An Evaluation of an Environmental Health Infographic in Community Settings

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Abstract

Background: Infographics are an effective way of communicating complex information due to their reliance on concise language and clear, uncluttered visuals. Research indicates that traffic-related ultrafine particles (UFPs) in air pollutions adversely affect human health, including respiratory and cardiovascular diseases. In this study, we work with community-based adult literacy programs to develop an infographic about UFPs in air pollution with the goal of community-driven problem solving related to traffic-related UFPs within affected neighborhoods. **Objective**: In this paper, we discuss the development and evaluation of an infographic about the dangers of UFPs from traffic pollution, and actions that readers in affected communities can take to protect their health. We used the infographic format to conceptualize UFP pollution and its health effects visually for community members many of whom are new immigrants and do not speak English as their first language. **Methods:** We conducted 1 focus group and 4 interviews over Zoom, and collected 74 anonymous surveys among Boston Chinatown and Somerville, MA residents. Community partner organizations assisted us in recruiting participants by sending a recruitment flyer to their email contacts and identifying specific people who were interested in participating. **Key Results:** Data from the surveys, focus group, and interviews yielded 8 themes that guided the revision of the infographic. The majority of the participants responded positively to the infographic: 95.9% (n = 71) of respondents reported that the purpose of the infographic was clear, that the infographic contained a clear message, and that the infographic uses images to explain important points. **Conclusions:** Our experience developing and evaluating an infographic about near highway pollution in environmental justice communities suggests that infographics can be a viable communication tool in this context. Further research with infographics of a similar nature but in diverse communities is needed to strengthen our conclusion.

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Highlights

- **What do we already know about this topic?**
  Infographics are an effective way of communicating complex information due to their reliance on concise language and clear, uncluttered visuals.
- **How does your research contribute to the field?**
  We developed an infographic with input from community members to communicate the dangers of ultrafine particles (UFPs) in clear, concise language supported by culturally relevant visuals.
- **What are your research's implications toward theory, practice, or policy?**
  Infographic is an efficacious public health communication tool that can be adapted to meet the needs of different communities based on their input and engagement.

Background

As scientific and public concern about environmental hazards grows, interest in how to communicate environmental health information clearly and accurately to affected communities is also growing.[1,2] The Internet has become one of the public's primary sources of health and science information.[3,4] Concerns over where people go online for health information include the trustworthiness of the source and clarity of information. Unfortunately, reliable information sources such as peer-reviewed journals are complex and difficult for the public to understand, and cannot be accessed without expensive subscriptions.[5]

There is increasing evidence that infographics are an effective way of communicating health-related information.[6-8] An infographic is a highly visual method of communicating information that is complex and technical.[9] Infographics are particularly useful for conveying and summarizing scientific data and study results. Successful infographics include several characteristics that make them easier to read and understand such a concise language and clear, uncluttered visuals.[10,11]

Ultrafine particle (UFP) pollution is an example of a technical issue that might be amenable to explanation through infographics. Ultrafine particles are aerosol particulate matter on a nanoscale (<100 nm) that have been shown to adversely affect human health, including respiratory and cardiovascular diseases.[12-14] They also enter the bloodstream, tissues and cells, and the brain via the olfactory nerve, leading to tissue inflammation, oxidative stress, delays in cognitive development in children, and accelerated cognitive decline in older adults.[15-17] Ultrafine particles are less well studied than particulate matter of less than 2.5 μm ($PM_{2.5}$) which are causally associated with health outcomes.[18] However, UFPs are particularly hazardous due to their small size since they can travel deep into the lungs and cross biological barriers, including into the blood and brain.[19-21]

Ultrafine particles are common in urban air pollution, arising particularly from motor vehicle exhaust. They constitute 90% of particulate number count in areas influenced by vehicle emissions.[16,17,22] This poses a particularly concerning problem for housing and schools in urbanized areas located proximate to highways and major roadways with high levels of vehicular traffic.[22,23]

Our work is informed by an environmental health literacy (EHL) theoretical framework, community-based participatory research (CBPR) methods, and plain language principles. Environmental health literacy is a theoretical framework that emphasizes dialogue, clear communication, and active engagement with communities on complex environmental health information. It also prioritizes clear linkages between environmental risk exposures and public health.[24] Community-based participatory research is a research approach that prioritizes collaborative engagement among all stakeholders affected by or contributing to specific public health concerns—essentially enhancing EHL of communities.[25] Plain language is a strategic response and integral part of developing clear communication between researchers and collaborating communities, which ideally leads to establishing transparency and trust between partners.[26] Working with community-based adult literacy programs builds EHL skills among affected communities with the ultimate goal of community-driven problem solving about the environmental exposures that can affect human health.

An EHL framework highlights the need for environmental justice and the structural problems that people face in improving their environmental health, as it emphasizes the (lack of) community-based communication and engagement around specific needs to mitigate negative environmental health outcomes. Our communities of focus are neighborhoods near highways that are considered environmental justice communities due to having large numbers of people who are lower income and/or racial/ethnic minorities and who face high levels of air pollution due to housing inequities.[27] Environmental racism, or racism in political decision-making and enforcement of environmental laws and regulations, burdens minority communities disproportionately affected by environmental pollution.[28] Multiple, intersecting factors, such as socio-economic status, language, ethnicity, and legal status, affect communities of color, particularly legal and equitable access to healthy land, air, and water.[29] In particular, transportation has "…a long and negative history with low-income, immigrant, and people of color communities that have been adversely impacted in the name of 'urban renewal'", a process which displaced thousands of people in the name of "urbanizing"

already-walkable cities.[30] Such factors contribute to some geographic and social communities being more vulnerable to consistent UFP exposure and the associated health risks than others. Environmental justice provides a much-needed context for assessing the infographic we developed and the participants' response to it. It was an underlying theme for survey-respondents and focus group/interview participants in the communities highlighted in this paper, and dictated the way in which we revised the infographic.

In this paper, we discuss an infographic emphasizing the dangers of UFPs, that was created by members of the Community Assessment of Freeway Exposure and Health (CAFEH) team. Community Assessment of Freeway Exposure and Health has a history of community engagement on environmental health topics and includes academic and community leaders who are dedicated to the mitigation of traffic-related pollution.[27,31,32] We utilized focus groups and individual interviews to evaluate the infographic and identify areas in which it can be improved for implementation. We also highlight actions that disproportionality affected communities can take to protect themselves. In particular, we analyze and discuss the feedback from community members.

Methods

We conducted our research in Somerville and in Boston Chinatown in Massachusetts, USA, 2 communities with large immigrant communities and geographic proximities to highways and major roadways with high volumes of vehicular traffic.[12,31] Both communities are intersected by Interstate 93 (I-93), and Chinatown is also adjacent to I-90; both also have long histories of community engagement to address traffic-related air pollution through the CAFEH studies.[31] We obtained approval from the Institutional Review Board at UConn Health (reference number 21X-024-1).

Creating the Infographic

The infographic design process started with several rounds of discussions within a subgroup of the CAFEH steering committee. Once all members of the committee felt comfortable with the design, we moved into the evaluation phase. The CAFEH steering committee consists of academic researchers, graduate students, and representatives from community and quasi-governmental partner organizations such as the Metropolitan Area Planning Council (MAPC). Members of the CAFEH steering committee decided to focus on 5 key messages and worked with a health literacy specialist to communicate these messages in plain language:

- Ultrafine particle air pollution is high near highways and busy roadways.
- People living near highways and busy roadways breathe in UFPs both indoors and outdoors.
- Breathing high levels of UFPs can harm your health

- Ways to protect yourself indoors include closing windows and using air conditioning or portable air filters.
- Ways to protect your health outdoors include planning to spend time outside when traffic is light, when it is warm, and when the wind blows toward the traffic.

We then worked with a digital artist to create images to support these messages in ways that were relevant to would-be viewers of the infographic. The infographic was designed with 5 panels arranged vertically, with each numbered consecutively. The text was iteratively refined using plain language principles. Graphics were created digitally, using a combination of 2D and 3D modeling and editing tools. The images illustrating outdoor and indoor scenes were created using architectural 3d model software (SketchUp Pro®, v.2017) to capture the urban environment characteristics of each community. All other graphics and layout were created with the photo/image editing software (Adobe Photoshop®, v.22.1.1).

Evaluating the Infographic

We developed an anonymous 25-question survey in Qualtrics for community members that was designed to capture their thoughts and opinions around the infographic (see the Appendix 1 for the full list of survey questions). Questions focused on whether the infographic's language, images, and overall messages were clear, whether the infographic's recommendations were actionable, and whether there were any changes the respondents would make to the infographic. Representatives from community partner organizations on the CAFEH team circulated invitations to take the survey in their networks. The partners were the following:

The Welcome Project (WP)[33] which serves immigrants in Somerville and offers adult literacy programs; the Chinatown Community Land Trust which works on community control of the land, affordable housing, and shared neighborhood spaces; And the Somerville Transportation Equity Partnership, an organization of residents advocating for transportation improvements in Somerville, MA to increase social equity, environmental health, and economic opportunity. The MAPC in Boston is a regional and public planning agency that promotes smart growth and regional collaboration in Metropolitan Boston. All are partners to the NIH-funded research within which this work was conducted.

We also conducted a focus group with Boston Chinatown residents and interviews with Somerville, MA residents. Working with our community partners enabled us to recruit participants and get feedback back from new immigrants and minority residents not represented in our survey. We conducted 4 interviews with Somerville residents and asked the same questions as we asked the 8 Chinatown focus group participants. Partner organizations circulated a recruitment flyer electronically to their listservs and asked community members who they thought might be interested in participating.

The focus group and interviews were held over Zoom due to the COVID-19 pandemic. Both the focus group and the interviews were one-hour and held in evenings after work. We followed a focus group script that probed key questions from the survey, such as if there were any images or words in the infographic that participants would change, whether the infographic's messages were clear, and how participants would follow the infographic's recommendations. We also asked participants for more detailed insight into the infographic's potential usefulness as a means of communicating the dangers of UFPs and the ways in which people could protect themselves from UFP exposure.

We conducted analysis of the survey data in SPSS®, version 26, and coded the focus group data manually. We did not have any disagreements in coding the data. Neither focus group nor survey participants were remunerated for their time. The qualitative researcher manually read the focus group transcripts to identify themes (topics that were mentioned by at least 2 people per focus group), and the other members of the research team cross-checked the analyses to confirm the themes.

Results

Infographic

Infographic panel 1 (Figure 1) indicates how UFP concentrations drop off with distance from the highway. The road cross-section representation includes smaller residential buildings characteristic of Somerville, MA, as well as apartment buildings common to Boston Chinatown. Infographic panel 2 shows that UFPs from traffic sources can affect people outdoors, but also indoors. As with Panel 1, this image includes residential building typologies from both communities. Infographic panel 3 explains how UFPs can enter the body and affect vital organs, lungs, heart, and brain. Infographic panel 4 describes strategies that can mitigate UFP exposure indoors, both by blocking the particulates from entering the building, and by filtering them once they are inside. Infographic panel 5 offers tips for reducing UFP exposure outdoors, based on traffic intensity, weather, and window direction.

Quantitative Data

Seventy-four participants completed the survey. A full list of the survey questions can be found in Table 1.

The majority of survey participants were female (N = 55.9%), between the ages of 45–64 (36.9%) and 25–44 (29.7%), and were primarily English speakers (67%). Almost half (43.8%) were residents of Somerville.

The majority of the respondents responded positively to the infographic: 95.9% (n = 71) reported that the purpose of the infographic was clear, that the infographic contained a clear

Figure 1. Original infographic.

Table 1. Full List of Survey Questions.

	Total (N = 84)
Is the purpose of the infographic clear?	
No	3 (3.6%)
Yes	72 (85.7%)
Missing	9 (10.7%)
Does the infographic contain a clear message?	
No	4 (4.8%)
Yes	71 (84.5%)
Missing	9 (10.7%)
Does the infographic use familiar, everyday words?	
No	7 (8.3%)
Yes	67 (79.8%)
Missing	10 (11.9%)
Are unfamiliar words clearly explained?	
No	14 (16.7%)
Yes	59 (70.2%)
Missing	11 (13.1%)
Does the infographic use images to explain important points?	
No	3 (3.6%)
Yes	71 (84.5%)
Missing	10 (11.9%)
Do the images reinforce rather than distract from the content?	
No	10 (11.9%)
Yes	63 (75.0%)
Missing	11 (13.1%)
Are the images clear and uncluttered?	
No	33 (39.3%)
Yes	41 (48.8%)
Missing	10 (11.9%)
Does the infographic name at least one action you can take?	
No	2 (2.4%)
Yes	70 (83.3%)
Missing	12 (14.3%)
Do the visuals show you how to change your behavior?	
No	5 (6.0%)
Yes	67 (79.8%)
Missing	12 (14.3%)
Does the infographic explain what are ultrafine particles?	
No	26 (31.0%)
Yes	47 (56.0%)
Missing	11 (13.1%)
Does the infographic explain how people's health may be affected?	
No	15 (17.9%)
Yes	57 (67.9%)
Missing	12 (14.3%)
Does the infographic explain what people can do to protect their health?	
No	1 (1.2%)
Yes	71 (84.5%)
Missing	12 (14.3%)
Will you change behavior based on recommendations from the infographic?	
No	27 (32.1%)
Yes	45 (53.6%)
Missing	12 (14.3%)

message, and that the infographic uses images to explain important points. Furthermore, 98.6% (n = 73) indicated that the infographic explained what people can do to protect their health, while 90.5% (n = 67) of respondents responded that the infographic used familiar, everyday words. Conversely, only 79.2% (n = 58) responded that the infographic detailed how UFPs affect people's health, 63.9% (n = 47) indicated that the infographic thoroughly defined UFPs, and 55.4% (n = 41) reported that the images were clear and uncluttered. (Tables 2 and 3)

Focus Groups

To get feedback from immigrants in each of the communities, we worked with our community partners to conduct a focus group with Chinatown residents (n = 8) and interviews with Somerville residents (n = 4). Eleven main themes appeared in the qualitative data, eight of them arose in both focus groups.

All of the participants in both focus groups agreed that while the images were easy to understand, the infographic overall was too cluttered, which made it hard to follow. One participant stated the following

Table 2. Demographics From the Infographic Evaluation Survey.

	Raw Count = 84	
Factor	N	%
Age		
18–24	3	3.6
25–44	25	29.7
45–64	31	36.9
65+	16	19
Missing	9	10.7
Gender		
Female	46	55.9
Male	28	33.4
Missing	9	10.7
Residence Location		
Boston Chinatown	5	6.9
Somerville, MA	36	43.8
Other	32	38.1
Missing	9	10.7
Education		
High school	5	5.9
College/university	27	32.1
Graduate school or more	41	48.8
Other	2	2.4
Missing	9	10.7
Language		
English Only	57	67
Chinese Only	3	3.5
Spanish Only	3	3.5
More than one language	11	13
Other	2	2.3
Missing	9	10.7

Table 3. Qualitative Themes From the Focus Groups.

Theme	Chinatown Focus Group	Somerville Focus Group
De-clutter the pictures, they are too busy	X	X
Use yards or feet instead of meters		X
Define UFPs more clearly	X	X
Explain why warm weather is better than cold weather for protecting against UFPs	X	X
Explain the importance of wind direction		X
Explain the overall impact of UFPs on health (not just on specific organs	X	X
Change the colors in the last 2 slides	X	X
Clarify the picture of the car exhaust, it's confusing	X	X
Give more specific scientific data to support the infographic's claims	X	X
Have a specific "call to action"	X	
Not everyone can change their schedules to accommodate differences in time of UFP exposure	X	X

Note. UFP, ultrafine particles.

Table 4. A Comparison of Recommended Changes vs Changes Actually Made.

Changes made to address community feedback

Community Feedback	*Changes made*
Better define UFPs, as they were vaguely described	Add an expanded definition of UFPs
The wind direction image was confusing, as it did not clarify why it was important	Took out concepts related to distance and wind direction
The green color in the last 2 slides indicated positivity, which is incongruent with the dangers presented by UFPs	Changed green color on health effects from green which represented health to black
Add more discussion on the overall health effects of UFPs (not just on specific organs)	Added more information on how the health effects take place
The different text colors were distracting	Change multi-color text to black text
Adding more scientific explanations for how behavior changes were important would be useful to encourage people to adhere to the infographic's recommendations	Added explanation about how behavior change protects your health

Note. UFP, ultrafine particles.

People might not stop to read the full infographic because it's too wordy and packed with information. They'll get lost reading it as it is.

Participants thought that the infographic needed to clarify the definition of UFPs, and that other viewers might not understand how dangerous they are. Relatedly, participants were confused about why the infographic focused on specific organs, such as the heart and lungs. Another participant informed us the following

The health information here is very generic, it doesn't say *how* ultrafine particles affect our health. Does it give us asthma? Lung cancer? People are concerned about their health and want details, especially if they don't really know what ultrafine particles are.

Participants also asked for more information about why warmer weather was better for going outdoors than colder weather

Clarify the point about warm vs. cold weather – how exactly is warm weather better than cold weather for avoiding air pollution? Boston gets cold in the winter, we can't always control when we need to leave the house for work or to buy groceries.

Concerns around clarification for warm weather vs cold weather were raised several times, particularly since Boston experiences 4 distinct seasons. In particular, participants wanted to know if they should keep their windows opened or closed in warm weather or cold weather, especially since many did not have forced air handling systems in their homes.

Updating the Infographic Based on the Collected Feedback

We sorted feedback according to the number of times a theme was mentioned, relevance to the infographic, and editability
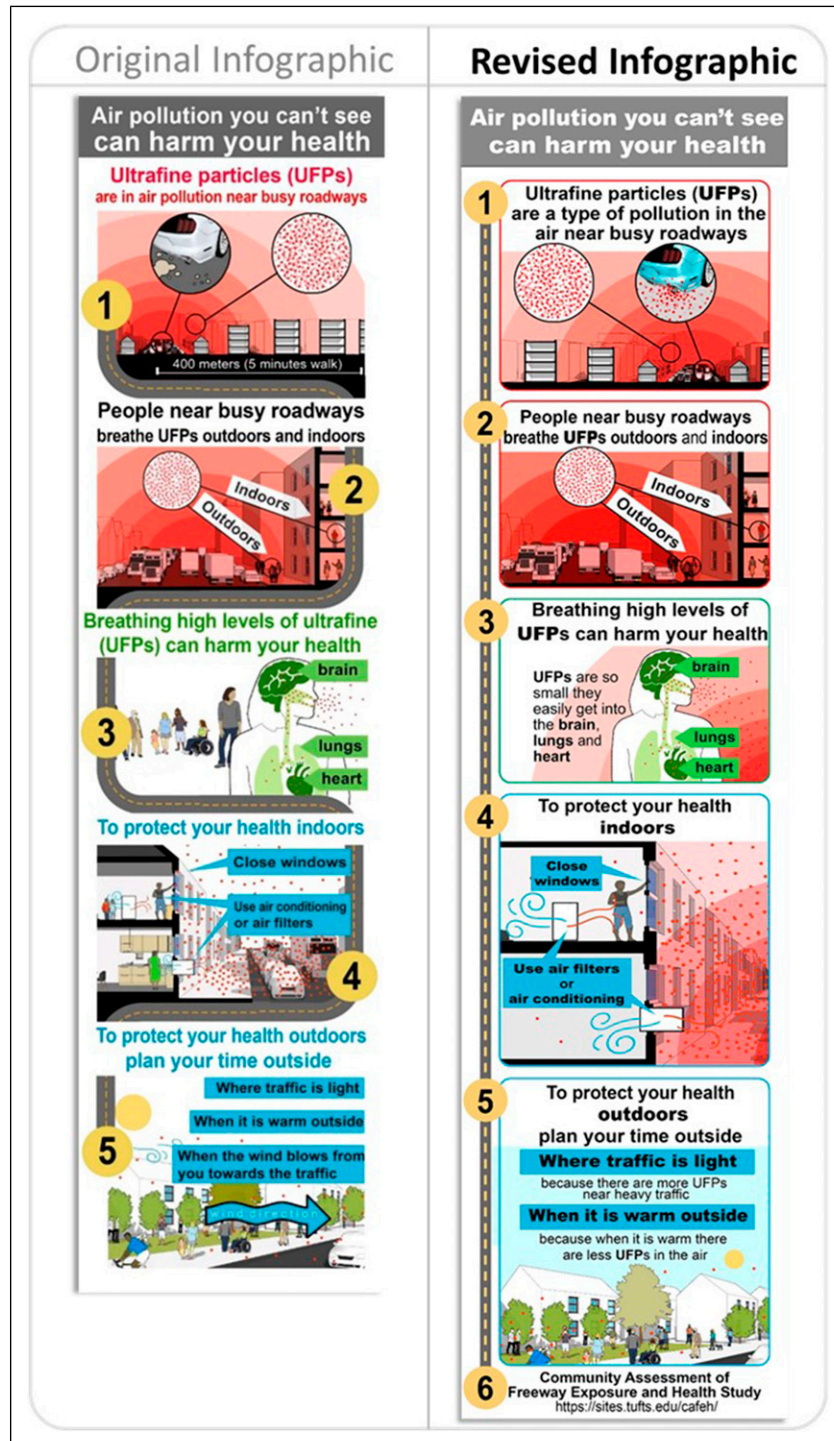
Figure 2. Revised infographic.

or ability to address. The team was able to address 6 of the themes, as highlighted in Table 4.

Based on the feedback from the surveys, focus group, and interviews, we developed a revised infographic (Figure 2).

Discussion

Our experience suggests that the infographic could be a useful tool for communicating information about air pollution for

communities near highways. While near-highway communities in Somerville reacted similarly to Boston Chinatown and provided overlapping feedback, the Chinatown residents also recommended that a call to action and broader policy changes be included in the infographic, rather than simply providing information and what individuals can do to protect themselves. Our outreach included both Chinatown residents and those who work in Chinatown, which explains the 43.8 percent of participants who wrote "other" in the residence location question. We reached data saturation with the interviews, meaning that themes repeated in the interviews until no new themes arose.

Chinatown's streets are among the most congested in Boston, with a history of rapid urban renewal that has razed affordable housing for highway construction and built luxury residential buildings with rents at unaffordable levels for long-term residents.[31,34] Chinatown is a neighborhood of Boston that has been historically marginalized, leading to local leaders and activists creating a grassroots advocacy approach to effecting change.[31] For example, the Chinese Progressive Association (CPA),[35] a local grassroots organization, is dedicated to the equality and empowerment of the Chinese community in Boston. Chinese Progressive Association is heavily involved in improving housing conditions for Chinese–Americans by effecting policy-level changes.[36] As such, Chinatown's focus on policy development for the infographic might be a response to its social and geographic history as a marginalized community which had to campaign for years to gain a say in its urban infrastructure.

In contrast, the Somerville residents' focus on literacy might reflect the city's bustling and growing multi-ethnic immigrant population, long history of social activism, and established working-class roots.[31,37] With 48.2% of school children speaking a language other than English at home, English-language literacy is not consistent throughout Somerville, particularly among older immigrants.[31] For example, The Welcome Project serves adult English language learners speaking a variety of languages including Spanish, Portuguese, and Haitian Creole. Somerville residents suggested simplifying the language would help the material appeal more broadly in the city.

The partners' commitment to social action and environmental justice is paramount to the future of this project. The first iteration of the infographic was primarily informational; however, it also drew attention to existing environmental injustices in underserved neighborhoods and the ways in which residents can protect themselves and their families. The infographic also drew attention to the environmental health resources available to residents And, unlike other research utilizing infographics,[10,38-40] this study incorporated feedback from community members to redesign and improve the infographic's health messages and overall communication.

Limitations

Due to the COVID-19 pandemic, it was difficult to recruit enough participants to meet the recommended focus group size of 6–8 people,[41,42] even though all focus groups were conducted virtually.

Conclusion

The number of recommended revisions highlights the community members' interest in the infographic and the ways in which it could be utilized in various community settings. This suggests the infographic's potential efficacy as a health communication tool, which also emphasizes the usefulness of EHL as a conceptual framework to guide infographic development and implementation. The multiple steps taken to revise the infographic also indicate that it can be adapted to meet the needs of different communities based on their input and engagement throughout the process of research development, implementation, and reporting of results. The infographic will be disseminated to community partners and residents.

Our experience developing and evaluating an infographic about near highway pollution in environmental justice communities suggests that infographics can be a viable communication tool in this context. Further research with infographics of a similar nature but in diverse communities is needed to strengthen our conclusion.

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Appendix I

Demographics

	Total (N = 84)
Participant language	
Spanish	0 (0%)
English	84 (100%)
How old are you?	
18–24	3 (3.6%)
25–34	8 (9.5%)
35–44	18 (21.4%)
45–54	14 (16.7%)
55–64	17 (20.2%)
65–74	13 (15.5%)
75+	1 (1.2%)
Missing	10 (11.9%)
Where do you live?	
Boston Chinatown	5 (6.0%)
Other	32 (38.1)
Somerville, MA	36 (42.9%)
Missing	11 (13.1%)
If other, where do you live?	
2115	1 (1.2%)
Arlington	1 (1.2%)
Arlington MA	1 (1.2%)
Belmont, MA	1 (1.2%)
Brighton MA	1 (1.2%)
Cambridge	1 (1.2%)
Connecticut	1 (1.2%)
Coring, NY	1 (1.2%)
I work closely w/ Chinatown groups	1 (1.2%)
Jamaica Plain	1 (1.2%)
Malden	1 (1.2%)
Malden, MA	1 (1.2%)

(continued)

(continued)

	Total (N = 84)
Medford	1 (1.2%)
Medford, MA	1 (1.2%)
Pittsburgh, PA	1 (1.2%)
Portland, ME	1 (1.2%)
South Boston	1 (1.2%)
Wilshire, England	1 (1.2%)
Worcester	1 (1.2%)
Worcester, MA	1 (1.2%)
Missing	64 (76.2%)
What is your gender?—Selected Choice?	
Female	46 (54.8%)
Male	28 (33.3%)
Missing	10 (11.9%)
What is your education or training?	
College or university	29 (34.5%)
Graduate school or more	42 (50.0%)
High school	2 (2.4%)
Other	1 (1.2%)
Missing	10 (11.9%)
Which language do you speak at home?	
Chinese	2 (2.4%)
Chinese, English	5 (6.0%)
English	57 (67.9%)
English, Haitian Creole, Other	1 (1.2%)
English, Haitian Creole, Spanish, Other	1 (1.2%)
English, Other	1 (1.2%)
English, Portuguese, Spanish	1 (1.2%)
English, Spanish	2 (2.4%)
Other	1 (1.2%)
Spanish	2 (2.4%)
Missing	11 (13.1%)