Most Natural and Propane (LP) Gas Service Users Report Not Having Electronic Gas Detectors

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Gas leaks in buildings can cause explosions and fire, which can result in serious burns, death and/or property damage. Since people may not smell the odorants added to natural and propane gas for a variety of reasons (e.g., being congested or asleep) electronic gas detectors could assist in detecting gas leaks. This study examined the extent to which electronic gas detectors are being used by persons reporting that they receive gas service. Three hundred seventy six participants were asked whether they have gas service at their residence and if so, what kind. Also they were asked what kinds of electronic gas detectors they had. Results showed that about half of the participants had gas service. While almost everyone reported having smoke detectors in their residence (whether or not they received gas service), less than half of the gas service users reported having a carbon monoxide detector. Very few gas service users (about 9%) reported having electronic gas detectors. Implications for warning about gas leaks and how HFE professional can aid in the production of better warnings in this domain are discussed.

INTRODUCTION

Natural and propane (LP) gas is widely used as a main energy resource in many machines and appliances. Gas has several benefits in that they are relatively clean burning fossil fuel, economical energy source, and efficient to use (EIA, 2012). However, there are safety issues with its use. During 2003 and 2007, an estimated 2,110 home structure fires reported annually with the ignition of natural gas, which resulted in an annual average of 43 civilian fire deaths, 152 civilian fire injuries, and $59 million in property damage (NFPA, 2012). Both gases are odorless, colorless, and extremely flammable. If ignited, gas leaks can cause fires and explosion potentially resulting in severe burns and death. Due to its potential hazardous characteristics, there are government regulations and industry standards to promote its safe use (EIA, 2012). Gas companies add an odor (mercaptan compounds) to help in the detection of leaks. The smell is described as similar to a rotten egg, skunk or dead rodent (EIA, 2012; Wogalter and Laughery, 2011). The odorant can be an aid in the detection of a gas leak.

Reliance on olfaction (sense of smell) may be inadequate to warn people because the added odorant is not always detected or recognized. There are many reasons for a failure to notice a gas leak. Some of these include nasal congestion, being asleep, being older, and so on (see Wogalter & Laughery, 2011). Thus, odorizing the gas does not fully solve the gas leak detection problem. Another method to augment gas leak detection is electronic gas detectors (e.g., Wogalter & Laughery, 2011). Most of these detectors are capable of detecting both natural and propane gas (depending on where they are placed) and are similar in appearance and shape to smoke and carbon monoxide detectors). Electronic gas detectors can be purchased in larger hardware stores or online.

The present study explored whether people who reported having gas service in their residence have electronic gas detectors. Participants were asked what kinds of residences that they live in and whether they receive gas service, and if so, what kind. They were also asked what kinds of electronic detectors that they had in the residence by choosing from a provided list.

METHOD

Participants

Data was collected between Fall, 2009 and Spring, 2010. A total of 376 individuals (199 females, 176 males, 1 missing gender information) was recruited. Average age of the entire sample was 32.4 years (SD = 15.7). Samples from two population pools were collected (1 missing student information): 50% were undergraduate students from a large southeastern university (M = 21.1 years; SD = 5.8) and 50% were non-student adult volunteers from the same general area in the southeastern U.S. (M = 43.8 years; SD = 14.3). The non-student adults were on average 21 years older with a wider age range than the students.

Materials and Procedure

The responses to questions were part of a larger questionnaire concerning various beliefs about safety and consumer products. In addition to a demographics questionnaire (e.g., asking age and gender), there were three main categories of questions. One asked the kind of residence that participants were currently living (house, apartment rental, etc.). Another set of questions asked whether they had gas service, and if so, what kind (natural gas, propane (LP) gas, or the option of "I don't know the kind of gas it is"). The third set of questions concerned what kind of electronic detectors that they had at their current residence. The alternative choices provided included both real consumer-available alternatives (carbon monoxide, natural gas, smoke, and propane [LP] gas) and two incorrect choices (carbon dioxide, oxygen). Two random orders of questions were used. Following the completion of these tasks, participants were debriefed and thanked.

RESULTS

Kind of Residence and Ownership

About a quarter or 26.6% (n = 100) of all participants reported that they are living in an apartment, 16.2% (n = 61) reported living in a dormitory, 50.5% (n = 190) reported house, 1.1 % (n = 4) reported living in a condominium, and 5.6% (n = 21) reported other domiciles (e.g., duplex, fraternity, sorority house, and townhome).

Students and non-student adults differed in the type of reported domicile, $\chi^2 = 122.49$, $df = 4$, $p < .05$. Table 1 shows the frequencies (percentages) of kind of residence separated by students and nonstudents. Students lived in various domiciles, such as apartments, dormitories, and houses; however, most non-students reported living in a house.

Table 1. *Frequency (%) of Kind of Residence and Students/nonstudents*

Kind of Residence	Frequency (%)	
	Students *f* (% of students)	Nonstudents *f* (% of nonstudents)
Total	188	187
Apartment	68 (36.2)	31 (16.6)
Dormitory	60 (31.9)	1 (0.5)
House	46 (24.5)	144 (77.0)
Condominium	3 (1.6)	1 (0.5)
Other*	11 (5.9)	10 (5.3)

*Other includes duplex, fraternity, sorority house, townhome, mobile home, and cottage.

Regarding ownership or renting of their residence, 47.3% (n = 178) of the participants reported that they lived in a residence that they or their family owned, whereas 52.7% (n = 198) of the participants reported that they or their family rent their residence. Students and non-student adults differed in ownership their residence, $\chi^2 = 95.45$, $df = 1$, $p < .05$. Table 2 shows the frequency (percentage) of ownership between students and non students. This table shows that students tended to rent, whereas nonstudents tended to own.

Table 2. *Frequency (%) of Ownership and Students/nonstudents*

Ownership	Frequency (%)	
	Students *f* (% of students)	Nonstudents *f* (% of nonstudents)
Total	188	187
Rent	146 (77.7)	51 (27.3)
Own	42 (22.3)	136 (72.7)

Possession of Gas Service

Out of a total of 376 participants, 44.7% (n = 168) of the participants reported that they have gas service at their residence.

Students and nonstudents differed on reported gas service, $\chi^2 = 11.35$, $df = 1$, $p < .05$. Thirty six percent (n = 68) out of the students reported they have gas service in their residence, whereas 53.5% (n = 100) of the nonstudents reported that they have gas service.

Gas Detectors

Participants were asked what kinds of the detectors that they have in their residence from a list provided. They were asked to choose *all* of the types of detectors that they have in their residence, which meant that they were allowed to choose more than one alternative. Almost everyone in the total sample (96%, n = 361) reported they had a smoke detector. A third of the participants (33%, n = 124) reported that they have a carbon monoxide (CO) detector. Very few individuals reported gas detectors that would warn about a gas leak (natural or propane gas). Only 3.7% (n = 14) of the participants reported they had a natural gas detector, and only 2.7% (n = 10) of the participants reported they had a propane gas (LP) detector. In addition, 2.4% (n = 9) reported having an oxygen detector and 6.4% (n = 24) reported having a carbon dioxide detector in their residence.

Natural gas and propane gas detector were combined for the following analysis since most of the consumer electronic gas detectors can be used to detect either kind of gas, depending on their placement—mounting them near the floor for propane gas (which is heavier than air) or near the ceiling for natural gas (which is lighter than air). These two detectors were collapsed into one category. The resulting total was that 5.6% (n = 21, 3 reported they have both) participants reported that they have explosive gas detectors.

Focus on Participants Having Gas Service

Further analyses were conducted only on the group of participants reporting to receive gas service (n = 168). Three analyses are reported below.

Types of Gas Service. Considering only participants having gas service, 54.0% (n = 88) of them reported that they have natural gas service, 20.9% (n = 34) have propane (LP) gas service, and 25.2% (n = 41) reported that they have gas service but they don't know what kind. Five participants had missing answers for this question. There was a significant difference between students and nonstudents on type of gas service, $\chi^2 = 25.84$, $df = 2$, $p < .05$. Table 3 shows the frequencies (% in parentheses) for the kinds of reported gas service received students vs. nonstudents.

Table 3. *Frequency (%) of Reported Types of Gas Service by Students/nonstudents*

Kind of Gas	Frequency out of *n* = 163 (100%)	
	Students	Nonstudents
Natural gas	29 (17.8)	59 (36.2)
Propane gas (LP)	7 (4.3)	27 (16.6)
Gets gas service but do not know which kind	30 (18.4)	11 (6.7)

Electronic Gas Detectors. People with gas service almost always (97%, n = 163) reported having a smoke detector. The next most frequently reported detector by gas service users was a carbon monoxide detector (44.6%, n = 75). Only 10.1 % (n = 17) reported they had a natural or propane gas detector. Table 4 shows specific types of electronic detectors participants reported.

Table 4. *Frequency (percentage) of Types of Gas Service and Kinds of Electronic Detectors*

	Types of Gas Service *f* (%)	Electronic Detectors *f* (%)
Total	163	278*
Smoke		163 (97.0)
Carbon Monoxide		75 (44.6)
Natural Gas	88 (54.0)	-
Propane Gas (LP)	34 (20.9)	-
Explosive gas		17 (10.1)
Oxygen		6 (3.6)
Carbon Dioxide		17 (10.0)
Don't know what it is	41 (25.2)	

*Participants were asked to select *all* of the types of detectors in their residence and so could report more than one type.

Specific Analysis for Non-Students with Gas Service. There were exactly 100 non-students with gas service in the total sample. This group was selected for particular focus because they were potentially most knowledgeable about gas service and safety than consumers as a whole. This group was older and more likely to live in a residence (house) that they or their family own. Furthermore this group is more likely to interact with gas companies directly and receive literature and view their warnings. One could then presume that they would be more knowledgeable about the general public about the topics of gas and gas detectors than nonusers of gas, students, and renters. Almost all of these non-student gas-service users reported having a smoke detector (n = 99). The next frequently reported detector was a carbon monoxide detector (n = 53). Only 9 non-students gas-service users reported having either a natural or propane gas detector. Two reported having an oxygen detector and 10 reported having a carbon dioxide detector.

Electronic Gas Detectors for Gas Users and Non-Users

Individuals reporting that they use gas at their residence were compared to individuals who reported not using gas with respect to types of detectors they reported having in their residence. Gas users and non-gas users differed significantly for carbon monoxide detector ($\chi^2 = 18.69$, $df = 1$, $p < .05$), for explosive gas (natural or propane gas) detector ($\chi^2 = 11.84$, $df = 1$, $p < .05$), and for carbon dioxide detector ($\chi^2 = 7.09$, $df = 1$, $p < .05$). Table 5 shows specific types of electronic detectors participants reported.

Table 5. *Frequency (%) of Types of Gas Detectors by Gas and Non-gas Users.*

	Frequency (%)			
	Gas Users		Non-gas Users	
Detector Type	*f* (% of gas users) n=168		*f* (% of nongas users) n=208	
Smoke	163	(97.0)	198	(95.2)
Carbon Monoxide (CO)*	75	(44.6)	49	(23.6)
Explosive (Natural or LP) Gas*	17	(10.1)	4	(1.9)
Carbon Dioxide (CO_2)*	17	(10.1)	7	(3.4)
Oxygen (O_2)	6	(3.6)	3	(1.4)

*$p<.05$

DISCUSSION

This study examined the extent to which people have electronic gas detectors in their residence particularly those with gas service. While natural and propane gas usually have an added odorant when delivered to residences and businesses, some people (and at some points in time, everyone) will not detect odorized gas by smell due to various reasons such as odor masking, habituation, congestion, and being asleep. One way to augment the detection of a gas leak is to install electronic gas detectors that are available in the consumer market for around $50 (e.g., in hardware stores or Internet). Gas detectors tend to be manufactured or branded by companies that also make smoke and carbon monoxide detectors.

About 45% of the total sample reported that they had gas service in their residence. When considering only those with gas service (n= 168), over half reported they had natural gas and about a fifth reported propane gas. About a quarter said they had gas service but did not know what kind of gas they received. One potential reason for the relatively large number of gas users who do not know what kind of gas that they use is that some participants may not have understood the names of the gases, i.e., natural gas and propane (LP) gas, despite the fact they are common names for these two gases. Knowing the type of gas service is important in determining proper placement of electronic gas detectors. Because natural gas is lighter than air, the detector should be placed near the ceiling, and because propane is heavier than air the detector should be placed near the floor. Not knowing what the kind of gas they are using would appear to reflect a basic gap in knowledge about a potentially dangerous product.

Most participants had smoke detectors. The next most frequently reported detector was a carbon monoxide (CO) detector. CO is an exhaust gas for many kinds of appliances and motors that use gas. CO is one of the leading causes of poisoning death in the U.S. (Johnson-Arbor, Liebman, & Carter, 2012). The results showed that less than half of the participants who reported getting gas service also reported having a CO detector. Only about a third of the total sample of participants had a CO detector. Clearly, this is much lower than desirable.

Less than 6% of the participants in the total sample reported having an electronic gas detector to detect gas leaks. Gas can leak into buildings from in-ground pipe ruptures and so even buildings not directly receiving gas service could be benefitted by having an electronic gas detector. However, buildings with gas service and their occupants are more at risk for a gas leak than the total population of all buildings and all consumers. Yet very few participants receiving gas detectors had gas detectors. Of the participants reporting having gas service, only 9% of them said they had an electronic gas detector. Even when considering the subset of participants that would be more likely to be knowledgeable about the gas that they receive (and may receive materials from the gas companies), the numbers with electronic detectors are not large. The data shows that only 9% of the group comprising non-student gas service users reported to have a natural or LP gas detector in their residence. This low number suggests that most gas service users do not have an electronic gas detector in their residence.

Some gas detectors currently in the marketplace are a combination unit of both CO and explosive (natural or LP) gas detection systems. However, installation of the dual detector could be somewhat problematic. For natural gas detection, the combination detector needs to be placed near the ceiling since natural gas is lighter than air, but to detect propane gas, the detector needs to be installed near the floor since propane gas is heavier than air. CO is heavier than air, so the dual function of the combination of CO and natural gas detection are in conflict.

Most people including gas users are probably unaware of a need for a separate detector (beyond smoke and CO detectors) for gas leaks. There are several potential reasons for this. Some people may not think about the topic at all. Some gas companies say little if anything on the topic and if they do it tends to be very general and inconspicuous. Some people may believe that they will smell a gas leak before anything bad happens to them. Reliance on smell as a cue for a leak is what a lot of gas-industry consumer literature suggests. Some gas companies include a brief inconspicuous mention about electronic gas detectors but often it is inconspicuous and relatively uninformative. These aspects need to be improved through better industry to consumer communications. They need to be more

conspicuous and given persuasively to motivate users to install electronic gas detectors. This might include prominent list of reasons why they might not smell the gas (e.g., allergies, colds, competing odors in the environment) (see e.g., Wogalter and Laughery, 2011). Gas companies are beginning to provide information in their literature how other sensory modalities could help in gas leak detection: auditory (hearing a hissing sound) or visually (seeing bubbling).

A few participants reported having in their residence O_2 (2.4%) and CO_2 (6.4%) gas detectors. Oxygen and carbon dioxide detectors are not commonly available in the consumer marketplace. Their inclusion into the list was to act as "foils." Their selection by participants can be indicative of several contributing factors such as not knowing much about electronic gas detectors and guessing, as well as social desirability, and sloppiness. The main point is that foil selection gives a measure of error rate, which appears to be in the realm of 2-6%. Note that the numbers of participants who selected the two foil alternatives were at about the same level of magnitude as the reports for having electronic natural and LP gas detectors. If one takes the percentage level of 2-6% as a sort of guessing rate then this could suggest that the rates of having an electronic gas detector for gas leak detection might be only somewhat above 0. In other words, the relatively low rate of having the natural and propane gas detectors in Table 4 is likely an overestimation.

When comparing gas service users and non-gas service users on having gas detectors, gas users reported more often having CO and explosive gas (natural and LP) detectors than non-gas users. This difference would be expected but the frequencies and percentages are much lower than needed. There was no difference for the reporting of smoke detectors between gas users and non-gas users as almost everyone in both groups reported having a smoke detector. As mentioned above, CO_2 and O_2 were false choices.

People were surveyed through a questionnaire and gave reports of having detectors. This was an economical way to measure this variable. However, it is not the same as actually checking whether people actually have them or not. Thus the numbers reported are estimates of their level of use. Also, just merely having a detector does not mean, of course, that it is in working order. Detectors may not be working properly for various reasons (e.g., absent a working battery, poor placement). Detector operability was not measured in this study.

Human Factors/Ergonomics (HFE) professionals could play a role in improving gas leak warnings. They could assist the gas industry and other organizations on how to better communicate the utility of electronic gas detectors to consumers. Additionally the gas detector manufacturers themselves ought to market their products better. Most stores with a large hardware department should stock them. They also need better and more usable instructions and warnings about proper placement, limitations, etc.

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