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Evaluating Social Vulnerability as a Key Social Determinant of Health Index in Iran

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Abstract

Background: The Social Vulnerability Index (SVI) is a practical metric that operationalizes the social determinants of health. This study aimed to develop a composite SVI for Iran and to measure the social vulnerability status across its provinces.

Methods: This ecological study utilized a composite indicator construction method to create a social vulnerability index for the provinces of Iran. Relevant indicators for the social vulnerability index were selected through the Delphi method. Factor analysis was employed to validate the index construction and select appropriate indicators and dimensions. Varimax rotation was used to rotate the indicators, and Principal Component Analysis was conducted for indicator extraction. The data were standardized using the Z-score method and aggregated through a linear aggregation technique. Weighting was performed based on the squared factor loadings, and sensitivity analysis was conducted to assess the robustness of the index.

Results: Based on the research findings, the SVI, tailored to the context and structure of Iranian society, comprises 17 indicators categorized into five dimensions. These dimensions include lack of social insurance and low education, household poverty and disability, household structure and population dependency, economic vulnerability, and unemployment and housing vulnerability. The spatial distribution map of social vulnerability across Iran's provinces reveals that Sistan and Baluchistan (2.40) is the most socially vulnerable province, followed by North Khorasan (1.68) and Golestan (1.62). Overall, peripheral and border provinces exhibit higher levels of social vulnerability compared to the central provinces. Among all provinces, Yazd (0.01) demonstrates the lowest level of social vulnerability.

Conclusion: The composite social vulnerability index for Iran's provinces can serve as a key tool for evidence-based and equitable policy-making and planning in the health sector. By identifying vulnerable provinces, this index can support prevention efforts and facilitate appropriate responses during disease outbreaks and other health emergencies.

Keywords: Social vulnerability, Composite indicator construction, Social Determinants of Health, Public health emergencies, Provinces of Iran

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Introduction

The Social Vulnerability Index (SVI) is one of the most comprehensive and widely used indices for measuring social determinants of health (SDH). The concept of social vulnerability broadly integrates key social determinants

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↑What is "already known" in this topic:
The Social Vulnerability Index (SVI) is among the most comprehensive indicators within the domain of social determinants of health, integrating numerous socioeconomic factors and determinants into a single composite measure. This index facilitates the identification of communities and groups that are disproportionately vulnerable to health risks and epidemics.

→What this article adds:
A Social Vulnerability Index tailored explicitly for the provinces of Iran was created using a composite index construction methodology. By leveraging the knowledge and expertise of local specialists familiar with the structural and contextual nuances of Iranian society, this index provides a robust and context-sensitive tool for health policy formulation and evaluation.

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and encompasses various social factors that influence health (1). The SVI focuses on social determinants of health and links them to community resilience in facing disease outbreaks or other human health threats (2). Therefore, in recent years, special attention has been paid to the conceptualization and measurement of social vulnerability in the health sector (3).

Researchers have used various methods to measure social vulnerability, including computer model-based, indicator-based, and GIS-based methods. The index-based method is widely employed for vulnerability assessment because of its significant advantages, including the aggregation of diverse social factors into a single index, which enables comparisons across different conditions (3). There are several notable social vulnerability indices, such as the "CDC/ATSDR Social Vulnerability Index" for emergency management (4) and the "Risk and Vulnerability Research Institute's Social Vulnerability Index" (SoVI) (5). Another tool, the "Social Vulnerability Measure (SVM)," offers a unified metric for SDH that more effectively captures its relationship with health outcomes (6). These indices were developed in Western countries, and their applicability to the context of non-Western countries is questionable (7).

Social vulnerability is a complex and multidimensional concept that varies based on the context and structure of each society, making it challenging to operationalize (8). One of the main challenges in this approach is the decision-making process involved in selecting various indicators. This process can be either unrestricted or heavily influenced by the specific contexts, customs, and structures of different societies. This challenge is even more pronounced in countries in the Global South, which are often underdeveloped or in the process of development. Researchers typically rely on methods such as expert consultation, literature reviews, contextual considerations, and data availability when selecting indicators (3,7).

Constructing an SVI suitable for any given society or country necessitates a thorough consideration of its unique social, economic, political, and cultural contexts (8). This issue holds particular significance for Iran, which possesses distinct developmental histories, as well as unique institutional and structural characteristics (7). Iran, as a prominent developing country, presents a unique geographical setting and a complex socioeconomic structure that render it highly susceptible to various hazards. The diverse and heterogeneous nature of Iranian society, with its numerous ethnic, religious, and linguistic minorities, further underscores the importance of developing an SVI that adequately accounts for these specific conditions (9, 10).

In recent years, alongside the emergence of the vulnerability concept in research and empirical studies across various countries, particularly in Europe and America, Iranian researchers have also shown growing interest in this domain (10-16). Most of the indices developed by Iranian scholars in this area have focused on the application of SVI within the context of disasters and hazards, aiming to measure vulnerability to specific events (11, 12, 17). However, many of these indices have relied on a limited set of indicators for their assessment (9). Among the few indices developed explicitly for social vulnerability in the health sector are those designed to measure social vulnerability at the county level within a province in response to the coronavirus disease 2019 (COVID-19) pandemic (13-15). Other efforts have predominantly focused on the conceptual and theoretical exploration of the SVI rather than the construction of a specific index (10). Several factors contribute to the scarcity of a comprehensive national-level SVI in Iran, primarily the inherent complexity of constructing such an index, and, more critically, the absence of accurate and reliable statistical data (9, 10).

Therefore, developing a social vulnerability index tailored to the structure and context of Iranian society, which offers adequate comprehensiveness and accuracy, is a crucial step in this field. Expert consultation and the Delphi technique can help incorporate such contextual characteristics and select the most suitable indicators. Additionally, assessing social vulnerability at the provincial level provides an appropriate tool for monitoring and evaluating provincial conditions, thereby facilitating evidence-based planning and policymaking.

Methods

This ecological study develops the composite SVI for Iran (ISVI), utilizing the Organization for Economic Co-operation and Development (OECD) methodology for creating composite indicators (18). The OECD approach involves the following steps: theoretical foundation, data selection, imputation of missing data, multivariate analysis, normalization, weighting, and aggregation. Given that social vulnerability is a dynamic, multifaceted concept that is context-dependent, a multidimensional approach to social vulnerability was adopted. Initially, the theoretical background of the concept (3, 19) was reviewed alongside an examination of relevant theoretical and empirical studies conducted in Iran (9, 10, 14, 16). From this review, dimensions and indicators pertinent to the domain of social vulnerability were extracted and subsequently shared with the Delphi panel experts. In 3 rounds, the Delphi members evaluated and scored the indicators and variables based on their relevance and suitability to the contextual and structural characteristics of Iranian provinces. A total of 65 indicators were selected as relevant measures of social vulnerability at the provincial level in Iran. Reliable and accurate data were available for 24 of these indicators.

The data were included in a multivariate analysis with no missing data. To examine the overall structure and select indicators and dimensions of the index, factor analysis (FA) was employed. The inclusion criteria for indicators were a Kaiser-Meyer-Olkin (KMO) measure >0.5 and the availability of valid data, while the exclusion criterion was cross-loading of indicators on more than 1 factor. Following FA, 7 indicators were removed, leaving 17 leading indicators retained. The extraction method employed was Principal Component Analysis, followed by Varimax rotation with Kaiser normalization.

Given the varying measurement units of the selected indicators, data were standardized using z-scores (mean = 0, SD = 1). This ensured comparability and consistency before aggregation. The values of the indicators were standardized before they were combined. A linear aggregation

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method was used to compute ISVI. Initially, the factor loading of each indicator was determined through exploratory factor analysis. Subsequently, the factor loadings were squared to eliminate any negative values. Finally, since the sum of the squared factor loadings exceeded 100%, they were standardized to a scale of 100. To assign weights to the indicators based on their factor loadings in the factor analysis, weights were allocated to 17 individual indicators. The weights assigned to each indicator are presented before the name of the indicator in the aggregation formula. The mathematical formula for the ISVI is:

ISVI = 0.13 * ZPercentage of people without social insurance + 0.12 * ZPercentage of households with no vehicles + 0.12 * ZHouseholds covered by supportive institutions + 0.11 * ZIlitracy rate + 0.07 * ZDivorce rate + 0.06 * ZPercentage of Population under 15 years old + 0.05 * ZPopulation aged 65 years and over + 0.04 * ZPercentage of households with disabilities + 0.04 * ZMalnutrition + 0.03 * Zdensity + 0.03 * ZDropout rate + 0.02 * Z Percentage of marriages under 18 years of age + 0.04 * ZInflation rate + 0.03 * ZGini coefficient + 0.03 * ZPoverty rate + 0.05 * ZUnemployment + 0.03 * ZHousing non-durable materials

In the overall index, a constant value of 1 was added to all the numbers to ensure that they all became positive. The robustness of the index was evaluated through sensitivity analysis. This involved systematically removing each of the 5 dimensions from the composite index and recalculating the values. The newly derived indices were then compared to the original index using the Spearman correlation coefficient. SPSS version 26 was used to run exploratory factor analysis, the Kaiser–Meyer–Olkin (KMO), and Bartlett's test. Finally, Microsoft Excel was used to produce a cartogram that visualizes ISVI across provinces.

Data

All 31 Iranian provinces were included in the study. Provincial-level data were obtained from the Statistical Center of Iran (SCI), the Central Bank (CB), the Iran Ministry of Cooperatives, Labor, and Social Welfare (MCLSW), the National Organization for Civil Registration (NOCR), and the Ministry of Sport and Youth (MSY). Table 1 presents the source of data.

Results

Based on Kaiser–Meyer–Olkin (.612), the data were adequate for the underlying analysis. Bartlett's test of sphericity (403.004, df = 136, $P < 0.001$) implied that the correlation matrix of variables was not an identity matrix. The first 5 factors altogether explained 78.06% of the total variance. The 12 other factors were able to explain 21.94% of the total variance in the data. Eventually, according to principal component analysis, data reduction is possible. The 17 indicators were structured under 5 dimensions/domains. Table 1 presents the descriptive statistics of ISVI indicators, and Table 2 outlines the 17 indicators of social vulnerability, along with their respective domains and basic descriptive statistics.

The domains were named according to their overall concept and the content of their respective indicators (Table 3). The researchers labeled the first domain: "lack of social insurance and low education (LSE)," which encompasses indicators such as the percentage of people without social insurance, the illiteracy rate, the dropout rate, and the percentage of marriages under 18 years of age. The researchers called the second domain: "household poverty/disability, (HPD), containing these indicators: households with no vehicles, households dependent on social welfare institutions, households with disabled children, and malnutrition of children under 6. "Household structure and population dependency (HSPD)" is the third domain, which includes indicators related to divorce rates, the number of children younger than 15 years old, seniors older than 65 years old, and household density. The fourth domain is "economic vulnerability (EV)," which includes indicators such as the inflation rate, Gini coefficient, and poverty rate. Finally, the fifth domain is "unemployment/housing vulnerability (UHV)," which encompasses the unemployment rate and housing indicators, excluding those made of durable materials.

A sensitivity analysis was performed to assess the robustness of the index. To achieve this, 6 different scenarios were developed. In the first scenario, ISVI was created

Table 1. Data Sources and Summary Statistics for the Indicators Incorporated in ISVI

Indicators	Source	Year	N	Minimum	Maximum	Mean	SD
Percentage of people without social insurance	MCLSW	2022	31	15	73	46.68	13.21
Illiteracy rate	MCLSW	2023	31	5.62	20.07	12.32	3.67
Percentage of households with no vehicles	MCLSW	2022	31	28.50	64.90	46.81	8.80
Households dependent on social welfare institutions	MCLSW	2021	31	4.50	27.60	14.97	5.93
Divorce rate	NOCR	2024	31	.80	3.50	2.23	.49
Percentage of population under 15 years old	SCI	2023	31	15.60	38.30	23.74	4.19
Population aged 65 years and over	SCI	2023	31	3.20	10.80	7	1.46
Percentage of households with disabilities	MCLSW	2021	31	3.10	7.80	5.42	1.22
Malnutrition	MCLSW	2021	31	.00	15.78	2.89	3.59
Population density	MCLSW	2021	31	.96	1.44	1.03	.08
Dropout rate	SCI	2023	31	2.17	5.90	3.86	.95
Percentage of marriages under 18 years of age	MSY	2022	31	1.80	13.70	5.75	3.36
Inflation rate	CB	2024	31	30.80	39.80	34.72	2.08
Gini coefficient	CB	2023	31	.26	.42	.31	.038
Poverty rate	MCLSW	2023	31	15.40	58.20	31.59	8.87
Unemployment	SCI	2024	31	3.40	15.20	8.42	2.81
Housing with non-durable materials	MCLSW	2021	31	.00	63.22	17.73	14.66

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Table 2. Rotated Component Matrix

	Component				
	1	2	3	4	5
Percentage of people without social insurance	.79				
Illiteracy rate	.73				
Dropout rate	.92				
Percentage of marriages under 18 years	.68				
Percentage of households with no vehicles		.69			
Households dependent on social welfare institutions		.84			
Percentage of households with disabilities		.70			
Malnutrition		.79			
Divorce rate			.84		
Percentage of population under 15 years old			.78		
Population aged 65 years and over			.80		
Density			.53		
Inflation rate				.80	
Gini coefficient				.56	
Poverty rate				.57	
Unemployment					.85
Housing with non-durable materials					.72

Table 3. Sensitivity Analysis Results: Correlation Coefficients of Modified ISVI Dimensions

Modified Index	Spearman Correlation with Original ISVI	Key Observations
ISVI without LSE	0.94	The correlation is very high, indicating that the removal of LSE has minimal effect on the ISVI rankings.
ISVI without HPD	0.84	The correlation remains strong, though slightly lower, suggesting that HPD is still significant in determining the overall index.
ISVI without HSPD	0.92	The correlation is very high, indicating that the removal of HSPD has minimal effect on the ISVI rankings.
ISVI without EV	0.86	The correlation remains strong, though slightly lower, suggesting that EV is still significant in determining the overall index.
ISVI without UHV	0.90	The correlation is very high, indicating that the removal of UHV has minimal effect on the ISVI rankings.

by integrating all 5 dimensions. In contrast, the remaining scenarios generated indexes based on combinations of 2 dimensions, with each dimension excluded from the aggregation process in turn. Finally, the developed indices were compared using the Spearman rank correlation coefficient. The findings indicated a strong correlation between the indices, with the lowest Spearman coefficient being 0.84.

Table 4 presents the rankings of Iranian provinces based on overall ISVI and its domains. Higher ISVI values and domain scores indicate greater social vulnerability. ISVI values varied considerably across provinces: Yazd was the most favorable (ISVI = 0.10), while Sistan and Baluchistan, located on the southeastern border, had the highest vulnerability (ISVI = 2.40).

A cartogram showed the ISVI distribution across Iranian provinces. The 31 provinces were categorized based on the ISVI into 5 distinct categories: provinces with the highest, high, moderate, low, and very low social vulnerability. According to Figure 1, the darker the color, the greater the social vulnerability. This figure shows that provinces located closer to the periphery, especially border areas, exhibit higher social vulnerability than central provinces. Moreover, as one moves from the center toward the periphery of the country, the level of social vulnerability increases.

Discussion

The aim of this study was to develop a contextually appropriate social vulnerability index for Iranian provinces and apply this index to assess social vulnerability at the provincial level. The findings demonstrated that social vulnerability in Iran is unevenly distributed across provinces, with provinces closer to the Iranian borders exhibiting higher social vulnerability compared to those in central areas. These findings are consistent with recent research assessing the social health and welfare status of Iranian provinces (20-22).

Like numerous studies assessing the social, economic, and health conditions across various provinces in Iran, this study identifies Sistan and Baluchistan province as being in a critical state (20-22). Provinces such as North Khorasan and Golestan also rank among the regions with the highest social vulnerability in Iran.

Several factors explain the elevated vulnerability in these provinces, the most significant being the prevailing development model in Iran—a pattern also characteristic of many Middle Eastern countries, including Turkey. This model is marked by pronounced spatial inequality and imbalance between the center and the periphery, where central regions accumulate capital, infrastructure, facilities, and resources, while peripheral areas remain underdeveloped and marginalized (23).

In Iran, the central part of the country is relatively more developed, with resources and opportunities historically concentrated there, whereas peripheral regions have been neglected. Many of these vulnerable provinces are located along the country's borders and are situated at considerable distances from the capital (24, 25). Additionally, these provinces tend to have a higher rural population, while

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Table 4. Score and Ranking of ISIV and Its Domains

Province	IASI	Rank	LSE	Rank	HPD	Rank	HSPD	Rank	EV	Rank	UHV
Sistan and Baluchistan	2.40	1	.87	1	.34	2	.01	12	.09	1	.08
North Khorasan	1.68	2	.52	3	.10	7	.06	3	.00	15	.00
Golestan	1.62	3	.27	9	.17	5	-.01	18	.09	2	.09
Lorestan	1.61	4	.25	10	.28	3	.01	11	.05	7	.02
Kurdistan	1.48	5	.25	11	-.03	16	.09	1	.06	5	.11
Hamadan	1.46	6	.45	4	-.05	18	.01	9	.03	8	.02
Ardebil	1.44	7	.29	8	.02	13	.04	5	.03	9	.07
West Azarbayejan	1.44	8	.54	2	-.18	29	.01	10	.07	3	.00
Khorasan-e-Razavi	1.34	9	.38	5	-.03	17	.07	2	.01	12	-.08
Kohgiluyeh and Boyer-Ahmad	1.26	10	-.16	20	.40	1	-.02	22	.02	10	.01
Kermanshah	1.23	11	.01	14	.12	6	.02	7	-.03	23	.11
Zanjan	1.21	12	.34	6	-.08	21	-.02	21	-.03	22	.00
East Azarbayejan	1.18	13	.32	7	-.13	25	.02	8	-.01	19	-.02
Qazvin	1.08	14	.22	12	-.06	19	-.01	20	-.01	18	-.06
Gilan	1.06	15	-.10	15	.07	9	.05	4	-.03	21	.06
Ilam	.98	16	-.12	16	.23	4	-.07	31	.00	14	-.07
Hormozgan	.89	17	-.23	23	.03	12	-.04	28	.05	6	.08
Fars	.88	18	-.13	19	.04	10	-.03	25	.00	16	.01
Khuzestan	.85	19	-.24	24	.01	14	.01	13	.02	11	.05
Chahar Mahaal and Bakhtiari	.84	20	-.12	17	.03	11	-.05	29	-.04	25	.02
South Khorasan	.80	21	-.13	18	.09	8	-.03	27	-.06	28	-.07
Qom	.79	22	.03	13	-.15	26	.00	17	-.05	27	-.04
Kerman	.66	23	-.16	21	-.11	24	-.02	23	-.04	24	-.01
Mazandaran	.57	24	-.27	25	-.11	23	.03	6	-.05	26	-.03
Markazi	.57	25	-.35	27	-.10	22	.00	16	.07	4	-.05
Alborz	.47	26	-.20	22	-.22	30	.00	15	-.08	30	-.04
Semnan	.33	27	-.51	28	-.06	20	-.03	24	.01	13	-.08
Tehran	.32	28	-.31	26	-.25	31	.01	14	.00	17	-.13
Bushehr	.29	29	-.52	29	-.03	15	-.07	30	-.07	29	-.02
Isfahan	.27	30	-.54	30	-.17	28	-.03	26	-.02	20	.03
Yazd	.01	31	-.63	31	-.17	27	-.01	19	-.10	31	-.07

development in Iran has predominantly been urban-centered, leaving rural communities less developed historically (26).

Another notable aspect is that a significant portion of the population in these provinces belongs to ethnic, religious, and linguistic minorities, reflecting the unequal distribution of power and wealth in Iran and indicating their social exclusion and marginalization (27).

To better understand the SVI, its results are reviewed and compared with those of other indices measuring related concepts. For instance, Zamankhani et al (22) developed and assessed a Social Health Index across Iranian provinces. They found that the highest social health performance was observed in the northwest, central, and

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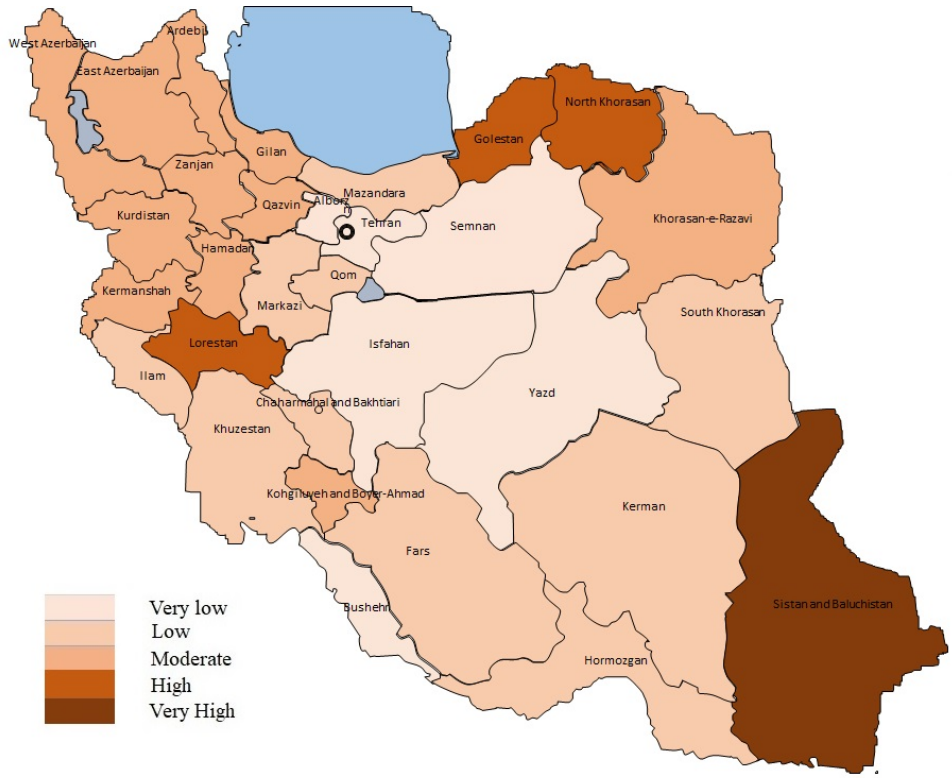

Figure 1. Categories of Iranian provinces, based on the ISVI

eastern regions of Iran. In contrast, the poorest performance was concentrated in the southeast and southern parts of the country. Additionally, Mohaqeqi Kamal et al (20) studied provincial social welfare in Iran. They reported that welfare status in provinces closer to the borders is significantly worse than in provinces located nearer to the country's center and capital.

The ISVI study integrates multiple dimensions, including those emphasized separately by the other 2 studies, thereby providing a more comprehensive assessment of social vulnerability. Behavioral issues (e.g., substance abuse), which are prioritized in social health, receive less emphasis in social welfare but may indirectly affect social vulnerability. Economic and infrastructural factors dominate social welfare but represent only part of the vulnerability picture.

However, provinces such as Tehran and North Khorasan exhibit divergent rankings depending on the indicators used. Tehran scores moderately in social welfare and social health but shows very low social vulnerability, highlighting how indicator selection influences outcomes. Similarly, North Khorasan's medium social welfare status contrasts with its high social vulnerability, suggesting that economic measures alone may not capture the full extent of social challenges.

The development of a social vulnerability index holds particular significance for developing countries in the Global South. This study takes an essential step in this direction by constructing a composite social vulnerability index for Iran's provinces. To ensure the index is well-adapted to the specific social and structural context of Iran, the research draws extensively on the local knowledge and expertise of Iranian specialists. The resulting index encompasses multiple dimensions and indicators, enabling a more nuanced and comprehensive evaluation of the complex concept of social vulnerability.

However, the lack of a comprehensive statistical infrastructure in developing countries, such as Iran, poses practical challenges that exclude many relevant factors from analysis. One significant limitation concerns indicators related to ethnic and religious minorities. Given the diverse and pluralistic nature of Iranian society, this gap is essential. It is crucial to note that demographic variables such as these gain decisive importance primarily when they intersect with the distribution of power and wealth. In this respect, economic indicators, although indirect, can partially capture these underlying dynamics.

Another challenge relates to the provincial scale of vulnerability measurement. While assessing social vulnerability at the provincial level offers a broad national overview, it inevitably sacrifices finer details and insights, such as those at the county level or within rural and urban communities.

Methodologically, relying solely on measurable indica-

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tors also presents limitations. This approach overlooks a vast array of intangible, yet potentially critical, information that can significantly influence social vulnerability. Therefore, integrating qualitative and mixed methods could substantially deepen our understanding and measurement of social vulnerability in Iranian society.

Building and measuring a social vulnerability index for Iran's provinces carries several important policy implications, which are as follows:

Identifying Vulnerable Areas and Groups: The index helps pinpoint provinces with the highest levels of social vulnerability, enabling targeted attention.

Targeted Support Policies and Resource Allocation: With a clearer understanding of social vulnerabilities, government agencies and relevant institutions can design and implement tailored support packages for the most vulnerable provinces.

Improving Emergency Health Response Planning: The index facilitates better anticipation and management of crises such as pandemics, contributing to the development of programs aimed at enhancing social resilience.

Strengthening Data-Driven, Evidence-Based Decision-Making: Establishing and regularly updating vulnerability indices and related databases provides essential infrastructure for policy-making grounded in data, as well as for evaluating policy effectiveness.

Reducing Social and Economic Inequalities: By focusing on vulnerability indicators, policymakers can address disparities in access to welfare, healthcare, and social services, thereby promoting social justice.

Conclusion

Measuring social vulnerability is crucial for developing intelligent, targeted, and equitable policies that address the social determinants of health. A provincial social vulnerability index for Iran can identify at-risk populations and guide more feasible, efficient interventions, particularly in underdeveloped, poor, or marginalized areas.

Although many inequalities stem from entrenched structural and institutional factors that are difficult to change, recognizing and defining them is a critical first step. This understanding supports the creation of informed policies that reduce disparities and strengthen resilience across communities.

Authors' Contributions

Hajeer Mahmoudi Panah: manuscript writing, data collection; Seyed Hossein Mohaqeqi Kamal: study design, data analysis; Mehdi Basakha: data analysis, visualization; Homeira Sajjadi: data interpretation; and Farhad Nosrati Nejad: conceptualization.

Ethical Considerations

This study received approval from the Research Ethics Committee of the University of Social Welfare and Rehabilitation Sciences, Tehran, Iran (IR.USWR.REC.1402.142). In the consultation with experts, the participation was voluntary and anonymous. The data for the indicators used in this study were secondary. Therefore, there was no interaction with human participants.

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Conflict of Interests

The authors declare that they have no competing interests.

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