RESEARCH ARTICLE

Developing environmental health indicators [EHIs] for Iran based on the causal effect model

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Abstract

Background Environmental health monitoring and its effects on health are very important in health systems. Relationship between environment and health can be done by simplifying data in understandable indicators for people and policy-makers. The present study presents the general framework for formulating environmental health quality index for Iran.

Methods This study was implemented through expert panel at two levels: indicator domain determination and domain specific variables selection. Domain specific variables were selected based on the Driving force-Pressure-State-Exposure-Effect-Action (DPSEEA) framework from the list of national and international variables.

Results Seven environmental health issues [air quality, drinking water, sewage disposal, food, radiation management and housing and human settlements] were determined, and three variables were selected for air quality, 8 variables for water quality, 5 variables for sanitation, 1 variable for food quality, 3 variables for housing and human settlements, 4 variables for solid waste management and 3 variables for radiation management.

Conclusions Environmental health indicators determination based on the causal effect model leads to a better understanding of the relationship between the environment and health by simplifying data in an understandable format for public and improves prioritization of policy-making in the environmental health. In this study, environmental health indicators for Iran were proposed.

Keywords Environmental health indicator (EHI) · Air quality · Water quality · Sanitation · Housing · Solid waste management · Radiation management

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Background

An EHI is defined as:

> "An expression of the link between environment and health targeted at an issue of specific policy or management concern and presented in a form facilitating, which facilitates interpretation for effective decision making"

Environmental health indicators can help to monitor environment state and its trends, investigate potential links between health and environmental risk factors and effectiveness of health policies or other interventions [1].

In 1992, principles of Rio Declaration and Agenda 21 were adopted by world's leaders and Human health was highlighted as a central aspect of sustainable development in the twenty-

first century. The importance of environmental health indicators to translate health and environment data into information for policy-makers motivated WHO researchers to initiate frameworks to organize environmental health information [2].

The concept of environmental health indicators was proposed in the early 1990s after the earth summit was conducted. Development of environmental health indicators resulted from identifying relationships of health and sustainable development [3]. Many efforts have been made to define environmental health indicators, including conceptual framework of the World Health Organization (WHO). This framework was developed based on the Organization for Economic Co-operation and Development (OECD) model [4, 5]. The DPSEEA framework proposed by WHO to formulate environmental health indicators and to monitor environmental health factors [2, 6].

Some countries such as Canada, Mexico, New Zealand, Brazil and the European Union have used DPSEEA framework to develop environmental health indicators. In each country or region, different indicators have been selected or constructed based on the local aspects and priorities [7]. Environmental health indicators selection is related to the social context, health priorities, health service structure, and industrialization level of society. This characteristic makes the formulation of specific indicators of each population inevitable [5, 8, 9].

Various specific indicators are constructed to monitor and evaluate different environmental and health domains such as: climate change and health indicators [10, 11], environmental health information system design [12, 13], outdoor air pollution indicators [14] indoor air pollution [15, 16], environmental health indicators for sustainable development [17–19], indicators for drinking water, sanitation and hygiene [20, 21], system dynamic model for the environmental performance index [22], children's environmental health indicators [23–26], environmental public health indicators [27–29] and tracking environmental public health issues [30–33].

In Iran, some indicators have existed for monitoring health and evaluating environmental health activities and assessing impact of environmental issues on the public health [34–36]. In the environment domain, the DPSIRO framework [Drivers, Pressure, State, Impact, Responses and Outlook] are considered for reporting the state of the environment at the national level [37].

Current environmental health indicators in Iran are action-based and have not been formulated based on a causal effect framework [38]. This study was conducted to propose specific environmental health indicators based on the casual framework and considering the health system in Iran. This new approach can improve assessment of the environmental health issues and provide information to improve environmental conditions.

Material and methods

Step1: To focus on measurement and target settings for EHI to select an appropriate framework, a chronological review of tools and frameworks was presented; this review suggested that there was no single appropriate measure for Iran within the current frameworks.

Step2: Indicator domains were discussed based on the local conditions. After extensive discussion, the experts agreed on seven domains for this measurement tool.

Step3: The existing guidelines and frameworks on the development of indicators for environmental health were reviewed, and domain specific variables were selected after extensive discussion in meetings.

Indicator framework

In this study, different indicator frameworks such as OECD models [39–41], DPSEEA framework [2, 7, 42], environmental performance indicator approach [19, 43, 44], environmental quality index [EQI] for the United States [5, 45], environmental health indicators for New Zealand [8, 46] and environmental health indicators for the European Region [29, 47, 48] were investigated. A list of the frameworks was prepared, and their aim, approach and methodologies were discussed in expert panels and interviews with individual experts.

In this study, the DPSEEA framework that is considered a casual model was selected as the conceptual basis for developing the proposed indicators (Fig. 1). The indicator domain was determined based on national, regional and international indicators, existing proposed models and health system structure. Proposed issues in the WHO documents and other countries were listed and discussed in expert panels.

Domain of the indicator

Seven issues (air quality, drinking water quality, sanitation, food quality, waste management, human settlements and radiation management) were determined for indicator domain based on health priority issues and social context.

Specific indicators

Specific indicators for each domain proposed based on WHO core set indicators [49], environmental quality index [5, 45], environmental performance index [44, 50, 51], environmental health indicators from some countries and regions such as New Zealand and European region [8, 29, 47], and national health equality indicators and environmental health indicators [34, 52] through focused group discussions for each issue.
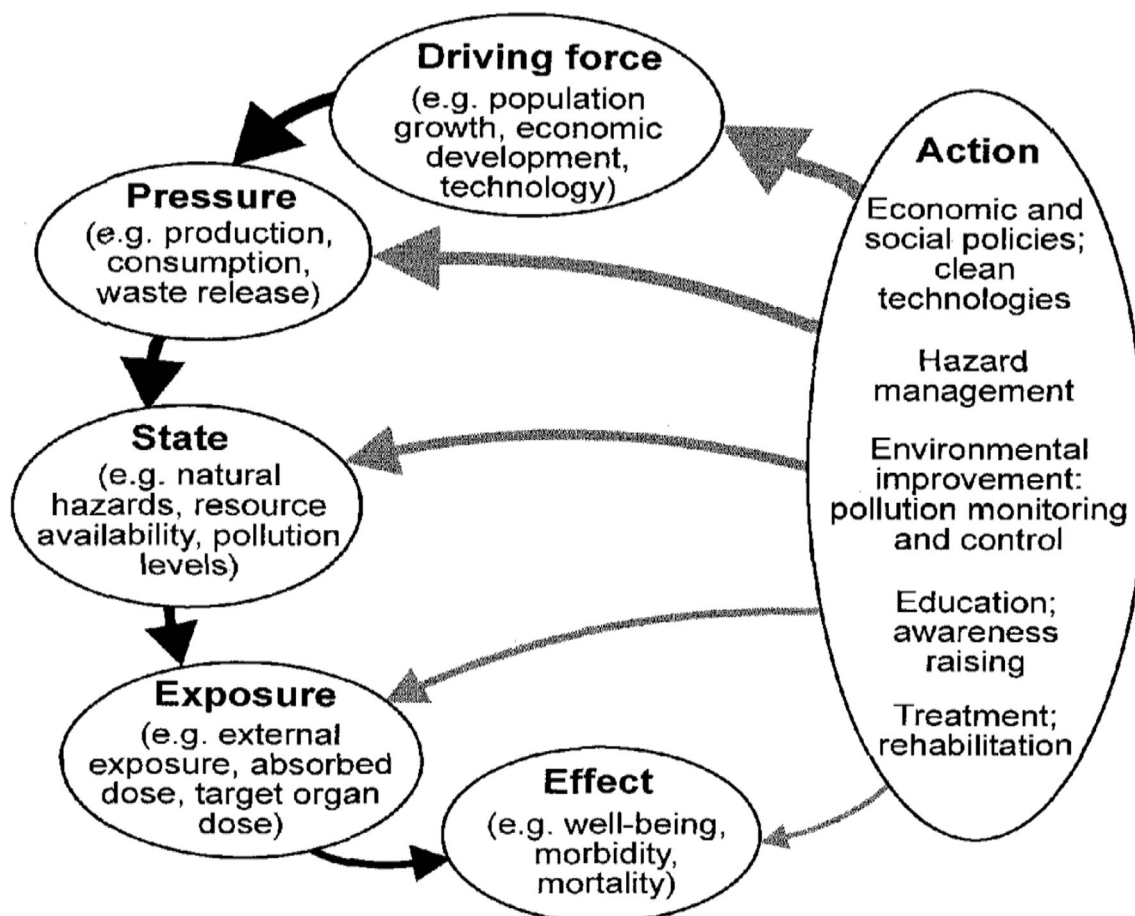
Fig. 1 Simplified diagram for the health and environment cause-effect framework [3]

Geographic level of indicators

Environmental health indicators are completely affected by geographical conditions [6]. Indicators should be measurable in local scales [23, 52–54]. Since this study is the first specific study for developing environmental health indicators in the causal effect method, in the first step, the provincial scale was determined to define the geographical disaggregation. However, this index on county scale may also be calculated.

Data source

One of the important steps for constructing an indicator is appropriate data availability [55]. On the other hand, some environmental risk factors do not have a long record history [49]. Considering the two above-mentioned constraints, indicators were usually formulated based on the existing datasets. In this study, the indicators were proposed based on available datasets, and some variables were also proposed for calculating the significant important indicators lacking recorded data.

Results

EHIs provide information on exposures, health outcomes and policy actions related to the environment and health priorities [12]. Literature reviews show that the frameworks, issues and indicators at subnational levels are different from those noted by the WHO. Each regional or country project chose the path most suited to its specific circumstances such as burden of disease, data availability and health systems structure [26].

In this study, seven issues, including drinking water quality, air quality, sanitation, food quality, solid waste management, radiation management and human settlement were selected for the indicator domain. Furthermore, specific indicators were selected for each domain based on the DPSEEA model from existing national indicators and proposed variables of international organizations via expert panels. Health relevance, data availability, scientific soundness and credibility, and indicator applicability were considered.

Air quality

Air pollution is one of the most serious problems worldwide and can cause long-term and short-term health effects in

countries with any socio-economic characteristic [56]. air pollution is considered the cause of 5.5 million premature deaths [57]. It is also one of the most important effective risk factors for health [58].air pollution is a major cause of death and disease globally, so this issue was seen in all environmental monitoring variables [5, 51, 57].

In the air quality domain, distance traveled per type of transportation system per person and the fuel consumed per type of fuel in the transportation system were selected as the driving force indicator; the emission of air pollutants was selected as the pressure indicator; concentration of criteria pollutants in the outdoor air based on population exposure was selected as the exposure indicator, and the death caused by respiratory diseases at all ages and the death caused by cardiovascular diseases at all ages were selected as the effect indicators.

Drinking water quality

Although access to safe drinking water has increased in recent years, it is one of the main goals of sustainable development [59]; this issue is still considered an important health indicator [5, 24, 51, 57, 60–62].

In this domain, indicators of chemical quality violation of drinking and recreational water and microbial quality violation of drinking and recreational water from the standard values were selected as the state indicators. In this regard, access to safe drinking water in accordance with national standards, access to safe drinking water and access to public water supply were selected as the exposure indicator and the number of outbreaks of waterborne diseases and outbreak of diarrheal disease among children and deaths caused by diarrhea in children were selected as the effect indicators.

Sanitation

Insufficient treatment and unsafe wastewater disposal are one of the main causes of waterborne diseases such as intestinal diseases [51]. Improvement of safe wastewater disposal was not as expected, and it is still considered one of the goals of sustainable development [61].

In this issue, wastewater treatment coverage and access to sanitary toilets were selected as exposure indicators, and its annual increase was selected as the action indicator. Risk of environmental exposure with non-sanitary sewage disposal was selected as the effect indicator.

Food quality

Foodborne diseases are among the important environmental factors; however, the cost of consuming unsafe food and burden of the foodborne diseases are not still clear [63]. Therefore, it is necessary to select an indicator to assess the effect of consuming unsafe food on health.

Human settlements

Human settlements are various, and their structural features affect the human health [5]. In most of the existing indicators, the variables depending on housing and human settlements can be found due to the effective relationship with the public health [5, 7, 24, 44, 50, 51].

In this issue, the population living in non-standard housing was selected as the exposure indicator, and death of children below 5 years old from domestic accidents and poisoning was selected as the effect indicator.

Solid waste management

Solid waste variables can be observed in most of the environmental health indicators [5, 7, 24, 50, 51]. In this study, contaminated lands with hazardous waste were selected as the state indicator, blood lead levels in children was selected as the exposure indicator, and hazardous waste management and urban waste management policies were selected as action indicators.

Radiation

Exposure to ionizing and non-ionizing radiations has been considered in formulating some environmental health indicators [1, 14].

In this study, the ultraviolet radiation was selected as the exposure indicator, incidence of skin cancer was selected as the effect indicator and valid licensing of radiation centers was selected as the action indicator.

Discussion

After initializing and conceptualizing by WHO, EHIs have been developed and used in different countries and regions [7]. In the U.S., the first National Environmental Public Health Tracking Network (EPHT) was developed based on DPSEEA framework. This network combine health and environment data and provide easily understandable information for decision-makers [15, 30]. Tracking program was established by centers for disease control and prevention (CDC) to integrate information from health and environmental data that would drive actions to improve the health of communities [15]. Tracking Program continues to support consistent use of its data and to help inform public health actions [33].

The Canadian Institute of Child Health as a partner of the WHO in a trilateral team from Canada, Mexico and U.S. prepared a feasibility study to develop children environmental health indicators (CEHI). This study proposed the DPSEEA framework as a starting point to develop CEHIs [4]. This

study and other studies initiated by the WHO in Africa, Europe and Eastern Mediterranean regions to develop CEHIs, improve assessment and provide data to inform policy-makers and measure effectiveness of policies and programs for children environmental health [26, 64].

New Zealand' ministry of health commissioned with The Institute of Environmental Science and Research (ESR) to develop environmental health indicators for New Zealand (EHINZ) in 2001. The study team concluded that the core set indicators initialized by the WHO had most applicability to New Zealand and were proposed to adopt this approach and further development was conducted based on such a model [8]. In further studies, four environmental health issues [water, quality, air quality, road and transport and biosecurity] were proposed mainly since these issues were highlighted in several surveys [46]. EHINZ currently covers the following topics: air quality, drinking water, recreational water, indoor environment, UV exposure, hazardous substances, border health, climate change and transport. The webpages were updated by the Centre for Public Health Research at Massey University [65].

In Europe, environmental health indicators were selected based on DPSEEA framework to provide information on exposures, health outcomes and policy actions related to the environment and health priorities [12] and they were presented in an interactive Environment and Health Information System [ENHIS] database [66]. EHIs was also used for the public health assessment, environmental impact assessment, environmental health programs evaluation, health policy and public awareness [1, 2, 7, 8, 10, 14, 47].

Indicator development related to social context as well as different implementing approaches, the management of environmental factors on health. So variable selecting for indicator components is different in various countries. Because these indicators are usually selected based on priority issues and available or required data [2, 5, 11, 24, 25, 36, 38, 53, 67]. The conceptual framework can explain environmental factors with human health linkage systematically through a significant relationship between these two domains. A framework helps us to define priorities and to select reliable and representative variables [18, 42, 65, 68]. The explanation of all relationships between the environment and health is very difficult by a set of indicators. The majority of these relationships and/ or linear dependency to the temporal and spatial variations have not been clarified yet [24].

Numerus documents from Canada [4, 69], the United States [5, 30], New Zealand [8, 46, 67] and European Region [12] were reviewed and after defining priorities, a selection of potential indicators was identified through expert panels and interviews.

In the composite indices, the component weighting represents the importance of variables in comparison to each other, and the statistical methods and expert panels can be used for

weighting [9, 55, 70, 71]. In some indicators, weighing of variables is considered as a ranking criterion [44, 53]. In many works, composite indices constructed with equal weighting and in the next editions, the weight of the index variables is changed [19, 51, 53, 54, 70]. In some approaches such DPSEEA and its relative indicators, weighting and aggregation were not considered [8]. In this study aggregation and weighing of variables were discussed and due to lack of objective observations for the preference issues, were not introduced to indicator formulation.

Conclusion

Indicators are developed mainly for health status measurement, decision-making and health policies assessment. In this study, the DPSEEA framework was a key starting point, which was considered the basis to develop EHIs for Iran. Although this tool was used in some regions and countries as a methodological tool, the output of works is different in scopes, domains and indicators. As a result, the aims, goals and objectives for developing indicators are different in any region or country.

Presentation ways to publish indicators are changing dramatically from books, report, brochure and electronic sources to interactive webpages by academic portals or national and international organizations. Almost all environmental health indicator sets and similar metrics are present in webpages to better communicate with scientists, researchers, policy-makers and particularly for public awareness and engagement. Thus, we proposed to develop an interactive web-based system to present information and indicators.

Compliance with ethical standards

Conflict of interest We declare that we have no conflict of interest.

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