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# Coping with sand and dust storms: Developing and validating of an adaptation assessment tool

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**ABSTRACT**

**Introduction:** Given the multitude of climate changes and the varying level of adaptation in different societies, it is necessary to measure the degree of adaptation to climate change in any society, as these aids in planning strategies to promote adaptation. Achieving such a goal requires the use of reliable, stable, and indigenous culture-based tools. The purpose of this study is to design and psychometrically assess the adaptation of Iranian society to dust.

**Materials and methods:** The present investigation is a sequential exploratory combined study that utilizes an instrumentation approach. The primary tool, consisting of 101 design items, was developed Based on indicators extracted from two qualitative studies and a systematic review. Its face (quantitative and qualitative), content (qualitative and quantitative), and structural validity among 432 citizens of Ahvaz in southwest Iran were evaluated using exploratory factor analysis. The reliability of the tool was then calculated using Cronbach's alpha test and the intra -cluster correlation index.

**Results:** After calculating the item effect score index with values higher than 1.5, the content validity ratio higher than 0.49, and the content validity index higher than 0.79, 40 items out of the initial 101 were selected. Through exploratory factor analysis, the items were further reduced to 34 and grouped into four areas, based on the eigenvalue being higher than 1. The tool's reliability was confirmed with a Cronbach's alpha of 0.974 and an Intra-Cluster Correlation index (ICC) of 0.951 with a 95% confidence interval.

**Conclusion:** This study successfully designed and produced a tool for measuring the adaptability to dust, comprising 34 items categorized into four areas: optimistic capacity, adjustment, adaptation, and response. This tool can quantitatively measure society's adaptability to dust. With its strong validity and reliability, the tool can identify both the weakness and strengths of a society's adaptation to dust, compare the level of adaptation across different societies, and determine trends within a society.

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## Introduction

Climate change, a well-known global phenomenon, not only leads to alterations in temperature and precipitation patterns [1] but also contributes to the increase's incidence of natural disasters [2]. Furthermore, it impacts air quality by influencing meteorological variables [3]. According to the Disaster Epidemiology Research Center in 2017, approximately 85% of reported natural disasters were linked to weather hazards [4], representing a significant increased over the past two decades [5]. The Center's data for 2022 revealed 387 climate change-related natural disasters, resulting in 30,704 deaths, affecting over 185 million individuals, and causing $223.8 billion in damages worldwide. Among these, 137 cases were associated with Asia, and 108 cases were related to hurricanes [6]. Among these climate risks, we can mention the increase in the occurrence of drought and dust [7, 8]. Dust is direct consequences of drought and reduced rainfall [5]. In 2017, out of a total of 318 natural disasters and $314 billion in economic losses, 85% of those losses were attributed to dust [4]. There are 45 countries recognized as dust source areas, with 84% of them located in Africa and Asia [9]. It is evident that climate change is exacerbating risks such as floods, droughts, and dust, which pose threats to people's livelihoods and infrastructure [10]. The response to these incidents depends on factors such as preparedness, capacity, and risk management within development strategies [11].

Dust storms disrupt human activities [12]. The effects of dust storms are numerous, severe, and costly, causing soil degradation, agricultural damage, reduced air quality, and health problems [13]. The western, southwestern, and central parts of Iran are the most affected by dust, leading to adverse effects on the environment, economy, and the health of residents in these areas [14, 15]. The total economic losses from dust storms in the western provinces of Iran (Ilam, Khuzestan, Kermanshah) during the period of 2006–2011 are estimated to be about 2.227 billion dollars [16].

More importantly than recognizing the adverse effects of climate change are the mechanisms and strategies to adapt to its effects, aiming to reduce vulnerability, restore, and control environmental degradation processes [15]. Studies emphasize the necessity of planning and implementing adaptation methods to address environmental consequences [17, 18]. Taking appropriate measures can significantly delay the onset of change consequences [19]. Due to the historical and long-term relationship between climate and human behavior, adapting to the environment is an active factor in human life [20] and is a critical priority in addressing environmental changes [21]. Adaptation to climate change involves adjusting social, economic, and environmental conditions to climatic consequences [22]. In a qualitative research study, a conceptual-functional definition for adapting to climate change was presented as "The ability of a system to be stable, sustainable, capable, productive, flexible, and transformable in the face of climate change through optimal resource utilization, resistance, adaptation, capacity building, and opportunity creation" [23]. This proposed definition outlines the main concepts of adaptation and offers effective solutions.

Investing in the implementation of adaptation programs is crucial. These programs should recognize and analyze potential risks, evaluate their impact on vulnerable societies, and assess the resilience of people, with a focus on economic and social aspects [24]. Planning for dust adaptation can enhance living conditions, integrate and coordinate responses to climate change effects, foster creativity and adaptability in society, increase resilience, reduce vulnerability, effectively manage societal independence, and ultimately lead to sustainable development [23]. The results a research indicate that improving adaptation capacity is not possible without considering the social context that forms the basis for the design, implementation, and utilization of adaptation strategies [25]. Findings from a study demonstrates that culture is one of the most influential factors in adaptation [26, 27].

The research results consider factors such as access to education, credit, transportation, literacy level, and membership in social groups to be effective

in determining farmers' ability to adapt to climate change [28]. The findings of the study show that people's knowledge, perceptions, and beliefs have the greatest impact on their adaptive behavior [29].

As the adaptation strategy is a primary solution to address this phenomenon, its measurement in society necessitates reliable and evidence-based tools. Additionally, there is a critical need for a tool that can quantitatively measure the degree of societal adaptation to the dust phenomenon and compare this degree across different societies, recording changes over time. This tool should numerically indicate the degree of compatibility with the dust phenomenon, enabling comparisons across societies with diverse social, cultural, and economic differences. This research was conducted to design and psychometrically measure a standardized tool for assessing dust adaptation in Iranian society.

## Materials and methods

The method of the present study is a sequential exploratory combined study with an instrumental approach. The steps of conducting this study are as follows: in the first step, a comparative inductive approach was adopted, and based on the qualitative study of content analysis [23, 27] and the results of a systematic review [26], a pool of items for designing a tool to measure compatibility with dust was formed. Subsequently, the face validity, content, structure, and reliability of the tool were evaluated. Formation of a pool of items:

The items from the qualitative study included indicators of compatibility areas in Iran, encompassing six economic, social, cultural, governance, natural, and physical areas, resulting in a total of 208 indicators [27]. Additionally, the systematic review yielded 176 indicators across seven human, physical, institutional, political, economic, social, and natural domains [26].

Item reduction process:

A total of 384 items were extracted from the two previous studies. As some items in the pool were similar, the research team, along with several stages of expert panel review from different fields, examined each item, resulting in the removal of 84 duplicate items. This left 300 items, of which 179 were conceptually similar. To select the most appropriate item from those with the same meaning, the research team utilized the expert panel method. Ultimately, 101 unique items were chosen to proceed to the validation stage. The steps to perform this stage are specified in figure 1.

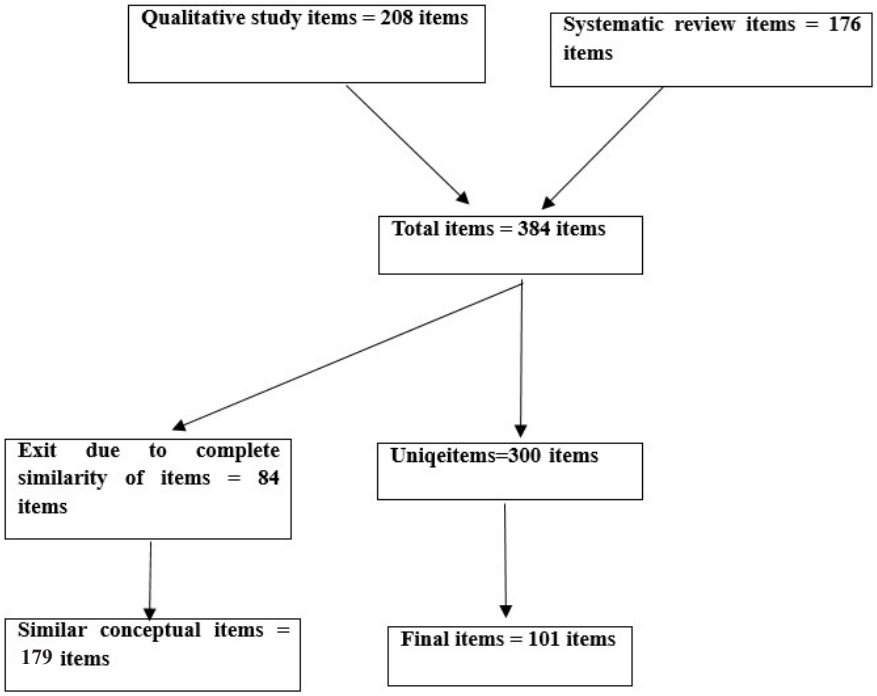


Fig. 1. The process of forming the pool of items and reducing it

***Validation of the tool***

First, the face validity of the tool was assessed using both quantitative and qualitative methods. The quantitative method involved the use of the impact score formula (Frequency x Importance) [30] to examine face validity. Fifteen individuals, representing diverse backgrounds and serving as the main beneficiaries, participated in the research. Items with an impact score greater than 1.5 were deemed suitable for subsequent analysis, while those scoring less than 1.5 were reviewed and corrected by the research team.

In the qualitative face validity study, each question of the tool was completed by 15 individuals, and their opinions on each item were evaluated in terms of difficulty level, expressiveness, ambiguity, simplicity, and comprehensibility. Confusing items were identified, and necessary corrections were made after consultation with the participants and the research team. Additionally, the time required to complete the tool was recorded.

Subsequently, the content validity was examined qualitatively and then quantitatively. In the qualitative review, 15 experts and officials in the field assessed the grammar of the questions, appropriate word usage, item placement, scoring range, comprehensibility, and clarity or ambiguity.

The quantitative content validity review involved the investigation of two indicators: Content Validity Ratio (CVR) and Content Validity Index (CVI) [30, 31]. Firstly, the content validity ratio was calculated based on the opinions of 15 university professors and experts in the fields of dust (3 people), weather and climate change (5 people), health in accidents and disasters (5 people), and environmental health (2 people). The necessity of each indicator to measure compatibility was evaluated using a three-choice Likert scale ("necessary," "useful but not necessary," "not necessary"). The Lawshe's table [32, 33] was then used to determine the necessity of each item quantitatively, and items with lower scores were removed. Secondly, the content validity index of the tool was calculated by presenting it to experts, who rated the relevance of each item on a 4-point Likert scale (very relevant=4, relevant=3, somewhat relevant=2, not related=1). Any item scoring less than 0.78 was removed from the tool.

To assess the construct validity, the exploratory factor analysis method (using the PAF principal axis factor extraction method) was employed to extract factors and subdomains. Two primary tests were used to ensure the appropriateness of the data for factor analysis: the Kaiser-Meyer-Olkin (KMO) test to verify the adequacy of sampling, and Bartlett's Test of Sphericity to confirm the correlation between the items.

***Checking the reliability of the tool***

To test the stability of the instrument, the Intra-cluster Correlation Coefficient (ICC) was used in this study, and Cronbach's alpha coefficient was used to evaluate the internal correlation of the instrument. The reliability of the tool was measured in two steps. First, reliability was measured in the form of item analysis before factor analysis to identify weak items and remove them before presenting the tool to a larger sample. At this stage, 30 people from the city of Ahvaz were selected to maximize diversity. A pre-test and a post-test were conducted on the same people after 14 days, and the intra-cluster correlation coefficient and Cronbach's alpha were calculated. The second stage was measured after assessing construct validity and removing unnecessary items.

**Results and discussion**

In examining the findings of face validity using a quantitative method, out of 101 items, 8 received an impact score of less than 1.5 according to the participants, which were re-checked by the research team. In the formal validity findings, two items were modified based on people's opinions. In the qualitative review of content validity, after applying the opinions of experts and officials, 13 questions were modified in

terms of grammaticality and comprehensibility. In the quantitative review of content validity, the minimum numerical value of content validity for 15 experts was 0.490 in Lawshe's numerical value. As a result, 24 items were removed at this stage, and 77 items remained. In the second step, the content validity index of the tool was calculated. At the end of this stage, 40 main items were selected out of the remaining 77 items.

In the construct validity section, a total of 440 samples were considered, with 11 samples for each item of the tool. Out of the 440 samples, 8 questionnaires were incompletely filled out, leaving 432 samples for analysis. All participants were over 18 years old, and in cases where they were not literate, the instrument was completed through an interview with the interviewer.

The descriptive characteristics of the items and the examination of the degree of correlation between the items indicated an appropriate level of correlation, demonstrating the suitability for factor analysis (see Table 1). The Kaiser-Meyer-Olkin test yielded a value of 0.819, signifying optimal adequacy of the samples, and Bartlett's Test of Sphericity resulted in a significant outcome ($X2=3755.726$, $p<0.001$).

Table 1. Descriptive characteristics of the items in the dust phenomenon compatibility questionnaire

| Row | Items | Number of analyses | Mean | Standard deviation |
|---|---|---|---|---|
| 1 | Dust is the most significant hazard in the region. | 432 | 4.44 | 0.830 |
| 2 | In recent years, there has been an increase of days with dust. | 432 | 4.20 | 0.970 |
| 4 | Dust has a greater impact on sensitive groups, such as patients, pregnant women, the elderly, and children). | 432 | 4.64 | 0.642 |
| 5 | Consuming foods such as milk, liquids, vegetables and fruits can be effective in reducing the effects of dust. | 432 | 4.51 | 0.762 |
| 6 | Creating green spaces is an effective way to adapt to dust. | 432 | 4.30 | 0.908 |
| 8 | I believe that the weather conditions will improve. | 432 | 3.59 | 0.128 |
| 9 | I have a positive attitude toward solving the dust problem. | 432 | 3.30 | 1.174 |
| 10 | Despite the presence of dust, I am not concerned about the future. | 432 | 2.73 | 1.311 |
| 11 | Despite the presence of dust, I feel safe. | 432 | 2.60 | 1.248 |
| 13 | I have a high tolerance level for dust. | 432 | 3.02 | 1.174 |
| 14 | I have found my experience to be successful in adapting to the environment. | 432 | 3.54 | 1.085 |
| 16 | I have no intention of relocating to another city due to the presence of dust. | 432 | 3.34 | 1.338 |

Table 1. Continued

| Row | Items | Number of analyses | Mean | Standard deviation |
|---|---|---|---|---|
| 17 | In my opinion, the authorities have implemented effective measures to address the issue of dust thus far. | 432 | 2.89 | 1.422 |
| 21 | I try to manage the existing situation. | 432 | 4.22 | 0.913 |
| 22 | I try to accept dust as a part of my life. | 432 | 3.19 | 1.409 |
| 27 | Similarly, I close the door and window in dusty conditions. | 432 | 4.59 | 0.731 |
| 29 | To minimize the impact of dust, we have installed double-glazed windows. | 432 | 3.47 | 1.820 |
| 30 | We use sealant to minimize the impact of the dust. | 432 | 3.81 | 1.191 |
| 31 | I stay at home during the peak of the dust storm. | 432 | 4.02 | 1.179 |
| 33 | I avoid engaging strenuous physical activity in dusty weather. | 432 | 4.43 | 0.951 |
| 34 | I have installed a ventilation system at home to reduce the impact of dust. | 432 | 3.63 | 1.505 |
| 35 | To reduce the effects of dust, I use a suitable cover for my food. | 432 | 4.58 | 0.779 |
| 36 | I use an N95 filter mask in dusty conditions. | 432 | 3.98 | 1.161 |
| 37 | I try to clean and sweep up the dust every day. | 432 | 4.48 | 0.826 |
| 38 | I conserve water and electricity in dusty conditions. | 432 | 4.12 | 1.047 |
| 39 | I participate in voluntary activities related to reducing the effects of dust. | 432 | 3.73 | 1.201 |
| 7 | The authorities' request for people's participation is effective in addressing the issue of dust. | 432 | 4.00 | 1.221 |
| 15 | I am committed and responsible towards addressing the issue of dust in my city. | 432 | 6.64 | 1.195 |
| 18 | Local trusted individuals must encourage people to participate in adapting to dust. | 432 | 6.86 | 1.142 |
| 28 | We use thick curtains to minimize the effects of dust. | 432 | 4.20 | 0.959 |
| 19 | Access to medical centers and emergency services is effectively reduces the effects of dust. | 432 | 4.06 | 0.993 |

Table 1. Continued

| Row | Items | Number of analyses | Mean | Standard deviation |
|---|---|---|---|---|
| 3 | The more intense the dust, the more damage it causes. | 432 | 4.70 | 0.568 |
| 25 | I pay attention to media messages, such as radio and television). | 432 | 3.97 | 1.071 |
| 23 | I am trying to improve my living conditions. | 432 | 4.33 | 0.815 |

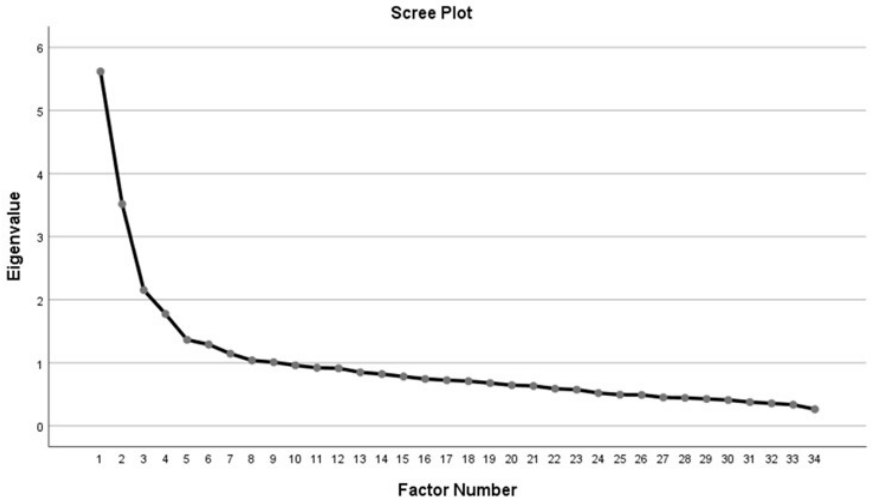


Fig. 2. Gravel diagram was also checked and showed the presence of 4 factors

Table 2. Results of the specific factor value calculations using the total variance explained analysis method

| Factor | Initial eigenvalues | | | Extraction sums of squared loadings | | | Rotation sums of squared loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Percent variance | Cumulative percentage | Total | Percent variance | Cumulative percentage | Total | Percent variance | Cumulative percentage |
| 1 | 5.618 | 16.522 | 16.522 | 4.966 | 14.606 | 14.606 | 3.985 | 11.721 | 11.721 |
| 2 | 3.516 | 10.342 | 26.864 | 2.856 | 8.400 | 23.006 | 2.836 | 8.343 | 20.064 |
| 3 | 2.152 | 6.329 | 33.193 | 1.444 | 4.248 | 27.254 | 1.793 | 5.273 | 25.337 |
| 4 | 1.775 | 5.221 | 38.415 | 1.101 | 3.237 | 30.491 | 1.752 | 5.154 | 30.491 |

Table 2 shows that in the factor analysis test, the eigenvalues for four factors were higher than one and accounted for 30.491 percent of the variance in the questionnaire.

In order to make the extracted components more interpretable, the varimax rotation method was used, and factor loadings equal to or greater than 0.4 was considered significant. Factor number one had 13 items, factor number two had 5 items, factor number Three had six items, and factor number four had 6 items loaded, resulting in a reduction of the total number of items from 40 to 34 (Table 3).

Table 3. Factor loadings of the four extracted factors after rotation using the Varimax method

| Group | Item | Level |
|---|---|---|
| 1 | Despite the presence of dust, I feel safe. | 0.761 |
| | Despite the presence of dust, I am not concerned about the future. | 0.678 |
| | I have a positive attitude toward solving the dust problem. | 0.629 |
| | In my opinion, the authorities have implemented effective measures to address the issue of dust thus far. | 0.557 |
| | I have a high tolerance level for dust. | 0.542 |
| | I believe that the weather conditions will improve. | 0.539 |
| | I try to accept dust as a part of my life. | 0.515 |
| | I have no intention of relocating to another city due to the presence of dust. | 0.513 |
| | I have found my experience to be successful in adapting to the environment. | 0.484 |
| | I try to manage the existing situation. | 0.371 |
| 2 | Creating green spaces is an effective way to adapt to dust. | 0.524 |
| | The authorities' request for people's participation is effective in addressing the issue of dust. | 0.522 |
| | I participate in voluntary activities related to reducing the effects of dust. | 0.471 |
| | Consuming foods such as milk, liquids, vegetables and fruits can be effective in reducing the effects of dust. | 0.399 |
| | I conserve water and electricity in dusty conditions. | 0.382 |
| 3 | Similarly, I close the door and window in dusty conditions. | 0.495 |
| | I am trying to improve my living conditions. | 0.481 |
| | Local trusted individuals must encourage people to participate in adapting to dust. | 0.477 |
| | To reduce the effects of dust, I use a suitable cover for my food. | 0.448 |
| | Dust has a greater impact on sensitive groups, (such as patients, pregnant women, the elderly, and children). | 0.432 |
| | Access to medical centers and emergency services is effectively reduces the effects of dust. | 0.428 |
| | I try to clean and sweep up the dust every day. | 0.422 |
| | I avoid engaging strenuous physical activity in dusty weather. | 0.411 |
| | In recent years, there has been an increase of days with dust. | 0.386 |
| | I am committed and responsible towards addressing the issue of dust in my city. | 0.366 |
| | Dust is the most significant hazard in the region. | 0.363 |
| | The more intense the dust, the more damage it causes. | 0.360 |
| | I stay at home during the peak of the dust storm. | 0.331 |
| 4 | To minimize the impact of dust, we have installed double-glazed windows. | 0.629 |
| | We use sealant to minimize the impact of the dust. | 0.464 |
| | I have installed a ventilation system at home to reduce the impact of dust. | 0.416 |
| | We use thick curtains to minimize the effects of dust. | 0.392 |
| | I pay attention to media messages, such as radio and television). | 0.354 |
| | I use an N95 filter mask in dusty conditions. | 0.327 |

Table 4. Naming the factors extracted from factor the analysis

| Row | Field name | Number of items |
|---|---|---|
| 1 | Optimistic capacity | 10 items |
| 2 | Adjustment capacity | 5 items |
| 3 | Coping capacity | 13 items |
| 4 | Response capacity | 6 items |

Naming the factors extracted from the factor analysis during the expert meeting resulted in the classification of 34 items related to compatibility with the dust phenomenon into four areas (Table 4).

### *Instrument reliability findings*

The results indicated that the item analysis conducted before factor analysis showed an Intra-Cluster Correlation (ICC) with a 95% confidence interval of 0.982 and a Cronbach's alpha of 0.809. In the subsequent step, the final reliability was assessed after structural validity. Following the removal of 6 items that did not score in the factor analysis, the reliability was re-evaluated, yielding a Cluster Correlation (ICC) with a 95% confidence interval of 0.951 and a Cronbach's alpha of 0.974.

The strategy of adapting to climate change is a key approach in addressing this phenomenon. However, measuring and monitoring it requires a valid tool. Dealing with any problem necessitates having information about the issue, as effective intervention and planning are not feasible without it [34]. A systematic review revealed the absence of a standard tool that has undergone the necessary developmental stages to measure the degree of compatibility with dust [26]. Therefore, it became apparent that there was a need to design tools and psychometrics with specific criteria to measure the adaptation of Iranian society to dust. Adaptation options encompass a range of available actions conducive to fostering compatibility. These actions are classified into structural, institutional, ecological, or behavioral categories [35]. Utilizing the outcomes of a qualitative study conducted in Iranian society [23, 27] and a systematic review of the factors influencing society's adaptability to dust [26] resulted in the formation of a comprehensive pool of items, comprising 384 items during the item creation stage. This comprehensive pool can play a crucial role in developing a reliable and comprehensive tool, demonstrating that the domains and factors influencing adaptation in diverse societies are interconnected, despite data collection from varied sources. To streamline the items, multiple stages of expert panels from diverse fields were convened to ensure consensus on the remaining items. Given that quantitative measurement can more effectively determine or compare the degree of adaptation in specific societies, a tool was devised to numerically indicate the

degree of adaptation to the dust phenomenon, enabling comparisons across different cities and even diverse urban areas characterized by social, cultural, economic, and environmental differences.Precision is essential in creating a valid instrument. Accuracy is pivotal in identifying the most essential and relevant items amidst a multitude [32]. The examination of the construct validity of the existing tool structure through exploratory factor analysis revealed four domains of compatibility with dust. This classification stands out as a key finding of this study, as the literature review highlighted the absence of domains for measuring the degree of compatibility with dust [26]. This study ascertained that, to gauge society's adaptation to dust, attention should be directed to four main domains, each of which holds significance in its own right. The researchers of this study proposed the term "optimistic capacity" for the first domain, as it appears that the initial step toward enhancing adaptation involves individuals maintaining a positive outlook on the future. In other words, fostering hope for the future embodies an "optimistic capacity" for adapting to dust. Questions in this domain included statements such as "I believe that the weather conditions will improve" or "I have a positive attitude towards resolving the dust problem". This concept is also reflected in the definition of adaptation as "the ability and productivity of taking advantage of opportunities" [36]. In support of this notion, the findings of the study also revealed that hope for the future correlates positively and significantly with the general strategy of adapting to climate change [37]. Consequently, this research underscored the necessity for individuals to harbor a positive outlook on the future as an initial step. Greater efforts should be made to cultivate a positive mindset among people.

The second area of adaptation identified in this study is named "adjustment capacity". Questions such as "Creating green spaces is an effective measure to adapt to dust" or "I participate in related voluntary activities to reduce the effects of dust" were included in this domain. Adjustment is typically a short-term solution that involves making minor changes to an existing system or process to improve its effectiveness or efficiency [38, 39]. The researchers in their review concluded that many believe the solution to environmental crises should involve changing human behavior and lifestyles. Instead of destroying the environment, humans can adjust their level of needs and adapt their lifestyles to existing limitations, which plays an important role in reducing and controlling environmental problems [40]. Many researchers believe that environmental problems caused by human activities cannot be solved by technology alone, and that changes in human behavior are necessary. The importance of this issue is such that the direction of environmental science and physics is shifting towards behavioral sciences [41].

The third area expresses "adaptation capacity" in a manner consistent with the part of the definition of adaptation that pertains to achieving stability, that is, people strive to reach the stage of adaptation after adjusting themselves to the surrounding environment. Items in this domain include people's attitudes and behaviors, demonstrating that people attempt to adjust and adapt in the next stage after adjusting themselves to the existing conditions. Questions in this domain include "I close the door and windows in dusty conditions" or "I try to improve my living conditions". Adaptability refers to changing behavior or adapting to a new type of situation, and can encompass comprehensive changes as well. Coping is defined as thoughts and behaviors mobilized to manage internal and external

stressful situations, and are specifically used for conscious and voluntary mobilization of actions [42]. The results of the study showed that the protection of the environment depends on the members of society, and their perception and attitude affect their behavior towards the environment. What they understand about their relationship with the environment and how they value it ultimately determines the environment in which they were raised [43].

In the fourth area, individuals took personal actions to achieve an appropriate response to adapt to the dust phenomenon. Examples include "to reduce the effects of dust, we have double-glazed the windows" and "to reduce the effects of dust in the ventilation system in my house". In a way, this area expresses the "capacity of response" in people. A researcher proposed a conceptual framework for the relationship between climate change and human responses that includes biological, psychological, and behavioral aspects for interventions [44]. Additionally, the response capacity items in this study clearly define the role of the economic field in adaptation. However, it should be noted that the economic field alone cannot always be effective. Understanding risk and people's insight are also necessary to use preventive measures despite the appropriate financial situation. The results of a research showed that financial restrictions can be one of the main obstacles to adapting to climate change [45]. A research in Iran demonstrated that social trust and risk perception are effective in adaptive behaviors, in addition to knowledge [46]. The findings of the study stated that the human way of life is considered an important and distinct component of culture in the adaptation of humans and the environment. The adaptation of humans and the environment emerges under the influence of human values, subjective meanings, and the capabilities of the environment [47].

These four areas obtained from the tool are well related to the UNISDR definition of adaptation, which is "The adaptation of natural or human systems in response to real or predicted climate stimuli or their effects in such a way as to lead to adaptation, which shows losses or benefits from beneficial opportunities" [36]. This definition includes the concepts of damage adjustment, taking advantage of opportunities, and adaptation. In another study, the researcher came to a functional and conceptual definition of adaptation, which was "The ability of a system to be stable, sustainable, capable, productive, flexible, and transformable against climate changes through the optimal use of resources, resistance, adaptation, capacity building, and opportunity building"[23]. This definition includes sustainability and stability, transformation and flexibility, and capability and productivity. All of these characteristics were manifested in this designed tool. Capability and productivity were mentioned here, which in the definition of UNISDR as productivity was a waste of opportunities, and in the tool, it somehow refers to an optimistic capacity. Transformation and flexibility were the adjustment capacities, which were also mentioned in the definition of UNISDR as damage adjustment [36]. Stability and stability can be attributed to the adaptation capacity, and ultimately, it is the response capacity. After acceptance, people try to find solutions to minimize the harm of dust. Although areas of adaptation such as resilience are not specified in the model, it is better to focus on this issue in the future. Prioritizing and weighting the areas of adaptation in different societies with different needs is also an important issue. By using standard tools, it is possible to measure the level of compatibility in different cities in Iran that are involved in this problem and compare the level of compatibility of people with each other. Officials can use the results of research in different areas to remove

obstacles in these four areas and improve people's adaptation. This quantitative tool was prepared as the first tool designed in Iranian society during the psychometric process. Only the necessary and related indicators were measured, and their reliability was checked, making it comprehensive. It measures people's compatibility in a simple and understandable language for all age groups. It seems that it can be widely used.

The important distinction between resilience and adaptation is highlighted here, demonstrating that adaptation primarily pertains to environmental phenomena and less to events such as floods and earthquakes. Adaptation is a long-term solution to significant changes and external factors, responding more effectively to environmental changes [39]. Another difference lies in the capacities, where resilience involves absorption, response, and recovery, whereas the adaptation tool, based on factor analysis, identifies four capacities. Perhaps the most significant difference between the two lies in the recovery aspect, as adaptation does not specifically seek recovery. Similar to resilience, recovery can be achieved at the right time and with the right efficiency, but in adaptation, a society that has adapted does not revert to its previous state. It is recommended to replicate the study in other cities affected by dust and compare the results for consideration in policymaking. Decision-makers are also encouraged to prioritize the main areas of adaptation in society, including social, cultural, economic, governance, natural, and institutional aspects, in their planning.

## Conclusion

Tool can effectively assess compatibility and aid in planning to enhance adaptation. It can identify the strengths and weaknesses of a society's adaptation to dust, and its wide range of indicators derived from qualitative studies and systematic reviews make it the first tool of its kind in society, developed through a rigorous psychometric process. Due to its measurement of essential adaptation-related indicators, it has broad applicability. Additionally, its simplicity allows for easy responses from individuals, making it suitable for planning improvements in society's adaptation to dust. One limitation of the tool is its focus on the urban population, necessitating the design of a separate questionnaire for coastal or rural areas, considering the differing levels of compatibility in different communities. To enhance the tool, it is recommended to develop a comprehensive multi-part tool based on its application in various areas. Replicating the study in other cities affected by dust and comparing their results should be taken into account in policymaking. Moreover, designing separate tools for other natural disasters, such as floods and storms, is also suggested.

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## Competing interests

The authors declare that they have no conflicts of interest.

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## Ethical considerations

This study received the ethical approval of research (IR.TUMS.SPH.REC.1396.4171) by Tehran University of Medical Sciences was confirmed. Ethical issues (Including plagiarism, double publication, data fabrication, Informed Consent, etc.) have been completely observed by the authors.

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