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Assessing heat-adaptive behaviors among older, urban-dwelling adults

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Abstract

Objectives—Health studies have shown that the elderly are at a greater risk to extreme heat. The frequency and intensity of summer heat waves will continue to increase as a result of climate change. It is important that we understand the environmental and structural factors that increase heat vulnerability, as well as examine the behaviors used by the elderly to adapt to hot indoor temperatures.

Study design—From June 1 to August 31, 2009, residents in 29 homes in Detroit, MI, kept an hourly log of eight heat-adaptive behaviors: opening windows/doors, turning fans or the air conditioner on, changing clothes, taking a shower, going to the basement, the porch/yard, or leaving the house. Percentages of hourly behavior were calculated, overall and stratified by

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Contributors
Jalonne L. White-Newsome wrote the first draft of the paper. Brisa N. Sánchez provided guidance on methods used for the statistical analysis. Edith A. Parker contributed by helping create the behavioral data collection tool. J. Timothy Dvonch contributed by helping understand the data outcomes. Zhenzhen Zhang contributed by inputting and preparing the raw data for analysis. Marie S. O'Neill supervised the study and oversaw the first draft of the paper. All authors declared that they have seen and approve the final version.

Competing interests
No authors have any competing interests.

housing type and percent surface imperviousness. The frequency of behavior use, as a result of indoor and outdoor predetermined temperature intervals was compared to a reference temperature range of 21.1–23.8 °C.

Results—The use of all adaptive behaviors, except going to the porch or yard, was significantly associated with indoor temperature. Non-mechanical adaptations such as changing clothes, taking showers, and going outside or to the basement were rarely used. Residents living in high-rises and highly impervious areas reported a higher use of adaptive behaviors. The odds of leaving the house significantly increased as outdoor temperature increased.

Conclusions—These findings suggest that the full range of heat adaptation measures may be underused by the elderly and public health interventions need to focus on outreach to these populations.

Keywords

Elderly; Adaptation; Public health intervention; Imperviousness; Indoor heat exposure; Climate change

1. Introduction

Muscle spasms, heavy sweating, physiological strain, anxiety, fatigue and confusion are all potential health impacts of heat stress on the body. If a person's internal body temperature stays elevated, the temperature control system stops working which can lead to heat stroke and be life threatening [1]. Populations that have been shown to be vulnerable to heat include, but are not limited to, those who are socially isolated, living in homes with high thermal mass, living on the upper floors of high-rise buildings, and those with chronic diseases and the elderly (over age 65) [2]. With heat-related mortality and morbidity expected to rise as a result of increased frequency of extreme heat events caused by climate change, institutional and personal responses to heat as health threat are critical. Personal perceptions of the health risks of heat are crucial in shaping individual actions to reduce these risks. In previous studies, when people perceive that adaptation to hot weather is unnecessary, they make few to no behavior adjustments to prevent heat-related health risks [3].

This study explores adaptive behaviors of elderly people to hot indoor temperatures and how residence type and environmental surroundings influence these behaviors. Specifically, this paper describes how senior citizens adapt to heat during the summertime while in their homes, identifies the variation in adaptations based on occupancy type and surface imperviousness surrounding the home, and provides specific recommendations for communities to address the barriers that could inhibit the use of personal adaptive behaviors as well as community-level adaptation.

2. Methods

Thirty volunteer participants living in the Detroit area were recruited based on their age (over 65 years of age) and willingness to allow temperature monitoring at their residency (homes or apartments). Participants were chosen to widely represent area neighborhoods and housing types. Individuals living in single family residences or high rise apartment buildings, with and without air conditioning (central or room unit), were recruited. Recruitment efforts targeted local agencies on aging and existing community organizations or clubs, and advertising occurred through word of mouth, flyers, and formal presentations. Participants gave written consent and allowed data collection visits every two weeks during the period of June 1–August 31, 2009. Participants received compensation of 10 USD per visit. The University of Michigan Institutional Review Board approved this study.

Behavioral data was collected through a daily activity log. Participants were provided with a daily activity log and instructed to record activities associated with adapting to feeling hot but not general daily activities (e.g., showering to cool off versus daily showering). Each page had a grid with time listed on the left margin: "Before 6 a.m."; separate hourly entry lines for the hours 7 a.m.–10 p.m.; "Evening" (11 pm) and "Bedtime" (midnight until 6 a.m. the next morning). Eight adaptive behaviors were listed across the top: opening or closing a window, turning on air conditioning, leaving the house, taking a shower, going to the basement, changing clothes, turning on a fan, or going to the porch (or somewhere directly outside the house). Participants could either "check the box or draw a line through the boxes" in the grid corresponding to the time they engaged in any of the eight activities when they felt "hot". Only the designated participant completed the activity log for each location.

Each residence's indoor temperatures were monitored and recorded using a HOBO Temperature Logger H08-001-02 from the Onset Corporation (http://www.onsetcomp.com/). Calibration specifications for the loggers are detailed in Appendix. To minimize individual indoor factors that could influence temperature logger readings, all loggers were installed on walls without windows or vents, approximately 1.5 m from the floor, away from any heat sources (e.g., a kitchen and floor heater/air conditioner) or a door leading to the outside. Outdoor temperature data was downloaded from Detroit Metropolitan Airport weather archives. We used temperature data in 1-h intervals compatible with hourly activity log data.

Imperviousness represents the percentage of land surface covered by surfaces impenetrable by water, such as asphalt or concrete. High imperviousness can exacerbate the urban heat island phenomenon, which refers to higher surface temperatures occurring in urban areas versus surrounding rural areas due to urbanization [4]. Urban imperviousness data was downloaded from the Multi-Resolution Land Characteristics Consortium (MRLC) National Landcover Database (NLCD) (http://www.mrlc.gov) 2001 products, generated through satellite imagery collected in the year 2001 with 30 m spatial resolution. ArcGIS software was used to map the physical address of each home onto the imperviousness image and a 30 m pixel average of the image, representing percent imperviousness at the study location, was assigned to each home. Each home was categorized as high imperviousness (>63%) or low imperviousness (<63%) based on the mean imperviousness of 63%.

2.1. Statistical analysis

We calculated and graphed the percentage of time each adaptive behavior was used within each of six indoor temperature ranges (<21.1 °C, 21.1–23.8 °C, 23.8–26.6 °C, 26.6–29.4 °C, 29.4–32.2 °C, >32.2 °C), overall and stratified by residence type and surface imperviousness. The proportions for these graphs were calculated using the total number of 1s (reported behaviors were coded as 1) divided by the total number of 1s and 0s for that behavior.

We then estimated logistic regression models to examine the probability of engaging in each behavior in a given temperature range compared to the reference ‘comfortable’ temperature range of 21.1–23.8 °C. The response variable for each model was behavior use and the explanatory variables were indicator variables for the different temperature ranges (<21.1 °C, 23.8–26.6 °C, 26.6–29.4 °C, 29.4–32.2 °C, <32.2 °C), with 21.1–23.8 °C as the reference category [5]. Because we gathered repeated measures of reported behaviors from the same individuals over time, logistic regression models were estimated using generalized estimating equations (SAS PROC GENMOD), which account for correlated responses within the same study location.

3. Results

Of the 30 initially recruited study participants, 29 recorded using at least two adaptive behaviors throughout the study period. One participant recorded no heat-adaptive activities during the summer and was therefore dropped from subsequent analyses. A total of 16 homes had central air conditioning and 20 had basements. Twenty five homes had an exterior made of brick, 2 of asphalt, 1 of wood siding and 1 of vinyl paneling. Eight high rise apartments were monitored, while 21 of the homes monitored were single family homes or two family flats. The range of urban imperviousness values surrounding all locations was 29% to a maximum of 89%.

The most frequently used behaviors over the entire study period were ‘opening windows or doors’, and ‘turning fans on’ (Table 1). Above 32.2 °C, ‘going to the basement’ or ‘going to the porch or yard’ was the least reported behavior, while ‘turning fans on’ was the most common. The frequency of most reported behaviors was highest during the 23.8–26.6 °C temperature interval, but lowest when indoor temperatures were above 32.2 °C. Odds ratios and 95% confidence intervals of engaging in behaviors at certain indoor and outdoor temperature ranges relative to the reference temperature range of 21.1–23.8 °C are shown in Table 2.

The odds of a behavior are defined as the probability of engaging a certain adaptive behavior versus not. Odds ratios compare the odds of the behavior in a given temperature range relative to the odds of the behavior in the reference range. For certain behaviors, the odds ratios were not calculated at the lowest or the highest temperature range due to limited sample size (sparse or nonexistent reports of those behaviors). All behaviors, except going to the porch or yard, showed a statistically significant association with indoor temperature for at least one of the temperature ranges (Table 2). Turning on fans and turning on air conditioner had increased odds for all temperature ranges above 23.8 °C. In contrast, the odds of taking a shower or changing clothes were lower as indoor temperature increased. Temperatures above 32.2 °C were not significantly associated with increases in adaptive behavior use, potentially due to lack of statistical power to detect associations given a relatively small number of time periods exceeding 32.2 °C. The total hours of reported

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behavior at temperatures above 29.4 °C was 516 h, while the total number of hours of reported behavior above 32.2 °C was 38 h.

Similar to the association with indoor temperature, the odds of turning the air conditioner on increased as outdoor temperature increased. In contrast, the odds of turning the fans on did not. The odds of leaving the house increased significantly with increasing outdoor temperature (Table 2).

3.1. Behavior frequency by housing characteristics

The percentage of time behaviors were reported being used varied by residential type-high-rise (apartment with more than 4 floors), single family (stand-alone residence) or a two-family flat (two distinct living quarters with separate entrances) (Fig. 1). High-rise residents had an overall higher use of reported behaviors, followed by single family residences and those living in two-family flats. None of the two-family flats had central air conditioning and none of the high-rises had basements. Air conditioner use was higher in high rise residences; ‘changing clothes’ and ‘taking a shower’ were reportedly used more in single family residences. ‘Opening windows and doors’ and ‘turning on fans’ were reported by all residence types more than any other behavior. Those in a two family flat reported ‘going to the basement’ and ‘going to the porch or the yard’, less than any other behaviors.

The percentage of time behaviors were reported also varied by level of surface imperviousness (Fig. 2). Most behavior use was reported in residences in high impervious areas.

4. Discussion

This analysis explored the predominant adaptive behaviors to hot indoor and outdoor temperatures among elderly Detroit residents, and how residence type and percent surface imperviousness around the home were associated with these behaviors. The highest reported behavior in the overall study was ‘opening windows or doors’; the least reported behavior was ‘going to the basement’. The highest frequencies of adaptive behavior use were reported at the 21.1–23.8 °C temperature range. Surprisingly, the least number of behaviors were reported at temperatures above 32.2 °C, which could have also been limited by the small number of days, based on outdoor temperature, that were over 32.2 °C. However, as expected, the frequency of turning the fans on increased significantly with increasing indoor temperature. Residents in single family homes reported more use of ‘taking a shower’, and ‘changing clothes’ than any other residence type. In a high rise, the use of ‘opening windows or doors’, ‘turning on fans’, ‘turning on the air conditioner’, and ‘leaving the house’ had reportedly higher use than the other residence types.

We also generated the odds ratios for behavior use based on outdoor temperature intervals. The use of taking a shower as an adaptive behavior – based on outdoor temperatures – showed the same fluctuations of use across increasing temperature intervals as the behavior use based on indoor temperatures. Changing clothes had a statistically significant increase at the 24.4–26.6 °C range, but the odds of changing clothes were higher at the lower outdoor temperature intervals. This could be true because as it gets hotter, some of the population might want to do nothing and just stay still to stay cool; that is, adapting by not acting. Some behaviors seemed to be more motivated by outdoor temperatures versus indoor temperatures. For example, the behavior of leaving the house, based on outdoor temperature, steadily increased over the pre-determined temperature intervals. This suggests that the perception of the weather being hotter – e.g., based on media reports – could encourage a person to leave the house, more so than the actual temperature indoors. The odds of opening windows or doors, using a fan, or going to the basement were not significantly associated with outdoor temperature which could indicate that those behaviors are more driven by indoor temperatures than outdoor temperature. The temperature a person is directly experiencing might cause them to engage in the simple behaviors that could bring some relief; such as using basements, which in most homes, are cooler than upper floors, whereas the perception of being hotter might influence them to engage in more complex behaviors.

Given the relatively low prevalence of reported behavior use in this study, we suspect seniors are underutilizing the full range of heat adaptation measures. Furthermore, even though we observed a limited amount of time periods when the indoor temperature exceeded 29.4 °C, our data suggests that seniors may also underuse the full range of adaptive behaviors during heat waves.

4.1. Context – other literature

Common ways that elderly persons in Baltimore, MD, adapted to ambient heat included wearing less clothing, taking in more fluids, using air conditioning or going outdoors [7]. In our study, more people reported 'opening windows or doors', 'using fans', 'leaving the house' and 'taking a shower' as ways of adapting to heat. However, in our study, we did not ask explicitly about taking in more fluids.

A study of older people in London, England, aged 75–92, examined not only the actions people take with extreme heat, but also their perceived vulnerability to heat, as well as factors that might support or impede certain behaviors. While some of the older people changed their behavior during heat waves, some did not even consider themselves to be either old or at risk during heat events [8]. While we did not examine perceived vulnerability in our study, we did find fewer reported behaviors at temperatures above 32.2 °C. This could reflect people adapting by not engaging in any action (i.e. adapting by not acting) at such high temperatures because of the physiological factors (e.g., fatigue and shortness of breath) that heat might exacerbate.

A survey of adults aged 65 and older in four North American cities evaluated perceived vulnerability, behavior and use of cooling systems within a home during a heat event [9]. More than half of the respondents believed that heat is "not dangerous or only slightly dangerous to them"; few respondents reported modifying their behavior because of a heat event, but most cited that staying indoors was their most common means of dealing with a heat event [9]. Further, when fans were used by respondents to cool their homes, they were used incorrectly (i.e. with the windows closed) a majority of the time. This practice can enhance dehydration by re-circulating hot air. In our study, fan use was highest at temperatures above 23.8–26.6 °C. Based on research staff observation, fans were not always being used correctly by the participants in our study. Additionally, the reported use of fans in areas with high surface imperviousness was greater than in homes surrounded by low imperviousness. Because areas with high surface imperviousness have been shown to hold more heat at a ground level, incorrect use of fans for adaptation (e.g., not opening windows with fans) would provide little to no relief from warm indoor temperatures.

While perceptions can be an integral part of determining how people will choose to adapt to heat, adaptation strategies are also linked to variation in indoor and outdoor temperatures. A survey of building occupants showed how the use of simple controls – such as opening of windows and use of fans – varied by changes in indoor and outdoor temperatures [10]. We also observed some behaviors that were associated with outdoor (perceived) temperature, but not with indoor (actual) temperature. We also found that the odds of opening windows increased after 21.1 °C and then decreased after indoor temperatures reached 29.4 °C. Additionally, the "non-mechanical" type of cooling adaptations (i.e. changing clothes, taking a shower, going to the basement, going to the porch or yard, leaving the house), had some of the lowest reports of behavior use at the temperatures above 29.4 °C. Again, this could be explained by adapting to temperatures by not acting. Observations and conversations by the research staff with some of the study participants indicated that people were sometimes too hot to move, or engage in any behavior that would cool them off. However, the odds of using air conditioning as a cooling device in our study did increase at temperatures greater than 26.6 °C, relative to the reference level of 21.1–23.8 °C. This observation makes sense, as people who have air conditioning would most likely use it at higher temperatures.

4.2. Potential barriers for seniors to adapt to hot temperatures

Although our study did not directly address barriers for the elderly to adapt to hot temperatures, other studies have. Several studies have identified economic factors – ranging from lack of funds to maintain air conditioners or pay for related electricity costs – to lack of funds to weatherize (e.g., add better insulation) and modernize the house to be more energy efficient, as important barriers to adaptation [11–13]. In our study, the dates residences were built ranged from 1912 to 1987, which can influence the amount and type of insulation in the thermal envelope of the home. Of our 29 elderly volunteers, only two indicated that they had had insulation added or some type of weatherization done on their home to help with reducing energy consumption. Nevertheless, heat-related illness is avoidable and a critical intervention is to encourage creative prevention strategies by susceptible individuals and their care-givers [6]. Since heat warning alerts may have limited impact, means of communication can also be a barrier to adaptation. A study explored whether a public outreach system for the cities of Houston and Portland and the results suggested that heat health warning alerts have limited impact on the population at large and a need for weather-related planning communication and outreach with a particular focus on marginalized groups [14].

One limitation of our study was its dependence on data recorded by our volunteer residents. Recording of adaptive behaviors could have decreased as the study progressed since study duration was 3 months. However, our study also has the longest study period compared to other studies of heat-related activities among senior citizens.

5. Conclusions

Elderly persons in Detroit, MI, tend to engage in fewer heatadaptive behaviors when indoor temperatures are greater than 29.4 °C. Further research on how the use of other indoor home cooling strategies – such as window shading and closing off one section of a home, as well as the influence of outdoor temperatures, financial barriers and impacts of weatherization would complement the insights we gained. Our research is consistent with other studies that suggest heat-adaptation strategies are under-used by the elderly, and serious health consequences may result. Understanding the predictors of such behaviors in vulnerable populations can help direct interventions, and inform the choice of mitigation strategies (e.g., tree planting and home weatherization) as communities prepare for climate change.

Based on this research and interactions with study participants, we have several recommendations for care-givers and providers of services to the elderly that could help encourage adaptation practices at a personal and community level. On the individual level, encouraging the elderly to understand the usefulness of engaging in simple adaptive behaviors could reduce their risk to heat related health impacts. These simple adaptive behaviors include: increasing fluid intake (this recommendation may vary for dialysis patients); wearing light clothing; and learning how to cool a home without air conditioning by using stationary fans appropriately so they are not just blowing around hot air (i.e. at least two windows should be opened in the home with the stationary fan placed in one of the windows, pointing towards the outside in order to help move the hot air out of the home while cooler air comes in).

In terms of adaptive behaviors at a community level, we recommend that multi-residential buildings – like senior apartments, nursing homes – create an emergency response plan that includes a plan for extreme heat. Included in this plan should be accommodations for a temporary residence or 'cooling location' where elderly residents can be moved during multiple days of extremely high temperatures. Often, days of extremely high temperatures can lead to an interruption in electrical power in the form of a brown-out or a black-out, leaving many seniors without the ability to cool their home with an air conditioner or fan, if that is even an option. The community-level adaptation must also consider how to respond to and re-locate the homebound elderly, especially those with significant physical disabilities living in high rise apartments or buildings with multiple floors. We also encourage community-level entities to provide information regarding financial assistance for the elderly to help with utility costs as well as home weatherization. All atrisk populations, community entities and providers of services to the elderly should recognize that the threat of getting sick or dying from heat exposure is as relevant inside homes as it is outdoors.

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Appendix A

A.1. Calibration Instructions for HOBO Temperature Logger H08-001-02

Each residence's indoor temperatures were monitored and recorded continuously at half hour intervals from June 1 to September 1, 2009 using a HOBO Temperature Logger H08-001-02 from the Onset Corporation (http://www.onsetcomp.com/). The data logger is a one-channel temperature recorder, with selectable sampling intervals and a programmable start time and date. These same exact loggers were used in a Montreal study of indoor heat exposure (Smargiassi et al., 2008). All HOBO loggers were pre- and postcalibrated using a National Institute of Standards and Technology (NIST) probe, EXTECH Instruments 407445 Heavy Duty Hygro- Thermometer provided by Frank Marsik of University of Michigan, as the gold standard. The HOBO loggers were placed in an enclosed room with the NIST probe among them to assess their accuracy and precision. Each calibration period lasted 27 hours.

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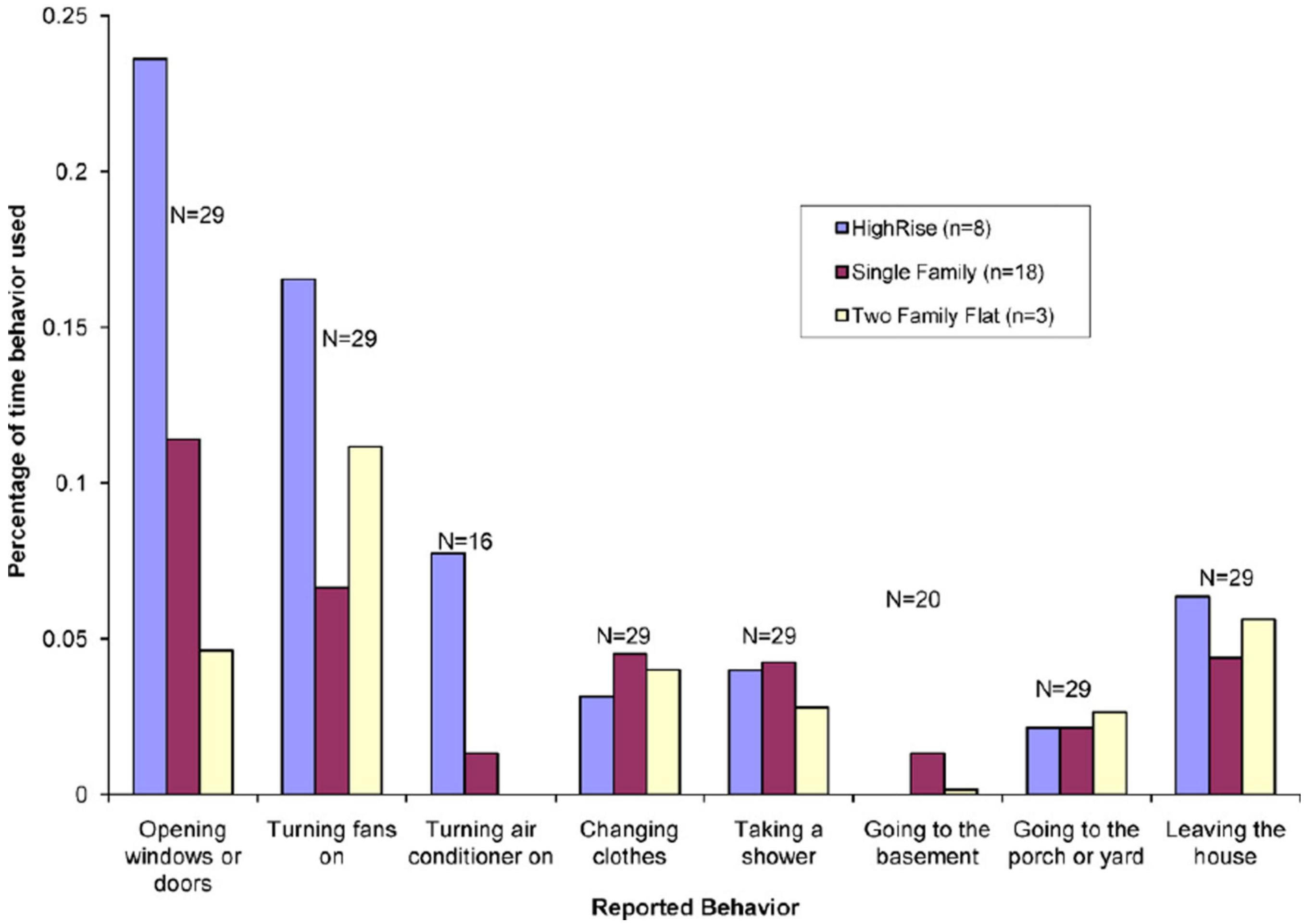

Fig. 1.

Percentage of time heat-adaptive behaviors reported being used by elderly residents in 29 Detroit, MI homes, summer 2009, by residential type. *N* = number of homes.

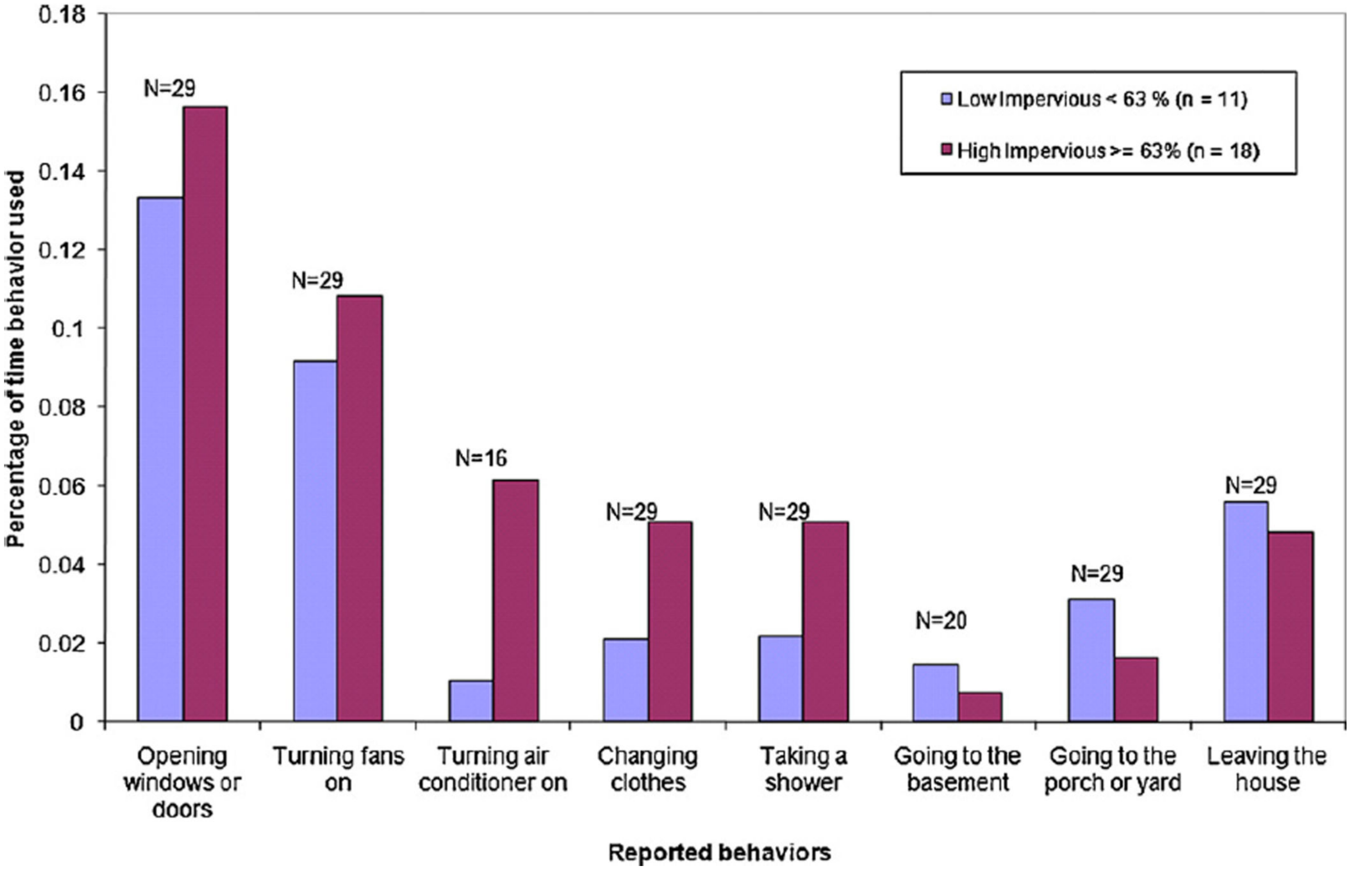

Fig. 2.

Percentage of time behaviors reported being used by elderly residents of 29 Detroit, MI homes, summer 2009, by level of surface imperviousness (<63%) or (≥63%) from the National Land Cover Dataset (NLCD 2001). *N* is number of homes.

Table 1

Heat-adaptive behaviors reported in an hourly activity log by seniors in 29 residences in Detroit, MI. Number/percent of total monitored hours when behavior was reported is provided for the entire summer 2009 (36,541 total monitored hours), and during times when indoor temperatures (measured hourly in each home with indoor temperature monitors) fell into specific ranges. All temperatures are measured in °C.

	Behavior							
	Opening windows or doors	**Turning fans on**	**Turning air conditioner on**	**Changing clothes**	**Taking a shower**	**Going to the basement**	**Going to the porch or yard**	**Leaving the house**
Number of homes where behavior was possible (**N**)	29	29	16	29	29	20	29	29
% of total study period[a]	14.8%	10.2%	4.8%	4.0%	4.0%	1.2%	2.2%	5.1%
Total hours monitored of behavior reported at locations where possible	5413	3734	960	1471	1476	270	792	1867
Total hours monitored in homes where behavior possible	36,541	36,541	19,813	36,541	36,541	23,196	36,541	36,541
<21.1 °C								
% of time reported[b]	7.8%	4.8%	0.0%	18%	2.7%	1.7%	3.8%	6.6%
Hours behavior reported	111	68	0	25	38	23	54	94
Total hours monitored	1419	1419	386	1419	1419	1365	1419	1419
≥21.1 °C, <23.8 °C								
% of lime reported[b]	17.4%	9.2%	2.0%	4.2%	4.4%	1.4%	2.6%	4.9%
Hours behavior reported	1160	614	60	281	292	75	173	330
Total hours monitored	6677	6677	2943	6677	6677	5258	6677	6677
≥23.8 °C, <26.6 °C								
% of time reported[b]	16.8%	11.3%	4.3%	4.8%	4.9%	1.2%	2.3%	5.2%
Hours behavior reported	2622	1762	377	748	759	117	354	812
Total hours monitored	15,598	15,598	8768	15,598	15,598	9996	15,598	15,598
≥26.6 °C, <29.4 °C								
% of tome reported[b]	12.4%	10.3%	7.0%	3.2%	2.9%	0.8%	1.8%	5.2%
Hours behavior reported	1388	1148	478	353	325	44	198	584
Total hours monitored	11,180	11,180	6856	11,180	11,180	5432	11,180	11,180
≥29.4 °C, <32.2 °C								
% of time reported[b]	7.9%	8.3%	5.5%	3.6%	3.6%	1.0%	0.8%	2.8%
Hours behavior reported	124	130	44	56	56	11	13	44

	Behavior							
	Opening windows or doors	**Turning fans on**	**Turning air conditioner on**	**Changing clothes**	**Taking a shower**	**Going to the basement**	**Going to the porch or yard**	**Leaving the house**
Total hours monitored	1560	1560	807	1560	1560	1050	1560	1560
≥32.2 °C								
% of time reported[b]	7.5%	11.2%	1.9%	7.5%	5.6%	0.0%	0.0%	2.8%
Hours behavior reported	8	12	1	8	6	0	0	3
Total hours monitored	107	107	53	107	107	95	107	107

[a]% of total study period: total hours of behavior reported/total where behavior possible.

[b]% of time reported = hours behavior reported/total hours monitored.

Table 2

Odds ratios and 95% confidence intervals (CIs) for seniors reporting adaptive behavior use at different temperature intervals (indoor temperature and outdoor temperature intervals), compared to a reference temperature of 21.1–23.8 °C. Data obtained from 29 residences in Detroit, MI, June–August, 2009. Indoor temperatures were the temperatures recorded by the indoor temperature loggers in each home. Outdoor temperatures were taken from Detroit Metropolitan Airport archives.

Behavior	<21.1 °C	24.4–26.6 °C	27.2–29.4 °C	30–32.2 °C	>32.2 °C
Indoor					
Opening windows or doors	0.59 (0.39, 0.88)	1.10 (0.75, 161)	1.27 (0.69, 2.32)	0.93 (0.45, 1.94)	0.98 (0.57, 1.67)
Turning fans on	–	1.88 (1.04, 3.39)	3.34 (1.47, 7.59)	3.46 (1.48, 8.06)	–
Turning air conditioner on	–	2.34 (1.34, 4.09)	3.43 (1.73, 6.83)	2.99 (1.66, 5.41)	–
Changing clothes	0.82 (0.68, 0.98)	0.92 (0.82, 1.03)	0.73 (0.56, 0.91)	0.68 (0.52, 0.90)	0.55 (0.08, 3.60)
Taking a shower	1.14 (0.95, 1.37)	0.79 (0.62, 1.01)	0.55 (0.40, 0.76)	0.56 (0.30, 1.03)	0.34 (0.09, 1.28)
Going to the basement	1.36 (0.94, 1.98)	0.66 (0.29, 0.85)	0.49 (0.29, 0.85)	0.49 (0.12, 2.09)	–
Going to the porch or yard	1.40 (0.69, 2.84)	0.99 (0.71, 1.39)	0.96 (0.62, 1.48)	0.65 (0.39, 1.10)	–
Leaving the house	1.59 (0.94, 2.68)	1.07 (0.73, 1.58)	0.99 (0.61, 1.61)	0.58 (0.37, 0.91)	0.78 (0.28, 2.16)
Outdoor					
Opening windows or doors	0.90 (0.68, 1.19)	0.39 (0.65, 1.25)	0.99 (0.54, 1.80)	0.79 (0.39, 1.56)	0.95 (0.41, 2.18)
Turning fans on	–	0.98 (0.69, 1.40)	1.22 (0.57, 2.61)	0.97 (0.36, 2.61)	–
Turning air conditioner on	–	2.31 (1.37, 3.94)	3.03 (1.54, 5.92)	5.77 (2.74, 12.15)	–
Changing clothes	1.39 (0.93, 2.09)	0.78 (0.63, 0.96)	0.65 (0.41, 1.01)	0.68 (0.38, 1.20)	0.63 (0.32, 1.23)
Taking a shower	1.64 (1.37, 2.11)	0.60 (0.49, 0.76)	0.32 (0.20, 0.52)	0.57 (0.27, 1.18)	0.37 (0.18, 0.79)
Going to the basement	1.17 (0.86, 1.60)	0.93 (0.65, 1.32)	0.83 (0.57, 1.20)	1.00 (0.52, 2.22)	–
Going to the porch or yard	0.74 (0.63, 0.88)	1.23 (0.86, 1.76)	1.43 (0.83, 2.48)	1.12 (0.61, 2.07)	–
Leaving the house	0.57 (0.41, 0.81)	1.39 (1.06, 1.80)	1.87 (1.35, 2.58)	2.23 (135, 3.70)	3.12 (1.61, 6.05)

Statistical significance denoted by gray shading.