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Original Article

From Climate Concerns to Health Equity: Local Government Priorities for Smart Healthy Cities in South Korea

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Abstract

Background: Smart healthy cities seek to integrate digital technologies with health-promoting environments to address urban health inequities. South Korea combines rapid urbanisation, population ageing, and advanced digital infrastructure, yet little is known about how local government health officials—key frontline implementers—prioritise health equity within smart healthy city agendas.

Methods: During the 2023 Korea Healthy Cities Conference, we conducted a real-time Mentimeter survey with local government health officials from 72 municipalities. Participants answered three sequential open-ended questions on (Q1) current healthy city challenges, (Q2) challenges better addressed through "smart" approaches, and (Q3) future priority values for Korean smart healthy cities. Free-text responses were coded into 43 indicators nested within 16 themes, mapped onto the six agendas of the World Health Organization (WHO) Copenhagen Consensus "6P" framework (People, Place, Participation, Prosperity, Peace, Planet). Aggregated counts were analysed using contingency tables, chi-square tests, correspondence analysis, and agenda-level (ie, across the six 6P categories) profile correlations.

Results: We analysed 482 coded mentions. For current challenges (Q1), responses centred on Planet (25.9%) and Participation (27.6%). For smart city–solvable challenges (Q2) and future priority values (Q3), distributions shifted markedly towards People: 23.0% (Q1), 41.4% (Q2), and 46.6% (Q3), while Planet and Participation declined. Agenda distributions differed significantly across the three questions ($\chi^2[10] = 79.50$, $P < .001$; Cramer's V = 0.29), and People-centred profiles for Q2 and Q3 were highly similar ($r = 0.86$, $P = .028$). Digital and health literacy, vulnerable populations, and service integration remained under-represented throughout.

Conclusion: Korean local government health officials increasingly frame smart healthy cities as vehicles for advancing health equity rather than as primarily environmental or technology-driven projects. However, persistent neglect of literacy, vulnerable groups, and service integration signals a gap between equity aspirations and implementation that equity-oriented digital governance and inclusive design must address.

Keywords: Smart Healthy Cities, Health Equity, Urban Health, Local Government, Republic of Korea, Mentimeter

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Background

Health equity has become a central concern in global urban health, as cities concentrate both health-promoting resources and structural determinants of inequality.[1,2] Rapid urbanisation, population ageing, and climate change are reshaping patterns of exposure and vulnerability, while digital technologies are transforming how health information and services are produced, governed, and accessed.[3-5] Against this backdrop, "smart healthy cities" have been proposed as a way to integrate technological innovation with the long-standing Healthy Cities movement, with the promise of reducing health inequities through better data, targeted interventions, and more responsive local governance.[6,7] Yet the equity implications of smart city agendas remain contested: digital infrastructures and data-driven interventions can mitigate but also reproduce or worsen existing social and spatial gradients in health.[8,9]

South Korea offers a salient context in which to examine these tensions. Over 80% of the population lives in urban areas,[3] generating high demand for housing, transport, and health and social care in dense metropolitan settings.[4,10] The country is also one of the fastest-ageing societies in the world, with growing needs for chronic disease management, long-term care, and age-friendly environments.[4] At the same time, Korea has world-leading digital infrastructure and has actively promoted smart city projects, including smart transport, environmental monitoring, and digital public services.[10,11] These assets create substantial opportunities for equity-oriented urban health interventions, but they also raise concerns about digital divides, selective uptake of services, and fragmented governance of health-relevant data.[7,9,10]

Within this landscape, Healthy City initiatives have expanded rapidly. As of 2024, 104 municipalities participate in the Korean Healthy Cities Network, with programmes typically

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Key Messages

Implications for policy makers

- Local government health officials in Korea already understand smart healthy cities primarily as tools to advance health equity rather than as purely technological or environmental projects. National policies and funding programmes should explicitly build on this equity-oriented framing.
- The strong alignment between perceived "smart city–solvable" challenges and future priority values suggests that once practitioners reflect on the potential of digital tools, their long-term visions converge around people-centred agendas. Policy frameworks can therefore use such exercises to co-produce realistic, equity-focused smart city roadmaps with local officials.
- Despite high digital infrastructure, digital literacy, health literacy, vulnerable populations (children, youth, persons with disabilities), and service integration remain blind spots in current planning. Smart city strategies should include targeted investments and incentives in these areas to prevent widening inequities.
- Using the World Health Organization (WHO) Copenhagen Consensus "6P" framework (People, Place, Participation, Prosperity, Peace, Planet) to structure local planning can help ensure that environmental, economic, and participatory agendas are systematically assessed for their equity impacts, keeping planetary sustainability and health equity as mutually reinforcing rather than competing priorities.
- Real-time interactive tools such as Mentimeter can be incorporated into national healthy city programmes as low-cost mechanisms to rapidly capture practitioner priorities, monitor shifts over time, and feed local experience back into policy design.

Implications for the public

As cities become "smarter," there is a risk that new technologies will mainly benefit people who are already better off. Our study shows that local government health officials in Korea increasingly want smart healthy cities to focus on health equity – making sure that everyone, not only the most connected or affluent residents, can benefit from digital services and healthier environments. At the same time, important issues such as digital and health literacy, the needs of children, youth, and persons with disabilities, and better coordination of services are still not receiving enough attention. For the public, this means that there is an opportunity to demand smart city projects that put fairness, access, and care at the centre – and to ask whether new technologies are really helping reduce health gaps in their own communities.

coordinated by local public health centres.[12,13] Previous studies have documented variability in resources, evaluation criteria, and intersectoral collaboration across Korean Healthy Cities, as well as enduring gaps between national policy rhetoric and local implementation capacity.[2,12-14] The transition from Healthy Cities to smart healthy cities is therefore not only a technological challenge but also a governance and equity challenge: It raises questions about who defines smart healthy city goals, which populations and determinants are prioritised, and how digital tools are deployed in ways that narrow rather than widen health inequities.[7,8]

Local government health officials occupy a pivotal position in this transition. They sit at the interface between national strategies, municipal politics, and frontline implementation, and they make day-to-day decisions about programmes, partnerships, and investments that shape urban health trajectories.[14] However, while there is a growing literature on the technical potential of smart cities and on citizen-level preferences, including equity-focused reviews of smart city and high-tech interventions targeting health,[7,8,15] the perspectives of these implementers remain under-examined, particularly in high-income settings with advanced digital infrastructures such as Korea. In particular, we know little about how local officials prioritise health equity relative to environmental, technological, and economic agendas when they are asked to envision smart healthy cities.[7,8,14]

Before proceeding, we clarify the two core concepts that structure this study. In this study, we use the term *Healthy City* in the sense proposed by Hancock and Duhl[1] as a city that continually creates and improves its physical and social environments and expands community resources so that residents can mutually support each other in performing all the functions of life and developing to their maximum potential. Building on this tradition, we define a *Smart Healthy City* as a multidimensional urban model that integrates digital technologies, data analytics, and sensor-based infrastructure into health-promoting urban environments across four interconnected dimensions—healthy environments, smart networks, social sustainability, and health empowerment—oriented toward three core objectives: health equity, smart connectivity, and system-level resilience.[16]

To operationalise these concepts and situate practitioners' priorities within an internationally recognised equity framework, we draw on the World Health Organization's (WHO's) Copenhagen Consensus of Mayors, which articulates six interrelated agendas for Healthy Cities: People, Place, Participation, Prosperity, Peace, Planet (the "6P" framework; see Table 1 in the Methods section).[17] The framework explicitly positions people and equity at the centre of healthy city development, while recognising that urban environments, governance processes, and ecological sustainability are tightly interconnected.[2,17] Using this framework, we classify local officials' views on smart healthy cities and examine how their emphasis on different 6P agendas changes as they move from current challenges to imagined smart city applications and, finally, to future value priorities.

In this study, we present findings from a real-time interactive survey conducted with local government health officials during the 2023 Korea Healthy Cities Conference. Using Mentimeter, a web-based audience response platform,[18,19] we elicited open-ended responses to three sequential questions designed to capture temporal shifts in priorities: current healthy city challenges (Q1), challenges perceived as better addressed through "smart" approaches (Q2), and future priority values for Korean smart healthy cities (Q3). Free-text responses were coded into indicators, themes, and 6P agendas following established qualitative and mixed methods approaches,[20,21] and then analysed using

chi-square tests, correspondence analysis, and agenda-level profile correlations.

The study addresses the following research questions:

- *RQ1 (current challenges):* How do local government health officials in Korea describe the most urgent Healthy City challenges, and to what extent are these framed in terms of health equity?
- *RQ2 (smart city potential):* Which challenges do officials believe could be more effectively addressed through smart healthy city approaches, and how does this shift the balance across 6P agendas?
- *RQ3 (future priority values):* What priority values should guide the future development of Korean smart healthy cities, and how closely do these future visions align with officials' understanding of smart city potential?

By focusing on practitioners' own formulations of smart healthy city priorities, our study contributes to the emerging literature on equity-oriented smart urban governance and offers empirical insights that may be relevant for other cities seeking to align smart city investments with global health equity goals.[2,7,8]

Methods

The overview of the data collection and analysis workflow is presented in Figure 1, and the detailed survey procedure is shown in Figure S1 (See Supplementary file 1).

Study Design

This study employed an exploratory, cross-sectional survey using open-ended questions to elicit local government health practitioners' perspectives on smart healthy city priorities in Korea. Free-text responses were treated as qualitative data and analysed using a qualitative descriptive approach to derive codes, themes, and agendas.[20] These categories were then quantified and examined using cross-tabulations and chi-square–based pattern analyses as part of an exploratory mixed methods design that integrates qualitative coding with subsequent quantitative analysis.[21]

Participants and Setting

The target population comprised local government health practitioners involved in healthy city initiatives across Korea. Using purposive sampling, we recruited participants from attendees of the 2023 Korea Healthy Cities Conference held in Suncheon on September 15, 2023.[12] The conference brought together 283 representatives from 72 local governments, including 1 special city (Seoul), 4 metropolitan cities, 2 special self-governing provinces, and 6 provinces (Supplementary file 1, Table S1).

Data Collection Approach

We utilised Mentimeter, a web-based audience response system (ARS) accessed by participants through personal mobile devices via a QR code displayed on screen.[18,19] The platform enables real-time collection of open-ended and structured responses and immediate visualisation of aggregated results to the whole audience as each entry is submitted. Although ARS technologies first emerged in educational contexts, they have been established for more than two decades as a data collection method in organisational, health, and community-based research,[22,23] particularly well suited to addressing low response rates, incomplete responses, and restricted access to specific institutional settings in applied research with professional audiences[22]—all pertinent to research with busy municipal health officials convened at a national conference.[18,19]

Methodologically, ARS-based open-ended elicitation occupies a space between conventional silent surveys and consensus-oriented group methods such as the Nominal Group Technique,[24,25] Delphi processes,[24] and focus group discussions,[26] which share a commitment to treating collectively generated and refined expressions of opinion as a legitimate object of inquiry. Accordingly, our aim in using this approach was not to estimate independent individual preferences, but to characterise how a professional

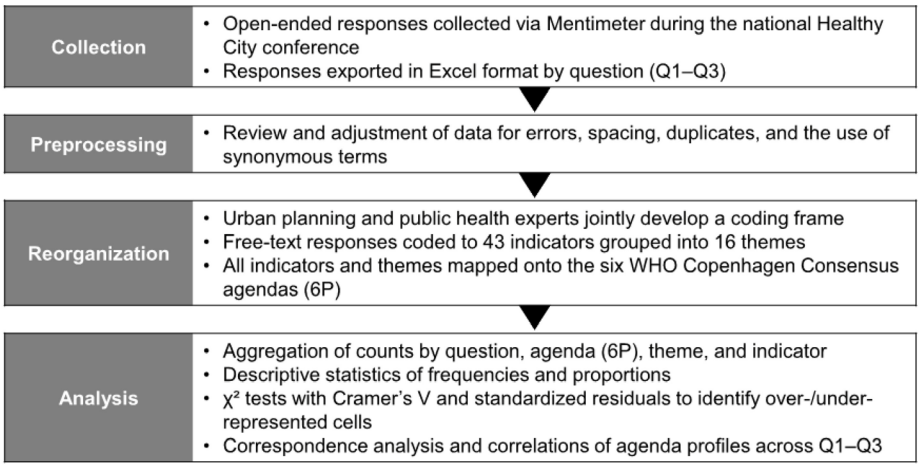


Figure 1. Workflow From Mentimeter Data Collection to Coding and Quantitative Analysis. Abbreviation: WHO, World Health Organization. *Note*: Open-ended responses were collected via Mentimeter during the national Healthy City conference, preprocessed to remove errors and harmonise synonymous terms, coded into 43 indicators grouped into 16 themes and mapped onto the WHO Copenhagen 6P agendas, and then analysed using aggregated counts, χ^2 tests with Cramer's V and standardised residuals, correspondence analysis, and agenda-level correlation analyses. Abbreviation: 6P, People, Place, Participation, Prosperity, Peace, Planet.

community—municipal officials assembled at the 2023 Korea Healthy Cities Conference—collectively frames and reframes smart healthy city priorities across the three sequential questions.

Survey Instrument

The survey consisted of three sequential open-ended questions (Q1–Q3), corresponding to RQ1–RQ3 and administered in a single plenary session: (Q1) urgent tasks that healthy cities should address in Korean society, (Q2) tasks that could be better solved through "smart" healthy city approaches, and (Q3) priority values that Korean smart healthy cities should pursue. These questions were developed based on literature review and expert consultation in urban health, but were not formally piloted with local government health officials prior to the conference session.

Data Analysis

Analytical Framework

Our analysis was structured using the WHO's Copenhagen Consensus of Mayors framework, which defines six interrelated agendas for healthy cities: People, Place, Participation, Prosperity, Peace, and Planet[17] (Table 1).

Coding Structure: Agendas, Themes, and Indicators

Responses were organised within a three-level hierarchical coding structure. At the most granular level, we identified 43 *indicators*, representing specific topics or keywords that appeared in the free-text responses. Closely related indicators were grouped into 16 *themes*, representing mid-level conceptual categories, and each theme was in turn mapped onto one of the six WHO Copenhagen 6P *agendas*, which form the top-level categories. Indicators are thus nested within themes, and themes are nested within agendas. An interdisciplinary team comprising three researchers with backgrounds in urban architecture and public health independently coded the responses, and categories were finalised through collaborative discussion and consensus-building. The full coding hierarchy, including all 43 indicators, their parent themes, and the corresponding 6P agendas, is provided in Table S2.

Statistical Analysis

Statistical analyses were conducted using Stata version 19 (StataCorp LLC, College Station, TX, USA). Because the Mentimeter survey platform did not capture individual identifiers, the dataset was structured as aggregated counts by question (Q1–Q3), 6P agenda (n = 6), theme (n = 16), and indicator (n = 43). Where appropriate, frequency weights were applied so that each cell reflected the number of mentions for that question. For all inferential tests, two-sided P values < .05 were considered statistically significant.

We first examined the overall distribution of coded responses across questions and agendas. A 3 (question: Q1–Q3) × 6 (agenda) contingency table was constructed, and Pearson's χ^2 statistics were calculated with Cramer's V as a measure of association strength. To visualise distributional patterns—that is, changes in the relative proportion of responses assigned to each agenda—in the joint distribution of questions and agendas, we applied correspondence analysis on this table and inspected the first two dimensions in a biplot.

To summarise agenda-level patterns for each question separately, we calculated the proportion of responses in each 6P category and report 95% confidence intervals (CIs) using exact binomial methods. These agenda-level distributions were used to describe current challenges (Q1), smart city potential (Q2), and future values (Q3). To quantify the similarity of 6P profiles across questions, the six 6P proportions for each question were treated as a profile vector (a six-element vector of agenda proportions summing to 1.0), and Pearson correlation coefficients were computed for all three pairwise comparisons (Q1 vs. Q2, Q1 vs. Q3, Q2 vs. Q3). Because each profile vector contained only six observations, these correlations are interpreted descriptively as indicators of

Table 1. An Overview of the Copenhagen Consensus of Mayors, WHO, 2018

Agenda	Contents	Explanations
People	Investment in people	Healthy cities prioritise people in social development by focusing on and investing in individuals, enhancing equity and inclusiveness through capacity building
Place	Urban space design for health and well-being	Healthy cities create environments where social, physical, and cultural settings are harmonised to foster active inclusion and promote health and well-being for all
Participation	Expanding participation and partnerships for health and well-being	A Healthy City ensures that individuals and communities are involved in decisions that impact their living, learning, working, loving, and recreational spaces
Prosperity	Enhancing community prosperity and access to public goods and services	Healthy cities promote community prosperity and strengthen assets through value-based governance of public goods and services
Peace	Promoting peace and security through inclusive societies	Healthy cities enhance peace through inclusive societies focused on place, participation, prosperity, and the planet, placing people at the centre of all policies and actions
Planet	Protecting the planet from degradation including through sustainable consumption and production	Healthy cities protect the planet from degradation by promoting sustainable consumption and production, safeguarding ecosystems, and mitigating climate change for current and future generations

Abbreviations: WHO, World Health Organization; 6P, People, Place, Participation, Prosperity, Peace, Planet.
Note: This table presents the foundational framework used to categorise and analyse survey responses. The framework consists of six key agendas – People, Place, Participation, Prosperity, Peace, Planet – that guide healthy city development.

profile similarity rather than as formal inferential tests.

At the theme (n = 16) and indicator (n = 43) levels, we constructed 3×16 and 3×43 contingency tables of question by category. For each table we obtained Pearson's χ^2 and Cramer's V to assess whether the distribution of responses across questions differed by theme or indicator. To identify specific categories that were over- or under-represented in particular questions, we calculated standardised residuals as the difference between observed and expected cell counts divided by the square root of the expected count; cells with absolute values of 1.96 or greater were treated as notably over- (positive) or under-represented (negative). Because the 3×16 and 3×43 tables contain many cells that are difficult to summarise through omnibus statistics alone, our in-text reporting focuses primarily on the 3×6 agenda-level table, with theme- and indicator-level residuals reported only for cells exhibiting the most substantive differences; agenda-level residuals and correspondence-analysis outputs are provided in Tables S4-S6, and full theme- and indicator-level residuals are provided in Tables S8 and S9.

Because the study relies on a non-probability, conference-based sample with aggregated responses, all analyses are interpreted as exploratory. We did not apply formal multiple-comparison corrections at the cell level; instead, omnibus χ^2 and Cramer's V are used to document overall distributional patterns, while standardised residuals highlight cells of substantive interest.

Using this common set of coded data and contingency tables, we then addressed each research question in turn. For current challenges (RQ1), we focused on the distribution of agendas, themes, and indicators in responses to Q1 and used exact binomial CIs to characterise the most frequently cited items. For challenges perceived as best addressed through smart healthy city approaches (RQ2), we compared the agenda distribution for Q2 with that for Q1 within the same χ^2 framework to assess whether smart city–potential tasks exhibited a different priority structure. For future priority values (RQ3), we examined the agenda and indicator distributions for Q3 and interpreted them in light of the correspondence analysis results to characterise the change in the "centre of gravity" of priorities across questions. Finally, to evaluate the alignment between perceived smart city potential and future values, we calculated Pearson correlation coefficients between the 6P distributions for smart city–potential tasks (Q2) and future priority values (Q3). We additionally examined pairwise correlations among the agenda distributions in Q1–Q3 as a descriptive check of question-level profile similarity.

Results

Overall Distribution, Distributional Patterns, and Agenda-Level Residuals

Sample Characteristics and Response Patterns

As described in the section above, the 2023 Korea Healthy Cities Conference brought together 283 local government health officials from 72 municipal governments across Korea (Table S1). The Mentimeter exercise was administered during a plenary session on the second day of the conference. Using the total number of registered conference participants (N = 283) as a conservative denominator, 86, 75, and 79 officials submitted at least one response to Q1, Q2, and Q3, corresponding to minimum response proportions of 30.4%, 26.5%, and 27.9%, respectively (Table S3). Because participants could enter multiple keywords per question, the number of raw text entries exceeded the number of respondents (171, 156, and 146 responses for Q1–Q3). After preprocessing (including removal of blank entries and splitting multi-topic responses into separate units), we analysed 174, 162, and 146 processed responses for Q1–Q3, respectively, yielding a total of 482 coded mentions used in the agenda-, theme-, and indicator-level analyses. The full cross-tabulation of agendas, themes, and indicators across questions, together with the omnibus chi-square tests and Cramer's V statistics, is provided in Table S2.

Overall Differences in 6P Agendas Across Questions

Across the three questions, we observed substantial differences in how participants distributed their responses across the six

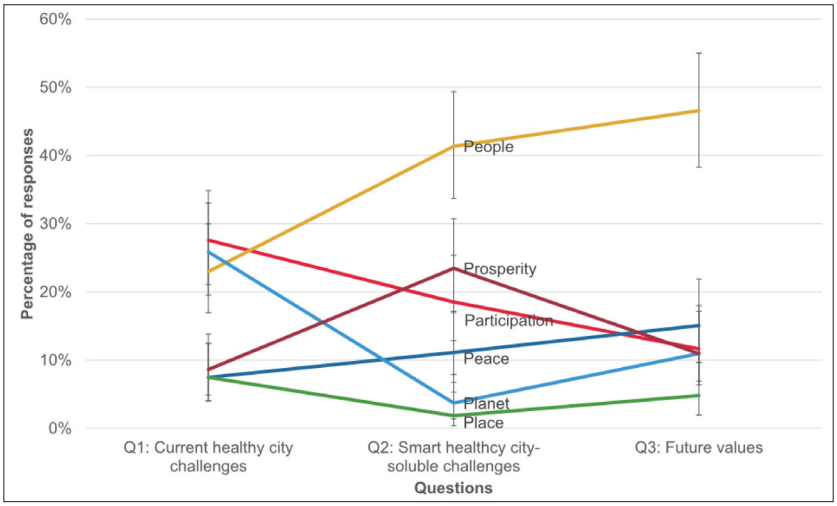


Figure 2. Agenda Profiles Across Questions (Q1–Q3) With 95% Confidence Intervals. Note: Points and lines show the percentage of responses assigned to each WHO Copenhagen 6P agenda for current challenges (Q1), smart city–solvable challenges (Q2), and future smart healthy city values (Q3). Vertical bars indicate 95% exact binomial confidence intervals. The figure illustrates the trajectory of change for each agenda across questions, complementing the row proportions reported in Table 2.

Table 2. Distribution of Responses Across WHO Copenhagen 6P Agendas by Question (Q1–Q3)

Questions	Statistic	Participation	Peace	People	Place	Planet	Prosperity	Total
Q1: Current challenges	Observed n	48.00	13.00	40.00	13.00	45.00	15.00	174.00
	Expected n	34.30	19.10	63.20	8.30	24.20	24.90	174.00
	Row %	27.59	7.47	22.99	7.47	25.86	8.62	100.00
Q2: Smart city potential	Observed n	30.00	18.00	67.00	3.00	6.00	38.00	162.00
	Expected n	31.90	17.80	58.80	7.70	22.50	23.20	162.00
	Row %	18.52	11.11	41.36	1.85	3.70	23.46	100.00
Q3: Future priority values	Observed n	17.00	22.00	68.00	7.00	16.00	16.00	146.00
	Expected n	28.80	16.10	53.00	7.00	20.30	20.90	146.00
	Row %	11.64	15.07	46.58	4.79	10.96	10.96	100.00
Total	Observed n	95.00	53.00	175.00	23.00	67.00	69.00	482.00
	Expected n	95.00	53.00	175.00	23.00	67.00	69.00	482.00
	Row %	19.71	11.00	36.31	4.77	13.90	14.32	100.00

Abbreviations: WHO, World Health Organization; 6P, People, Place, Participation, Prosperity, Peace, Planet.
Note: For each question, "Observed n" shows the observed number of responses, "Expected n" shows the expected number of responses under the null hypothesis of independence, and "Row %" shows the percentage within each question. Pearson $\chi^2(10) = 79.498$; $P < .001$.

WHO Copenhagen Consensus agendas (Figure 2, Table 2). The 3×6 question-by-agenda contingency table was strongly non-uniform (Pearson $\chi^2[10] = 79.50$, $P < .001$; Cramer's $V = 0.29$; total $N = 482$), indicating meaningful reordering of priorities between Q1, Q2, and Q3.

At the agenda level, Participation and Planet were over-represented in Q1 and then declined, whereas People and, to a lesser extent, Prosperity became more prominent in Q2 and Q3 (Table S4). Standardised residuals from the 3×6 table showed that Participation (Q1 $z = 2.34$; Q3 $z = -2.20$) and Planet (Q1 $z = 4.23$; Q2 $z = -3.48$) were significantly over-represented in Q1 and then under-represented in subsequent questions. In contrast, People was under-represented in Q1 ($z = -2.92$) and over-represented in Q3 ($z = 2.06$), while Prosperity was under-represented in Q1 ($z = -1.99$) and over-represented in Q2 ($z = 3.08$). Peace and Place showed smaller deviations from expectation across questions (Table S4).

Correspondence Analysis of Agenda Profiles

Correspondence analysis of the same 3×6 table further clarified these distributional patterns. The first two dimensions captured all of the inertia (total inertia = 0.165), with Dimension 1 explaining 82.2% and Dimension 2 explaining 17.8%. On Dimension 1, Q1 was positioned on the positive side (coord = 0.79) together with Planet and Participation, whereas Q3 was located on the negative side (coord = -0.29) closer to People and Peace. Dimension 2 mainly separated Prosperity and Participation (positive) from Peace and Place (negative). This pattern indicates a trajectory from an initial emphasis on environmental and participatory agendas (Planet/Participation) toward an equity- and people-centred profile (People/Peace/Prosperity) over the course of the exercise (Figure 3, Tables S5, S6a, and S6b).

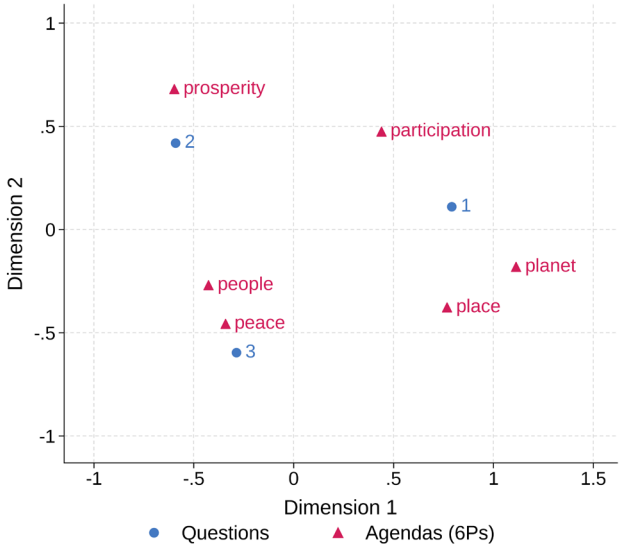
Similarity of Agenda Profiles Across Questions

Treating the six 6P proportions for each question as a profile vector, the correlation between Q2 and Q3 agenda distributions was high ($r = 0.86$, $P = .028$), whereas Q1 showed only modest and non-significant correlations with Q2 ($r = 0.26$, $P = .61$) and Q3 ($r = 0.34$, $P = .51$). These results suggest that participants' views of smart city–solvable challenges (Q2) and future priority values (Q3) were closely aligned, but both differed from the pattern observed for current challenges (Q1) (Table S7).

RQ1–RQ3: Agenda-Level Distributions by Question

RQ1 – Current Challenges (Q1)

When describing current healthy city challenges (Q1), respondents emphasised environmental and participatory agendas. Planet accounted for 25.9% of Q1 responses (45/174; 95% CI: 19.5–33.0), with "Actions on climate change" and



Coordinates in symmetric normalization

Figure 3. Correspondence Analysis Biplot of Questions (Q1–Q3) and WHO Copenhagen 6P Agendas. Abbreviations: WHO, World Health Organization; 6P, People, Place, Participation, Prosperity, Peace, Planet. *Note*: The first two dimensions capture the main structure of the 3×6 contingency table, positioning Q1 with Planet and Participation and Q3 closer to People and Peace, indicating a shift from environmental and participatory agendas toward a more people- and equity-centred profile.

"health-promoting environment" among the most frequently cited indicators. Participation also featured strongly (27.6%, 48/174; 95% CI: 21.1–34.9), reflecting concerns about collaborative governance, engagement, and partnership processes. People represented 23.0% of responses (40/174; 95% CI: 17.0–30.0), while Peace, Place, and Prosperity each remained below 10%, indicating that immediate concerns were framed more around environmental risk and participatory processes than around people-centred equity agendas.

RQ2 – Smart City Potential (Q2)

For smart city–solvable challenges (Q2), the agenda profile shifted markedly toward People and Prosperity. People increased to 41.4% of Q2 responses (67/162; 95% CI: 33.7–49.4), and Prosperity rose to 23.5% (38/162; 95% CI: 17.2–30.7), whereas Planet and Place declined to 3.7% (6/162; 95% CI: 1.4–7.9) and 1.9% (3/162; 95% CI: 0.4–5.3), respectively. Equity-related themes and indicators (eg, "Improving equity," "Health equity") became more prominent in this question, suggesting that participants perceived digital and data-driven tools as especially useful for tackling social gradients in health and improving resource allocation rather than primarily addressing environmental exposures.

RQ3 – Future Priority Values (Q3)

In future-oriented responses (Q3), the People agenda became even more dominant, accounting for 46.6% of all Q3 responses (68/146; 95% CI: 38.3–55.0). Peace emerged as the second most frequently selected agenda (15.1%, 22/146; 95% CI: 9.7–21.9), while Planet and Prosperity each accounted for 11.0% (16/146; 95% CI: 6.4–17.2). Participation decreased to 11.6% (17/146; 95% CI: 6.9–18.0), and Place remained below 5% (4.8%, 7/146; 95% CI: 1.9–9.6). The prominence of People in Q3, combined with the high correlation between Q2 and Q3 profiles, indicates that participants' long-term visions for smart healthy cities are strongly equity-centred and closely tied to how they understand the potential of smart city tools.

Under- and Over-Represented Areas at Theme and Indicator Level

Theme-Level Differences (n = 16)

At the theme level, the 3×16 contingency table showed significant heterogeneity across questions (Pearson $\chi^2(30) = 121.4$, $P < .001$; Cramer's $V = 0.36$). To keep the presentation interpretable, we report only those themes whose standardised residuals reached $|z| \geq 1.96$ in at least one question; the full residual matrix is provided in Table S8. "Improving equity" was strongly under-represented in Q1 ($z = -3.40$) and over-represented in Q3 ($z = 2.87$), mirroring the aggregate shift toward the People agenda. "Actions on climate change" was over-represented in Q1 ($z = 4.07$) and under-represented in Q2 ($z = -2.90$), highlighting the declining emphasis on environmental themes once smart city tools and future priorities were considered. "Investment in information technology" was notably over-represented in Q2 ($z = 2.88$), while "Stable administrative foundations," "Sustainable and ethical development strategies," and "Social justice and implementation of inclusive societies" each showed significant over- or under-representation in a single question, indicating more localised shifts in governance and justice-related concerns.

Indicator-Level Differences (n = 43)

At the indicator level, the 3×43 table likewise indicated substantial redistribution across questions (Pearson $\chi^2[84] = 211.9$, $P < .001$; Cramer's $V = 0.47$). As with the theme-level analysis, we restrict in-text reporting to indicators with $|z| \geq 1.96$ in at least one question; the complete residual matrix is provided in Table S9. Seven indicators met this threshold. "Health equity" (People) was strongly under-represented in Q1 ($z = -3.94$) and over-represented in Q3 ($z = 3.04$), reinforcing the pattern seen at the People/Improving equity theme level. In contrast, "Climate change" (Planet) was over-represented in Q1 ($z = 3.75$) and under-represented in Q2 ($z = -2.88$). "Care" (People) shifted from under-representation in Q1 ($z = -2.08$) to over-representation in Q2 ($z = 3.47$), while "Improvement of health levels" (People) and "Data collection" (Prosperity) were over-represented in Q3 and Q2, respectively. Finally, "Ethics" (Peace) and "Effective program operation" (Participation) showed isolated over- or under-representation in Q3, suggesting more specific concerns about ethical frameworks and programme management in future-oriented responses.

Overall, these theme- and indicator-level residual patterns support the agenda-level findings: participants moved from an initial focus on climate and environment to a more pronounced emphasis on equity, care, and data-enabled governance when thinking about smart healthy cities and future values. At the same time, several equity-critical areas remained consistently under-represented across all three questions: digital literacy (1 (0.6%), 0 (0.0%), 2 (1.4%) responses in Q1, Q2, Q3 respectively), health literacy (1 (0.6%), 0 (0.0%), 0 (0.0%)), children and youth (1 (0.6%), 0 (0.0%), 0 (0.0%)), disability (2 (1.1%), 0 (0.0%), 0 (0.0%)), and service integration (3 (1.7%), 3 (1.9%), 1 (0.7%)) (Table S2, Panel A).

Discussion

Our study reveals three key findings about how Korean health practitioners envision the transition from traditional healthy cities to smart healthy cities: a marked shift from environmental to equity priorities, a strong convergence between perceived smart city potential and future priority values around people-centred agendas, and the identification of critical gaps in current planning frameworks. Together, these findings extend existing work on smart cities and health equity by shifting attention from technical solutions and citizen-level preferences to the priorities of local government practitioners who shape smart healthy city agendas in practice.[7-9]

Transition in Priorities: From Environment to Equity

The evolution in priorities across the three questions represents our most substantively important finding, supported by robust statistical evidence. While climate change dominates current concerns (21.8% of responses to Q1), health equity

emerges as both the primary perceived benefit of smart city approaches (24.7% in Q2) and the leading priority value for the future (46.6% in Q3). The prominence of climate change as an immediate concern aligns with global urban health trends and reflects growing awareness of climate impacts on urban health, including heat-related illnesses and changing disease patterns.[5] At the same time, the relative diminution of climate change in future-oriented responses (declining to 7.5% for the "climate change" indicator in Q3), together with the over-representation of Planet in Q1 and its subsequent under-representation in Q2, suggests that practitioners view technological solutions as necessary but insufficient for addressing environmental challenges.[27] Instead, they increasingly conceptualise smart city technologies as tools for addressing systemic inequities that underlie both environmental and health vulnerabilities.[7,8,14]

This pattern warrants careful interpretation. Two plausible readings coexist and are likely complementary. First, local government health officials may reasonably perceive smart city tools as more directly deployable for addressing health inequities – a domain over which they have greater jurisdictional reach through public health centres, welfare programmes, and service delivery platforms – than for mitigating global environmental risks, which typically require supra-local coordination and longer policy time horizons. Viewed this way, the Q2–Q3 shift reflects a realistic appraisal of what smart healthy city technologies can plausibly contribute to municipal practice, rather than a dismissal of environmental concerns as such. Second, however, this prioritisation carries an important risk: if environmental determinants of health—including air pollution, extreme heat, flood exposure, and ecological degradation—recede from the envisioned scope of smart healthy cities, they may also receive insufficient attention in subsequent planning, investment, and evaluation efforts. We therefore do not interpret our findings as evidence that climate change is becoming less relevant for urban health; rather, we suggest that smart healthy city frameworks should explicitly integrate climate resilience and environmental health alongside equity-oriented digital interventions, so that the People and Planet agendas reinforce rather than displace one another.[5,27] This imperative is not new: a commitment to environmental sustainability has been intrinsic to the Healthy Cities concept since its inception,[1] and as evidence on planetary boundaries accumulates, the health these cities seek to share more fairly is increasingly understood to rest on ecological foundations extending well beyond municipal borders.[5,28] Given the predominantly local mandates of municipal officials, smart healthy city planning should therefore build explicit mechanisms to connect local action to these global environmental implications, ensuring that officials think globally even as they act locally.

At the agenda level, this pattern is reflected in the trajectory from Planet and Participation toward People and Prosperity. Correspondence analysis positioned Q1 on the same side of the primary dimension as Planet and Participation, while Q3 clustered more closely with People and Peace, indicating a move from environmental risk and participatory processes toward people-centred and equity-oriented agendas over the course of the exercise (Figures 2 and 3). Theme- and indicator-level residuals reinforce this pattern: "Improving equity" and "Health equity" were strongly under-represented in Q1 and over-represented in Q3, whereas "Actions on climate change" showed the opposite pattern, being over-represented in Q1 and under-represented in Q2.

Alignment of Smart City Potential and Future Values

Our analysis also revealed strong alignment between practitioners' views of smart city potential and their priority values for the future. Treating the six 6P proportions for each question as a profile vector, the correlation between Q2 and Q3 agenda distributions was high ($r=0.86$, $P=.028$), whereas Q1 showed only modest and non-significant correlations with Q2 ($r=0.26$, $P=.61$) and Q3 ($r=0.34$, $P=.51$). This pattern suggests that once participants considered which challenges might be addressed through smart healthy city approaches, their visions of future priorities converged around a similar equity-centred profile.

The People agenda illustrates this convergence most clearly: it accounted for 23.0% of responses for current challenges, increased to 41.4% when respondents reflected on smart city–solvable tasks, and reached 46.6% in future priority values. Prosperity followed a similar, though more moderate, trajectory, becoming over-represented in Q2 and remaining an important component in Q3. These findings indicate that practitioners' understanding of smart city capabilities is closely linked to how they imagine the future direction of smart healthy city development, rather than being a separate or purely technical consideration. Read through the lens of the group-deliberative data collection approach described in the Methods, this alignment reflects a shared framing that emerged as the practitioner community collectively worked through what smart healthy cities could and should be, rather than the aggregation of independent individual views.

Critical Gaps and Future Challenges

The analysis also revealed several critical areas receiving insufficient attention in current smart healthy city planning. Digital and health literacy emerged as particularly neglected domains, with minimal representation across all three questions.[9,15] This gap raises significant concerns about potential barriers to equitable access and effective utilisation of smart city services.[10] The limited consideration of vulnerable populations, including children, youth, and persons with disabilities, highlights risks of perpetuating existing health inequities through technological advancement.[29,30] The relative neglect of service integration and continuity of care likewise raises concerns about the long-term effectiveness of smart city health initiatives.[13]

These gaps, taken together, point to a broader disconnect between technological capability and social implementation.[31] While Korea possesses advanced digital infrastructure,[11] the integration of these technologies with health service delivery remains fragmented,[10] and the silence around literacy, vulnerability, and service integration in our data suggests that these concerns have yet to be fully internalised within the smart healthy city agenda. From an equity perspective, this

blind spot is critical: without explicit attention, smart healthy cities risk reinforcing existing gradients in who can access, navigate, and benefit from new digital infrastructures and urban health investments.[8,9,29]

Methodological Strengths and Limitations

A central methodological feature of our study is that data collection was conducted through Mentimeter as a group-deliberative elicitation tool rather than as a conventional silent survey. Because participants saw their colleagues' responses materialise on a shared screen as they submitted their own, the trajectory from an environmental- and participation-centred profile in Q1 to a people- and equity-centred profile in Q3—and the high correlation between Q2 and Q3 agenda profiles ($r = 0.86$)—is best read as a collectively negotiated reframing of priorities within a practitioner community, rather than as a simple aggregation of private, independent opinions.[22,24] This positioning has three implications for how our results should be read. Our inferences apply at the level of collective framings within a professional community; the specific composition of the 2023 Korea Healthy Cities Conference plenary is part of the data-generating context rather than a nuisance to be adjusted away, so that replications in other settings would be expected to produce different convergent framings; and conventional concerns about response bias from social influence apply less forcefully here than in surveys designed to capture independent individual measurement, though we cannot rule out that later participants were anchored by early-emerging keywords.[32]

The digital nature of the data collection process presents additional complexities. While Mentimeter's anonymity feature likely reduced social desirability bias compared with traditional focus groups,[18] it may have introduced selection bias by excluding less technologically comfortable participants—a consideration particularly relevant here, as comfort with digital tools could correlate with attitudes toward smart city initiatives.[11] Character limits and the simplified interface may also have restricted the expression of more complex perspectives. The three survey questions were developed through literature review and expert consultation but were not formally piloted; although our analytic frame treats the sequential structure of Q1–Q3 as a substantive feature rather than a confound, future studies using piloted and counterbalanced question orders could further separate the contribution of question wording from underlying practitioner priorities.

Our data are based on a non-probability sample attending a single plenary session for which we did not have a separate attendance roster. Using total conference registration ($N = 283$) as a conservative denominator, minimum response proportions were 30.4% (Q1), 26.5% (Q2), and 27.9% (Q3); even accounting for the lower number likely present in the plenary, these approximately 30% response proportions indicate a self-selected subset—plausibly those most engaged with Healthy City activities and most comfortable with digital survey tools—whose views may not generalise to the broader population of Korean local government health officials.[21] Our primary aim, however, was not to estimate population-level prevalences but to characterise relative differences in priorities across questions within this practitioner group. Because the Mentimeter platform did not capture individual identifiers, we were also unable to collect demographic and professional information (educational background, area of specialisation, gender, experience, prior familiarity with Healthy City concepts), which may shape how officials prioritise the 6P agendas; this also precluded formal modelling of within-municipality clustering. Future studies should link open-ended responses to respondent characteristics while preserving the low-barrier, real-time engagement that ARS-style tools afford. Lastly, our analyses relied on aggregated counts and used a small number of agendas ($n = 6$) for profile correlations, so results are interpreted descriptively; we also examine equity at the level of priorities and framings rather than observed differences in health outcomes or service use.[13]

Our findings should also be interpreted in light of the considerable heterogeneity of the participating municipalities. The 72 local governments represented in the conference spanned a wide spectrum of urban settings, including highly urbanised metropolitan districts—notably the 21 autonomous districts of Seoul, which alone accounted for approximately 29% of participating municipalities—together with medium-sized cities, small towns, and rural municipalities experiencing population decline (Table S1). These contexts differ substantially in digital infrastructure, public health workforce capacity, fiscal resources, and demographic profiles, all of which are likely to shape how the 6P agendas are prioritised and operationalised in practice. Our aggregate findings therefore represent a composite picture that may obscure meaningful local variation. For example, climate-related and environmental concerns may be especially salient in municipalities facing severe air pollution or flood risk, while service integration and digital literacy may be most urgent in ageing rural communities with limited workforce capacity. Future research should examine whether the equity-centred framing and the blind spots identified here are equally salient across different city types, and how smart healthy city strategies can be tailored to municipalities with divergent capacities and needs.[12,13]

Policy Implications

The findings suggest several key directions for smart healthy city development. First, technological implementations should prioritise reducing health disparities over pursuing purely efficiency-based gains.[33] City planners and policy-makers must ensure that smart city initiatives explicitly address health inequities, not only by deploying new technologies but also through targeted interventions and equitable resource allocation,[34] within broader smart city policies that remain oriented toward sustainable urban development.[35] Second, comprehensive digital literacy programmes must be developed to ensure equitable access to smart city services.[9] The current lack of emphasis on digital literacy threatens to exacerbate existing health disparities as cities become increasingly digitised.[9] Third, unified health service platforms should be created to connect various healthcare providers and social services, addressing the current fragmentation in service

delivery.[10] Fourth, because environmental determinants of health recede from smart city–specific and future-oriented priorities in our data, explicit mechanisms are needed to keep climate resilience and environmental health on the smart healthy city agenda – for instance, through integrated monitoring platforms that pair environmental sensing with equity-focused service delivery.[5,27]

Conclusion

Our study demonstrates that Korean health practitioners increasingly envision smart healthy cities through an equity lens, prioritising human-centred approaches over purely technological solutions.[2] Across three sequential questions, priorities shifted from an initial focus on environmental concerns—particularly climate change—to a profile in which health equity and people-centred agendas dominate future visions for smart healthy city development. Agenda-, theme-, and indicator-level analyses, together with correspondence analysis and agenda profile correlations, suggest that this transition reflects a coherent reorientation rather than random fluctuation: perceptions of smart city potential (Q2) and future values (Q3) converge strongly around the People agenda, while the salience of Planet and Participation diminishes over the course of the exercise.

At the same time, our findings highlight persistent blind spots. Digital and health literacy, vulnerable populations (including children, youth, and persons with disabilities), and service integration remain systematically under-represented across all three questions, raising concerns that smart healthy city strategies may reproduce or even deepen existing inequities if these gaps are not explicitly addressed. These aspirations must also be reconciled with the municipal heterogeneity of Korean local governments, whose differing capacities and contexts are likely to shape how the 6P agendas are operationalised in practice. As cities worldwide face increasing challenges from urbanisation, climate change, and health inequities, an equity-focused, people-centred approach to smart healthy cities—one that integrates rather than displaces climate and environmental concerns—could inform more inclusive and effective urban health strategies.[6]

Future research should address the critical gaps identified in our study, particularly the limited attention to digital literacy and vulnerable populations. Specifically, research is needed to develop and evaluate digital literacy programmes that can support equitable access to smart city services; design and test frameworks for integrating health and social services within smart city infrastructure; assess the effectiveness of equity-focused smart city initiatives in reducing health disparities; and examine how governance structures can best support the transition from environmental to equity priorities while maintaining service integration. These research directions, guided by our agenda-, theme-, and indicator-level findings, will be crucial for ensuring that smart healthy city development effectively balances technological innovation with social equity goals.

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Disclosure of artificial intelligence (AI) use

Not applicable.

Ethical issues

Ethical approval for this study was obtained from the Institutional Review Board of Korea University [KUIRB-2023-0077-01], and the requirement for written informed consent was waived because participation was anonymous and based on voluntary conference attendance.

Conflicts of interest

Authors declare that they have no conflicts of interest.

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Disclaimer

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Supplementary files

Supplementary file 1 contains Figure S1 and Tables S1-S9.

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