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The practices of heat adaptation among elderly in Dezful: A qualitative study

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Abstract:

BACKGROUND: Useful experiences of the elderly in adapting to the environment may play an important role in formulating future policies. This study was conducted to explain the past experiences of the elderly in Dezful in adapting to heat.

MATERIALS AND METHODS: This study was conducted with a qualitative research approach and a qualitative content analysis method in 2020 and 2021. The experiences of 18 elderly in Dezful were collected through semi-structured interviews via recording, face-to-face interviews, and data observation. Sampling was performed by the purpose-based method, and the data of this stage were analyzed using a content analysis approach using the Zhang and Wildemuth method.

RESULTS: During the data analysis process, three main themes were extracted, including psychophysiological, socioeconomic, and environmental adaptation. Also, twelve subthemes including changes in physiological conditions, urban architecture, house architecture, diet, clothing, business conditions, mindset, life conditions, and the use of factors (spirituality, experience, and natural capacities) were extracted.

CONCLUSION: Explaining the experiences of the elderly in Dezful, who have lived with heat for many years, can provide better identification of solutions and more tangible experiences of adaptation to heat for other communities. These experiences can be used in urban, cultural, and social planning.

Keywords:

Adaptation, aged, climate change, disasters, extreme weather, life change events

Introduction

Humans are changing the global climate by increasingly using fossil fuels, which release and increase greenhouse gases. As global temperatures rise, climate change shifts to more intense temperatures and more extreme climate fluctuations take place.^[1,2] Global warming is one of the most important causes of environmental degradation. The global average temperature, which has risen by more than 0.7 degrees Celsius during the past 300 years, is projected to rise by more than 1.5 degrees Celsius by 2050. This issue will become even more important when

we know that among the dozens of natural disasters reported during the past 40 years, heat waves have been among the worst disasters in terms of their impact on human life.^[3,4] These increases in heat currently have significant and costly effects on community health.^[2,5-7] Some studies have shown the harmful effects of heat and heat waves on health.^[5,8-10] With the frequent occurrence of heat weather, the prevalence of diseases, the rate of hospitalization, and mortality related to the weather will increase significantly. These conditions indicate that heat weather is an important risk factor for human health. In Europe, the death toll from such disasters is higher than other natural disasters such

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as floods and hurricanes.^[1,2] International studies and reports state that climate change, and subsequent global warming, is a major threat to human health, and this is where the issue of warming and adaptation becomes more important. Recently, it was reported that most countries have not yet considered health issues when formulating climate change policies, and as a result of these policies, climate change and heat weather become more intense.^[9-14] Since human health is recognized as one of the most important issues affected by climate change, research in this area is a global priority.^[13,15-17] Given that other places are likely to experience more heat and heat waves in the future, it seems necessary to explain how people experience and adapt to heat. The results of research in this field may be used by current and future generations to use this experience and become familiar with solutions to adapt to heat. Documenting these experiences can be helpful in developing heat adaptation strategies in other communities as well. Studies have shown that to effectively deal with the negative effects of heat, residents' perceptions of the health risks of heat weather must be improved and adaptive measures must be taken.^[18,19]

An important aspect in assessing human health threats posed by climate change is to assess the extent and type of "individual adaptation." There are several definitions of adaptation to climate change. The United Nations International Strategy for Disaster Risk Reduction section defines adaptation to climate change as "adaptation to natural or human systems in response to real or expected weather stimuli or their effects that reduce harm or seize opportunities becomes useful."^[1] Also, the Intergovernmental Panel on Climate Change also defines adaptation as follows: "The process of adjustment to actual or expected climate and its effects." In human systems, adaptation seeks to moderate or avoid harm, or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to an expected climate and its effects. According to the results of the Salehi 2019 study, "adaptation to climate change is the ability of the system to have stability, sustainability, empowerment, productivity, flexibility and climate change through the optimal use of resources, resilience, coping, capacity building and opportunity creation." In addition to being a conceptual definition and referring to the main features of adaptation, this definition also refers to climate change adaptation policies, including the use of capacities and opportunities.^[12,14]

Older people have had to respond to heat throughout their lives, so they used and developed behavioral and environmental strategies.^[1,2,12] In a study aimed at examining the resilience and adaptability of a group of older people in a community exposed to heat, the results showed that, in general, this group had a high degree

of heat resistance due to some exposure to a hot climate for a long-life span and a proper understanding of what needs to be done to minimize exposure.^[20] Therefore, these strategies can be explored and published for the larger population to read to learn how to adapt to heat and reduce dependence on artificial cooling or air conditioning.^[14] Studies show that people's adaptation to heat and heat waves can greatly reduce negative health effects.^[11,16] These studies have suggested the following measures to adapt to heat: air conditioning, going to a cooler place, wearing light clothing, and drinking plenty of fluids.^[11,21,22] Some people who are exposed to the health risks of heat and heat waves still do not know what to do to avoid the negative effects of heat exposure or are unsure of those methods.^[17,23] Therefore, it seems that recording experiences of adaptation to heat can be very important in ensuring its use for others.^[11,16,17,23]

Dezful is an old Iran city with a warm and semi-humid climate. The innovation of this study is that the experiences of the elderly of this city, who have lived in the field of heat for many years, were extracted for the first time in this city, one of the hottest places in the world so that it can be used for planning and policymaking to adapt to the heat in other places that have experienced excessive heat due to global warming.

Researchers of this project have observed, experienced, and understood the excessive heat of Dezful. Also, the experience of the researchers shows the fact that despite the intense and oppressive heat of this region, many people of this city have adapted to the phenomenon of heat and have overcome these bad weather conditions through various methods. Therefore, if the experiences of these people in terms of adaptation to heat are collected and processed and shared with others, this may affect the quality of individual, family, and social life of people and even the type of urban policies. Therefore, this study is designed to identify the past ways to adapt to the heat weather in the city of Dezful.

Materials and Methods

Study design and setting

This study was an extract of experiences and methods collected by qualitative research method based on a qualitative content analysis approach to identify the practices of heat adaptation among elderly in Dezful.

Content analysis is a systematic method with the aim of reaching the depth and breadth of the description of the phenomenon that leads to revision, valid inferences from information and production of knowledge, and possibly new insights and is suitable for people's experiences and attitudes toward a particular topic. The content analysis focuses on the life experience,

interpretations, and meanings that individuals have encountered.^[24] Therefore, in this study, using the content analysis method, based on the descriptions of study participants, explicit and implicit concepts were identified. These concepts were then coded, summarized, and classified, and finally, the themes were extracted.

Data collection method and inclusion criteria

In this study, the data collection method was a semi-structured open and in-depth interview. The inclusion criteria of this study were as follows: Each person must be over 60 years old, was born in Dezful, has lived in Dezful for all of his/her life, and has the ability to communicate and answer the questions.

Sampling was performed based on purpose and available sampling. The samples were collected until the data were saturated. To observe ethical considerations before starting the study and conducting interviews, observing ethical points in this research was approved by the ethics committee of Tehran University of Medical Sciences (IR.TUMS.VCR.REC.1397.680), and issues such as conscious entry into the research, receiving written informed consent to record interviews, right to withdraw, anonymity, and confidentiality were observed throughout the study whenever the participant wished.

Information collection tools and interview process

Data collection tools were audio recording and open questionnaire. Through face-to-face interviews, observation, recording, and writing the experiences of the elderly in Dezful, the past experiences of adaptation to heat were explained. The interview method was adjusted depending on each person's responses. The first step was that the researcher coordinated by phone or in person with the participants and determined the time and place of the interview according to the participants' point of view. In the following step, the researcher re-explained the study objectives to each of the participants in the project and the interview method in the place of the meeting determined according to the wish of the interviewees. After the confirmation of each participant and expressing their clear interest in participating in the study, he/she was provided with the consent form of the study and was asked to sign this form if they wished. Before the interviews began, an initial guide to the interviews was prepared to help the researcher to ask further questions. The interviews began through communication and by gaining the trust of the participants in the first place.

First, an open-ended question such as "Tell us about your past experience of the heat and how to cope with it?" was asked, and then, other questions were asked based on the purpose of the interview and the participants' answers, such as follows: How did you cope with the

heat? What did you do to get rid of heat? Give a few examples. How effective had these solutions? To what extent did heat affect you?

Also, exploratory questions such as "Can you explain more" were also used as needed in each interview. At the end of each interview, the participant was asked to comment if there was anything left. In the end, after thanking the participants and expressing appreciation to them, they were told about the possibility of conducting further interviews. Interviews were conducted on one or more occasions depending on the time and tolerance of the participant, the information obtained, and the willingness of the participants. Interviews lasted approximately 65 to 90 minutes per person. It was also emphasized that at any stage of the research, they can announce their withdrawal from participating in the research and their details will be kept confidential during and after the research. All interviews were recorded with an MP3 player device, and before using this device, the need to do so was explained to the participant and his or her informed consent was obtained. In the shortest possible time, all interviews were implemented and typed word by word by the first researcher. During and after the interviews, all the interviews were listened to again and the accuracy of what was said was confirmed with the typed content. The notes were presented with the initial codes to a number of interviewees to ensure the interviews are clear of any misconceptions and to create transparency and increase the validity of the research. All participants agreed with the codes provided.

Trustworthiness

Guba and Lincoln's qualities are applied to increase the research's accuracy and ensure the findings' validity and reliability, and they posit that the trustworthiness of a research study is important in evaluating its worth.^[25]

Credibility: Samples with maximum diversity were selected from different neighborhoods of the city and different genders to increase the study's credibility. The participants should have enough appropriate time, enthusiasm, ability to express their experiences, and ability to think and rethink. The interviewing and extracting codes and concepts lasted about six months. At the beginning of the interview, the participants gained trust by stating the research objectives and introducing the interviewer.

The expertise, interest, continuous, and long-term contact of the researchers with the data and the efforts of the research team to get to know the elderly's experiences of adaptation in depth led to a deeper understanding of the subject. The manager of the research team, who was the research interviewer, was a native of the region and familiar with the customs, traditions, and culture of the area. A persistent observation technique

was used throughout the study to focus on interview details. Each text's extracted codes and concepts were feedback to the participants through face-to-face visits or phone calls to ensure that the extracted principles and images were correct and approved (member check). Five health professionals who were familiar with the fields of resilience and climate adaptation during disasters and were not involved in the research process provided the codes extracted from the first and most important interview to ensure the accuracy of the coding (peer check). The meaning-extract, and coding methods were done with the guidance of high-quality professors and experts in resilience, adaptability, and heat waves (Expert check). During the research, triangulation led to considering different points of view and attitudes to other dimensions of the subject. The opinions of several analysts reviewed the findings, and some observers referred to the data in the analysis and continuous comparison during the study.

Transferability: A complete and detailed description of the study steps achieved transferability.

To facilitate the transferability of the findings to people, times and situations, and other data settings, the details of the data and reports are in the last part of the problem statement and methodology, results, and data interpretation.

Dependability: In this study, we tried to seek the help of two researchers who were not in the role of research process to review and provide opinions about the study process and the study results (external audits) (this review aimed to evaluate the accuracy of the study and evaluate whether the data support the findings, interpretations, and conclusions or not).

Confirmability: From the beginning of the plan's development, the findings confirm this part (bracket); its documentation is with the researcher (audit trail). Conformability of the study was performed through triangulation and by surveying for six months, comparing the experiences of people with different views, and adding a public meeting to express the experiences of some interviewees to the study (triangulation of sources) using several analysts to review the findings (analyst triangulation). The observation was the principle of neutrality in the research (reflexivity).

Data analysis was performed using Zhang and Wildemuth methods, which is carried out in eight steps: data preparation, definition of units to be analyzed, develop categories and a coding scheme, test our coding scheme on a sample of text, code all the text, assess our coding consistency, draw conclusions from the coded data, and report your methods and findings.^[26] In this

method, first the semantic units were identified and then open coding was performed. In the next step, by classifying similar codes, the subgroup and then the main category including heat adaptation methods were extracted.^[24]

Results

Participants in this study included 18 married elderly people from Dezful, of which 11 were male and seven were female, and the age of participants was between 60 and 76 with an average of 66.72 years. The findings of the interview analysis to identify the practices of heat adaptation among elderly in Dezful are presented in Table 1.

Based on this exploratory study, all adaptation methods of the Dezful people, according to the Dezful elders' quotations, were emphasized. According to the traditional and indigenous context of Dezful City, all these adaptation methods usually are still used in parts of this city. According to the elders, the architecture of houses and public buildings has changed, and the desire to use construction or to use Shavadan in the new context of the city is less seen among young people.

Psychophysiological adaptation

Physiological changes

The human body has the ability to adapt to different conditions, including different climate situations, which is by changing physiological conditions. One of the strategies mentioned by the contributors in this study was a natural change in physiological conditions due to constant exposure to heat.

A change in physiological conditions means a change in the physical mechanisms of the body to coexist and adapt naturally to heat conditions. The elderly participants in the study believed that they were somehow used to living continuously in the hot climate of the city, which has longer warm seasons and very hot summers. According to the participants who live in this climate, getting used to the warm climate and heat, which naturally increases the body's resistance, is seen as a case of increasing adaptation (participant number 2 (P. 2)).

"This is how the people of Dezful grew up. It was hot since old times, and heat is just a part of life here and part of our lifestyle. Thus, the resistance of body against heat in the people of this city is higher than that of other cities" (P. 2).

Benefiting from the factor of spirituality

What is meant by spirituality here is the religious beliefs people had in this region. The participants of this study think that spirituality was a factor that helped the people of the region have patience and tolerate heat. The

Table 1: Classes and subclasses of how to adapt to heat in the elderly of Dezful

Main theme	Category	Subcategory	Sub-subcategory	Codes	
Heat adaptation	Psychophysiological adaptation	Physiological adaptation	Coping with heat	Fusion of heat with life, getting used to heat, heat as a part of life, accepting heat as part of the process of life, getting used to heat	
			Adaptation to heat	Find a way to endure heat, compromise by any means possible, the necessity to adapt	
			Heat tolerance	Tolerate heat, natural increase in body resistance, increase body endurance	
		Mindset	Spirituality	-	Loving God, trusting God, religiosity, fear of God, belief in God
			Using positive thinking mechanism	Using positive thinking mechanism	Positive thinking, positive attitude, considering benefits of warmth, seizing available opportunities
			Using alternative thinking mechanisms	Using alternative thinking mechanisms	Focusing on livelihood instead of thinking about heat, prioritizing daily needs, not prioritizing heat, thinking about bigger priorities
			Using mechanism of forgetfulness	Using mechanism of forgetfulness	Not paying attention to heat, being together and having fun with family members and forgetting about heat, not thinking about heat
			Using assertive thinking mechanism	Using assertive thinking mechanism	Decision to stay, decision to persevere, determination to resist, not to give in to heat, striving to survive, accepting heat while struggling
			Experience	-	Experience, experimentation, expertise, recognizing vulnerabilities
			Environmental adaptation	Urban architecture	Urban architecture
	Building architecture	Building architecture		Basement construction, Shavadan construction, Kat construction, increasing the thickness of the walls and ceilings of buildings to prevent heat, using mud and straw in the construction of houses, separating the kitchen from the rooms, setting up windows in the walls to allow air flow, constructing two courtyards in the house, for summer and winter use, building the house at a two- or three-step level lower than the courtyard, and increasing the height of the roofs	
	Natural capacity	Natural capacity		The use of Dez River water, the use of gardens and trees for creating a cool atmosphere, underground food storage and Shavadan, the use of wet plants to cool the environment	
	Socioeconomic adaptation	Food diet	Food diet	Consume soothing foods, cool and juicy fruits of the season, fruits and food specific to the region like cucumber, okra, and mung bean as nutrition. Also, drinking a lot of fluids	
			Clothing style	Use cotton shoes with cotton or leather soles, use of light and loose cotton clothes, the use of Keffiyeh (head clothing), wetting clothes, the use of cotton quilts, the use of chogha (is a white cloth, with black striped lines and no sleeves)/taqiyah or araqchin (a short, rounded skullcap)	
		Home utensils	Home utensils	Use utensils like mud pot or sheep musk to keep water cool and utensils and straw mats were also used	
			Work and business condition	Work and business condition	Match the business with the time people are in town, adjust working hours with ambient temperature, replace jobs that require longer stays in a warm environment with other jobs
		Family life	Family economy	Family economy	Eliminating any type of competition, contentment
				Change in livelihood	Storage of cereals and food in the basement and Shavadan, using more local foods to avoid turning on the stove too much and reducing the heat like cucumber doogh (yogurt drink) juice and onion juice
			Simplify things Optimization	Simplify things	Having all the daily necessities in Shavadan for less movement upward
				Optimization	Caring for children while working at home under the Shavadan gate by that synchronizes work and child care, hanging a basket on the Shavadan gate to pull up and down items that needed to stay cool
Collective life			Collective life	Changing the children's playground from the street to Shavadan, living together in Shavadan, allocating a room in Shavadan for married couples, connecting Shavadans to each other	
Change in location			Change in location	Go to the Shavadan in humid weather, sleep imitate others on the roof on non-sunny nights, go to the Kat on very hot days, stay in the garden on warm nights	
Reduce daily stress	Changes in the timing of daily activities	Changes in the timing of daily activities	Reduce the presence of women and children outdoors in hot hours, carrying out hard and tedious work during non-hot hours, presence in the outdoor environment during cooler hours		
	Reduce daily stress	Reduce daily stress	Reduce other political and economic concerns and shocks, eliminate other family and work problems, preserve and return to old traditions		

participants also believe that the love of God, having faith in Him, religiosity, and fear of God are among the factors that help people manage the heat in a better way (P. 3).

“Having faith in God and depending on him helps one tolerate difficulties and heat better. When someone loves God, this love helps the person tolerate situations for better or for worse (heat). Also, in the past, people’s faith in God was very strong” (P. 3).

Change in mindset and way of thinking

The change in the type of thinking means using mechanisms such as positive thinking, alternative thinking, using the mechanism of forgetfulness, and using the mechanism of assertive thinking. In this regard, positive thinking is to direct the series of thoughts in a positive direction and against difficult situations, which is mentioned in this interview, including positive thinking and not thinking about heat (P. 7).

“During the summer, it just gets a little warmer and nothing happens” (P. 7).

For alternative thinking in the interviews of this study, focusing on livelihood instead of thinking about heat, knowing the importance of daily needs, not prioritizing heat, and thinking about bigger priorities were mentioned (P. 2).

“If we think too much about who will earn the bread and butter issues,” or “When I go out in the morning, I think I should earn my bread in the evening, we would not pay much attention to the heat” (P. 2).

The mechanism of forgetfulness mentioned by the participants included not paying attention to the heat, being together, having fun with the family, and forgetting the heat to adapt in a better way (P. 4).

“It was warm, but we spent time together. The children and we were happy to be together in Shavadan (basements), and we would forget the heat” (P. 4).

The mechanism of resolute thinking is expressed in the decision to be perseverant, being determined to resist, not to give in to heat, and to accept heat and hardship. Some participants in the study stated the following:

“We were defeating the heat, we were always ready to adapt.”

Benefiting from the experience factor

Since the residents of these areas are born there and lived for a long time there as well, they are able to benefit from their experience and the experience of their ancestors in terms of dealing properly with the heat. In these interviews, participants considered having experience and expertise to be involved in recognizing vulnerabilities and being more adaptable to heat (P. 6).

“Since I have tolerated hardships before, my tolerance of heat is more than the youth, or for example farmers who spent a lot of time in the heat are able to tolerate the heat a lot better” (P. 6).

Environmental adaptation

A change in the architecture of houses

When we talk about a change in the architecture of residential houses, this is represented in the changes that have been made in the construction of houses in Dezful. For example, most of the houses in Dezful had a basement, which is known as Shavadan or Kat. A Shavadan is a structure that provides a cool underground space in the building. It provides cool air through ground cooling and air conditioning. Other solutions used in the design of buildings include increasing the thickness of the walls and ceilings of buildings to prevent heat, using mud and straw in the construction of houses, separating the kitchen from the rooms, setting up windows in the walls to allow air flow, constructing two courtyards in the house, for summer and winter use, building the house at a two- or three-step level lower than the courtyard, and increasing the height of the roofs (P. 10).

“The walls of the roof had windows to allow air flow to take place. Each house has either a basement or bedchamber. The walls of old houses are quite thick and this is why it is less warm and cool enough” (P. 10).

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“The walls of the roof had windows to allow air flow to take place. Each house has either a basement or bedchamber. The walls of old houses are quite thick and this is why it is less warm and cool enough” (P. 1).

Benefiting from natural capacities

The use of natural resources and plants and plant tissue of the local geography has been one of the ways

to adapt to heat. In this study, the use of Dez River water, the use of gardens and trees for creating a cool atmosphere, underground food storage and Shavadan, and the use of wet plants to cool the environment were mentioned as natural capacities in thermal adaptation (P. 5).

“During old times, there were thorns that we soaked and put around the fan to cool the fan, by that turning it into a water cooler. When it was too hot, we would go to the garden or there was a tree in the houses. Generally, all the houses had trees to create shade and make the environment cooler” (P. 5).

Socioeconomic adaptation

A change in the food diet

A change in diet means the use of foods appropriate for hot weather. The elderly people of Dezful used to eat food that is appropriate for the warm climate of the city. They mostly consume soothing foods, cool and juicy fruits of the season, and fruits and food specific to the region. Also, drinking a lot of fluids is one of the nutritional patterns of that area (P. 13).

“Foods of the summer were usually foods that are of a cool nature and helped fight thirst. You could find watermelons and melons in abundant quantities in the Shavadan of the city during summer. People would eat cold watermelon and Armenian cucumber a lot because it is juicy and cools off the body” (P. 13).

A change in the clothing style

The change in the type of clothing is related to the type of textile the residents of these areas would wear. The use of light and loose cotton clothes, the use of Keffiyeh (head clothing) and wetting clothes, the use of cotton quilts, and the use of chogha (a white cloth, with black striped lines and no sleeves)/taqiyah or araqchin (a short, rounded skullcap). Hats and headscarves have been common in these areas (P. 16).

“People use taqiyah or araqchin and hats (Felt hats) for fighting heat or they tie a Keffiyeh (kufiya) around their head. Clothes are made from cotton or wool fiber since these are cool” (P. 16).

Change in home utensils

What is meant here by change in home utensils is to use the right ones to cool food and reduce heat. The interviewees said that utensils such as mud pot or sheep musk were used to keep the water cool and utensils and straw mats were also used (P. 9).

“To cool the water in the Shavadan, we would put the water in a mud pot or sheep musk to keep it cool, or we would wash the ground with water to cool it and then we would put a straw mat and then we would put the sleeping mattress. The straw mat would absorb moisture and stay cool” (P. 9).

Change in conditions of work and business

Change in business or work conditions refers to changes in the way certain tasks are performed or the market activity schedule, to reduce or modify activities and make more use of cooler hours and decrease scheduled activities during peak hours (of heat). Among the items mentioned in the interviews below are the following: Changes in some jobs were made to match the ambient temperature, work hours were adjusted in terms of temperature and heat conditions, and jobs that require more stay in a warm environment were also replaced or adjusted (P. 8).

“We carried out tough tasks in the early morning when the weather is cool, and people would go out in the afternoon when the sun is not scorching hot. Shops would open in the morning until noon (12:00 p.m.), merchants would then go home and come back to work at 5:00 p.m. and work until night” (P. 8).

Changes in family life

A change in family life meant planning to make things easier. Examples are changes in livelihoods such as storing grains and food underground and, in Shavadan, simplifying tasks such as having all the daily necessities in Shavadan for less movement upstairs and downstairs, optimization, for example, caring for children while carrying out house chores under the window of Shavadan simultaneously, living together in Shavadan, changing the time of daily activities such as reducing the presence of women and children outdoors in hot hours or doing hard and exhausting work in non-hot hours and reducing stress, and reducing political and economic concerns, and other family and work problems were also mentioned by the interviewees (P. 2).

“People were satisfied. Whoever is satisfied is more tolerant. We had a big basket in which we would send things to Shavadan to keep cool. We would take everything we needed with us to Shavadan so that we would not have to go up and down too much. When we were working upstairs, we would put the little kids under the Shavadan window (hole) to see them” (P. 2).

Discussion

The aim of this study is to explain the practices of heat adaptation among elderly in Dezful in Khuzestan, Iran, which is exposed to extreme heat. The results are recommended to create a structure for heat adaptation in other places with similar heat experiences. This chapter analyzes and discusses the results of this study. Regarding physiological changes, the results of the research on the minimum mortality temperature show that human sensitivity to heat decreases over time.^[27] Todd argues that a decrease in heat sensitivity over time may not be solely related to climate change.^[28]

Human physiological adaptation to the environment has occurred over time through the use of adaptive methods. Therefore, human adaptation to increasing ambient temperature can be attributed to various factors such as physiological, behavioral, and technological adaptation or changes in infrastructure.^[28,29] According to research results, repeated exposure to heat leads to physiological adaptation and as a result may lead to a more or less permanent state of heat adaptation.^[30,31] Therefore, it can be concluded that the human body gradually becomes accustomed to heat after exposure to heat, using its own compensatory mechanisms. Understanding human compensatory and natural mechanisms can be helpful in creating natural adaptation to heat. According to the results of this study, the use of physiological changes in the elderly of Dezful has been one of the mechanisms that have been used to deal with heat. Existing studies confirm the accuracy of this mechanism.

Regarding spirituality, it acts as a bridge between scientific policies and social needs to adapt to climate change, local understanding, and familiarity with their capacities and resources. To adequately equip people to respond to disasters, we need to expand our understanding of the ways in which individuals, individually and collectively, manage and respond to harmful situations and social suffering. One of these methods is spiritual experiences that bring peace to people who have suffered.^[32] Spirituality and religious faith are important coping mechanisms for managing stressful life events, and many studies have examined their positive effects on natural and man-made disasters caused by climate change. Research shows that disasters often have a spiritual and psychological “effect” on the affected communities. Religion and spirituality serve as a barrier against the possible destructive effects of a certain disaster and the psychological distress following it. According to research results, spirituality is inversely related to depression and anxiety related to exposure to an accident. In addition, researchers found that religious comfort helped protect participants from the negative consequences of emotional and physical health traumas that are often associated with loss of resources, as well as posttraumatic growth. Religious pressure is associated with poor consequences for emotional and physical health following the loss of resources in disasters. A survey of approximately 600 Mississippi residents who survived Hurricane Katrina found that people with positive religious and spiritual beliefs were less likely to be affected by Hurricane Katrina and the loss of resources. They also experienced a reduction in the symptoms of posttraumatic stress disorder (PTSD), depression, and alcohol consumption.^[33-35] Another study found that negative religious coping was associated with the severity of posttraumatic symptoms and that religious forgiveness and positive coping were

associated with posttraumatic growth. Similarly, a study of earthquake survivors in Haiti found that those who relied on their spirituality to make sense and cope were more resilient during and after the disaster than those who did not.^[36,37] These studies and similar studies show that the factor of spirituality can be one of the factors that increase adaptation to heat in humans. Evidence shows the suggestion that the strong belief in God of the elderly in Dezful helps them cope with the heat can be true.

Regarding mindset, in line with the current results, Carman in a study found that the use of coping strategies such as distracting the mind from focusing on the matter and adjusting expectations are seen as mental stress management strategies related to dealing with the impact of climate change.^[38] Also, a study conducted by Wu examined the methods of thermal adaptation in the humid warm regions in Taiwan and suggested distraction, relaxation, and optimism to change his personal mood and tolerate more thermal environments.^[39]

Regarding experience, the transfer of traditional knowledge depends on close relationships between experienced people and the younger generation, which may be eliminated by job changes, migration for work, and new cultural influences.^[40] However, the importance of integrating indigenous knowledge in adaptation strategies and the role of indigenous peoples in policy development and adaptation programs tailored to the needs, abilities, and interests of society is one of the reasons for identifying adaptation capacities in the past that should be the focus of future studies.^[41] In line with the current results, in a study in Accra, people’s experiences during floods, droughts, and heat waves have caused a lot of adaptation to climate change, which is seen as a basis for long-term response and adaptation to climate change. In this study, climate-related stressors identified by residents included floods, overheating, drought, and rising sea levels. Flood and overheating scores indicated that both climate variables were perceived as having serious consequences for society. Participants described a set of indigenous climate monitoring systems and indicators that have been passed down from generation to generation and used by the residents. Based on the results of this study, indigenous monitoring systems help residents predict wet and dry seasons, flood events, and drought. Analysis of the use of indigenous surveillance systems showed that residential ethnic clustering and strong community ties to different groups and communities in the Accra metropolis have led to the sharing and transfer of knowledge of climate patterns and trends in the long run. Therefore, understanding and creating indigenous knowledge and tools can increase the design, adoption, and implementation of climate change adaptation strategies

for urban areas and other developing countries. People's experiences during past floods, droughts, and heat waves have brought a lot of adaptation to climate diversity, which has been considered as a basis for a more adaptive and long-term response to climate change.^[42] Given the importance of using indigenous knowledge and the tools that the ancients used to deal with heat, the existence of this experience and its transmission to the future can be useful in their adaptation to heat effects.

Regarding urban architecture, in line with the results of the present study, in a case study, a positive correlation was found between urban morphological parameters and local climate factors. According to this study, all the studied elements have been created by the force of nature and the designers of these cities have used these important factors to achieve the goal. In addition, a thorough understanding of the local climate was the key to having an urban morphology that is unique to each city. In this study, roofing of alleys and various visual arts in brick designs are ways to adapt to the warm climate.^[43] In addition to Dezfoul, urban morphological parameters have also been considered in two similar cities in Iran: Shushtar and Yazd. In these cities, there are dome-shaped structures to deal with heat, as well as structures such as aqueducts and windbreaks. Because climate change exacerbates the impact of urban microclimates in tropical and subtropical environments and makes cities more vulnerable, a proper understanding of climate and urban morphology is crucial for climate-based urban planning and design.^[44] Regarding the architecture of houses, research has been conducted to determine methods to promote adaptive behaviors through residential design. According to this research, residential design modifications offer solutions to deal with severe weather conditions.^[45] Among the studies that are in line with the results of our study are studies on the construction of basements, Shavadans, Kats, and the use of window walls. In these studies, Shavadan has been introduced as an indigenous architectural model that provides cool underground spaces with optimal comfort conditions in buildings located in warm climates. A Shavadan can provide favorable living conditions through the use of natural energy sources such as land energy and air conditioning. During the night, the air circulates inside Shavadans and is stored for several hours, thus cooling the inhabitants on hot days.^[46-49] The Kat is also another structure created with a specific architectural goal to live in hot and humid areas. Among the man-made spaces on earth, such as tunnels, underground waterways, water reservoirs, and Shavadans, the deep structure known as Kat is dug into the rocks so that people can fight the hot climate. These structures are dug on the slopes of rocks and near rivers. It is close to the cool air of the river and people feel comfortable on hot days.

The use of lattice bricks or mesh bricks facilitates airflow. The type of materials in the structure affects the thermal conductivity of the interior spaces. For example, if the effect of thermal energy is high, increasing the thickness of the walls and the use of empty blocks and hollow bricks can have a great effect in reducing the effects of heat on the building.^[50] This adaptation, which includes the application of strategies in the architecture of buildings, seeks to protect the building from external influences to create a stable indoor environment for the satisfaction of residents against heat.^[51] Some other studies show that the properties of heat stress resistance in buildings as a science have not been given enough attention.^[52,53] Therefore, the need for further studies in this area and the application of long-term development strategies are recommended. Also, in line with the results of this study on the use of natural capacity and plant tissue, a study in Taiwan showed that outdoor thermal environments have a significant effect on the thermal adaptation of individuals. In this study, Tzu Ping Lin *et al.* used a questionnaire on thermal comfort in a public park in southern Taiwan to determine the effects of thermal comfort and compatibility with it: to what extent and at what times do people use natural shaded spaces in parks in the face of rising temperatures. The results showed that the acceptable thermal range of individuals (thermal comfort point) leads to significant changes in their overall presence in shaded areas in different seasons of the year. As the majority of participants stated, they mostly use the shaded spaces of parks in the warm seasons and the cold seasons of the year, and they use open and unshaded spaces of the parks. However, in both seasons, whenever the temperature rises, people tended to use shaded environments. Other results of this study also showed that the effectiveness of personal adjustments such as changes in clothing and the use of hats or umbrellas plays an important role in adapting to ambient temperature, and therefore, people decide to resort to certain behaviors in outdoor environments to deal with the effects of heat and cope with the fall and rise of temperatures.^[54]

Numerous experimental studies have focused on behavioral thermal adaptation strategies. A literature review shows that many of the thermal adaptation strategies that people use when they feel uncomfortable include behavioral strategies such as adjusting clothing (clothing, hats, umbrellas), adjusting diet (eating and drinking hot or cold food or drinks), and using natural capacities (going under a tree or looking for shade). These results are in line with the results of our study. Thus, despite the different geographical locations and climatic conditions, these issues can often affect people's decisions and perceptions of thermal adaptation strategies. The cited behavioral strategies have been mentioned in various studies, including joint adaptive strategies to deal with heat.^[39,54,55]

Regarding work and business conditions, heat affects working conditions. In a study in Australia that looked at occupational injuries in the heat from 2001 to 2010 by analyzing occupational and meteorological data, the hottest weather injuries occurred in men and male workers, aged 55 and older, particularly those in agriculture, forestry, fishing and electricity, and gas and water services. According to this study, occupational burns, wounds, tears and amputations, and heat illnesses were significantly associated with heat waves. In conclusion, the need for appropriate adaptation and prevention measures at the level of action and policy for vulnerable groups is recommended. Another study in Australia examined work-related injuries and illnesses during heat waves, which showed moderate-to-high severity in injuries in both subtropical and temperate climates, and raising awareness in these areas is recommended to minimize the damage.^[56,57] In this regard, similar to the results of the current study, the results of other studies in this field show that in a warm environment, more dynamic activities can be changed to more passive activities to adapt to heat and prevent heat effects. Because this particular thermal compatibility strategy is more practical, it is likely to be adopted by users as much as possible.^[39,58] In tropical environments, one of the behavioral adaptations, in addition to reducing the burden of physical activity, is to increase rest time. In line with the results of this study, a study in Brazil examined the risk of heat exposure in workers through macro-risk analysis across Brazil and reviewed the index estimate from 50 years of meteorological observations, the risk of heat exposure at load light, medium, and heavy work. It also reviewed heat exposure hazard maps separately from decade to decade and season to season. The results of the study showed that summer has a greater impact on workers with heavy workload. In the final conclusion, increasing the risk of exposure to heat showed the need for control measures. The researchers suggested continuous measures such as environmental and physiological monitoring, the use of light clothing, and flexible work shifts to adapt to the heat.^[59]

Regarding family life, a systematic study of how households adapted to climate change in the United Kingdom found that British households relied on traditional responses and strategies to build long-term adaptive capacity. The study found that household adjustment in developed countries, especially the United Kingdom, has grown steadily since 2006. Several key findings stand out in the discussion of how compatibility exists among the articles reviewed in this systematic study. As UK households usually take small, low-cost, low-tech, intuitive, and fast-paced actions in response to existing climate change, more active adaptations to larger changes due to the need for more personal, financial, and technical investments

such as air conditioning installation or porous surfaces are rarely done. Exposure to severe climates in the past, social pressures, and long-term financial rewards in these households also appear to be other factors in household adjustment.^[60]

Also, in another systematic review study that investigated climate change adaptive behaviors, the authors of the reviewed journals identified more than 200 potential personal and home adjustment behaviors. These behaviors were divided into eight types among which are supporting the house, changing lifestyles in accordance with the environment, and self-protection, which are in line with the results of our study.^[38]

Limitations and recommendation

The most important strengths of this study are extracting adaptation methods from a society that has been facing hot weather for many years and has been able to use the most and best methods of adaptation to heat for survival. The most important limitation of this study was the lack of comfort of the participants in the interview during the outbreak of the coronavirus disease 2019 (COVID-19) disease. In this regard, the researchers decided to expand the interviews after the vaccination and the relative relaxation of the participants.

Conclusion

One of the main reasons for the acceleration of global warming is human industrial activities in the production of greenhouse gases. The countries that have the largest share in the production of these gases, due to macroeconomic interests, refuse to accept international protocols to reduce greenhouse gases, so we inevitably live in a world that is increasingly exposed to severe climate change, including global warming. Given the dangers of heat and its effects on human health, we must look for solutions to adapt to heat waves. Excessive use of cooling devices, in addition to imposing a heavy economic burden on households, leads to high consumption of water and electricity, increases greenhouse gas emissions, and ultimately leads to increased negative effects on health by creating a vicious cycle. Therefore, being aware of the beliefs of the people of the past and providing methods of popular adaptation can provide an effective approach to better and less costly adaptation. Our study sought to find ways to adapt to the heat waves of the past and identified the most effective methods from the perspective of the elderly people of Dezful, and based on this, adaptation solutions were proposed. This study showed that elderly people in Dezful use different kinds of actions to deal with hot weather including physiopsychological, environmental, and socioeconomic adaptation actions. Therefore, due to the need to adapt to global warming and climate change

as one of the strategies to combat climate change, it is suggested to use the experiences extracted in this study in different areas of individual and social life. The results of this study can be useful in developing new strategies for adapting to climate change.

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Authors' contributions

HA and AOT designed the study; HA, LAA, and MM collected the data; HA, AOT, and LAA analyzed and interpreted the data. HA, AOT, HS, and MK prepared the manuscript. All authors contributed to the drafting and final review of the manuscript. The author(s) read and approved the final manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Tehran University of Medical Sciences (TUMS) Ethics Code: R.TUMS.VCR.REC.1397.680. Informed written consent was obtained from all participants, and also, all methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable.

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Conflicts of interest

There are no conflicts of interest.

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