

ORIGINAL RESEARCH

Do Americans Understand That Global Warming Is Harmful to Human Health? Evidence From a National Survey

Edward W. Maibach, MPH, PhD, Jennifer M. Kreslake, MPH, PhD, Connie Roser-Renouf, PhD, Seth Rosenthal, PhD, Geoff Feinberg, MA, Anthony A. Leiserowitz, PhD

Fairfax, VA; and New Haven, CT

Abstract

BACKGROUND Global warming has significant negative consequences for human health, with some groups at greater risk than others. The extent to which the public is aware of these risks is unclear; the limited extant research has yielded discrepant findings.

OBJECTIVES This paper describes Americans' awareness of the health effects of global warming, levels of support for government funding and action on the issue, and trust in information sources. We also investigate the discrepancy in previous research findings between assessments based on open- versus closed-ended questions.

METHODS A nationally representative survey of US adults (N = 1275) was conducted online in October 2014. Measures included general attitudes and beliefs about global warming, affective assessment of health effects, vulnerable populations and specific health conditions (open- and closed-ended), perceived risk, trust in sources, and support for government response.

FINDINGS Most respondents (61%) reported that, before taking the survey, they had given little or no thought to how global warming might affect people's health. In response to a closed-ended question, many respondents (64%) indicated global warming is harmful to health, yet in response to an open-ended question, few (27%) accurately named one or more specific type of harm. In response to a closed-ended question, 33% indicated some groups are more affected than others, yet on an open-ended question only 25% were able to identify any disproportionately affected populations. Perhaps not surprising given these findings, respondents demonstrated only limited support for a government response: less than 50% of respondents said government should be doing more to protect against health harms from global warming, and about 33% supported increased funding to public health agencies for this purpose. Respondents said their primary care physician is their most trusted source of information on this topic, followed by the Centers for Disease Control and Prevention, the World Health Organization, and their local public health department.

CONCLUSIONS Most Americans report a general sense that global warming can be harmful to health, but relatively few understand the types of harm it causes or who is most likely to be affected. Perhaps as a result, there is only moderate support for an expanded public health response. Primary care physicians and public health officials appear well positioned to educate the public about the health relevance of climate change

KEY WORDS climate change, global warming, health effects, risk perception, public health, health communication

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From the Center for Climate Change Communication, Department of Communication at George Mason University, Fairfax, VA (EWM, JMK, CR-R); and Yale Project on Climate Change Communication, Department of Forestry & Environmental Studies at Yale University, New Haven, CT (SR, GF, AAL). Address correspondence to E.W.M. (emaibach@gmu.edu).

INTRODUCTION

The effects of global climate change are already being observed in the United States and worldwide, and are projected to increase substantially over the next century and beyond.^{1–3} Rising atmospheric carbon dioxide levels, warmer temperatures, and altered precipitation patterns are resulting in increases in drought, wildfire, air pollution, sea-level rise, coastal flooding, ocean acidification, intense storms, and disrupted ecosystems.⁴

Although it is a relatively new area of research, there is a rapidly increasing base of knowledge about the public health implications of climate change.^{4,5} Worldwide, for the next several decades, climate change is projected to harm human health primarily by exacerbating health problems that already exist (including injury, heat stroke, malnutrition, and vector-borne illnesses), with the worst health problems taking place in developing nations with high rates of poverty.⁵

The human health implications of climate change in the United States were recently summarized in 4 key findings of the Third National Climate Assessment (2014).⁴ These findings are reported verbatim because, by virtue of highlighting these 4 statements as their “key findings,” the authors of the National Climate Assessment deemed them to be the most important information for all Americans to know about climate change and health:

1. Climate change threatens human health and well-being in many ways, including impacts from increased extreme weather events, wildfire, decreased air quality, threats to mental health, and illnesses transmitted by food, water, and disease-carriers such as mosquitoes and ticks. Some of these health impacts are already underway in the United States.
2. Climate change will, absent other changes, amplify some of the existing health threats the nation now faces. Certain people and communities are especially vulnerable, including children, the elderly, the sick, the poor, and some communities of color.
3. Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As threats increase, our ability to adapt to future changes may be limited.
4. Responding to climate change provides opportunities to improve human health and well-being across many sectors, including energy, agriculture, and transportation. Many of these strategies offer a variety of benefits, protecting people while

combating climate change and providing other societal benefits.

Broadly stated, the questions we ask and answer in this study are:

1. To what extent does the American public understand these important findings about the human health impacts of climate change?
2. To what degree does the public support action by public health agencies to protect people from these impacts?
3. Who is in the best position to (further) inform Americans about the health implications of climate change?

A tenet central to the practice of public health is that the public should be informed about threats to their health and well-being.^{6,7} Individuals require sufficient knowledge so they can understand how they are at risk, take actions to reduce their risk, and participate in meaningful public discourse about collective actions that can be taken to reduce public health risks.⁸

With regard to climate change, a range of important prevention (ie, mitigation) and preparedness (ie, adaptation) actions can be taken by individuals, communities, and nations to reduce the health risks. Effective preparedness measures against climate change health threats—so that people are not needlessly harmed—happen largely at the subnational level, in households, businesses, communities, states, and regions. Conversely, because of the global nature of the causes, effective prevention measures—intended to limit the extent of climate change—happen largely at the national and transnational, or global, levels. Informing members of the public, and the full range of other decision makers, about climate change risks and response options creates important opportunities to protect prior gains in public health—locally and globally—and to further advance the health of the public, worldwide.⁹

Although there is substantial general awareness about climate change among most segments of the US population and in other industrialized countries, important misunderstandings persist; climate change often is perceived by Americans as a distant, future threat with limited personal relevance.^{10–14} Americans’ ambivalence about the existence, urgency, and magnitude of climate change has been attributed to many factors, including national political dynamics designed to generate debate

around the existence and cause of climate change (despite broad scientific consensus that it is accelerating due to human activity),^{15–17} and issue framing that promotes ambivalence (eg, climate change as an environmental problem, a scientific problem, and a political problem) rather than perceptions of personal relevance and issue engagement (eg, climate change as a health problem, a dangerous weather problem, and an economic problem).¹⁸

Few studies have examined what the American public knows about health risks associated with climate change. In 2011, a nationally representative survey found that 25% to 33% of Americans said that if nothing is done to address global warming, over the next 20 years there will be “many more” deaths and injuries from a variety of causes—including flooding (31%), hurricanes (30%), severe winter storms (29%), malnutrition due to spikes in food prices (27%), wildfires (26%), and heat strokes (26%). The remainder said either there would be “a few more,” “no more,” or “fewer” deaths and injuries if nothing is done to address global warming, or in most cases, they responded “don’t know.”¹⁹ These findings are consistent with an earlier study that measured the perceived likelihood of increases in the rates of serious disease over the next 50 years as a result of global warming. Thirty-eight percent of the sample in that study regarded this as unlikely and 35% perceived it to be likely, with 25% falling in the middle.¹²

Although these results suggest that a substantial minority of Americans may understand the human health consequences of climate change, very few Americans report this knowledge as a top-of-mind association: In the 11 nationally representative Climate Change in the American Mind surveys conducted since 2008 (N = 12,723), respondents have been asked an open-ended question, before any other question about global warming: “When you think of ‘global warming,’ what is the first word or phrase that comes to your mind?” Almost no respondents spontaneously made the link between climate change and human health in open-ended responses in any of these surveys.²⁰ Similarly, representative population surveys conducted in Canada and Malta found few spontaneous associations between climate change and health in response to open-ended questions.²¹ This lack of top-of-mind association between global warming and human health stands in contrast to the other survey findings reported previously that suggest that many people may understand that global

warming has human health implications, at least in general terms.

One possibility is that closed-ended survey questions may elicit answers that overestimate the extent of the public’s knowledge about health and climate change. This could occur if—in response to a survey question asking about a topic they know nothing about (eg, climate change impacts on health)—survey respondents generalized from their overall sense that climate change is “bad” to conclude and respond that it must also be “bad for health.” Rather than engaging in an intensive cognitive process for every judgment and decision they face, people often rely on easily accessible heuristics, or cognitive shortcuts.^{22,23} Attribute substitution is a process that occurs when an individual evaluates one attribute of an object using a different property of that object that comes to mind more easily,^{24,25} and the halo effect is a process by which people’s global evaluations about something influence their judgments about its specific traits.²⁶ Although closed-ended questions intended to assess people’s understanding of the health implications of climate change are efficient, they may not capture the respondent’s actual understanding because they provide the respondent with readily available response options.²⁷

Conversely, open-ended questions provide an effective means to reveal people’s understanding (or lack thereof) of an object or issue, and elicit details about their reasoning in making judgments. Open-ended questions are less frequently used in population surveys, however, because they are labor intensive to analyze.²⁷

The first objective of the present study is to compare answers provided in response to open-ended questions about the health effects of climate change to answers provided in response to closed-ended options. We expected that people’s answers to open-ended questions would reveal a much more limited understanding of the health implications of climate change than would answers to closed-ended questions. In other words, we expected that answers to closed-ended questions would give the illusion of knowledge and preformed opinions that did not exist before being asked the questions. We also expected that people’s general beliefs about climate change would guide their responses to close-ended questions (ie, that general beliefs about the reality and danger of climate change would lead respondents to infer health threats of which they have no actual knowledge).

The second objective of this study was to assess levels of public support for a public health response

to climate change. Because we expected relatively limited understanding of the public health relevance of climate change, we also expected relatively limited public support for a public health response. Given that climate change is a major public health threat, the final objective of this study was to assess which sources of information are best positioned to provide information about the problem.

METHODS

Sample. The data were obtained from a nationally representative survey of US adults (N = 1275), aged 18 and older, conducted from October 17 to 28, 2014. Questionnaires were self-administered using an online platform and took an average of 29 minutes to complete. The average margin of error (95% confidence interval) for the survey is ± 3 percentage points.

The sample was drawn from an online panel (GfK's Knowledge Panel) that uses a probability proportional to size-weighted sampling approach to recruit its members. Prospective respondents were recruited using a combination of random-digit dialing and address-based sampling techniques that cover virtually all noninstitutional residential phone numbers and addresses in the United States. Respondents without access to the Internet were loaned computers and given Internet access to participate. The survey had a 57% completion rate.¹

The health questions on the instrument were preceded by approximately 10 minutes of questions covering issues in the news; energy-use behavior; and global warming beliefs, behaviors, and policy preferences. The term *global warming*, rather than the term *climate change*, was used in all relevant questions because prior research has shown the term *global warming* is more commonly used by Americans when they talk about the issue.²⁸

¹The survey had a recruitment rate of 13.5%, a profile rate of 64%, a completion rate of 57.4%, and an American Association for Public Opinion Research cumulative response rate 1 of 4.9%. Response rate metrics for online panel surveys are still under development, and do not compare directly to surveys in which a single questionnaire is administered. The cumulative response rate is calculated as the product of the panel's recruitment rate, profile rate (the proportion of respondents who completed the initial profile survey to become panel members), and completion rate.⁴⁴ Although the cumulative response rate appears low compared with telephone surveys, studies show that probability-based Internet surveys yield more accurate results than telephone interviews, with the optimal combination of both sample composition and response accuracy.⁴⁵

Measures. General and health-specific affective assessments of global warming.

An affective assessment of global warming in general was measured by asking respondents to rate whether they thought global warming was a bad or good thing on a scale from -3 (*very bad*) to 3 (*very good*), with no neutral midpoint. Later in the survey, before other questions about global warming and health, to determine health-specific affective assessment of global warming and health, respondents were asked: "On a scale from -3 (*very bad*) to $+3$ (*very good*), do you think global warming is bad or good for the health of Americans?" This scale included "0" as a neutral midpoint.

Unaided associations regarding climate change and health.

Respondents were asked up to 2 additional open-ended questions to assess their specific awareness of the health effects of global warming and of the affected populations. The first question asked: "In your view, what health problems related to global warming are Americans currently experiencing, if any?" This was followed by the closed-ended question, "Do you think that some groups or types of Americans are more likely than other Americans to experience health problems related to global warming?" Respondents who answered affirmatively were asked an additional open-ended question to assess their beliefs about which groups are more likely to be affected: "What groups or types of Americans do you think are more likely than other Americans to experience health problems related to global warming?" A coding scheme was developed for the responses to each of these open-ended questions using an iterative grounded-theory approach. Two of the authors collaborated in developing the coding framework, and 3 coded the data. Discrepancies between coders were discussed and resolved on an individual basis. Codes and examples of responses in each coding category are provided in [Supplementary Tables 1 and 2](#).

Closed-ended assessment of risk perceptions. The survey measured various dimensions of perceived risk for health harm associated with global warming.

1. Perceived current and near-future harm to self, family, and other Americans. Six items assessed respondents' perceptions of the severity of harm global warming is currently causing ("How much, if at all, do you think global warming is currently harming...") and will cause ("Over the next 5 to 10 years, how much, if at all, do you think global warming will harm..."). Harm to the respondent, the respondent's family, and other Americans were assessed using scales from 1 (*not at all*) to 4 (*a great deal*). A *not sure* option was also provided.

2. Perceived near-future local effects. Respondents were asked: “Do you think each of the following will become more or less common in your community over the next 10 years as a result of global warming, if nothing is done to address it?” Fifteen health-related conditions were listed. The response scale ranged from 1 (*much less common*) to 7 (*much more common*).
3. Perceived current and distant-future global health harm. In 4 separate questions, respondents were asked to estimate the number of people worldwide who, due to global warming are currently injured or become ill each year; are currently killed each year; will be injured or become ill each year 50 years from now; and will die each year 50 years from now. The response scale was: *none, hundreds, thousands, millions, or don't know*.

Desired level of governmental response. Five items assessed the level of response that respondents believe government should be taking to protect Americans from global warming’s health effects. Respondents were asked, “In your opinion, should each of the following be doing more, less, or about the same amount as they are doing now to protect people from health problems related to global warming?” Scales ranging from 1 (*much less*) to 7 (*much more*) assessed the desired level of response from

- President Obama,
- US Congress,
- Federal agencies (the Centers for Disease Control and Prevention [CDC], the National Institutes of Health [NIH], and the Federal Emergency Management Agency), and
- Respondent’s state and local governments.

Support for funding to health agencies. Three items asked respondents whether they support or oppose increased funding to “protect people from health problems related to global warming.” Support for funding increases were assessed for the respondents’

- Local public health department,
- State public health department, and
- Federal health agencies —CDC and NIH.

Scales ranging from 1 (*strongly oppose*) to 5 (*strongly support*) were used; a *not sure* response option was provided, and recoded as 3 (*neither support nor oppose*).

Trust in information sources. The survey asked closed-ended questions about credibility of specific sources for information on the health effects of global warming, with response options ranging from *strongly distrust* to *strongly trust* (*in between* was

provided as the neutral option, as well as a *not sure* category). The list of sources assessed included individual sources (primary care doctor, climate scientists, nonclimate scientists, television weather reporters, religious leaders, US military leaders, and friends and family) and institutional sources (CDC, World Health Organization [WHO], Environmental Protection Agency [EPA], American Medical Association [AMA], environmental organizations, respondent’s local health department).

Prior thought and worry. To assess people’s prior cognitive and affective investment in the health aspects of global warming, 2 questions were asked: “Before taking this survey, how much if all... (a) had you thought about how global warming might affect people’s health? and (b) did you worry about how global warming might affect people’s health?” Response categories were: *not at all, a little, a moderate amount, a great deal, and not sure*”

Statistical Analysis. We weighted the data using current US Census estimates of key demographic variables to improve its representativeness of the US adult population.ⁱⁱ Analyses were conducted using SPSS 19.0 and Stata 13.1.

RESULTS

Sample Description. The demographics of our sample, as compared with the US adult population, are presented in Table 1. Our sample, due to weighting, did not differ significantly from US Census Bureau estimates on sex, age category, educational attainment, income, race/ethnicity, or geographic region.²⁹

Knowledge of Health Effects of Global Warming. The majority of respondents (61%) reported that, before taking the survey, they had given little to no thought about how global warming might affect people’s health; conversely, 10% had thought about it “a great deal,” and 22% “a moderate amount.” In response to the general affective assessment of global warming, the majority of respondents (74%) felt global warming was “bad,” with 34% identifying it as “very bad.” In response to the specific affective assessment of global warming’s effect on the health of Americans, 64% of participants indicated that global warming will be “bad” for health, 31% responding with the most negative option (very bad); 25% indicated no effect, and only 8% viewed global warming as beneficial to health (Fig. 1).

ⁱⁱData were weighted by sex; age; race/Hispanic ethnicity; education; census region; metropolitan area; and Internet access.

Table 1. Sample demographics (N = 1,275)

	US Census Bureau American Community Survey 1-y estimates (2013)	Survey Respondents (weighted %)	χ^2 (P value)
Sex			0.02 (n.s.)
Male	49	48	
Female	51	52	
Age (y)			0.59 (n.s.)
Millenials (18–30)	22 (18–29)	23	
Generation X (31–48)	34 (30–49)	29	
Baby Boomers (49–67)	32 (50–69)	35	
WWII (68+)	12 (70+)	13	
Education			0.28 (n.s.)
Less than high school	13	12	
High school graduate	28	30	
Some college/tech	29	29	
College graduate	18	17	
Postgraduate	11	13	
Household income (thousands)			1.39 (n.s.)
<\$25	24	18	
\$25-<\$50	24	23	
\$50-<\$75	18	18	
\$75-<\$100	12	15	
\$100-<\$125	23 (\$100+)	13	
>\$125	–	13	
Race/ethnicity			0.06 (n.s.)
White	66	66	
Black or African-American	12	12	
Other	7	8	
Hispanic	15	15	
Region			0.02 (n.s.)
Northeast	18	18	
Midwest	21	21	
South	37	37	
West	24	23	

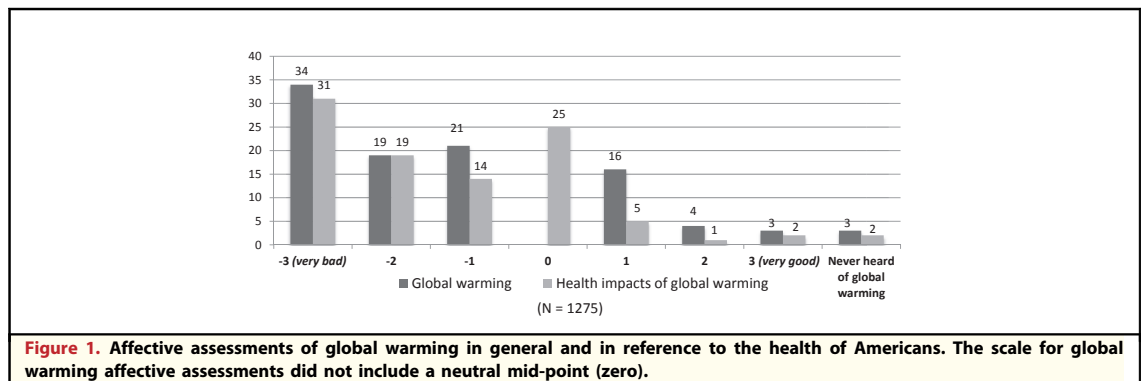
In response to the open-ended question about health effects, however, few respondents provided examples of specific health conditions (Fig. 2).

Twenty-seven percent named at least one health problem related to global warming. Respiratory diseases (eg, lung disease, asthma) were the health conditions mentioned most frequently (14%), followed by injury or death from extreme weather and natural disasters (6%), and skin cancer and other skin diseases (5%). Of the sample, 57% did not provide any response or replied that they did not know, and an additional 11% incorrectly maintained that there are no health effects from global warming.

In response to the closed-ended question, 33% of respondents correctly answered that some groups of Americans are more affected than others, whereas a plurality (45%) were not sure, and 23% said no group was at higher risk. In responding to the subsequent open-ended question about which Americans would be more affected, only 25% were able to identify one or more specific vulnerable groups (Fig. 3). Seniors were cited most often (8%), followed by people with low socioeconomic status (7%), people who are sick or disabled (7%), infants or young children (5%), minorities and indigenous peoples (1%), people with sensitive or light-colored skin (1%), and outdoor workers and farmers (1%). People living in specific geographic locations were mentioned by a small number of respondents: residents of cities (2%); coastal, storm prone and flood regions (1%); and other specific regions (1%).

Risk Perceptions: Beliefs About Current and Future Harm. Perceived current and near-future harm to self, family, and other Americans. About one-third (31%) of respondents reported that global warming is currently harming the health of Americans “a great deal,” or “a moderate amount,” whereas about half think global warming is causing “only a little” harm (26%) or no harm at all (28%); 14% “don’t know” (Table 2). Far fewer respondents reported that their own health, or the health of others in their household is being harmed, with almost twice as many reporting “only a little” or “not at all” (70% and 69%, respectively, versus 54% for the health of Americans). When asked about health harms 5 to 10 years in the future, estimates of “a great deal” or “a moderate amount” of harm increased for all groups (ie, self, household members, Americans) by approximately 10 points.

Perceived near-future local effects. Approximately half of the respondents said that global warming will not have an effect on the prevalence of each of 15 conditions over the next 10 years, even if nothing is done to address it (Table 2). Of the respondents,



19% to 32% said these conditions will become somewhat or a little more common, and about 5% think these conditions will become much more common.

Perceived current and distant-future global health harm. The modal response for each of the 4 questions asked about current and future global health effects of global warming was “don’t know”

(43%–44%). The next most common response to each of these 4 questions was “none” (21%–33%). Relatively few respondents thought that “thousands” (12% currently, 16% in 50 years) or “millions” (3% currently, 12% in 50 years) were being or were likely to be sickened or injured each year. Even fewer thought “thousands” (11% currently, 17% in 50 years) or “millions” (1% currently, 8% in 50 years)

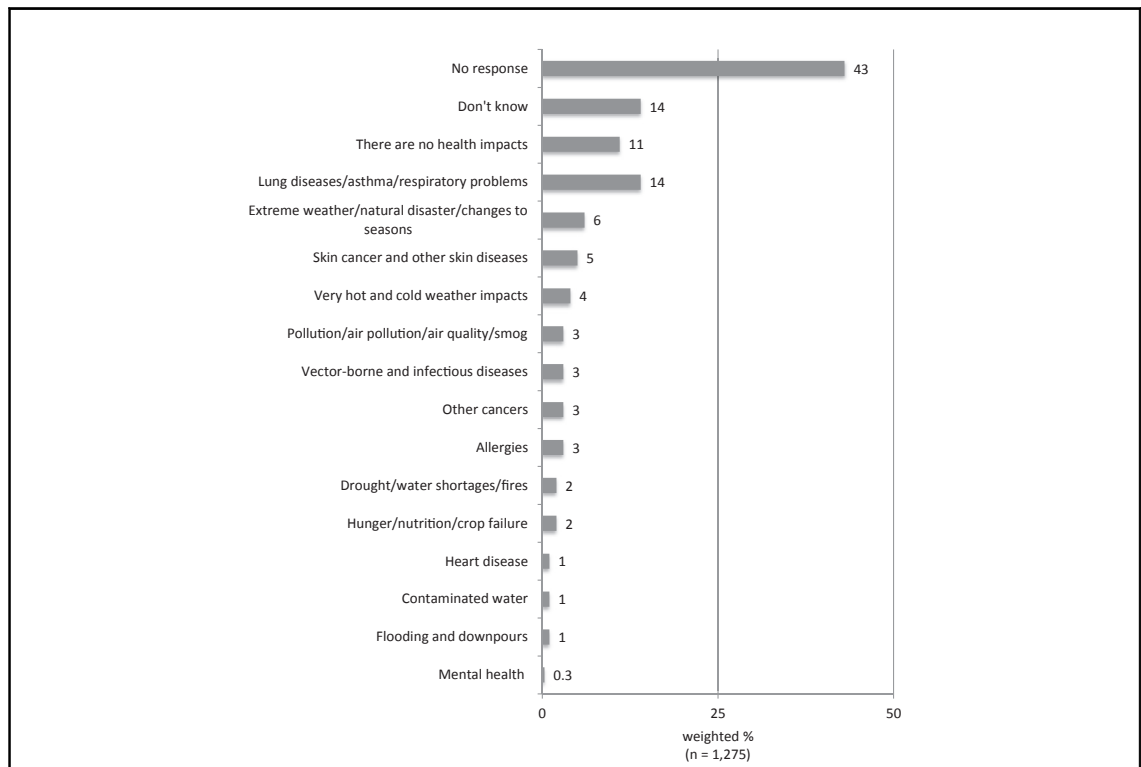
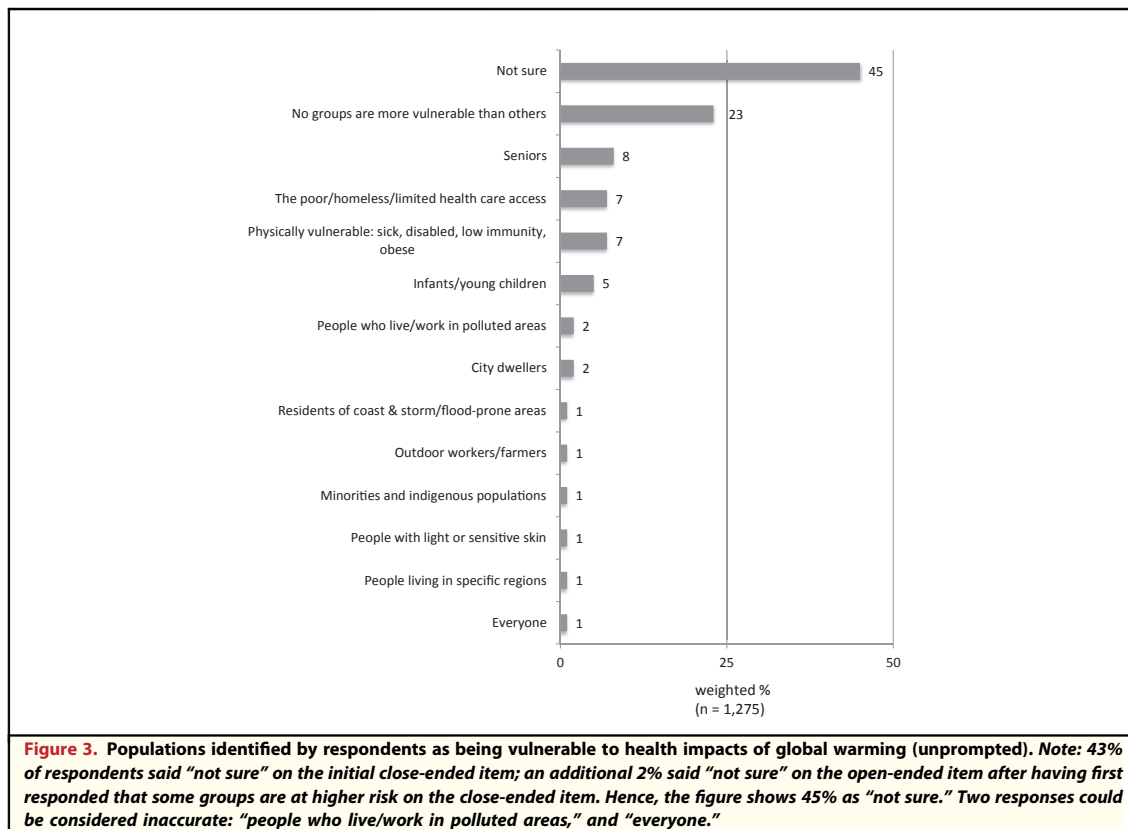


Figure 2. Global warming-related health problems identified by respondents (unprompted). Note: Most of the health issues listed above are projected to increase due to climate change; currently, however, we have only limited evidence that climate change will increase skin cancer, and no evidence that it will increase heart disease or other cancers. These responses might, therefore, be considered inaccurate.



were being or were likely to be killed each year as a result of global warming.ⁱⁱⁱ

Actual versus inferred knowledge of global warming-related health threats. The vast majority of respondents who said, in response to closed-ended questions, they expect global warming will cause particular forms of harm to the health and safety of their communities over the coming decade did not volunteer the same views on the open-ended question asking what types of harm global warming causes to human health. For example, 35% of respondents said bodily harm from extreme weather and/or hurricanes will become more common in their community over the next decade if nothing is done to reduce global

warming, but of these, only 13% had responded to the open-ended question earlier in the survey with an answer that indicated an awareness of extreme weather effects.

Support for government agencies to act on health effects of global warming. Slightly fewer than half of respondents felt that Congress (46%), the president (41%), federal agencies (47%), their state government (44%), and their local government (41%) should be doing more to protect the public against the health effects of global warming. About 25% of respondents believed that government agencies should continue with the status quo, approximately 15% to 20% felt government should do less, and 11% didn’t have an opinion (Fig. 4).

Approximately 33% of respondents supported increased funding to federal health agencies and state and local public health departments to protect against the health effects of global warming, whereas approximately 33% were neutral (Fig. 5). Slightly less than 25% opposed increased funding for federal health agencies (22%), state (23%), and local (23%) public health departments, and approximately 10% were unsure.

Trusted sources of information on global warming and health. Primary care physicians were the most trusted sources for health information related to global

ⁱⁱⁱClimate change exacerbates existing health threats, making it difficult to accurately estimate the number of people currently being harmed. But one recent study estimated that 400,000 people around the world currently die annually due to hunger and communicable diseases aggravated by climate change, and that 4.5 million die from air pollution caused by the use of fossil fuels. Most of these deaths occur in developing nations. Without action to reduce climate change and fossil fuel use, deaths are projected to increase to 6 million annually by 2030. For more information, see <http://daraint.org/wp-content/uploads/2012/09/CVM2ndEd-FrontMatter.pdf>.

Table 2. Beliefs about current and future health impacts of global warming (N = 1,275).

	Weighted %				
	A great deal	A moderate amount	Only a little	Not at all	Not sure
Global warming is currently harming					
Health of Americans	8	23	26	28	14
Health of household members	4	13	23	46	13
Own health	4	13	25	45	12
In 5–10 years, global warming will harm:					
Health of Americans	13	26	20	24	16
Health of household members	7	21	21	35	15
Own health	6	21	23	33	15
	Millions	Thousands	Hundreds	None	Don't know
Currently, due to global warming					
Number sick/injured each year	3	12	11	32	43
Number die each year	1	11	11	33	44
In 50 years, due to global warming:					
Number sick/injured each year	12	16	8	21	43
Number die each year	8	17	9	22	44
	Much more common	Somewhat/a little more common	About the same	Somewhat/a little less common	Much less common
If nothing is done in next 10 years, will become more or less common in your community:					
Air pollution	8	30	44	8	8
Pollen-related allergies	7	31	45	7	7
Asthma and/or other lung diseases	6	31	45	8	8
Bodily harm from severe storms and/or hurricanes	5	29	45	10	8
Bodily harm from flooding	4	23	50	10	10
Bodily harm from wildfires (incl. smoke inhalation)	4	22	51	11	9
Heat stroke from extreme heat waves	4	32	45	7	8
Illness from food- / water-borne bacteria or viruses	5	27	48	9	8
Diseases carried by insects	4	29	48	8	8
Hunger/malnutrition due to expensive food	4	26	48	10	10
Severe anxiety	5	22	54	8	8
Depression	4	22	53	8	8
Cancer*	5	26	52	7	7
Infections with Ebola virus*	3	19	50	13	12
Influenza*	5	24	55	8	6

*Note: Some rows do not total 100% due to missing data. Not all the global warming impacts shown above affect every community; flooding and wildfires, for example, are unlikely to occur in desert regions, although in some regions of the country they will increase. Hence, stating that a risk will not increase is not necessarily an inaccurate response. Items designated with an * were included in the survey as intentionally inaccurate responses in that they are not predicted to occur due to global warming in any region of the U.S.*

warming, with 49% of respondents reporting that they “strongly” or “moderately” trusted their doctor (Fig. 6). Family and friends, and the CDC were the next most-trusted groups, at 41% each. Religious leaders, the military, and television weather reporters were the least trusted sources for health information about global warming. For all of the sources, however, between 12% and 15% of respondents were not sure how much they trusted the source, and approximately 33% of the

sample reported a neutral score (27%–37% depending on the source, data not shown).

DISCUSSION

These findings support our thesis that most Americans have little understanding of the health relevance of climate change. A large majority of the survey respondents do have a general sense that

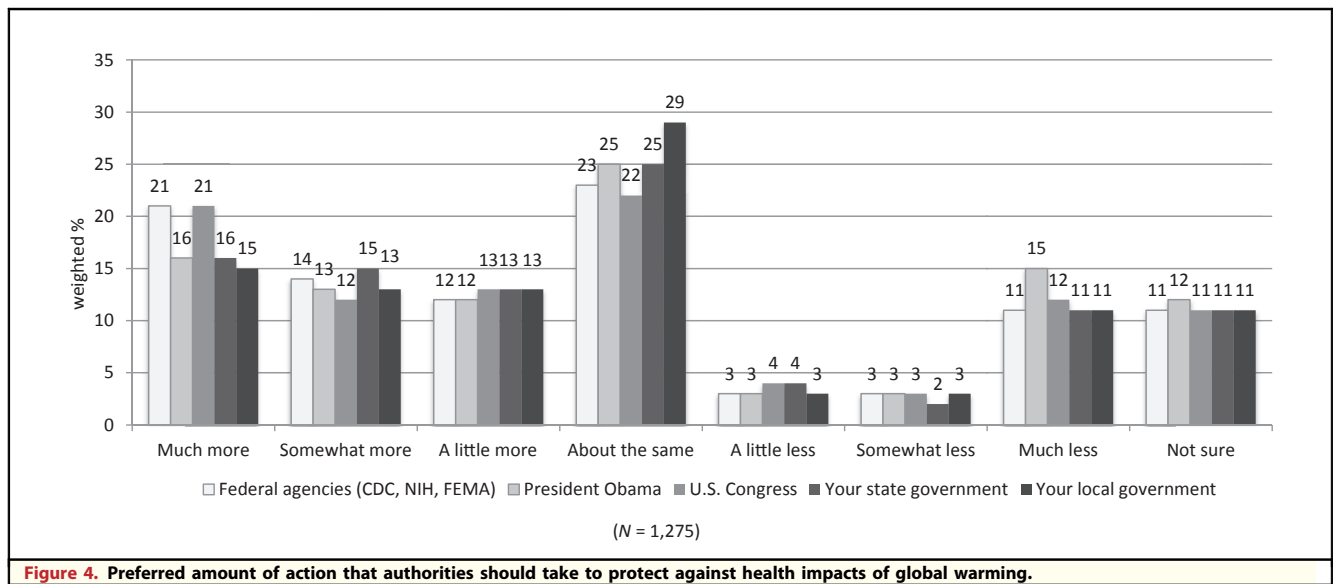


Figure 4. Preferred amount of action that authorities should take to protect against health impacts of global warming.

climate change is a “bad thing,” and many answered closed-ended questions in a manner that suggests they have some understanding—or are inclined to accept—that climate change has deleterious human health consequences. Conversely, nearly 2 in 3 Americans have given little or no thought to the health risks associated with climate change. Moreover, when asked specific open-ended questions about climate and health, relatively few respondents provided an answer: When asked what health problems related to global warming (if any) Americans are currently experiencing, only about 1 in 4 provided even a single correct answer (Table 3); and similarly, when asked which groups of Americans, if any, are most at risk for experiencing these problems, only about 1 in 4 were able to provide at least one correct answer.

We contend that people’s unprompted responses to our open-ended questions are likely a more

accurate reflection of their actual understanding of the effects of global warming on health than are their responses to our close-ended questions. Three distinct sources of bias could be contributing to inflated estimates in response to our closed-ended questions:

1. Respondent’s answers may reflect prompted recall (ie, at some point they may have heard that global warming poses health risks, but because the information lacked salience, the information was not available to them in an unaided memory search);
2. Respondents may be constructing new opinions on the spot, inferring an answer to an unknown question based on their prior beliefs about a related easier question—the reality and harmfulness of global warming; this may apply primarily to those who have relatively firm beliefs about the reality/unreality of global warming; and
3. Respondents who do not hold firm opinions on the reality and harmfulness of global warming may be

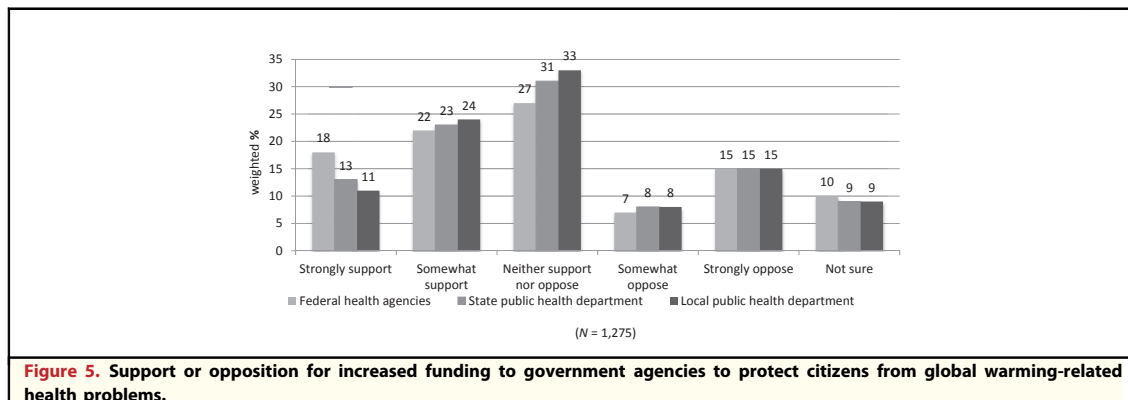


Figure 5. Support or opposition for increased funding to government agencies to protect citizens from global warming-related health problems.

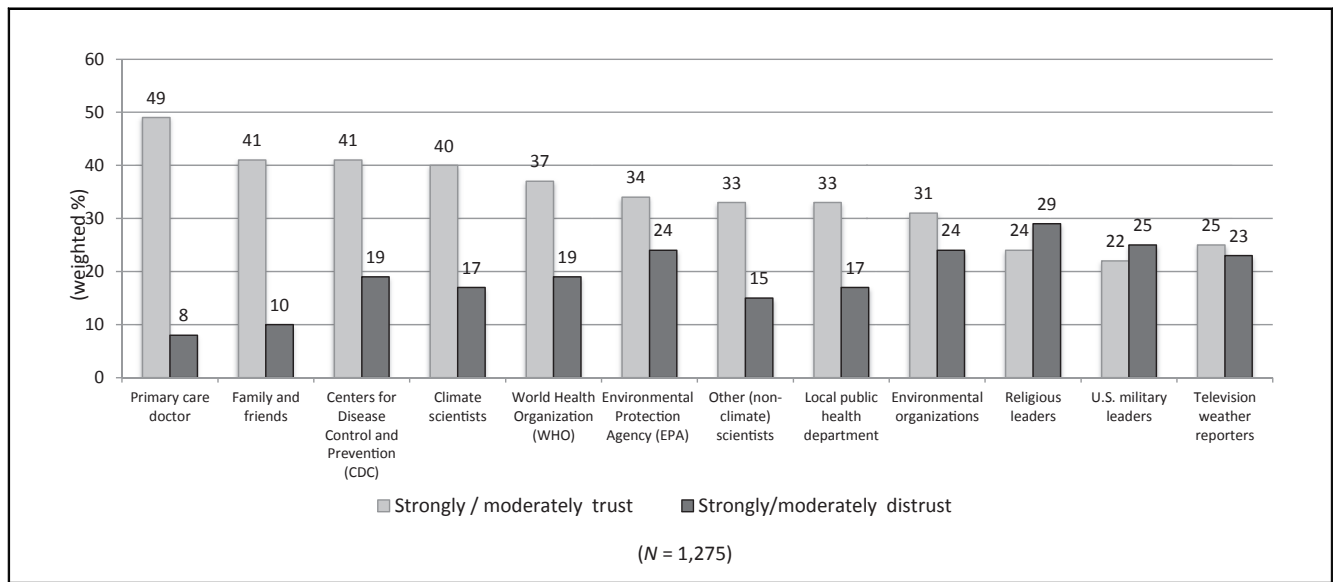


Figure 6. Trust in information sources on the health impacts of global warming.

inferring the “right” answers (ie, the answers they think the investigators want to hear) and providing those answers.

There is a clear need to better inform the public of the health threats associated with climate change. The findings from the present study demonstrate that large portions of the public are unaware of these risks, regardless of the method used to assess their understanding. It is the responsibility of public health officials to provide members of the public with information that will aid them in making appropriate health risk management decisions for themselves, and will enable them to participate in public dialogue about collective risk management strategies. Without adequate forewarning, members of the public, communities, and organizations are unlikely to become adequately forearmed.

Despite low levels of public awareness about the health implications of climate change, we found that nearly half of the public feels that actors at all levels of government should be doing more to protect people from the health impacts of global warming. Much of the public also supports increased funding for this purpose. It is important to note, however, that these levels of support for a public health response to climate change are lower than the levels of support expressed by the same survey respondents for both general government actions against global warming, and for specific actions aimed at protecting other resources (eg, our nation’s infrastructure).²⁰ For example, 56% of respondents

felt Congress should be doing more (in general) to address global warming, but only 46% felt Congress should be doing more to protect people from the health effects of global warming. Similarly, 54% felt that their local government should be doing more (in general) to address global warming, but only 41% felt their local government should be doing more to protect people’s health from global warming.

Table 3. Discrepancy between open- and closed-ended responses to questions on global warming-related health threats.

	Percent that expect an increase in the next decade if global warming is not reduced	Of those who expect the health condition to increase, percent who also mentioned it on the open-ended question
Air pollution	38%	5%
Allergies	38%	8%
Asthma/lung disease	37%	28%
Heat stroke	36%	8%
Bodily harm from extreme weather	34%	13%
Vector-borne diseases	33%	7%
Mental illness	32%	1%
Hunger/malnutrition	30%	3%
Flooding	27%	3%
Fires	26%	1%

Perhaps most telling, 83% of survey respondents support increased funding for improvements to roads, bridges, and buildings to make them more resistant to extreme weather, yet only approximately 40% support increased funding for government health agencies to protect people from health problems related to global warming.

One possible explanation for these discrepancies is that the public values public roads, bridges, and buildings more than public health, but that seems unlikely. Polls conducted by the Pew Research Center in 2014 found that health issues (securing Medicare, 61%; reducing health care costs, 59%) ranked as much higher public priorities than improving our nation's infrastructure (39%).³⁰ The more likely cause for these paradoxical findings is that the public does not have an adequate understanding of the threat to human health and well-being posed by climate change. Or perhaps these findings suggest that the public feels that public health departments are adequately funded to deal with climate risks. That is a possibility, although research with local public health department directors has found that funding—and the expertise that funding can procure—is a rate-limiting factor in their current efforts to address climate health risks.^{31–33}

If public education about the health risks of climate change is needed, who should lead such efforts? The findings from the present study suggest that traditional public health agencies including the CDC, and local public health departments (and by extension, state health departments) are relatively well positioned to educate the public given that they are trusted as sources of information about the health effects of global warming by many. Perhaps unsurprisingly, however, people's own primary care doctors are the most trusted sources of information about health problems related to global warming. Several recent physician surveys have shown that large majorities of the members of several medical societies—the National Medical Association; American Thoracic Society; and the American Academy of Allergy, Asthma, and Immunology, each of which are likely to see patients who have elevated risk of health problems associated with climate change—feel that physicians and their professional societies have a responsibility to bring the health effects of climate change to the attention of their patients and to the public. It is worth noting, however, that these physicians also see the need for more medical education on climate and health in the form of medical school curriculum and continuing medical education opportunities.^{34–37}

A public communication campaign led by physicians and their medical societies, with traditional public health agencies playing a supportive role, and with efforts to promote social reinforcement by members of the public (ie, family and friends), may be an effective means of educating the public about the health relevance of climate change. Such an effort should focus not exclusively on the health risks posed by climate change, but also on the health benefits associated with taking actions to address climate change. As per the National Climate Assessment's fourth and final key finding,⁴ these benefits are an important part of the story, and research has shown that a focus on health benefits creates an important opportunity to engage people across the spectrum of climate change beliefs more deeply in the issue.³⁸ A variety of informational resources are available to help guide climate change-related public health education and communication efforts.^{39–41}

Limitations. Several limitations of this research should be considered. Our affective assessments of global warming in general, and in reference to the health of Americans, are not directly comparable because we included a neutral mid-point in the scale in only 1 of the 2 questions. Moreover, measures of perceived risk to self, family, and community reported here were not conditioned on the actual circumstances faced by respondents, their family members, and their community. Young, healthy, affluent people, for example, may be correct in assessing their risk for health effects from climate change as low; similarly, affluent respondents are likely correct in assessing that food shortages will not impact their community in the near future, even if recognizing that such impacts will be felt in other communities in the United States or globally. Future research should assess the degree to which actual risk status—of respondents and their family (eg, age, health status), and their community (eg, high poverty rates, environmental exposures)—influences people's assessments of the health risks associated with climate change.

Our extensive survey may have primed respondents on the topic of global warming before they were asked to consider its health implications. Evaluative judgments are not necessarily comprehensive representations of an individual's "true" attitudes, but rather are based on momentarily accessible, salient information.^{42,43} The extent of order and content effects on the validity of responses to health-related questions is unclear, but the preceding sections of the survey presented dozens of questions on various aspects of global warming, providing

respondents with ample time to think about global warming before providing their perceptions of its health risks. This process may have activated affective assessments or attitudes about global warming generally, and therefore respondents' awareness or concern about its health effects may have been amplified. We maintain that our results may represent Americans' knowledge and beliefs about the health implications of global warming when they are at their most engaged in the issue. Despite extensive priming and some expressed awareness in closed-ended responses, open-ended responses reveal the dearth of knowledge Americans have about the connection between global warming and health. Should our results represent attitudes while actively thinking about the issue of global warming, Americans' baseline levels of knowledge or concern may be even lower in the absence of priming.

CONCLUSION

Improving Americans' understanding of the health effects of climate change is imperative so that—as individuals, families, businesses, communities, states, and as a nation—they become better able

to make important prevention and preparedness decisions that will protect health. As the results of this study indicate, the American public is only vaguely aware of the human health consequences of climate change, and this lack of awareness manifests in relatively weak support for protective action by public health agencies. Public health communication efforts should use trusted sources to provide clear linkages between climate change and health outcomes to increase awareness among the American public, moving toward the ultimate goal of improving protective actions and informed engagement in relevant policy decisions.

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SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.aogh.2015.08.010>.

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