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Heat wave adaptation paradigm and adaptation strategies of community: A qualitative phenomenological study in Iran

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Abstract:

BACKGROUND: Heat wave adaptation is a new concept related to experiencing heat. The present study aims at investigating a conceptual definition, that is, the mental framework of heat wave adaptation and its strategies.

MATERIALS AND METHODS: A phenomenological study was performed to explain the mental concept. At the same time with the data collection process, data analysis was also performed using Colaizzi method. Semi-structured interview method and purposeful sampling with maximum variety were used. Interviews were conducted with 23 different subjects in the community. The accuracy of the data was guaranteed using Lincoln & Guba scientific accuracy criteria.

RESULTS: The two main themes of the adaptation paradigm as well as its strategies were divided into the main categories of theoretical and operational concepts, as well as personal care measures and government measures. Under the category of individual measures, we obtained “clothing, nutrition, building, place of residence and lifestyle,” and under the category of governance actions, the “managerial, research, health, organizational” subcategories were obtained.

CONCLUSION: According to the results of the conceptual-operational definition, heat wave adaptation is an active process and an effort to reduce the adverse effects of heat waves on individual and social life, and striking a balance that will not only result in individual awareness and actions that will lead to lifestyle changes, but also mostly requires integrated and comprehensive planning in the community. On the one hand, heat waves could not only be regarded as a threat or danger, but can also become an opportunity for the development of a community through identification and smart measures, and for adaptation, the community must take it as a risk. The community should have a plan in advance, apply the necessary rules and training, and use the new facilities and rules where necessary. This practical concept definition includes the main features of heat wave adaptation.

Keywords:

Adaptation, adaptive behaviors, heat waves, qualitative research

Introduction

Climate change poses major public health challenges. Heat wave is a severe weather phenomenon that can directly or indirectly affect human health.^[1,2] Several studies from the United States, Canada,

Europe, Asia, and Australia have provided comprehensive reports on the mortality resulting from heat wave. There have been numerous other reports of the effects of heat waves on mortality around the world in recent years.^[3-6] More than 70,000 deaths in Europe – in August 2003,^[7,8] 55,000 in

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Russia – in summer 2010, 51,233 in Australia,^[9] and thousands in Pakistan, in 2017, were among these reports.^[10]

Exposure to high ambient temperatures, that is, temperatures above the long-term average and extreme heat (heat wave), especially in the summer months, not only increases mortality, but also causes numerous financial and life losses.^[11]

Severe heat is associated with increasing emergency room visits and hospitalizations,^[12-14] increased mortality from cardiovascular and other diseases,^[11] mental health problems,^[15] adverse pregnancy and birth outcomes,^[16] as well as increased health care costs. Studies show that adults >65 years, individuals with cardiopulmonary disease and other chronic diseases, and children are more vulnerable to the effects of heat, regardless of the income level or the geographic area.^[17-20] According to the fifth Assessment Report of the Intergovernmental Panel, heat wave climate change is becoming more prevalent worldwide, and this trend has continued and increased throughout this century.^[21] Therefore, the effects of heat and the associated direct medical costs are expected to increase. Direct medical costs include the heat-related health service costs such as personnel, medical equipment, medicines, procedures and diagnostic tests.^[22]

Many heat-related diseases and fatalities can be prevented by enhancing our preparedness and reducing heat damage. Heat wave adaptation is an option to reduce heat wave damage.^[23]

Studies on disaster management indicate that adaptation measures are closely related to risk reduction.^[24] Adaptation strategies are required to reduce the effects of heat waves at all levels and for all groups. In this direction, there is an urgent need to have information about the current level of knowledge, adaptation methods, and factors affecting heat wave adaptation. As a result, understanding public attitudes will guide for policy makers to design public education and communication strategies to reduce climate impact.^[25] When formulating adaptation policies for a society, it is necessary to be aware of adaptive behaviors. The adaptive behavior may reduce vulnerability. Therefore, if a climate hazard is created to which the population can adapt, there will be lower impacts on health.

The experiences of multiple disasters clearly show that disaster risk management is a comprehensive, integrated, and multidisciplinary approach that requires identification of all the affecting factors.^[26]

Given that there is little evidence of adaptation to heat waves in the study area. The present study is designed to

fill the information gap and identify solutions for the heat wave adaptation. In this regard, a qualitative study was conducted using a phenomenological approach in the affected community in Dezful. Dezfúl city, in northern Khuzestan in Iran, has a hot and humid climate. During the last decade, the temperature of the city during some days of the year reached higher than 50°C and sometimes the city is on the list of the hottest cities in the world.

In this study, we identified heat wave adaptation strategies as well as the concept of heat wave adaptation. Hence, since this study covers a community exposed to heat waves, the findings provide useful insights into heat wave adaptation strategies and policy-makers.

Materials and Methods

Study design and setting

This was a qualitative phenomenological study that was conducted in 2021 aiming at explaining the experience of adaptive behaviors of people in the community against heat waves. In the present study, a descriptive phenomenological approach was used. In descriptive phenomenology, the three stages (1) direct perception, (2) analysis, and (3) description were used. In the direct perception stage, the researcher is completely immersed in the intended phenomenon. In this process, while avoiding any criticism, personal review, and comment, the researcher recognizes the intended phenomenon as described by the participants. In the analysis stage, the researcher seeks to identify the essence of the phenomenon based on the information obtained, and as the research progresses, he recognizes the elements and components of the phenomenon, and reveals the main and common themes in the data. In the description stage, as the last stage complementing the previous ones, the main components and indices of the phenomenon are related and the themes and essences in the phenomenon are grouped together.^[27]

Participants in this study were selected from the natives of Dezfúl who experienced heat waves. The duration of the interviews was 6 months from July to December. In this study, the Colaizzi method was used to analyze the data.^[28]

Study participants and sampling

In this study, interviews were conducted to collect data by the first disaster health researcher with the help of a supervisor who had experience in qualitative studies. Semi-structured interviews were conducted and inclusion criteria included those aged 18 years and older, nativeness and experiencing heat waves, willingness to participate in the research, having and spending the necessary time to conduct interviews. Maximum variation purposive sampling was performed. To achieve this goal, interviews were conducted with different occupations

and different age groups. Also, beneficiary departments such as Meteorological Department, Jihad Agriculture, Environment, Resources and Forestry, Municipality and Dezful University of Medical Sciences, which were part of the study population, were interviewed.

None of participants dropped out of the study. The interviews continued until new interview did not add any new data to the previous data, and finally, data saturation was reached after 23 interviews.

Data collection tool and technique

The data collection tool in the present study was a semi-structured questionnaire. Interviews were conducted according to a pre-prepared protocol. The total number of questions was five to ten questions. The protocol includes: introductions, interview questions, and termination instructions. Since the present study coincided with the Covid-19 pandemic. Therefore, at the request of the participants, some of the interviews were conducted through face-to-face interviews in a place where the participants themselves were interested, mainly their workplace, and some interviews were also conducted through telephone. In each interview, the researcher first introduced themselves, explained the purpose of participating in the research to the participant, and their verbal consent was obtained. Initially, an explanation of the general structure of the interview was provided to the participants, and they were asked to question about the general structure of the interview at baseline. The interview lasted for approximately 40–60 min/person. All the interviews were recorded using a voice recorder and then typed. Data analysis was performed simultaneously with the interviews and the next interview was conducted after the coding process.

Data analysis

Data analysis was carried out using Colaizzi method, which includes the following stages: First, the descriptions of each participant were written, recorded, and read several times. The second stage was to identify the important phrases. In the third stage, a general concept was extracted from each important phrase by the researcher. The concepts were categorized based on their similarity in the fourth stage. In the fifth stage, the findings were combined into a comprehensive description of the phenomenon and more general categories were created. Then, a comprehensive description of the studied phenomenon was presented. Finally, results were returned to the participants and were asked to validate them.^[28] Data management was carried out using MAXQDA 10 software.

Validity and reliability of the findings

To ensure that the findings reflect the true experiences of the participants, the Lincoln & Guba model was used,

which included four criteria of credibility, transferability, dependability, and confirmability.^[29]

Credibility: In the present study, to increase the accuracy of the data and the acceptability of the findings of in-depth interviews; the post-interview notes, participant reviewing for the verification of the accuracy of the data and extracted codes and making necessary corrections, reviewing the analysis process in coding stages, classification, and extraction of themes were used by the faculty members and experts to adapt and ensure that the categories matched the participants' statements.

Dependability: To ensure the dependability of the findings, the external observer method was used to examine the similarity of the participants' understanding with the researcher's and to inquire for conflicting cases, which provided basic codes from the participants' experiences, examples of how to extract themes and excerpts from the interview transcriptions for each of the themes.

Transferability: To increase transferability, we tried to provide a clear, accurate and purposeful description of the research process to allow following this direction and the characteristics of the study population. The results of the study were also presented to a number of people who did not participate in the study to assess their similarities between the results and their experiences.

Confirmability: To ensure the confirmability of interview transcriptions; codes and extracted categories were provided to peer reviewers and a number of faculty members who were familiar with the analysis of qualitative research and did not participate in the research.^[29]

Ethical considerations

To observe ethical considerations before starting the study and interviews, the ethical points were approved by the ethics committee of Kerman University of Medical Sciences (Ethics Code: 400000143). Factors such as informed consent for participation, verbal consent, withdrawal at discretion, anonymity, and the confidentiality were observed throughout the study.

Results

In this study, saturation was obtained with 23 participants. The demographic characteristics of the interviewees are presented in Table 1.

The extracted primary codes were classified into two main categories. The analysis of the interviews was divided into two themes (the concept of heat wave adaptation, strategies of heat wave adaptation) which are presented in Table 2.

Table 1: Demographic characteristics of the participants

Job	Level of education	Age	Gender	Participants
Manual worker	Diploma	40	Man	1
Housewife	Illiterate	65	Woman	2
Teacher	Bachelor	50	Woman	3
Nurse	MA	28	Woman	4
University student	Diploma	19	Man	5
An employee at environmental department	MA	53	Woman	6
Retired	High school	70	Man	7
University student	Diploma	21	Man	8
Farmer	Bachelor	34	Man	9
An employee at natural resources department	Bachelor	45	Man	10
Housewife	High school	56	Woman	11
Faculty member	PHD	42	Man	12
Farmer	Bachelor	38	Man	13
Physician	Resident	35	Woman	14
An employee at meteorological department	MA	48	Man	15
Housewife	Diploma	23	Woman	16
An employee at Agricultural Jihad Department	Bachelor	54	Man	17
Nurse	MA	24	Woman	18
Retired	Bachelor	55	Man	19
Municipal crisis management	MA	56	Man	20
Faculty member	PHD	41	Man	21
Retired	Diploma	54	Man	22
Faculty member	PHD	40	Man	23

In the data analysis, the concept of heat wave adaptation and adaptive solutions were described. According to the findings, the theme of “adaptation paradigm” included the main category of “concept of adaptation”, the concept of adaptation itself included two subcategories of “theoretical definition and operational definition” and the theme of “adaptive strategies” included two main categories of “personal care measures” and “governmental measures.” The main category of personal protection measures included the subcategories of “clothing, nutrition, building, place of residence and lifestyle” and the main category of “governmental measures” included the subcategories of “management, research, health care and organization.” Details of subcategories and their codes are provided in Table 2.

Heat wave adaptation

Data analysis of the heat wave adaptation paradigm defines the main category of the concept of adaptation in two subsets of the theoretical concept of adaptation, and individuals’ views on operational characteristics, that is, how heat wave adaptation can be implemented or practiced.

Theoretical definition of heat wave adaptation: Data analysis is the sub-category of “theoretical definition” which includes ten main concepts. These are described below.

Conceptual definition

Heat experience

Understanding heat waves as a health hazard leads to adaptation measures. People who have no experience with heat waves and its dangers do not consider themselves exposed to the effects of heat waves and rarely use protective measures. Adaptation is associated with constantly experiencing heat and living in hot places. According to the participants, people who have lived with and experienced heat waves and related hazards understand the concept of heat wave adaptation and take strict adaptive measures to prevent health hazards.

Participant 22: “In Khuzestan and Dezful, we experience lots of hot days which are mostly bearable and we do not have any problem with them. However, there are days which we call *Badsoor*, during which the temperature is above 50°C. The hot wind in those days is like scratching the face with nails.”

Individual and social adaptation

To adapt to heat waves, not only individual awareness and actions, but also the measures that are managed and monitored by the government are required. The main point in adaptation is to pay attention to the general measures in the society and inter-organizational coordination and partnerships, because when we face heat waves at high degrees, that is, in warm climates, individual measures alone will not be enough for

Table 2: Codes, subcategories, main categories in adaptation solutions

Theme	Adaptive paradigm	Adaptive strategies
Main category	Concept of adaptation	Personal care measures Governmental measures
Subcategory	Theoretical definition Operational definition	Clothing Nutrition Place of residence Building Lifestyle Managerial Research Healthcare Organizational
Code	Adaptation is associated with constant experience of heat and living in heat Adaptation is both individual and social Adaptation is an active process Using threats as opportunities Accustoming to heat Coexistence with heat Continuity of activities Not giving up and not fighting Balance between inside and outside of body Need for support of all institutions and organizations Lifestyle change Creating and using new facilities and equipment	Use of hats, gloves, and sunglasses Bright and light clothes Less clothing Wet clothes before leaving the house Wet towel on the head Drinking abundant water Using fluids and summer fruits Consuming light foods Avoiding sweet and heavy fatty foods Blocking vents to prevent cool air from escaping Use of air conditioners in all rooms Covering the yard and skylights to prevent light and heat from entering Living in the basement Turning off the lights Using curtains Avoiding turning off the air conditioners even when leaving the house Cover the roof of the yard Shavadoons* Standardization of building in line with warm climate Staying at home as much as possible Doing chores in the early morning and cooler hours Frequent bathing Changing sleep and rest patterns (sleeping during the day and doing things at night) Limiting and changing party hours Avoiding walking as much as possible Changing the days or times of doing tasks as much as possible Shopping in the night hours Using the shade of trees or canopies Using window covers in cars Taking water and ice when leaving the house Keeping the head cool Taking leaves from work on hot days Not holding ceremonies on hot days Using air conditioners in the car Vehicle type (motorcycle aggravates heat effects) Construction of beach resorts Equipping public places with cooling systems, drinking fountains Urban water resources management Allocating funds for programs and building infrastructure Transportation system management (implementation of traffic constraints on hot days, regulating the use of cooling systems in public transport and monitoring it) Equipping bus stations with cooling systems Tree planting and green coverage Water fountains

Contd...

Table 2: Contd...

Theme	Adaptive paradigm	Adaptive strategies
		Regulations to standardize buildings based on the hot climate (replacement or removal of ornamental granite stones) Attention to the phenomenon of the urban heat island in roads and building construction River water management Land use management to allocate green space Providing facilities to hazardous jobs with the highest human and financial losses during heat waves, such as farmers Roofing markets Planning and projection for reducing office hours in proportion to changes in lifestyle during the hot seasons Distributing shopping malls in different parts of the city for public access Create canopies in the city Using private sector and public projects Allocating financial resources for heat control measures, especially in the agricultural sector Planning and management of wetlands (Hurolazim) Having schedules and teams for forest fires. Planning in education centers to reduce the damages of heat waves to students (changing class hours in hot days, equipping schools with cooling devices, using online education, appropriate number of students in each class) Management and monitoring of media (proper public education, training of vulnerable people, early warning system, specialized training to increase risk perception for executives, etc.) Implementing and monitoring tree planting based on the type of climate Planting summer crops Water outage management on hot days Planning of organization personnel in accordance with the hot days Plans and projects to change the working hours of shopping centers and buses Construction guidelines for warm climates and monitoring its implementation Programs to educate employers about the effects of heat waves Programs for using virtual training on hot days Design of heat wave initial warning system Carrying out projects and researches about the effects and dimensions of heat waves on health and economic situation, life and work and providing solutions Investigating the effects of heat from the socioeconomic, physical, and mental aspects Presenting research results as a guidance in decision making for officials Review and use of research results and solutions provided in similar climates Promoting resilience against heat waves in hospitals and health centers Establishment of pre-hospital emergency medical emergency teams with appropriate dispersion on heat warning days Standardization of hospital buildings Assessing the adequacy of hospital cooling systems Assessing workload and clients on hot days Planning based on evidence Planning to deal with the effects of heat waves, for example, the existence of a generator for power outages Prioritization of vulnerable groups Scheduling for providing medical services on heat wave days Forming a working group to deal with heat in the form of a crisis management headquarters Preparedness of rescue forces and organizations to deal with fires Internal work plan of each organization based on the type of work and the level of vulnerability of personnel Educational and cultural programs Self-care training for hot days (through media, related organizations, sending educational text messages) Introducing solutions to farmers for cultivation, planting trees and suitable crops, drip irrigation, etc. Providing loans and facilities to farmers vulnerable to heat Planning the water and electricity outage management on extremely hot days Wastewater treatment in suburban areas Improving networks

*Underground structures that were used in ancient building architecture in the hot climates of Iran as a part to shelter the inhabitants of the house in extreme heat whether

adaptation, and measures beyond the individual level will be required.

Participant 1: *“Adapting to heat waves is something beyond individual measures and requires planning by the government and various organizations and groups.”*

Adaptation in an active process

To encompass adaptation, practical measures should be taken. Adaptation is the effort to continue activities and life. Adaptation is not a passive process itself to be performed by sedentary life. Conversely, adaptation is the result of a dynamic effort to live with heat waves.

Participant 12: *“Adaptation is an active process. We must always try to identify our vulnerabilities to heat waves and existing solutions and possibly move dynamically to adapt to it.”*

Using threat as an opportunity

In adaptation, the negative effects should also be taken into account and efforts must be made to overcome them, and the potential opportunities that arise in this direction must be considered and used. Considering the duration of exposure, heat waves could be taken as a threat or danger or an opportunity for the development of our society.

Participant 21: *“We must live in such a way that we should neither get harmed nor increase it by our inappropriate actions such as increasing greenhouse gases or destroying the forests, but we must adapt to it and use its benefits. For example, in very cold regions, farmers can only cultivate only once a year because the crops will be lost, while in the tropical areas we can cultivate at least two to three times, so we have to use models to adapt to heat and its values.”*

Accustoming to the heat

We are having a peaceful life despite the heat waves. In fact, here we accept that heat wave adaptation is not a struggle, but it means getting accustomed to nature. In this way, we can also learn from the nature itself.

Participant 22: *“When we have to stay in our place of residence and we are at risk of heat waves, we must learn from nature. For example, there are some species of trees that can withstand heat waves and have adapted, so we may be able to use our wisdom and knowledge in relation to the various dimensions of heat waves and its effects, to invent adaptive methods and solutions. In the meantime, we know that over the years, some of these measures have been formed and used by people. We have to identify them and use them as a roadmap. Also, due to the increasing trend of heat and at the same time changes in human lifestyle, it is necessary to provide new methods in relation to adaptive measures.”*

Coexistence with heat

Just as heat waves come and go, we also live next to them and leave them behind. In fact, we try to spend the days

that include heat waves just like other days, and heat waves become part of our lives.

Participant 14: *“We grew up in such a climate and have become accustomed to it. I myself have had many experiences of extreme heat and heat waves.”*

Continuity of activities

We should continue with our daily activities as much as possible despite the heat waves and try not to be disturbed by these waves. In fact, the continuation of activities is one of the signs of adapting to the existing conditions.

Participant 9: *“Some people cannot postpone their activities due to heat waves. I myself had to go to the farm at temperatures above 50 degrees, which was very hard and exhausting. Sometimes we get overheated and went to the hospital, but we cannot shut down our jobs. But there are some jobs that could lower their activity in those days.”*

Not giving up and not fighting

We have accepted and lived with heat waves as part of the nature's wrath, and at the same time we are trying to reduce its negative effects on our individual and social life. Heat waves are advancing and increasing, but we should empower ourselves and do not give up trying to get more adapted.

Participant 23: *“Adaptation does not mean that we fight with something and either destroy it or get destroyed, but it means that we should come to terms with it (here, hot climate), and try to reap mutual benefits.”*

Balance between inside and outside of body

In adapting to heat waves, we try to strike a balance, a balance between inside and outside the body and between inside and outside of our residence- or work-place.

Participant 19: *“In general, adaptation to heat waves means striking a balance between inside and outside of the body. We cannot achieve our other goals until we establish this balance because first, our body must be in balance with the environment to be able to think and act, and then the ambient temperature must be balanced so that our body becomes prepared to achieve a normal life.”*

Need for support of all organizations

The adaptation to heat waves is more complex at a social scale than an individual scale. In this regard, all stakeholders should provide services and get involved in providing the conditions for the implementation of adaptive measures, at both individual and social scales.”

Participant 20: *“Adaptation to heat waves is an extensive issue and requires 100% cooperation and coordination of all*

organizations in the society, because each of these organizations are involved either directly or indirectly in providing services related to the effects of heat wave prevention programs, rules and regulations, and instructions at all stages of the disaster management cycle.”

Practical definition

Changing lifestyle

In order to be able to adapt to the heat waves and continue our daily lives, we need lifestyle changes to be implemented at the required time.

Participant 16: *“One of the most significant things about adaptation is the issue of lifestyle, because, for example, in cold cities, everyone goes to bed at about 7 pm and wakes up at 6 am, while in Khuzestan province, people leave their houses only after 6 o’clock in the afternoon to get to their daily affairs, they are usually very active until 1 A.M., and of course at noon, for example, at 4 P.M, no one leaves the house. In cold cities, someone who does not work at 4:00 PM is said to be lazy. I think this is a lifestyle change, and here in Khuzestan, the times of work, sleep and rest are different from other places due to the hot hours.”*

Creating and using new facilities and equipments

In order to adapt to heat waves, the society should take it as a risk, have a plan in place to deal with it, apply the necessary rules and training, and use new facilities and regulations wherever necessary.

Participant 13: *“The concept of adaptation to extreme heat is that if we are to be in the heat, we must use suitable facilities and equipment, for example, it is necessary to invent or import some agricultural devices or some new and mobile energy-efficient coolers.”*

Adaptation strategies

In order to be able to improve our adaptability to heat waves, we must identify adaptive strategies and teach and learn them. In this regard, we examine the adaptive solutions used and proposed in this study, which we have divided into two main categories. First, we deal with personal protection measures, including “clothing, nutrition, building, place of residence, and life style.”

Personal care measures

Clothing

According to the participants, changing the type of clothing and using lighter clothing as well as the use of protective equipment such as hats to protect the head from the intense sunlight and glasses to protect the eyes, and sunscreens and gloves to protect the skin are major personal protection strategies for the heat waves.

Participant 3: *“We usually use thin, cotton clothes and things like hats and gloves. We use light clothes and sometimes wet our clothes or body before going out. We also use glasses and sunscreen.”*

Nutrition

Participants were of the opinion that due to the metabolism of most fatty, fried, and heavy foods in the body, consuming such foods on hot days causes thirst and digestive problems. This was stated by participants whose jobs were associated with physical activity outside home, so they advocated avoiding these foods and instead using cold, light, summer foods and cool drinks.

Participant 1: *“On hot days, we use cool, watery foods such as yogurt and cucumber, and foods high in fiber and water because they help replace the water lost through sweating. We try to include grapes, cucumbers, tomatoes, and yogurt in our diet.”*

Building

Participants mentioned the restoration of old styles of design and architecture of buildings, this time using light insulation instead of mud and clay, as well as the use of structures such as Shavadoon as important adaptive factors. The warm climate and the use of colored granite stones to decorate new buildings and high-rise apartments were considered to be factors in increasing the effects of heat.

Participant 10: *“Buildings and constructions are one of the big problems of cities today, because they are so dense and compact that in terms of engineering and architecture, all buildings that have a very high density and compaction lack the required engineering principles. Specifically, apartments that are built in cities such as hot and dry or hot and humid cities and have a stone facade intensify the heat. In the old days, since houses were made of mud and clay, they were much cooler, but now the since they are usually made of stone and cement/concrete, they increase the heat intensity, and therefore multiple-floor apartments, for example, more those with than 8 or 10 floors, should have open environments and should not be too dense or compact. In the surrounding areas of these buildings, grasslands and trees should be used to reduce the heat, and as a result, construction plays a huge role in heat in urban areas.”*

Place of residence

Participants proposed the following activities as adaptive solutions: using coolers in the living space, blocking the vents of the rooms to prevent cool air from escaping, using air conditioners in all rooms, covering the yard and skylights to prevent infiltration of light and heat, living in the basement, turning off the lights, using the curtains and avoiding turning off the air conditioners even when leaving the house, and also taking into account the construction site in terms of regional patterns of urban green coverage and wind patterns.

Participant 15: *“On very hot days, I usually try to cover the vents so that cool air cannot get out of the house and heat or dust cannot enter the house.”*

Life style

All of the participants believed that adapting to heat waves would automatically lead to a change in lifestyle. Measures such as staying home as much as possible, doing chores in the early morning and cooler hours, frequent bathing, changing sleep and rest patterns (sleeping during the day and doing things at night), limiting and changing party hours from day to night, avoiding walking as much as possible, shopping at night, using the shade of trees or canopies when leaving the house, using window covers in cars, taking water and ice when leaving the house, keeping head cool, taking leaves from work on hot days, not holding some family-religious or cultural ceremonies on hot days, using car air conditioners, and prioritizing cars over other vehicles such as motorcycles, among others.

Participant 6: *“In the summer, we generally change our active hours and lifestyle because we could not go out for a few hours at noon, or we may have to perform our activities (such as shopping) early in the morning or at night. We sleep for a few hours at noon and instead, stay awake until late night.”*

Governmental measures

The main category of governmental measures actually refers to those measures that must be taken at the community level through affiliated bodies under the supervision of the government in a coordinated and integrated manner. The governance measures category is divided into “management, research, health and organization.”

Management

Management subcategory refers to the measures taken at different levels of management to reduce damage, preparedness, and response to the risk of heat waves. In the management process, planning and coordination, financial and human resources and equipments, as well as awareness of the risk and performance skills of managers are the main features. In this subcategory, the opinions of the participants in the form of the codes of Table 1 included the following: allocating financial resources for programs, construction of infrastructure, management of the transportation system (implementation of traffic constraints on hot days, regulating the use of cooling systems in public transport and supervising it), planting trees and construction of green coverage, water fountains, obligation to standardize buildings according to the principles of warm climate (replacement or removal of ornamental granite stones), and other items.

Participant 10: *“Managerial measures in all organizations are among the most important measures to reduce the risk of heat waves and plan and manage its consequences.”*

Research

Codes obtained from the research subcategory include: planning and research on the consequences and various dimensions of heat waves on health, economic and work status and provide solutions, studying the effects of heat from social, cultural, physical and mental aspects in various geographical areas, presenting research results as a decision guide for officials, as well as reviewing and using research results and solutions obtained from similar climates.

At various levels, scientific evidence is required to make the right decisions. Any subject that challenges humanity is a subject for reflection, and its various dimensions should be identified through scientific research and decisions should be made at different levels based on the research results. Participants believed that it is the results of studies that direct the focus of activities and resources. We need to know what health effects heat waves have in different groups residing in the area and what socioeconomic effects they cause and that which parts of society require a higher protection against heat waves. We also need to know what measures and technologies have been taken in similar climatic areas for adaptation and for reducing the damage, and whether they are applicable or usable in our region. Through studies, adaptation strategies and their adequacy are identified and examined. In fact, research is the scientific foundation in the governance of society.

Participant 4: *“I think the healthcare system doesn’t know what problems it will encounter. You know why? Because the healthcare system is not a scientific research system based on expertise. The healthcare system is not connected to science and research at all. The administration booth in the hospital receives your money when you are hospitalized and when you will be released. None of your data is properly recorded or analyzed in this route and not a single expert examines them properly. This is the most important problem, that is, the lack of scientific evaluation of these issues. Now you ask the EMS physician how many patients he had on a cold or hot day? He may only give you an estimated number, not a scientific description. It’s all about connecting science and research to the caring center, and the most important thing is that we should do it right. If we can do this procedure correctly, we can get better results. That’s because we do not know what is going to happen, we cannot plan for it.”*

Healthcare

As the front line of medical services, hospitals always face various challenges. At the time of crisis, if the performance of hospitals is improper, the whole society will become anxious and uncertain. Therefore, they need to identify threatening hazards and implement danger-reducing and preparedness measures. Also, as health supporters and leaders in preventive measures,

healthcare centers should apply plans for any of the health threats, including heat waves. Participants opinions in this study have been presented in Table 1 as: codes to promote resilience in hospitals and health centers against heat waves, the establishment of pre-hospital emergency medical teams distributed on heat warning days, attention to standardization of hospital buildings and health centers in accordance with hot climate, attention to the adequacy of cooling systems, existence of different programs for various possible scenarios to deal with the effects of heat waves, such as generators for power outages, attention to the prioritization of vulnerable groups, etc.

Participant 14: *“Healthcare sector, which has the treating role in the caring sector and a preventive role in the health sector, and should have higher budgets to be able to act in the preventive areas or use updated methods in the treatment sector. In terms of prevention, individuals in the healthcare and environmental health sector have a huge role to play and can go a long way in educating about the consequences of heat stroke and how to deal with it.”*

Organization

Every organization – whether governmental or non-governmental, in addition to the integrated national and provincial instructions – is also obliged to adopt instructions based on the conditions of its employees and according to its area of authority, including the regulations and rules about the danger of heat waves. In the present study, participants mentioned the following obligations for the organization as the codes of the study: the internal work plan of each organization based on the type of work and the level of vulnerability for staff, training programs and culture, using experts in the relevant area to train officials, providing solutions to vulnerable groups, including farmers, providing loans and facilities to owners of jobs vulnerable to heat, including farmers, management of water and electricity outage on hot days, treatment of sewage in the suburban areas and improvement of networks, intersectoral coordination, and avoiding constrained performance.

Participant 17: *“Organizations should be coordinated with each other so that they can work together to improve the conditions to deal with heat, for example, the municipality, the governorate, the agricultural jihad, the water and electricity supply organizations and others should be coordinated to reduce people’s problems in the hot season. For example, the municipality should not give permission to the construction of very high or problematic buildings. There should also be high supervision over the construction, for example, the use of thin walls, very tall buildings or those with a large number of units, and the use of stone facades increase the electricity consumption and put more pressure on electrical systems. On the other hand, with the power outage, people are exposed to*

diseases caused by extreme heat, such as heatstroke, and even increased mental problems.”

Discussion

Most studies in recent years have attributed the occurrence of severe weather events such as heat waves to global warming.^[30] Intense heat waves are one of the deadliest threats right now, and the threat is getting worse around the world due to the combined effects of climate change as well as the Urban Island Heat. Effective planning for adaptation is therefore increasingly critical.^[31]

Very little is known about the relationship between the effects of local climate change and the various socioeconomic and behavioral adaptations that are often implemented to mitigate climate-related effects at the local level, especially in developing countries. The present study is an attempt to fill this gap with the experience of local heat waves and adaptive strategies that residents are pursuing to deal with heat waves in Dezful.

In this section, based on the findings of the study and interviews with participants, adaptation strategies and the concept of adaptation to heat waves were extracted. The adaptation paradigm included the “concept of adaptation” as the main category and the “theoretical and practical definitions” as two subcategories. “Adaptive strategies” includes the two main categories of “personal protection measures” and “governmental measures” with the subcategories of “clothing, nutrition, building, place of residence and lifestyle” and “management, research, health and organization”, respectively.

According to the results, adaptation to heat waves is an active process and an effort to reduce the adverse effects of heat waves on individual and social life and balance. In addition to individual knowledge and measures that will lead to lifestyle changes, it mainly requires integrated and comprehensive planning in the community. Heat waves, as a threat or danger, can become an opportunity for the development of a community through recognition and smart actions, and to be able to adapt to it, the community should be take it as a risk, create plans in advance, apply the necessary rules and training, and use the new facilities and rules where necessary.

In Salehi’s study, the concept of adaptation to climate change was presented as “the ability of a system for stability, sustainability, empowerment, productivity, and flexibility through optimal use of resources, resilience, coping, capacity building and creating opportunities”.^[32] There has never been a specific definition for heat wave adaptation, and it was first presented in this study.

Based on the results of the present study, heat wave adaptation strategies included two main categories of individual and governmental measures. In Meerow's study, which was similar to ours, heat wave resilience strategies were divided into two main categories of heat reduction measures and heat management measures.

Heat reduction strategies include designing and planning interventions to reduce the contribution of the built environment in extreme heat and include land use policies, urban design, urban green cover, and heat loss. Heat management strategies are efforts to prepare for and respond to extreme heat and include strategies related to energy, exposure, general health, and emergency preparedness.^[33]

In addition, in Salehi's study in Iran, the characteristics of adaptation were "sustainability, productivity, stability, empowerment, change and flexibility" and its consequences were "sustainable development, improving life, coordination and integration of response, creativity and innovation, promoting resilience, reducing vulnerability, effective management and independence".^[32] Another similar study conducted by Taghizadeh *et al.*^[34] in Iran tried to extract the areas of adaptation from the viewpoint of experts in the social, cultural, economic, natural, physical, and governmental areas.

Effectively responding to heat events without individual contribution and only based on organizational arrangements is difficult. The general public needs to know what heat waves are, what their sensitivities toward heat waves are, and what steps they can take to protect themselves from heat events. However, there is a unique challenge associated with heat wave hazards. Unlike other natural disasters, heat waves are not unexpected and have a lower severity.^[35]

Adaptive measures are used to reduce the damage caused by heat waves. Among these measures are individual adaptive behaviors that reduce vulnerability to heat waves.^[36]

The heat wave adaptation strategies obtained in our study include personal protection measures and governmental measures. Personal protection measures include nutrition, building, place of residence, and lifestyle. In this study, participants who had experienced heat waves considered the following as personal protective measures: lifestyle modification, use of thin, cotton clothing, use of low-volume, lighter, simpler and cooling foods and use of plenty of fluids and water, use of air conditioning, staying at home, reduced walking or bicycling, reduced physical meetings, especially during the day, and increased communication through social networks, walking and working in the early morning,

changing sleeping and waking hours, use of personal protective equipment (e.g., hats, sunscreen).

Other studies reported different strategies in this area, including air conditioning, wearing less clothing, drinking more fluids, etc., all of which are in line with the results of the present study.^[24,37-41]

In the study area, considering the very high temperature and humidity, people even block the vents of houses to prevent the entry of hot air, while opening windows or using balconies and fans are likely to be applicable in areas with lower humidity and temperature.^[24,41,42]

Also, due to cultural factors, in our study, using light bright colored clothes was limited in the female population, while in other studies it was implemented as a solution.^[24,38,43] Despite that, there were also some other studies that considered cooler cloths to be specific to men.^[33]

Other personal protective measures obtained in our study were also related to the building and the place of residence. In this regard, participants believed that the observance of building codes regarding warm climate, such as architecture and building design, materials used, canopies, passive ventilation, construction regulations, location of the building considering the urban green pattern and the age of the building were among the influential factors. In the same sense, examining the relationship between building and heat effects, there were other similar studies which reported a combination of building architecture, building age, orientation of surrounding buildings, and surfaces and type of insulation as effective factors against heat waves.^[44-51]

These studies indicate the importance of damage-reduction measures for adaptation. Proper building design can help reduce overheating of homes. These measures include a range of passive interventions to reduce overheating during heat wave periods, and less common interventions such as mechanical cooling that lead to climate change. The cost of using such systems can also be expensive for vulnerable people in the community. Such interventions also enable targeted adaptation to make optimal use of available resources.^[52]

Other heat wave adaptation measures obtained in our study are governmental measures that include management, organization, research, and health.

The development and implementation of adaptive strategies, including heat wave-related plans, programs, and projects for stakeholder participation, should be performed through an integrated governmental approach, in which case, collective decision-making between

governmental and non-governmental stakeholders will be encouraged. An important prerequisite here is to promote understanding of the dangers of heat waves in executives, which will be possible through training and enhancing awareness.

Intersectoral cooperation is an effective part of governmental institutions, organizational arrangements, administrative procedures, and related management processes and policies. In climate adaptation, the government provides the protocols in which adaptation policies are developed and should be implemented. In general, public political processes should be conducted through governmental interaction with organizations, community groups, and other stakeholders. Such interaction creates a platform for meaningful stakeholder engagement that encompasses a core set of values including transparency, effectiveness, and accountability across different organizations in order to achieve the intended goal.^[53] This approach prevents parallel and islanded performance and improves productivity. In the present study, planning to promote the understanding of heat wave risks among managers and the provision of integrated programs to promote cross-sectoral participation of stakeholders as holistic measures at the community level were obtained as important requirements to improve adaptation measures against heat waves.

The experience of heat waves in Adelaide also showed that the need for an in-state heat wave response plan was unknown before experiencing the effects of heat waves in 2009, after which decision-makers, health planners, and emergency management personnel began a comprehensive program to design an adaptation strategy to respond to the future heat waves. In France, too, heat waves were unknown before 2003. Following the 2003 heat wave, prominent figures in France, such as the Prime Minister and the Minister of Health, began to develop a heat-related policy.^[53] In our study, experts and managers in relevant organizations and areas stated that they do not have a single instruction or internal protocol for heat waves, which indicates the need to enhance the understanding of the risk of heat waves among managers. It was only the agricultural unit of the meteorological organization that followed the national guidelines for “application area development” about informing farmers before the start of heating systems.

This project divides the country into seven regions based on strategic products, and performs specific instructions and monitoring for each region. In this way, in the study area, farmers will receive text messages about major hazards, such as the onset of heat waves, and in other areas, hazards such as storms or floods, and its monitoring will be performed by agricultural meteorologists.

In the United States survey, 70% of planners were concerned about the risk of extreme heat in the working community, and heat was ranked fourth out of the fourteen potential natural hazards in terms of concern (National Center for Drought Reduction 2018). In contrast, assessments of more than 3,500 sources of climate adaptation in the United States showed that only 4% focused specifically on heat.^[54] Even when heat hazards are widely acknowledged and heat resistance practices are understood locally, they are often not prioritized over other values of society, such as aesthetics.^[55] In the present study, despite the fact that farmers are the largest group exposed to the dangers of heat waves, even in agricultural jihad, there was no specific protocol about heat waves. There are only general measures related to changing the harvest period existed and were implemented for damage reduction and heat wave adaptation.

Organizationally, extreme heat planning is challenging both in practice and in research because it requires the cooperation of various disciplines, government departments, government levels, and stakeholders.^[31]

Other measures in the organizational and managerial areas are those related to the municipality. Due to the growing risk of heat waves, cities should plan to adapt to it. Urban design strategies refer to factors such as the orientation of buildings and streets to maximize shade, create canopies, using cool or reflective pavements in green spaces and parks, use of green roofs and increasing vegetation that reduces heat.^[56,57] In our study, municipality-related measures, including adaptation to standards in urban spaces and buildings to prevent heat island (which doubles the effects of heat waves), construction of parks and increasing the per capita green coverage, planting trees considering the native trees species, and construction of water structures in the city were among the adaptive measures.

In addition, measures that reduce heat generation can lower the effects of hot air – for example, through reducing air conditioning as well as the use of vehicles. However, in our study, due to very high temperatures and humidity, reducing the use of air conditioning is not practical. Reduced use of private vehicles and using public vehicles equipped with cooling systems at specified hours of the day also resulted in this present study.

Heat management involves energy-related strategies, such as increasing the flexibility of the power grid to prevent power outages during heat events.^[58] In the present study, the participants also expressed the definite management of water and electricity, especially on the days of the required heat waves. The adverse effects

of heat on health and work capacity and productivity at the individual level as well as the economic damage caused by occupational health hazards caused by heat in workers have been investigated in several studies.^[59-63] In this study, our participants stated that changing working hours or closing work in some jobs and training to raise awareness and understanding of the risk in employers as key factors in adapting to heat waves.

Emergency preparedness strategies rely on extreme heat warning systems, emergency response planning and coordination. Typically, measures for early warning include disseminating information through the media, providing heat-related recommendations especially for vulnerable populations, and other interventions. As part of a heat warning system, these measures could reduce complications and mortality on hot days.^[64,65]

In the present study, the most common warning system was the media, including television and radio, which provided warnings and recommendations provided by the meteorological agency, but participants reported that the dissemination range of relevant advice and training was very weak, especially for vulnerable populations. Work is needed in this area to increase adaptation. Also, the second method is to inform all the organizations by the National Meteorological Organization. Here, too, the participants believed that knowledge of the risk of heat waves by officials and organizational managers should be increased to formulate and present heat wave preparedness programs and to take advantage of adaptive measures for reducing the damage caused by heat waves using the early warning system.

Another subcategory of this study is measures related to health centers. Just as the architecture, materials, and design of housing must be based on warm climate codes, hospital buildings are also required to secure various domestic environments according to the diverse needs of patients and staff in warm climates. Among these requirements, the thermal comfort which describe an individual's satisfactory understanding of the thermal environment, is an important design criterion for indoor (domestic) air quality that affects patient recovery processes and the well-being of medical staff. Thermal comfort of patients, especially on very hot days, is a priority due to medical conditions and immune system defects.^[66]

Also, considering the adequacy of hospital cooling systems, adopting programs to deal with the heat wave effects, such as using generators for power outage as well as programs to provide medical services on hot days are other adaptation measures in hospitals. Hospitals and health centers need to improve their functional, physical, and managerial resilience to heat waves. In the

present study, participants believed that, in addition to standardizing the environment and building for heat waves, hospitals should have programs to provide health services on the relevant days and programs to support their staff.

The goal of "disaster-safe hospitals" was set at the World Disaster Reduction Conference in Hyōgo. The Third World Conference, held in Sendai, Japan in 2015, also focused on the resilience of health infrastructure and disaster mitigation measures.

Hospital resilience is associated with a reduction in vulnerability to catastrophic shocks and an increase in adaptive capacity resulting from improved measures and opportunities.^[67]

To assess how hospitals respond to the risks, such as heat waves, safety of hospital buildings, equipments, equipment availability, and emergency management capacities should be assessed.^[68-70] In the assessment of hospital resilience, several concepts including hospital safety, emergency services, overcapacity, commanding, planning, logistics, staff capability, training, communication and collaboration systems, recovery and compatibility should be considered.^[71]

According to the results of our study, attention to vulnerable groups, existence of specific programs to provide services to these groups, as well as education at the community level are other adaptive measures that are the responsibilities of the health centers.

Other studies in this regard described the responsibilities of health systems as applying health management strategies for vulnerable groups, counseling, risk management, preparation and implementation of training campaigns, updating heat response programs, preventive measures, taking learning and knowledge enhancement opportunities, planning and strengthening access.^[72-74]

The next extracted subclass of our study is "research". One of the most important infrastructures in creating scientific evidence that influences local, regional, national, and global decisions is performing research in this field, especially in areas affected by hot waves. According to the participants, research in this field is very necessary and there should be scientific evidence for estimations and evaluations of the effects of heat waves on various health parameters such as mortality, cardiovascular disease, hospitalization rate and vulnerable groups as well as their effects on various socioeconomic dimensions of food agriculture. Also, there must be scientific evidence for various socioeconomic dimensions of food, agriculture, and environment in order to lead the way for managerial decisions in various social areas.

As mentioned, extreme heat control measures have received less attention in comparison with other hazards such as floods.^[75] A study listing 3,500 online resources for climate adaptation found that only 4% focused on heat, while 21% focused on sea level rise and 14% on flooding. In addition, while thermal planning research is growing rapidly, 60% of papers published between 2013 and 2018 focused on modeling, and only <7% focused on planning processes and executive actions.^[31,54]

Therefore, there is a need for scientific evidence and research to reveal the effects of heat on various aspects of society and health, and thus enhance the perceived sensitivity to the dangers of heat waves. Some studies have also been performed in this regard in various parts of the world and on different groups, but further studies are still required.

For example, while studies reported that the elderly were more likely than other age groups to experience illness and death from extreme heat worldwide,^[76-78] there are few studies that showed no direct association between heat-related illness and age.^[79] This indicates that other factors may be influential at the local level. Heat-related mortality also appears to be associated with a wide range of chronic diseases including cardiovascular and cerebral, respiratory, endocrine, reproductive, nervous system, and mental health disorders to varying degrees in different parts of the world^[80-84] which requires further studies in this area. Other subgroups vulnerable to heat-related illnesses include women, workers and farmers, children and those working outdoors or in cold, ventilated environments, people in isolation, people with low socioeconomic status, the homeless or those living in insecure communities, and those who are in areas with low access to green space and health services are also vulnerable to the effects of heat.^[85-90] Research is also required on factors that increase the effects of heat waves, including the effect of the Urban Heat Island (UHI), where temperatures in urban areas increase as a result of man-made structures and activities. Therefore, since different climates play an important role in defining the heat wave and its effects, and that the physiological conditions, awareness, governmental, economic, social, and cultural conditions are different in various geographical areas, it is necessary that every region investigates the effects of heat waves and relevant adaptive solutions so that the results not only enhance the understanding of heat wave dangers, but also provide solutions that can accelerate the damage reduction, preparedness, and adaptation policies in other areas with similar climates.

Research innovation

According to the studies conducted, very few researches have investigated the acclimation of society to heat

waves and in Iran, despite having a different climate and the phenomenon of heat waves, there were no such studies. This study was an attempt to identify heat wave acclimation strategies and the results of this study, in addition to identifying and presenting heat wave acclimation strategies, which can be implemented as educational and executive solutions at different levels of society in the stage of harm reduction and preparedness, was applied as part of the doctoral dissertation to design a tool to determine acclimation against heat waves in different parts of the world. So that planners by examining the acclimation level in different communities can consider effective management to reduce the risk of extreme heat in areas with less acclimation and higher risk.

Conclusion

Adaptation measures in Dezful were defined in both individual and governmental aspects. Although heat wave adaptation is of different levels of importance in various societies based on the priorities of natural disasters in each geographical area, it seems that the increasing trend of global warming will increase the frequency and intensity of heat waves in future, in different regions. Awareness of heat waves and adaptive measures to reduce damage can be a valuable scientific resource. It should also be noted that social, economic, cultural, and managerial factors play a significant role in adaptive measures and have different contributions in different societies. Community adaptation to heat waves is a holistic approach and requires not only individual measures and awareness but also more broadly depends on the functioning of a society as a whole; and requires extensive, effective, efficient, and comprehensive governance, management, planning, and research so that the society can be resistant, stable, and empowered against heat waves.

In this study, the conceptual and operational definitions of heat wave adaptation were investigated in the study area. In terms of operational concept definition, heat wave adaptation is an active process and an effort to reduce the adverse effects of heat waves on individual and social life and to establish a balance that, in addition to individual knowledge and measures that will lead to lifestyle changes, mostly requires integrated and general planning in the community. Despite the fact that heat waves are a threat or danger, they can be turned into an opportunity for social development through identification and smart actions, and to adapt to it, the society must take it as a risk, adopt plans to deal with it, apply the necessary regulations and training, and use the new facilities where necessary. Also, solutions to heat waves adaptation were obtained in the two main categories: (i) personal protection measures and (ii)

governmental measures. The comprehensive measures, including those in the field of effective management, stakeholder organizations, health and research, have more extensive contribution in our society. Although heat waves may have different levels of importance in different societies, it seems that holistic indicators can improve adaptation effectively and quickly. Adaptation to heat waves in society as a comprehensive approach not only provides effective, efficient, and comprehensive heat wave management in the society, but also affects other aspects of society and will make it sustainable, independent, and empowered.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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