city with extremely high concentration of air pollutants. Utilizing the Health Belief Model (HBM) framework previously used to understand an individual's health decision-making, we evaluate levels of citizens' awareness of the poor air quality, their perception of risk and harm it poses to health, and their willingness to devote time and resources to reduce their air pollution exposure. The issue of air quality in Almaty–Kazakhstan's most populous and wealthiest city– has received much attention in recent years, but little research has been done to thoroughly examine public attitudes, which ultimately would drive any solutions to the problem. Our study finds that although citizens are aware of the gravity and general harms of Almaty's air pollution, they significantly underestimate their personal risks and health consequences. The survey also shows citizens are unwilling to think of air pollution as their own personal health problem and often engage in daily routines that exacerbate their exposure to pollution. We conclude that shifting public discourse from the collective/government to the individual/community problem domain will have a beneficial effect on daily practices which may lead to reduction of exposure and improvements in public health outcomes. Such attitudinal and behavioral changes are necessary first steps to promote environmental consciousness and effective pollution reduction programs.

Keywords: HBM, air pollution, environment, public opinion, public health, Kazakhstan, Almaty

Introduction

The city of Almaty is the largest urban area in Kazakhstan, an upper middle income and the most prosperous country in Central Asia. A former capital, the city is home to 1.8 million people, or nearly 3 million, including the entire metropolitan area. A major exporter of oil and minerals, Kazakhstan is an industrialized and dynamically growing transitional economy. Unlike many other Kazakh cities that host industrial production, Almaty's economy is primarily service oriented. With no major polluting industries around the city, population growth and increased prosperity have been the major factors contributing to increasingly poor air quality: heating and traffic in a megapolis surrounded by the world's highest mountains (Tian-Shan mountain range is part of the Himalayas) are the major culprits of air pollution.

A 2020 study that analyzed most common air pollutants between 2013 and 2018 reported that annual averages of PM2.5, PM10, and NO_2 pollution concentrations in Almaty exceeded the WHO annual limits by 5.3, 3.9, and 3.2 times, respectively (Kerimray et al., 2020). The US Environmental Protection Agency considers PM2.5 (particulate matter 2.5 micrometers or smaller) pollution to pose the most severe health risks because the particles are small enough to penetrate lungs and get into the bloodstream (EPA.gov). According to the World Bank in 2013, the levels of PM10 and PM2.5 in Almaty cost the city an additional 486 million US dollars in medical care (Kerimray et al., 2020). These health costs increase the number of people with asthma, chronic obstructive pulmonary disease (COPD), and other cardiovascular health issues. Research has conclusively linked air pollution across Kazakh cities to higher than average instances of respiratory and cardio-vascular disease. Air pollution is estimated to contribute 16,000 cases per year to the national mortality estimate (Kenessariyev, 2013). The poor air quality contributes to the severe visible smog, accumulation of dust and residue inside buildings, and residents reporting difficulty breathing. In 2018, city residents spontaneously organized online groups and traditional civil initiatives to seek more information about the extent of air pollution, its sources, health effects, and to pressure the government to enact environmental measures. Still, Kazakh meteorological services or medical institutions do not issue air quality alerts to the general public, nor do they advise vulnerable populations to avoid outdoor pollution. The information from the existing air quality monitors remains a purview of a narrow group of specialists and enthusiasts. No individual protection and mitigation measures, such as air filtration systems, avoidance of outdoor activities for vulnerable populations, or face mask wearing are being practiced or promoted in the city.

The local government of Almaty has taken steps to address the air pollution problem in their city. These include regulatory initiatives, infrastructural changes, and renovation of the central heating plants. Starting in the late-1990s the city introduced environmental inspection block posts to enforce traffic emissions standards. It invested in municipal tree planting and banned unauthorized logging of trees, which are widely regarded as essential components of air pollution mitigation. In 2018 the city of Almaty launched a program to develop a more sustainable bus system, and became a customer of Eurobus, an electric bus service, in an attempt to reduce pollution from traffic. In 2021 the city awarded a contract to upgrade the existing coal and natural gas powered heating plants that supply hot water and heat to the vast majority of city's residential and business buildings. The purpose of the upgrade is to reduce harmful emissions that contribute to nearly half of particulate matter pollution during a 6-month long heating season. Nonetheless, the government is still not doing enough to address the public health consequences of poor air quality. With the city population growth projections, existing measures might be able to slow deteriorating pollution, but are unlikely to revert the trend in the near future.

Kazakhstan is rich in hydrocarbon resources. The government's high share of ownership in the energy sector allows it to subsidize energy prices for residents, which make coal and natural gas the most cost-effective sources of residential heating. Heating with hot water is produced and distributed centrally and most residents do not have access to alternative heating options. Average incomes are high enough for gas-powered vehicles, but not sufficient for more expensive electric cars. These factors make a speedy energy transition highly unlikely in the near future.

As the air pollution continues to affect Almaty residents, preserving their health becomes the most paramount concern. Unfortunately, the city takes no preventative public health measures to mitigate adverse health effects of air pollution. Even the majority of the citizens of Almaty are not taking the necessary steps to keep themselves safe. Moreover, they often preserve unhealthy and environmentally damaging practices, such as opening their windows during the heating season. Such practices simultaneously increase their exposure to air pollution and increase the demand for more heat generated by burning fossil fuel. Due to the lack of governmental and individual effort to mitigate the health risks of poor air quality, it is pertinent to find out what is stopping people from engaging in healthier behavior. To understand why most Almaty citizens do not take action to reduce their air pollution exposure, we conducted a public opinion survey, distributed electronically throughout the city of Almaty.

One purpose of the survey is to evaluate the general awareness the public has of poor air quality and their opinion of the environment in Almaty. To our knowledge there are no national surveys that tell us what the population of Almaty knows about air quality. However, a 2013 study measured the awareness Kazakhs had on the health effects of smoking. Roberts et al. found that only 61.6% and 58.2% of people in Kazakhstan are aware that smoking can cause heart disease and bronchitis respectively and found that only 19.4% of Kazakhs had the characteristics associated with a high knowledge of the harmful effects of tobacco (Roberts et al., 2013). Because poor air quality causes many of the same health problems, but is a more obscure problem, it is likely that less than 19.4% of Almaty residents have high levels of knowledge of the negative effects of air pollution.

To analytically disintegrate various aspects of an individual's opinion on air quality's health effects we design survey questions about awareness, perception of harm, and behaviors. Our approach is inspired by the theoretical framework of Rosenstock's Health Belief Model (HBM). The HBM is a collection of five perceived attitudes of a certain health risk, which theoretically can predict if a person will make a health behavior change. These attitudes include: 1) Perceived severity, 2) Perceived Susceptibility, 3) Barriers to Preventive Action, 4) Benefits of Preventative Action, and 5) Self-efficacy (Rosenstock et al., 1988). The sixth factor of this model is cue to action, which is the trigger for the health behavior. The model posits that, if perceived susceptibility and severity are high, barriers to preventive action are low, benefits of preventive action are high, and self-efficacy is high, a person is likely to follow healthier behavior.

The HBM can be used to predict taking a medication or quitting smoking or attending a program or getting a mammogram test, any positive health behavior. We believe that this model is well suited to analyze individual behaviors to reduce air pollution exposure as well. In other words, we expect that the lack of awareness of individual harm and belief in the efficacy of individual actions can explain why some Almaty residents engage in practices that increase their exposure and aggravate the negative public health effect of pollution.

HBM is well established. The predictive quality of all the factors of the model is not certain. In a meta-analysis study of 18 studies using the health belief model, benefits and barriers were the only strong predictors of longitudinal behavior change (Carpenter, 2010). The model has stronger

predictive ability when the treatment was preventative versus for an existing illness (Carpenter, 2010). There is also debate about whether self-efficacy should be officially included in the HBM, but it will be included in this study. A 2021 study found that self-efficacy was the only predictive factor of healthy eating in young adults (Dumitrescu and Iacob, 2021). In a study that tested when Jordanians adhered to home quarantine instructions during the COVID-19 pandemic using the HBM, researchers found that seriousness (or severity), benefits, and barriers were significant predictors (Al-Sabbagh et al., 2022). These results are significant in the case of air quality because reducing exposure to air quality requires many of the same actions as reducing exposure to COVID-19. We expect to see similar results for air pollution attitudes in Almaty.

Using questions that correspond to different perceived attitudes within the HBM, we will assess which of these factors are most relevant to making good health choices in the Almaty population, and attempt to target those attitudes with information distribution. The survey will combine demographic questions with questions addressing the HBM in order to control for variables that might impact attitudes. A study found that a higher level of education and income lead to increased knowledge about cancer and, therefore, healthier practices like not smoking (Wilkinson et al., 2009).

Contextualizing our Study: In-person Interviews, Observations, and Interactions

To better understand various ways Almaty residents are being affected and respond to air pollution between May 19th, 2022 and May 29th, 2022 we conducted observational field research in Almaty. We learned that people in Almaty are not oblivious to the poor air quality around them, but often view the problem as an unavoidable consequence of living in the city. In conversation, people mentioned air quality issues are discussed as early as elementary school. People made it clear they believe air quality is poor in Almaty, but it is much worse in other parts of the world. The day to day exposure to poor air quality has made people apathetic to the issue. Many activists blame the construction of high rise buildings for disrupting air flow in the city, but these claims are as of yet unsupported by scientific evidence.

Rapid urbanization within the city of Almaty has not only led to the construction of new high rise buildings, but increased transportation and energy demands as well. This has resulted in decreasing air quality, but has not led to changes in behaviors. In peak stand-still traffic cars sit idle with their windows open, even when functioning air conditioning is available. This exposes passengers and drivers to PM2.5 concentrations of over 35 μg/m^3 in summer months when air quality is considered best. Homes and professional buildings equipped with air conditioning chose to open windows when it is hot regardless of proximity to major pollutants, letting particulate matter contaminate cleaner indoor air. This is due to the widespread belief that air conditioning can cause illnesses like the cold.

In winter months air quality is at its worst due to pollution from coal heating plants, at-home furnaces used for heating, and vehicle emissions. In homes built before 2005, residents are unable to regulate the temperatures of their at-home radiators. The heating is state-regulated, and the state sets the temperature of the water that travels out to every home. Many homes then

become too hot, with residents subsequently deciding to open their windows for relief, which, in turn, allows in polluted air.

Additionally, representatives for air filtration units come to school, but it is agreed these units are too expensive for most people to purchase. As one person said, the units are too expensive because the problem is not of high enough importance.. Some people mentioned they would be willing to take alternate routes to school to avoid poor air quality, but they often must walk near high pollution sources like major roadways. Nearly every person shared the same thought process: air pollution is a problem, but it is an unavoidable one.

Survey Design and Data Collection

The survey was developed on the Qualtrics platform and is being distributed electronically in Almaty, Kazakhstan. The survey can be taken anonymously on a personal computer or a smartphone. The Qualtrics platform ensures anonymity and prevents multiple submissions. Confidentiality of respondents is enhanced in electronic distribution: they can answer survey questions in the privacy of their homes and at the time most convenient for them. The prospective study participants were enrolled via two methods: a QR code available to scan and a list of emails provided by the Almaty Management University (AlmaU). At the end of the survey respondents had an opportunity to send the survey invitation to their friends and families, forwarding the anonymous survey link to their phones or emails.

The Qualtrics survey solicits participants' informed consent, explains the purpose of the study, and provides the PI's and local contact information. Participation in the survey is voluntary and can be terminated at any point during the survey. The survey was translated to local languages, Kazakh and Russian, giving the respondent an option to choose their preferred language. The accuracy of translation was verified by our Kazakh co-investigators fluent in Russian and Kazakh.

At the beginning of the survey the participants are informed about the anonymity of their responses and that the results will be used in an aggregated format to study public attitudes and general behavioral patterns of city residents. At the end of the survey we provided a debriefing statement that more specifically outlines the air quality focus of the research. Our survey questions encompassed multiple categories to give us a strong and more complete understanding of the health and beliefs of citizens in Almaty. Our main categories of questions include: awareness of air pollution, concern regarding air pollution and its health effects, behaviors increasing risk of exposure to air pollution, and the willingness to change behavior and/or pay.

Our first category of questions, awareness of air pollution, focuses on understanding the basic knowledge regarding air pollution among citizens in Almaty. There were a total of seven of these questions, and they were positioned at the beginning of the survey. These questions were largely scale or ranking based, so as to give us a better understanding of awareness regarding air pollution, as a single-input approach may have not provided the larger picture that a ranking system of questions does. Furthermore, we placed these questions at the beginning of the survey to get as unbiased responses as possible, as information later in the survey may have influenced

participants to select answers indicating more awareness of air pollution. However, these answers may not have been completely organic, as they could have been influenced by previous questions, but placing them at the beginning minimizes this effect as much as possible.

Closely related to our first category of questions are our questions which asked participants their level of concern regarding air pollution and its health effects. These questions were somewhat intermixed with the first category regarding awareness, as this would again protect against potential bias they may experience if these questions were placed later in the survey. These questions, again similarly to the first category of questions, were answered either on a scale or in levels. This was integral, as we wanted to gauge concern among and between different demographic groups in the city, and a scale system allowed us to do this.

The next category we included in the survey is behaviors increasing risk of exposure to air pollution, and is by far the longest. It is also the most important, as it gives us a direct look into what actions and behaviors people in Almaty are partaking in. These questions are framed in ways that do not immediately create a bias, and never mention air pollution. This is done to ensure participants do not answer these extremely important questions with a bias, as we want to truly understand their behaviors, especially if they are dangerous in relation to air pollution. These questions focused on home life, travel, and activities outside, as actions and habits regarding these settings often account for the vast majority of air pollution exposure in Almaty. These options for responses to these questions range in format, based on whatever is deemed most appropriate in order to get the clearest understanding of the respondent's behaviors. This was done because we wanted specific and generalizable behaviors and habits that we could address, instead of a large board of different answers which would make it difficult to create a solution to the problem. Furthermore, we sacrificed some customizability for the sake of time, as though we did have fill-in-the-blank options, too many would lead to a far longer survey, which often leads to far fewer responses.

Lastly, we included questions relating to individuals' willingness to change their behavior/pay to mitigate the level of air pollution. These questions were specially designed, and treated as experimental questions. They were placed at the very end of the survey, as we were not as concerned with bias with these questions, as they would be more informed moving forward regardless. These questions were specially designed by our team, and utilized graphics to more accurately convey the question, due to the moderate level of complexity in the questions. Furthermore, we tested levels of knowledge as well, as we first asked what percentage of monthly income would individuals spend to reduce their risk by 33%. However, the next question included information detailing the true nature of the air pollution problem in Almaty, and then asked the participant the same question to test if more awareness would change beliefs among the citizens.

Along with the four main categories of questions mentioned above, we also included a large number of demographic questions to give us a better idea of who each participant was so we could draw more advanced socio-economic conclusions. These demographic questions were placed throughout the survey, and often overlapped with other categories of questions like actions exposing individuals to air pollution, children, and household location.

Data Management and Analysis

Qualtrics' platform recorded anonymous survey responses and stored these on the inscription-protected server. After the survey was concluded the anonymous data was downloaded and all digital identifiers, such as the timestamp of the survey collection were purged from the data. The data bill is organized by assigning unique identifiers to the anonymous respondents. These data were analyzed with the difference of means (for the randomized experimental element) and regression analysis tools using STATA.

The final survey consists of 49 questions and is expected to take 10 minutes to complete. We translated the questions to Russian, Kazakh, and English languages to make the survey accessible for the whole population of Almaty. The first distribution took place on April 17 on Almaty Marathon, which our AlmaU partners have attended to distribute the posters with the printed QR code for the survey. It was a crowded event, so people were approached to complete the survey. During the fieldwork, on May 27, our team did the second QR code distribution during a presentation of the project to the Almaty public at the "American Corner" public meeting space located in the center of Almaty and administered by the US Consulate's public affairs division. Before the presentation, the attendants had the option to scan the code or start the paper version of the survey, but all opted for the digital version and completed the survey.

The other major distribution took place in April, when we sent out the email about the survey to over 4,500 AlmaU faculty and students. In the email, we introduced the AlmaU and Lehigh partnership and provided the overview of the project. Our final distribution strategy is designed to reach a wider public and is following a snowball sampling approach in which the participants of our email-distributed survey will receive a sharable link to forward to their friends and family. We expect to finalize data collection by June 30th and reach 300 completed responses.

Perception	Questions that apply	Answer that indicates a perception	Level of perception
Perceived susceptibility	Do you think pollution affects your health?	Yes	high
	In your opinion, what are the major causes of health problems you and your relatives have? (you may choose multiple answers)	bad environment, pollution (other answers irrelevant here)	high
Perceived severity	How concerned are you about environmental pollution?	1 to 3	low
		4 to 7	mid
		8 to 10	high
	To what extent do you agree or disagree with the following statements?: Air pollution can lead to serious health problems	agree	high
		middle	mid
		disagree	low
Perceived benefits	To what extent you agree or disagree with the following statements?: I can take actions to prevent negative health effects of air pollution	agree	high
		middle	mid
		disagree	low
Perceived barriers	What best describes your position on air purifiers?	I have an air purifier and use it	low
		I have an air purifier, but don't use it as often as I should	mid
		I have an air purifier, but don't use it because it does not make a difference	mid
		I don't have an air purifier because these are not available/ affordable	high
		I don't have an air purifier and i don't believe i need one	high
		I don't have an air purifier but I want to buy one	mid
		I do not know what an air purifier is	high
	Do you use air conditioner (have an air conditioner?	I use it all the time when needed	low
		I don't use as often as I would like to save energy	mid
		I don't use it because it does not make a difference	high
		I don't use it because I don't need it	high
	Do you use air conditioner (do not have an air conditioner)?	I don't have an air conditioner because these are not available/affordable	high
		I don't believe I need one	high
		I do not have an air conditioner but I want to buy one	mid
		I do not know what an air conditioner is	high
	Do you wear a face mask while outdoors?	often	low
		sometimes	mid
		rarely	high
		never	high
	Does the way you travel to work or school change depending on weather?	Never	high
		Rarely	high/mid
		Sometimes	mid
		Often	low
		Always	low
Perceived self efficacy	Which of the following do you feel has the most potential to protect the environment in Almaty? (Rank order options: 1 - the most potential, 8 - the least potential)	Citizens rank 1-2	low
		Citizens rank 3-6	mid
		Citizens rank 7-8	high
	To what extent do you agree or disagree with the following statements?: Wellness practices (diet, exercise, etc.) can prevent illness	agree	high
		middle	mid
		disagree	low

Table 1: This table explains how we will analyze each of the questions associated with perceptions included in the HBM. Note that rating high in perceived barriers will work against completing a healthy behavior while rating high in other perceptions is in favor of a healthy behavior.

To test for the role of cues to action, the survey embeds an experimental design. Respondents are randomly assigned to two treatment groups and one control group. The treatment groups receive one of two prompts: 1) discussing risks of air pollution and benefits of mask wearing and air filtration; 2) discussing the risks only. The prompt is then followed by a question that asks the participant to select their willingness to pay (WTP) for a marginal reduction in premature mortality risk. This question will help us quantify the value of statistical life (VSL) in Almaty, which provides a general understanding and estimate of how dire Almaty citizens feel their current situation is (OECD, 2014). VSL was developed in the European Union, and is primarily used there. Because of this, the VSL had to be converted in order to be properly calibrated to the socio-economic status of Almaty. This WTP question will also be accompanied by a graphic illustrating the magnitude of risk change based on their answer. Here are examples of this graphic:
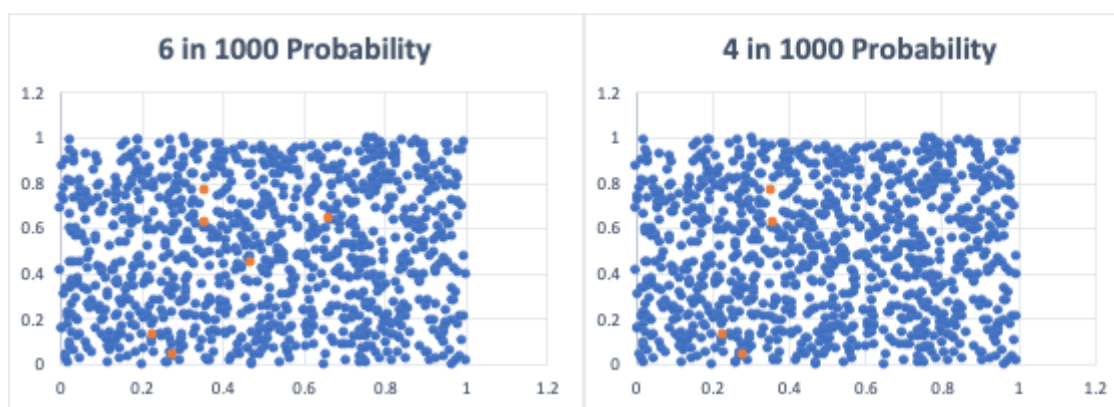
The next questions touch on the respondents' willingness to change their daily commute, wear masks, insulate and air-filter their houses. The survey also includes a battery of socio-demographic questions to address the confounding variables suggested by the theoretical model.

After we finish data collection, we plan to test hypotheses about how different components of the HBM contribute to the self-reported pollution-mitigation practices. In accordance with the HBM, we expect separate and positive effects of various measures of awareness and harm perception on individual pollution-mitigation practices. By analyzing the distribution of responses to our question we will be able to identify the "weak links" in public awareness and behavioral practices. This may suggest promising areas for the community-outreach activities, such as designing health and well-being information campaigns, developing wellness mobile applications, and interacting with the local stakeholders representing the vulnerable populations in the city of Almaty.

Results of Survey

We received a total of 34 complete responses from the survey across our distributions. This was less than we anticipated, but still provides us with a better understanding of the citizens of Almaty

and their attitudes towards air pollution and their health. The first questions in our survey, those asking participants of their knowledge of air pollution, were surprising to us. On our first question, which asked "How concerned are you of environmental pollution? (on a scale from 0- not concerned to 10- very concerned)", 34% of participants responded with a ten. Furthermore, 53% of respondents chose answers of 7-9 on the scale of concern. We did not anticipate this, and were expecting a number closer to 30% of responses for the entire scale of 7-10 in concern.

This trend of apparent higher awareness of air pollution continued, especially in earlier questions which dealt directly with knowledge of air pollution. However, we did find something we were expecting in our question inquiring as to the effect of air pollution on individuals' health. Our sixth question asked: "Do you think air pollution affects your health?", and the possible responses to this were yes, no, and maybe. The responses to this question were that 94% of participants stated they believed air pollution affected their health. These responses were not surprising, given the trend of seeming increased awareness of air pollution. However, we wanted to measure not just the overall awareness of air pollution and base effects on health, but wanted to get a sense of just how much individuals thought air pollution affected their health. To better understand this, we included question 9, which asked participants "In your opinion, what are the major causes of health problems you and your relatives have? (you may choose multiple answers)." The responses to this question shed some light on the previous responses to earlier questions asking about baseline awareness of air pollution and its effects, as only 17% of responses selected air pollution as a major cause of health problems. The effect of poor air pollution on health problems in Almaty is expected to be much higher than 17%, and is something we were expecting to see, which is a lack of high levels of knowledge on the issue of air pollution and its effects.

Another important aspect we noticed in responses was a lack of knowledge of effective and safe methods of air pollution exposure mitigation. For example, our 11th question which posed the question "To what extent do you agree with the following statements?", and then listed: "air pollution can lead to serious health problems", "it is important to spend time outside to get fresh air", "it is important to ventilate my home to let fresh air in", "wellness practices can prevent illnesses", "sometimes it's better to stay inside to not breathe bad air", "I can take actions to prevent negative effects of air pollution", and "sometimes air outside is worse than air inside my house." The majority of these statements are false in Almaty, and the air outside homes is typically 2-3 times more polluted than inside the home. We asked this question to further gauge true knowledge of air pollution and its effects on health. We received expected responses, such as 68% of participants believed it is important to spend time outside to get fresh air and 65% of participants believed it is important to ventilate their homes to let in fresh air. Additionally, 47% of participants selected a 5 or lower on a scale of 10 as a response to the statement "I can take actions to prevent negative effects of air pollution." The responses on this question in particular reinforces our idea that action can be taken to better inform the public on their ability to mitigate the effects of air pollution, and that the majority of people in Almaty are not as informed as is necessary to protect themselves from air pollution.

Another integral element of this survey was that of the behaviors and habits of the citizens of Almaty. We dedicated a large portion of our questions to this purpose, and received results we

were mostly expecting. For example, for our question 29, we asked participants to check all the statements they agreed with, and included answers of "When the heating is on, the best way to to make my house comfortable is to open windows", "On hot days, it is better to open the windows than to run air conditioning", "In a car or on a bus I like open windows for fresh air", "I regularly check air quality reports to know levels of pollution", "On days when the air is highly polluted I do not feel well", and "On days when the air quality is bad I avoid outdoor activities." This question was extremely important for us, as it would give us a much better understanding of the habits of the people of Almaty, and their level of danger in relation to air pollution. Predictably, the habits expressed in this question are not mitigating the effects of air pollution. 29% of responses to this question agreed the best way to make their house comfortable when the heat is on is to open the windows, and this was validated by observations and conversations during fieldwork. This is an extremely dangerous habit given air pollution is at its worst during the winter months. Furthermore, 32% of respondents agreed they like to open windows in buses or cars for fresh air. Again, this habit only increases exposure to air pollution, as traffic is one of the main contributors to air pollution in Almaty, and air pollution readings are extremely high on roads. Possibly the most startling statistic in the entire survey was also received in response to this question, only 0.4% of respondents agreed they regularly checked air pollution readings. As stated earlier, these responses are alarming, but they reinforce our resolve to continue our work to mitigate individuals' exposure to air pollution in Almaty, especially through education, as a change in just a few of these habits could significantly increase quality of life for so many.

The last category of questions were the experimental questions included at the end of the survey. The experimental element consisted of two questions, with the same set of answers, but with differing information. The first question asked participants what percentage of their income they would be willing to contribute to bring their risk from getting sick due to air pollution down from 6 in 1000 to 4 in 1000. Every respondent selected that they would contribute some percentage of their income, with the majority selecting to contribute 1-5% of their income. The follow-up question contained all the same answers to the question, and consisted of largely the same writing, but also included writing of how this cost would most-likely also include changes in habits, such as taking different routes to work and biking more. Unlike the answers to the previous question, there was a single response that indicated they would not spend any of their income to reduce their risk.

As noted in Table 1, each question was part of a certain perception category and each answer was assigned a level of perception (high, medium, or low). For all of the categories, except for perceived barriers, a high level of perception works in favor of healthy behavior. For perceived barriers, a low level of perception works in favor of healthy behavior. Calculating the percentage of people that had perceptions in favor of healthy behaviors allows us to gain a wider understanding of how likely people in Almaty are to change their habits. These percentages were calculated by question and then averaged within each category. Perceived susceptibility had the highest average, with 82.7%. Perceived severity and perceived self-efficacy were next, with 49.5% and 46.85%, respectively. Perceived barriers average was 23.2%, and, finally, perceived benefits fell last, with an average of just 17%.

Conclusions

Our study indicates that people in Almaty generally understand that there is a severe air pollution problem, but they do not feel confident they, as an individual, can do much about it. They feel the barriers are high enough to prevent easy access to exposure mitigation options, and they subsequently feel that, even if they took steps to protect themselves, it would not make a substantial difference. While it is good that citizens understand the problem, our work now lies in increasing awareness about the ease with which people can protect themselves. It is clear there is a negative attitude towards the city's air pollution, but the results of the survey indicate there are certain behaviors that we can now directly address. For example, considering only 59% of people use air conditioners regularly and only 6% of people use air purifiers regularly, targeting these two products by convincing more people to use them and increasing their accessibility would make a significant difference in people's indoor air pollution exposure.

Further, based on answers to a question about what influences views about the environment, people are open to receiving information from academics and scientists, with 73% of respondents ranking academics/scientists within the top 3 ways they are influenced. This means initiatives like ours do, in fact, have the potential to influence citizens' views.

The major limitation of our conclusions is that they are based on the narrow demographics, which are likely to overestimate the level of awareness. Nearly 78% of respondents are ages 18-24, with no respondents older than 54 years, and 84% of respondents report having completed at least an undergraduate college degree. This reveals most of the survey respondents are young, educated people, who are generally more environmentally educated and aware. While this was to be expected given the survey was primarily distributed to AlmaU students, it likely means that results with representation from more of Almaty's older citizens would decrease the perception percentages even more. Ultimately, by increasing the number of survey responses and sample diversity we will build a better picture of Almaty citizens' perceptions of the air pollution issue, but even with our current responses, we can see some clear patterns, ones that are strong enough to point our team in the right direction. We now know we must focus efforts on educating people, not about the air pollution problem, but specifically that mitigation efforts *will* work. With the preliminary conclusions from this study, our team feels confident in our next steps, moving forward with the necessary HBM information to change citizens' habits and, ultimately, improve the public health in the city.

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