Review

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Environmental disease monitoring by regional Environmental Health Centers in Korea: a narrative review

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This study explores the development, roles, and key initiatives of the Regional Environmental Health Centers in Korea, detailing their evolution through four distinct phases and their impact on environmental health policy and local governance. It chronicles the establishment and transformation of these centers from their inception in May 2007, through four developmental stages. Originally named Environmental Disease Research Centers, they were subsequently renamed Environmental Health Centers following legislative changes. The analysis includes the expansion in the number of centers, the transfer of responsibilities to local governments, and the launch of significant projects such as the Korean Children's Environmental Health Study (Ko-CHENS). During the initial phase (May 2007–February 2009), the 10 centers concentrated on research-driven activities, shifting from a media-centered to a receptor-centered approach. In the second phase, prompted by the enactment of the Environmental Health Act, six additional centers were established, broadening their scope to address national environmental health issues. The third phase introduced Ko-CHENS, a 20-year national cohort project designed to influence environmental health policy by integrating research findings into policy frameworks. The fourth phase marked a decentralization of authority, empowering local governments and redefining the centers' roles to focus on regional environmental health challenges. The Regional Environmental Health Centers have significantly evolved and now play a crucial role in addressing local environmental health issues and supporting local government policies. Their capacity to adapt and respond to region-specific challenges is essential for the effective implementation of environmental health policies, reflecting geographical, socioeconomic, and demographic differences.

Introduction

Background

Industrialization has played a significant role in increasing environmental pollution and the prevalence of diseases associated with hazardous chemicals, profoundly impacting public health, quality of life, and socioeconomic systems. In 1985, South Korea faced a major public health crisis known as the "Onsan Disease" in Onsan-myeon, Ulsan. This incident was triggered by pollutants discharged into the air and water from a nearby metal industrial complex, leading to neuralgia, skin diseases, and systemic pain among 700 local residents, including children. During the 1990s, health issues surfaced among residents living near the Yeosu Yeocheon industrial complex, attributed to unpleasant odors, particulate matter, and toxic gases released by oil refining and fertilizer manufacturing facilities [1].

The 1991 Nakdong River phenol contamination incident, resulting from two illegal discharges in March and April, polluted the middle and downstream sections of the Nakdong River. This event heightened national awareness of environmental issues and prompted substantial changes in environmental policies [2].

Abandoned metal mines, such as the one in Goseong County, Gyeongnam, have been linked to suspected cases of itai-itai disease among nearby residents [3]. Additionally, residents living near cement factories have experienced health impacts, including chronic obstructive pulmonary disease and pneumoconiosis, due to exposure to dust. These incidents exemplify the public health damages caused by environmental pollution during the industrialization process [4]. Furthermore, the production, processing, and use of various chemical substances have led to significant environmental issues. There is increasing evidence that these environmental

exposures negatively impact biologically vulnerable populations, such as infants and children. Specifically, these exposures can affect respiratory and pulmonary functions [5,6], growth and development [7], neurocognitive development [8–11], and renal function [12].

Per- and polyfluoroalkyl substances were detected in 99% of participants in the National Environmental Health Survey [13]. Higher concentrations of harmful substances in adults were associated with the use of personal hygiene products, including cosmetics and hair care items, as well as food storage containers [14,15]. Additionally, children's use of slime or clay was linked to exposure to bisphenol A [16].

Public awareness of environmental issues is increasing, leading to a greater interest in the relationship between the environment and human health. This shift has encouraged the adoption of lifestyles that emphasize sustainability and well-being. In response, the Ministry of Environment, pursuant to Article 26 of the Environmental Health Act [17], has operated Environmental Health Centers since 2007. These centers aim to proactively manage health risks linked to environmental hazards.

Objectives

This study explores the evolution of Environmental Health Centers over time and assesses the roles and significance of the current Regional Environmental Health Centers by evaluating their status and functions.

Evolution of Environmental Health Centers in Korea

Phase 1: Environmental Disease Research Centers (May 2007–February 2009)

Phase 1 marked the establishment of Environmental Disease Research Centers following the formulation of the 10-Year Comprehensive Environmental Health Plan in 2006 and the drafting of the Environmental Health Act [18]. This stage represented a shift from the traditional media-centered approach, which focused on air, water, waste, and soil, to a receptor-centered approach that emphasized the impacts of environmental pollution on humans and ecosystems. Ten centers were designated in total: eight focused on environmental diseases, one on hazardous factors, and one on asbestos [19].

In 2007, three specialized research centers were established: the Asthma Research Center at Korea University Anam Hospital, the Atopic Dermatitis Research Center at Samsung Medical Center, and the Pediatric Developmental Disorders Research Center at Dankook University Medical Center. These centers focused on identifying vulnerable populations, investigating environmental factors influencing asthma, and exploring the links between environmental exposure and pediatric developmental disorders.

In 2008, six additional centers were established to focus on congenital disorders, allergic diseases, pediatric cancers, and asbestos-related diseases. Notable initiatives included monitoring and public health interventions in areas impacted by environmental pollution, such as the oil spill in Taean [20]. By 2009, the Asbestos Pulmonary Disease Research Center at Soonchunhyang University Cheonan Hospital had been designated to study asbestos-related diseases.

This phase was pivotal in changing the paradigm surrounding environmental issues and enhancing public awareness of environmental diseases. However, its emphasis on research faced difficulties in effectively communicating findings to the public and translating them into actionable policies [21].

Phase 2: Environmental Health Centers (March 2009–2015)

The second phase commenced with the enactment of the Environmental Health Act in 2009, which led to the renaming of the centers as Environmental Health Centers. This phase signaled a nationwide expansion to 16 centers, including nine disease-focused centers, five centers concentrating on hazardous factors, and two centers specifically addressing asbestos-related issues.

The six new centers are each dedicated to a specific area of research: Ulsan University Hospital focuses on atopic diseases, Yonsei University Wonju Campus investigates natural radon exposure, Gangwon National University Hospital explores respiratory diseases, Dong-A University studies heavy metal exposure, Soonchunhyang University Gumi Hospital examines harmful gas exposure, and Asan Medical Center researches hazardous chemicals.

During this phase, the Environmental Health Centers played a critical role in addressing emerging environmental health issues and generating diverse research outcomes.

Phase 3: Environmental Health Centers with National Cohort Projects (2015–2019)

Phase 3 introduced the Korean Children's Environmental Health Study (Ko-CHENS) [22], a 20-year national cohort project aimed at examining the effects of environmental hazards on growth, development, allergies, and emotional health from fetal to adolescent stages. Between 2015 and 2020, approximately 70,000 pregnant women enrolled in the study, with follow-up assessments planned until their children reach the age of 16.

Environmental Health Centers engaged in various cohort-related activities, including conducting environmental surveys, collecting biological samples, assessing growth and neurocognitive development, and monitoring indoor air quality. Throughout this phase, the centers strategically shifted their focus, contributing to the development of comprehensive environmental health policies through evidence-based research.

Phase 4: Regional Environmental Health Centers (2020–Present)

The Fourth Comprehensive Environmental Health Plan (2020) highlighted the importance of a "community-centered environmental health foundation" [23]. This shift transferred responsibilities from the central government to local governments, thereby strengthening the legal framework for regional environmental health planning, health impact assessments, and governance.

Regional Environmental Health Centers are now focused on developing local environmental health systems, addressing issues specific to each region, managing regional governance, and delivering tailored environmental health services. By integrating local characteristics into their policies, these centers strive to improve community well-being and promote sustainable development.

In addition to the Regional Environmental Health Centers, four Policy Environmental Health Centers have been established to support the development and implementation of environmental health policies. These centers specialize in different areas of expertise and are divided into four distinct categories. The Environmental Big Data Center, managed by the Korea Environment Institute, is dedicated to developing an integrated environmental health information system. It focuses on monitoring environmental factors and using advanced data analysis techniques to predict health impacts. The Environmental Toxicology Center, situated at Soonchunhyang University Gumi Hospital, aims to create a comprehensive database of chemical information related to bioactive ingredients found in consumer products. This center also plays a

crucial role in enhancing public education and outreach concerning toxic substances.

The Environmental Health Research Information Center, managed by Seokyeong University, consolidates environmental health research into a centralized database. It performs literature reviews and generates reports on both domestic and international environmental health issues and research trends, offering valuable insights for policymakers and researchers. The Health Big Data Center, located at Wonju Severance Christian Hospital, leverages data from the National Health Insurance Service to produce detailed statistics on environmental diseases. The work of this center enhances our understanding of the connections between environmental factors and public health, aiding in evidence-based decision-making. Together, these centers provide essential infrastructure and expertise that bolster environmental health policies and research in Korea.

To cultivate environmental health professionals, the Department of Preventive Medicine at Catholic University, University of Seoul, Inha University Hospital, and the Korean Society of Environmental Health are actively training experts in preventive medicine, toxicology, occupational and environmental medicine, and environmental health sciences.

Status and role of regional Environmental Health Centers

Current status

As of December 2024, 14 Regional Environmental Health Centers are operational across South Korea, located in Gangwon, Chungnam, Seoul, Incheon, Daejeon, Ulsan, Busan, Chungbuk, Jeju, Jeonbuk, Gyeongnam, Gyeonggi, Gyeongbuk, and Jeonnam (Table 1) [24]. These centers are hosted by leading institutions, including Kangwon National University Hospital in Gangwon, Ajou University in Gyeonggi, Gyeongsang National University in Gyeongnam, Dongguk University in Gyeongbuk, and Seoul National University College of Medicine in Seoul, among others (Fig. 1).

Personnel structure

The Ministry of Environment mandates that organizations eligible to operate Regional Environmental Health Centers must possess the capability to conduct research and surveys, as well as provide policy support related to environmental health information [25]. Eligible organizations include national or public research institutions, universities, and public or private hospitals located within the specified region.

Each center is comprised of a director, a secretariat head, and administrative staff. The director is generally an expert in disciplines pertinent to the center's goals, while the secretariat head is usually a specialist with a background in environmental health, either academic or professional. Currently, the directors are predominantly physicians and professors with expertise in preventive medicine, occupational and environmental medicine, and respiratory medicine. Secretariat heads, on the other hand, often hold doctoral degrees in fields such as preventive medicine, public health, or environmental engineering, reflecting the center's focus. As of 2024, the 14 Regional Environmental Health Centers employ approximately 200 personnel, including both full-time and part-time staff. The staffing at each center varies, ranging from as many as 30 to as few as 5 members, based on the center's size and operational scope.

Funding

The financial support for Regional Environmental Health Centers is equally divided between the Ministry of Environment and local governments, with each contributing 50%. Starting in 2024, each center will operate with an annual budget of approximately 600 million KRW, which

Table 1. Current status of regional Environmental Health Centers (as of December 2024)

No.	Designated area	Host institution	Operating period	Project focus
1	Gangwon	Kangwon National University Hospital	`20.01.01–`24.12.31	Establishing an environmental health foundation for the Gangwon region
2	Chungnam	Soonchunhyang University Cheonan Hospital	`21.01.04–`24.12.31	Establishing an environmental health foundation for the Chungnam region
3	Seoul	Seoul National University College of Medicine	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Seoul region
4	Incheon	Gachon University	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Incheon region
5	Daejeon	Daejeon University	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Daejeon region
6	Ulsan	Ulsan University Hospital	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Ulsan region
7	Busan	Dong-A University	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Busan region
8	Chungbuk	Chungbuk National University Hospital	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Chungbuk region
9	Jeju	Jeju National University	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Jeju region
10	Jeonbuk	Jeonbuk National University	`23.04.01–`27.12.31	Establishing an environmental health foundation for the Jeonbuk region
11	Gyeongnam	Gyeongsang National University	`23.04.01–`27.12.31	Establishing an environmental health foundation for the Gyeongnam region
12	Gyeonggi	Ajou University	`24.03.20–`28.12.31	Establishing an environmental health foundation for the Gyeonggi region
13	Gyeongbuk	Dongguk University (WISE Campus)	`24.03.20–`28.12.31	Establishing an environmental health foundation for the Gyeongbuk region
14	Jeonnam	Chonnam National University Hospital, Hwasun	`24.03.20–`28.12.31	Establishing an environmental health foundation for the Jeonnam region

is split evenly between the Ministry of Environment and local governments, each providing 300 million KRW.

Major activities

The primary activities of the Regional Environmental Health Centers are outlined in Table 2.

Establishing a preliminary monitoring system

Centers are responsible for investigating and monitoring environmental diseases and hazardous factors. Their activities include assessing and monitoring exposure in vulnerable areas, as well as using biological samples (e.g., blood and urine) to evaluate region-specific exposures.

Building a regional environmental health foundation

While the authority and responsibility for environmental health have been transferred to local governments, many still lack the necessary human and systemic resources for effective implementation. The centers are vital in supporting local governments to carry out environmental health policies. They assist in developing regional environmental health plans, establishing collaborative governance structures, conducting regional health impact assessments, and

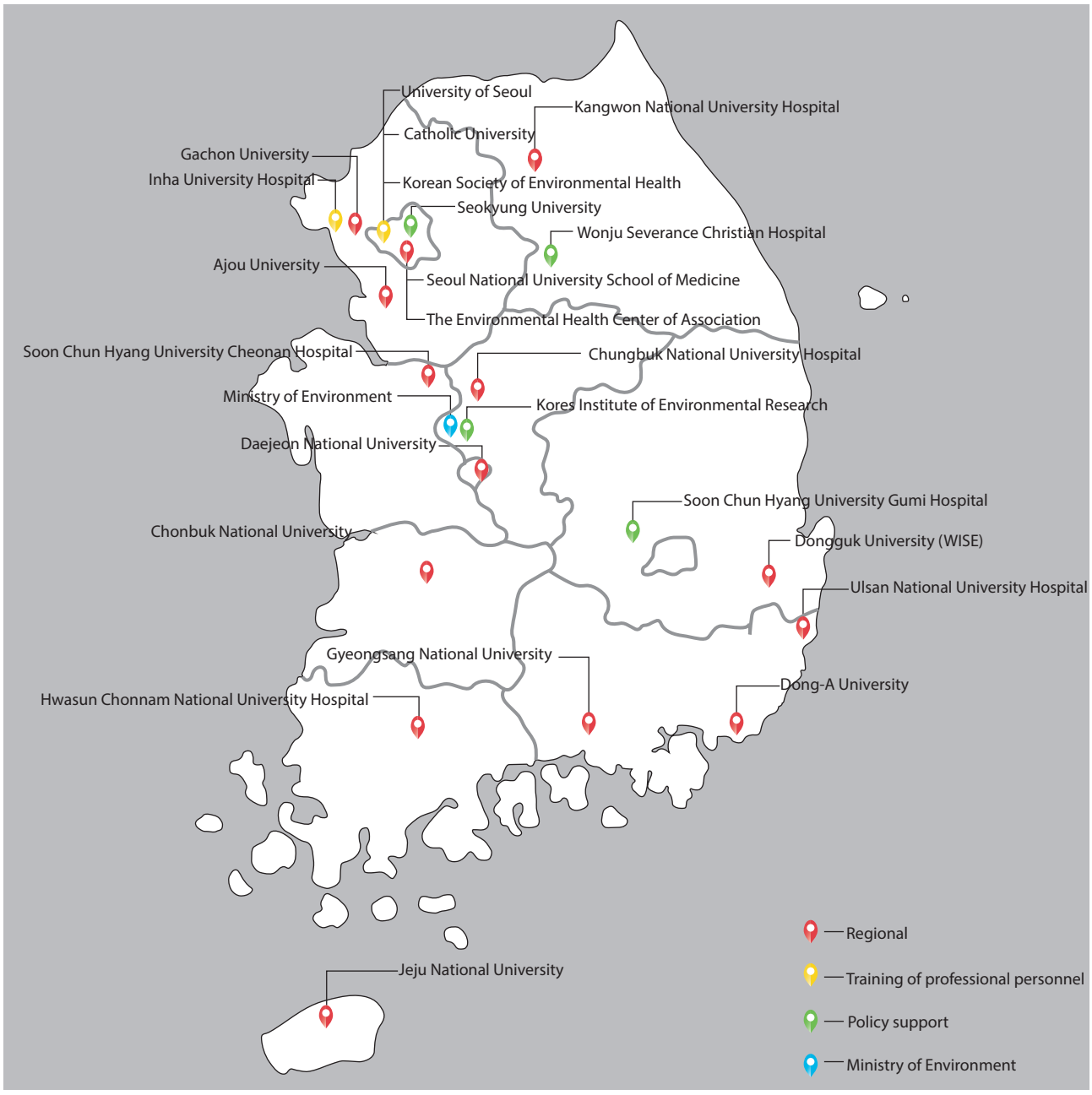

Fig. 1. Current landscape of Environmental Health Centers in Korea.

building big data systems for environmental health. This support provides the scientific evidence needed for local policymaking.

Facilitating risk communication

Centers increase public awareness of environmental health by providing information to local residents, offering tailored education programs for sensitive populations, conducting environmental health camps, and disseminating information online. These efforts help to raise public consciousness about environmental health.

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Table 2. Activities of regional Environmental Health Centers

Category	Detailed activities
Establishing preliminary monitoring systems	- Investigation and monitoring of environmental diseases and hazardous factors - Exposure and health monitoring in environmentally vulnerable areas - Chemical exposure assessment using biological samples (e.g., blood or urine) by region
Strengthening regional environmental health systems	- Supporting the development of regional environmental health policies - Establishing collaborative governance for environmental health - Supporting health impact assessments and petition handling - Building regional environmental health big data - Conducting expert forums and related initiatives to strengthen the regional environmental health foundation
Developing regional risk communication systems	- Establishing and operating environmental health information delivery systems - Hosting environmental health camps for residents on local environmental health issues - Conducting environmental health communication activities (e.g., Environmental Health Open Concerts, newsletters)
Collaboration in key research projects of the Ministry of Environment	- Conducting health impact studies in environmentally vulnerable areas - Participating in the Ko-CHENS - Supporting investigations and assessments related to humidifier disinfectants - Conducting preventive initiatives for vulnerable groups with environmental diseases - Health support projects in health impact assessment areas
Other activities	- Supporting the Environmental Health Integrated Information System - Conducting research, investigations, or providing consultations, as stipulated in the Environmental Health Act or as requested by the Minister of Environment or local governments

Supporting research and investigations

Centers support health impact assessments in environmentally vulnerable areas and support projects like the Children's Environmental Health Birth Cohort Study.

Other activities

Centers are responsible for managing the Environmental Health Integrated Information System, which was established by the Ministry of Environment. They also conduct research, investigations, and consultations as required by the Environmental Health Act or as requested by the Minister of Environment and local governments.

Key achievements [26]

Establishment of a preliminary monitoring system for environmental hazards

- Health impact surveys supported vulnerable populations, with 2,776 individuals completing questionnaires and 2,893 undergoing clinical examinations.
- For environmental hazard monitoring, 34 internet of things–based air quality monitoring stations were established, and a database of 10,788 entries was developed.

Strengthening regional environmental health systems

- Identifying regional environmental health issues and supporting the development of environmental health plans.
- Article 6-2 of the Environmental Health Act mandates that mayors and governors formulate regional environmental health plans considering local characteristics. Centers in Seoul, Jeju, and Gangwon have supported the formulation and implementation of these plans for respective local governments.

Strengthening governance for environmental health systems

- Projects were initiated to strengthen governance by facilitating local environmental health petitions and supporting risk communication during health impact assessments, as specified in Article 17 of the Environmental Health Act. For example, the Ulsan Center carried out health impact assessments and improved communication for residents living near an asphalt concrete plant. Additionally, governance structures were reinforced by disseminating information about regional environmental health conditions and policy trends, and by exploring solutions to local challenges.

Advancing risk communication in environmental health

- Efforts include establishing cooperative frameworks with relevant institutions to efficiently address environmental health issues.
  The "Mobile Environmental School" initiative was launched in collaboration with environmental disease prevention centers to provide elementary students with education and activities focused on the climate crisis and disease prevention. In 2023, this program reached 1,159 students across 55 classes in 24 schools, including those in underserved island regions, thereby ensuring equitable access to environmental health education.
- An environmental health concert was held to address citizens' concerns about environmental health through a series of online and offline lectures, complemented by real-time Q&A sessions. In 2023, the event comprised five sessions, which were attended by 1,474 participants, thereby increasing public awareness.

Hosting international symposia on environmental health

- Centers collaborated with domestic and international experts to host symposia, fostering knowledge-sharing and networking. For example, in 2024, the Seoul Center co-hosted two symposia with WHO ACE, focusing on "Environmental Health Indicators for Climate Change." These events shared global and local case studies and identified actionable points for Seoul.

Health Sharing Camps and support programs

- Health Sharing Camps were organized to serve individuals with environmental diseases and vulnerable populations, offering educational and ecological experiences. In 2023, a total of 27 camps were conducted, engaging 1,097 participants in collaboration with the National Park Service.
- The Vulnerable Population Support Program offered medical and prescription cost assistance to 118 individuals with environmental diseases.

Participation in the National Children's Environmental Health Birth Cohort Study

- Since 2015, various centers have been involved in a long-term cohort project aimed at investigating the health impacts of environmental factors from pregnancy through adolescence. As of 2023, follow-up studies have been conducted for 2,223 children.

Conclusion

The role of Environmental Health Centers has evolved significantly over time. Initially established as Environmental Disease Research Centers with a focus on research-oriented activities, their responsibilities have now expanded to include education, public outreach, and

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risk communication with citizens. This transition reflects a shift from a centrally driven model to one where local governments are supported in developing and implementing environmental health policies, as well as in identifying and addressing region-specific issues.

Currently, 14 Environmental Health Centers are operational, and the Ministry of Environment intends to increase this number. Addressing environmental health challenges necessitates tailored solutions that consider the geographical, environmental, socioeconomic, and demographic characteristics specific to each region. In this context, the Regional Environmental Health Centers function as specialized institutions that assist in developing and implementing localized environmental health policies.

Moreover, these centers play an important role in promoting governance by facilitating discussions among local governments, experts, and residents to address regional environmental issues. They serve as communication hubs, responding to the growing public need for information on environmental health and offering services focused on citizen well-being. As primary contacts for local environmental health matters, these centers aim to boost public involvement and provide concrete benefits to communities, in line with the increasing awareness and expectations of citizens about the relationship between the environment and health.

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