ORIGINAL ARTICLES

Some like it hot: Results of a community intervention trial aimed at improving safety behaviors to prevent hot water scald burns

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ABSTRACT

Objective: Hot water scalds continue to pose a serious threat in the home, causing over 1,500 hospital admissions and 100 deaths each year in the United States. We aimed to determine whether households who participated in an enhanced home safety visit demonstrated improved safety behaviors about hot water compared to homes receiving a standard home visit. This community intervention trial took place between April 2010 and April 2011.

Methods: Hot water temperature and self-reported prevention behaviors were recorded at a baseline visit, and retested 6-9 months later in a follow-up visit. Residents whose hot water temperatures remained at an unsafe temperature were asked why they did not adjust the temperatures. Demographic data were also recorded.

Results: A total of 708 households participated. No significant difference emerged between the two study groups in the proportion of households observed to have adjusted their hot water temperature to safe levels between the baseline and follow-up visits (t = 1.24; P = .22). Residents who received the enhanced education were more likely to report testing their water temperature (27% *vs*. 11%; $P < .01$) and turning their hot water temperature below 120°F (43% *vs*. 32%; P = .08). Among those who had unsafe temperature levels and did not reduce the water temperature, the most common reason (26%) offered was that they "liked it hot".

Conclusions: These results demonstrate that water temperatures are unsafe in many urban homes. The effect of educational interventions may be mitigated by personal preferences of hot water temperature.

Key Words: Injury prevention, Scald burns, Hot water heaters, Fire and burns, Home visits, Consumer products

1. BACKGROUND

The Consumer Product Safety Commission (CPSC) recommends that water heater manufacturers preset the temperature of hot water heaters to 120°F. Though this manufacturing recommendation has been in place for decades hot water scalds are responsible for about 1,500 hospital admissions and approximately 100 deaths in the US per year.[1,2] Older adults and children are at increased risk for hot water scalds because they have thinner skin that burns more quickly than thicker skin of young and middle aged adults. Each year approximately 21,000 children are treated for scald burns of all causes, Scald burn injuries comprise about 65% of all burn hospitalizations for children aged 4 and below.[3] Hot tap water is responsible for about a quarter of all scald burns

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in the United States and is associated with more deaths and hospitalizations in children than any other hot liquid.[4–7] Older adults who suffer scalds from hot tap water face higher death rates, longer hospitalizations, and more severe health complications than younger adults who sustain similar injuries.[8,9]

Costs for scald burn deaths and injuries among American children ages 14 and below total about $44 million each year, with the children aged 0-4 years accounting for over 90% of this cost.[3] In New York City, societal costs attributed to tap water scald injuries for people of all ages from 1996 to 2003 were estimated to range from between $102 million and $149 million.[10]

The severity of hot tap water scalds depends on the temperature of the water and the duration of time to which the skin is exposed.[2] Exposure to water at 120°F can result in a serious burn in 10 minutes, whereas exposure to water at 140°F can result in a serious burn in as little as 3 seconds.[11] In the home, tap water scalds predominately occur in kitchens and bathrooms.[12] Scalds occurring in the bathroom present a great danger for young children, as more of the body is exposed to hot water during bathing.[13] Young children experiencing scalds in the bathroom, in predictable ways including falling into the bathtub, coming into contact with hot running water, and being placed into excessively hot water accidentally or intentionally.[13]

Previous work has demonstrated an association between water temperature and the number of individuals in the home, size of water heater, homeowner status, and type of water heater.[14] Interventions to reduce hot water temperatures, mostly educational in nature, have been the focus of much previous research. A pooled analysis of 16 studies showed varying outcomes, but overall, families participating in the intervention arms were found to be more likely to have a discrete study-defined "safe hot water temperature", than families in the control arms (OR = 1.41, 95% CI [1.07, 1.86]).[15] While existing studies have measured the effect of home safety interventions on a household's hot water temperature, there are no reports in the literature about reasons why participants in these educational interventions, who had excessive hot water temperatures, did not turn down their hot water temperature.

This study primarily aimed to determine whether households who participated in an enhanced home safety visit demonstrated improved safety behaviors about hot water compared to homes receiving a standard home visit. We hypothesized that participants in the enhanced area would be more likely to have safe water temperature, and higher self reported testing behaviors. We also sought to examine household characteristics that predict safe hot water temperature, and based on the literature and our previous work, we hypothesized that rental properties, and homes with fewer residents would be more likely to have safe water temperatures. Finally, we additionally explore participants' self report of testing behavior and reasons for not adjusting water temperature when they had been counseled to do so, which has not been previously reported in the literature.

2. METHODS

As part of a community trial evaluating a fire department home visiting program previously described,[12] hot water temperatures were tested during a home visit intervention. This community intervention trial took place between April 2010 and April 2011. Two study areas received one of two home visiting interventions. Homes in the standard area received an unannounced home visit from the fire department and for any resident that agreed, the installation of a lithium battery smoke alarm on each level of their home. At this baseline intervention visit, study staff recorded the temperature of the hot water and provided feedback on the safety of the temperature. Homes in the enhanced area received the same services as homes in the standard area, but the visits were enhanced with advance notice of the home visit and opportunities for the resident to receive educational messages from a safety educator who accompanied the firefighter. Education was about current temperature and need for change was provided to all families. Intervention families also received tailored information based on their answers to knowledge questions and a thermometer to assist with water testing. The educational materials were developed with attention to the needs of a low literacy population. Safety educators and data collectors followed standard protocol collection and for delivery of information. A follow-up visit to assess outcomes was made 6-9 months later for families who gave permission for the data collectors to return. All survey items were cognitively interviewed to ensure understanding prior to being used in the field.

2.1 Data Collection

Data collection took place inside residents' homes at the time of the fire department home visit (baseline) and six months later (follow-up). After permission to enter the home was granted for the baseline home visit, the firefighters installed the smoke alarms while trained data collectors recorded their activities. When the firefighters finished installing the alarms, the data collectors asked the resident to complete a brief survey about their home visit experience and their home safety knowledge (the baseline survey). This community intervention trial took place between April 2010 and April 2011.

During the fire department home visit, study staff tested the resident's hot water temperature. Hot water was considered unsafe if the temperature was above 120°F. Study staff informed the resident the temperature of their hot water and advised them to lower the temperature if the hot water was above the recommended 120°F. Participants in the enhanced area received further education about the dangers of water that is too hot and the risks of scald burns. Participants in the enhanced area whose hot water was above 120°F were provided specific instructions on how to reduce the temperature setting on their water heater (turn down the gauge on a gas water heater or call an electrician for an electric water heater) and a thermometer to retest the water temperature after adjusting it.

Residents who completed the baseline survey were informed about the six-month follow-up and asked if they would be willing to participate. Six months after the home visit, each participating household was visited to complete the follow-up survey and to have all the installed alarms checked. Residents completed an interviewer-administered, computer-assisted survey. Following the survey, data collectors recorded the temperature of the hot water as described below. Respondents were ineligible if the home had become vacant, if the original respondent had moved, or if the respondent was impaired and unable to complete the follow-up visit. The remainder was lost to follow-up (ten unsuccessful attempts by data collectors to reach the participant and complete the survey).

The Johns Hopkins School of Public Health Institutional Review Board approved this study.

2.2 Measures

2.2.1 *Demographics*

Respondents self-reported household size, education level, income, owner status and household composition at follow-up. Using self-reported household income and the number of people supported on that income, the household was classified as living in poverty if the income was below the 2010 Federal Poverty Guidelines.[16]

2.2.2 *Water heater characteristics*

Water heater type (gas or electric), and size in gallons were observed during follow-up by data collectors while in the home. Using the self-reported household size and observed size of the water heater, we calculated gallons per person.

2.2.3 *Observed hot water temperature*

Data collectors used a candy thermometer to test the temperature of the hot tap water during the fire department baseline intervention and follow-up visits. Candy thermometers provide a measure of temperatures between 75°F and 400°F. Water temperature was tested in the kitchen. Data collectors were instructed to completely open the hot water faucet for one minute, to fill a cup with that water, and then to measure the temperature with the candy thermometer. Hot water was considered "safe" if the temperature was 120°F or less.

2.2.4 *Self-reported prevention behaviors*

Three questions were asked to all respondents during follow-up to determine protective behaviors taken to reduce the chance of scald burns from tap water including testing behavior, and if an adjustment was made by the respondent or landlord.

2.2.5 *Reason for not adjusting water temperature*

Participants who reported they had been advised to turn down the hot water temperature at the baseline intervention visit but had not were asked a select-all-that-apply multiple choice question at follow-up about their reason for not adjusting the water temperature.

2.3 Statistical analysis

Descriptive statistics on demographics and household characteristics were generated for the standard and enhanced study areas and compared with a chi-square test. Hot water temperatures as measured during the baseline intervention and follow-up visits were cross-tabulated for the standard and enhanced areas. Differences between standard and enhanced areas in change in safe water temperatures were compared using a paired *t*-test.

A sub-analysis of participants whose water was too hot at the baseline intervention visit was conducted to examine hot water safety behaviors, including adjusting water heater temperature and retesting water temperature with a thermometer. This subsample was selected because it represents the group of participants that need to change their hot water temperature and are able to do so. Behaviors for the standard and enhanced areas were compared using a chi-square test.

Among those with a gas water heater who were told that their hot water temperature was too high, but did not adjust the water heater temperature, reasons for not turning down the hot water temperature were tabulated. Only those with a gas water heater were included in this analysis because these residents were instructed how to turn down the temperature of their water heater.

A logistic regression was run to identify the correlates of having safe hot water at follow-up among those whose water was too hot at the baseline intervention visit, adjusted for study group, the gallons per person, reported adjusting the water heater temperature, type of water heater, and home ownership status. Type of water heater, gallons per person and homeownership have been associated with safe hot water

temperature in the literature.[14] Observations that were missing one or more variables were excluded from the regression.

All analyses were performed in SAS 9.3 (SAS Institute Inc., Cary, NC) *P*-values less than .05 were considered statistically significant.

3. RESULTS

A total of 2,197 residents, 983 in the standard program and 1,214 in the enhanced program areas, participated in the baseline fire department home visit. Of these, 680 (69.18%) in the standard program and 709 (58.40%) in the enhanced program completed the baseline survey ($p < .01$), making them eligible for the six-month follow-up. Of those completing the baseline, 633 (93.08%) in the standard program and 629 (88.72%) in the enhanced group were interested in participating in the follow-up ($p < .01$).

Between January 2011 and December 2011, 754 follow-up interviews were completed. There was no difference in the completion rates across groups for the follow-up survey: 373 (58.92%) in the standard area and 381 (60.57%) in the enhanced ($p = .55$) completed the follow-up. Those who did not complete the follow-up either refused, were ineligible, or were lost to follow-up.

Respondents were typically female (72%), with at least a high school diploma or GED (80.85%) and were homeowners (58%). Participants in the standard area were more likely to have children in the home (53% *vs*. 37%, $p < .01$) (see Table 1).

Table 1. Demographics

		Standard N = 341 (%)	Enhanced N = 367 (%)	Total N = 708* (%)	χ^2
Gender	Male	82 (24.05)	110 (29.97)	192 (27.12)	3.14 ($p = .08$)
	Female	259 (75.95)	257 (70.03)	516 (72.88)	
Age	18-24	13 (3.82)	14 (3.84)	27 (3.83)	12.89 ($p = .01$)
	25-34	85 (25.00)	60 (16.44)	145 (20.57)	
	35-44	58 (17.06)	74 (20.27)	132 (18.72)	
	45-55	80 (23.53)	72 (19.73)	152 (21.56)	
	≥ 55	104 (30.59)	145 (39.73)	249 (35.32)	
Household role	Head of household	289 (84.75)	302 (82.74)	591 (83.71)	0.52 ($p = .50$)
	Other	52 (15.25)	63 (17.26)	115 (16.29)	
Education	< high school diploma	59 (17.35)	76 (20.82)	135 (19.15)	3.80 ($p = .28$)
	HS diploma/GED	128 (37.65)	145 (39.73)	273 (38.72)	
	Some college	67 (19.71)	54 (14.79)	121 (17.16)	
	Completed college	86 (25.29)	90 (24.66)	176 (24.96)	
Household income below the poverty line?	Yes	75 (26.69)	83 (27.21)	158 (26.96)	0.02 ($p = .89$)
	No	206 (73.31)	222 (72.79)	428 (73.04)	
Homeowner status	Rent	144 (42.73)	148 (40.66)	292 (41.65)	0.31 ($p = .58$)
	Own or pay mortgage	193 (57.27)	216 (59.34)	409 (58.35)	
Children in home (< 18 y)	Yes	180 (52.79)	137 (37.33)	317 (44.77)	17.07 ($p < .01$)
	No	161 (47.21)	230 (62.67)	391 (55.23)	
Number of people in the home	1 person	34 (10.00)	77 (21.10)	111 (15.74)	18.01 ($p < .01$)
	2-3 people	169 (49.71)	174 (47.67)	343 (48.65)	
	4-6 people	119 (35.00)	98 (26.85)	217 (30.78)	
	7 or more people	18 (5.29)	16 (4.38)	34 (4.82)	
Type of heater	Gas	269 (87.91)	281 (86.46)	550 (87.16)	0.29 ($p = .59$)
	Electric	37 (12.09)	44 (13.54)	81 (12.84)	

* Some variables do not add up to 708 due to missing item responses.

Measurements for the hot water temperature for both the baseline intervention visit and the follow-up visit were available for 679 households. Table 2 shows the change between baseline and follow-up of participants who went from safe to unsafe, vice versa, or remained unchanged. The temperature of the water was hotter than recommended (greater than 120 degrees) at baseline in 39% of homes (264/679) and in 41% of homes at the follow-up (277/679). At baseline, the 264 homes with unsafe water temperature had a mean temperature of 130.9°F. Of these homes, 91 had safe hot water temperature at follow-up with a mean temperature of 113.9°F. There was no difference between the standard and enhanced groups in the percentage of homes changing from unsafe and safe hot water temperatures (t = 1.25; p = .22). In all, roughly two-thirds (65.53%) of those with unsafe hot water temperatures at baseline remained unsafe at follow up.

Table 2. Hot Water Temperature at Baseline and Follow-up (N = 679)

Hot water safe*?		Standard			Enhanced			Total		
		Follow-up (n = 332)			Follow-up (n = 347)			Follow-up (n = 679)		
		Safe	Unsafe	Total	Safe	Unsafe	Total	Safe	Unsafe	Total
Baseline	Safe	145 (71.43)	58 (28.57)	203 (100)	166 (78.30)	46 (21.70)	212 (100)	311 (74.94)	104 (25.06)	415 (100)
	Unsafe	43 (33.33)	86 (66.67)	129 (100)	48 (35.56)	87 (64.44)	135 (100)	91 (34.47)	173 (65.53)	264 (100)
Total		188 (100)	144 (100)	332 (100)	214 (100)	133 (100)	347 (100)	402 (100)	277 (100)	679 (100)

*Paired t-test between Standard *vs.* Enhanced for changes from baseline to follow-up: t = 1.24 (p = .22).

Table 3 displays the frequency of self-reported hot water safety behaviors among N = 224 participants with a gas water heater who had water that was too hot at the baseline intervention visit. Few participants reported turning down the temperature of the hot water (n = 83; 31%) or testing the hot water temperature with a thermometer (n = 42; 16%) at follow-up. However, participants in the enhanced group were significantly more likely to report testing the hot water temperature with a thermometer (27% *vs.* 11%; $p < .01$) and they were somewhat more likely to report turning the temperature down (43% *vs.* 32%; p = .08) although the difference was not statistically significant.

Table 3. Self-reported hot water safety behaviors among residents with a gas water heater whose water was too hot at baseline (N = 224)

		Standard N = 129 (%)	**Enhanced N = 135 (%)**	**Total N = 264 (%)**	**Chi-Square**
Have you taken any of the following actions to prevent hot tap water burns in your home in the last 6-9 months?*	Test the hot water with a thermometer	12 (10.53)	30 (27.27)	42 (15.91)	10.31 ($p < .01$)
	Turn the hot water heater down below 120°	36 (31.58)	47 (42.73)	83 (31.44)	2.98 (p = .08)
	Install an anti-scald device	0 (0.00)	1 (0.91)	1 (0.38)	1.04 (p = .31)
Have you or anyone else (like a landlord) adjusted the temperature setting of your water heater in the last 6-9 months?#	Yes, made it hotter	9 (8.41)	6 (5.61)	15 (5.68)	4.11 (p = .13)
	Yes, made it cooler	32 (29.91)	46 (42.99)	78 (29.54)	
	No/Don't know	66 (61.68)	55 (51.40)	121 (45.83)	

*Items are not mutually exclusive.

#Does not add up to 224 due to missing item responses.

Table 4. Reported reasons for not turning down water temperature (N = 95)*

Reason	**Count**	**Percentage**
We like it hot	28	26%
I don't know how	18	17%
We actually did turn it down	13	12%
Not needed	10	9%
Don't no/no reason	9	8%
I need help (from family or landlord) to lower it	7	7%
It will be too cold to get the dishes or laundry clean	6	6%
My family will complain if it is too cold	5	5%
I have not made the time	5	5%
Turned it down did not like it and then turned it back up	4	4%
Bath would be too cold if it was lower	2	2%
No access to change it	0	0%

*Items are not mutually exclusive respondents were able to select multiple answers.

Table 4 describes the reasons why people did not lower their water temperature even after being told at baseline that it was too high. The most frequently cited reason was that they liked it hot (n = 28; 26%). Others reported that they did not know how to lower it (n = 18; 17%), that they needed help to adjust it (n = 7; 7%), that they needed it hot to clean their dishes or laundry (n = 6; 6%), and that other people in their home would complain if they turned it down (n = 5; 5%).

In the multiple logistic regression model predicting safe hot water temperature at follow-up among those whose water was too hot at the baseline intervention visit (see Table 5), study group assignment and self-report of adjusting the wa-

ter temperature were not significant. Homeowners were had odds 2.41 times higher than renters to have a safe hot water temperature (p = .02).

Table 5. Logistic Regression of Safe Hot Water Temperature at Follow-up among those with Unsafe Temperatures at Baseline (N = 203*)

		Odds Ratio of Safe Hot Water Temperature at Follow-up	*p*-value
Study group	Standard	Reference	
	Enhanced	1.10	.77
Gallons per person in the home	Per 1 gallon increase	1.01	.49
Reported adjusting hot water temperature	No/Don't know	Reference	
	Yes, made it hotter	2.41	.34
	Yes, made it cooler	1.98	.53
Type of water heater	Gas	Reference	
	Electric	0.66	.64
Homeowner status	Rent	Reference	
	Own or pay mortgage	2.41	.01

*n = 61 participants (n = 20/91 with safe hot water at follow up; n = 41/173 with unsafe hot water at follow up) were missing data on one or more variables in the regression and were excluded.

4. DISCUSSION

This manuscript reports on the results of a community intervention trial aimed at improving observed hot water temperature, and testing behaviors. Based on our results, the hot water intervention was not effective in our sample. Observed hot water temperature remained higher than recommended in 41% of homes at follow-up, with no differences found between groups. Our ability to measure differences between groups may have been muted by the fact that the data collectors informed residents in the standard group when their water temperature was higher than the recommended temperature. In addition, our measurement of observed water temperature may be too crude, as it does not take into account recent water usage from the water heater, which could affect the observed water temperature. This is supported by the fact that we saw shifts from safe hot water temperatures to unsafe temperatures from baseline to follow-up in both samples as well as shifts in the desired direction. Our one-time educational intervention which counseled at-risk individuals to lower their water heater temperature setting may not have been robust enough to affect change. Temperature gauges on water heaters are complicated; the settings on the gauge do not equate to actual temperature readings and require an iterative process of turning the dial back, waiting, and testing the water temperature to reach a desired temperature.14 Residents may be more likely to set their water heater temperature at a safe setting if the actual water temperature at the tap was more easily determined by a clearly marked safe setting on the gauge.

The effect of the home safety intervention on whether at-risk families lowered their water heater temperature settings is also not ideal, as only 31% of respondents who were counseled to lower their water temperatures reported doing so across the two interventions, and the enhanced intervention that provided more detailed information about testing and turning down the temperature did only slightly better. Participants in the enhanced group were significantly more likely to report testing the water temperature with a thermometer although only 27% of them reported actually doing so. It possible that our one time intervention was not enough to effect the change we recommended.

Our results are similar to those found by others who have tested educational interventions to promote safe residential hot water temperatures. Work by Babul *et al*. demonstrated that families receiving a home safety intervention were two times more likely to adjust their hot water temperature to safe levels, than families who did not receive a home safety intervention.[17] Engineering interventions that install anti-scald devices at the tap have shown more promise in protection from scalding water. Kendrick *et al*. has demonstrated a decrease in scald burns after utilizing this passive intervention.[18] While potentially more promising, the installation of anti-scald devices cost about $250 per room ($100 for the valve and $150 for installation).[19] Such an intervention was beyond the budget of our community intervention trial but should be considered, as anti-scald devices may be a cost-effective way to reduce burns from tap water. An educational intervention targeting landlords should also be considered. Rental properties in our sample were more likely to have unsafe water temperatures. An intervention targeting landlords with an injury prevention and liability minimization message may be effective.

An additional finding of note from our work comes from the reasoning of respondents who reported that they did not

lower their hot water temperature. Participants whose water was too hot at baseline and did not adjust the temperature before follow-up were asked reasons for not having lowered their water heater setting. The most common reasons for not having lowered the temperature where that they liked it hot (26%) or that they did not know how to adjust their heater setting (17%). It may be necessary to improve risk awareness to affect change in this group. It may also be helpful to recommend that families purchase larger water heaters to accommodate household hot water demand. Our previous work demonstrated that the availability of more hot water for each person (gallons per person) was associated with lower hot water temperatures.[14]

Our study results are limited by it having been conducted as part of a community intervention trial, as opposed to a randomized controlled trial. Our hot water outcomes may be muted by our protocol to inform participants in both the standard and enhanced group when their water was too hot. Though the enhanced group intervention was more robust educationally, it may not have been different enough to effect change between groups.

The research reviewed above describes the risk of injury associated with tap water scald burns and the previous prevention efforts to educate residents/families about the need to test their water temperature and adjust their water heater setting. The aims of this paper are to report on the effect of reported and observed behaviors of an intervention aimed at encouraging residents to test and when need to lower their water temperature in a large sample of urban homes; and to report residents' reasons for not lowering their water temperature.

The human and financial costs of residential scald burns are significant and noteworthy. Most of these burns can be prevented. Our educational intervention experienced some success but additional attention is needed to determine the best combination of interventions to reduce unintentional scald burns in the US.

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