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Regional Medical Resources and Unmet Healthcare Needs: A Multilevel Analysis of Korean Nationwide Data

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ABSTRACT

This research investigated whether the availability of medical resources in one's residential community affects the likelihood of experiencing unmet healthcare needs in South Korea, a nation where population concentration is a growing concern. Two open-access datasets were analyzed: the individual-level Korean Community Health Survey and regional-level Korean medical utilization statistics, comprising 176,378 participants. Because individuals are nested within regions, a multilevel analytical design was adopted, integrating demographic characteristics and health-related variables from the individual level.

Residents of small cities and rural regions that possessed sufficient healthcare resources showed 1.26 times higher odds of unmet healthcare needs compared to those in well-equipped metropolitan areas. The greatest adjusted odds ratio, 1.32, was observed among people living in small cities and rural communities with inadequate medical resources. Stratified analyses indicated the widest income-related gap in unmet healthcare needs in areas with ample resources; individuals with the lowest income were 1.77 times more likely to report unmet needs than those with the highest income. In metropolitan regions, income disparities were similarly evident, with the lowest-income group having an adjusted odds ratio of 1.66. These results indicate that residing in smaller cities or rural regions with poor medical infrastructure—and having a low income even where services are adequate—substantially heightens the risk of unmet healthcare needs. The findings highlight the importance of equitable regional distribution of medical resources and public health policies that prevent socioeconomic obstacles from restricting access to care.

Keywords: Unmet healthcare needs, Medical resource, Regional health disparity, Multi-level model

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Introduction

Unmet healthcare needs describe situations in which individuals require medical services but are unable to obtain them for various reasons. Although not always directly predictive of adverse health outcomes, they reveal hindrances to achieving optimal health and are associated with reduced well-being, preventable illnesses, and avoidable mortality [1].

Such unmet needs can stem from supply-side issues (e.g., insufficient healthcare infrastructure) and demand-side challenges (e.g., financial burdens, limited health literacy, or low awareness of available services) [2]. These barriers often manifest as problems of accessibility (such as high expenses), availability (such as a shortage of nearby providers or transportation), and acceptability (such as long wait times or preferences for particular types of care). Each dimension influences healthcare utilization differently [3, 4].

Two major approaches exist for evaluating unmet healthcare needs: a clinical approach, based on professional standards, and a subjective approach, relying on individuals' perceptions of their own needs and healthcare experiences.

The subjective approach is frequently favored in research because people are uniquely positioned to assess their own health situations and identify gaps in care. While clinical criteria offer objective benchmarks, subjective

assessments may better reveal perceived inadequacies in service delivery and overall well-being. Consequently, this study adopted a subjective measure of unmet healthcare needs [5, 6].

South Korea extended its national health insurance coverage to all residents in 1989, substantially improving access to healthcare services. Enhanced insurance benefits and improvements to the copayment ceiling system further promoted service accessibility [7]. Despite these advances, certain vulnerable groups continue to face unmet needs and receive insufficient medical care [8, 9]. Balancing rising healthcare expenditures with the demand for necessary services remains a persistent challenge.

Unmet healthcare needs are not unique to South Korea. Taiwan, for example, introduced its National Health Insurance (NHI) program in 1995 to provide essential services and reduce financial strain, yet unmet needs remain [10]. South Korea, with 13.2 hospital beds per 10,000 people—far more than Taiwan's 5.7 beds per 10,000—still experiences unmet healthcare needs, implying that countries with fewer beds may face even greater challenges [11]. These observations emphasize the importance of improved resource distribution and ensuring adequate access to care as key global public health priorities. Beyond hospital bed shortages, numerous additional factors—such as geographic variations and limited numbers of physicians, nurses, and specialists relative to population—also contribute to unmet healthcare needs [12, 13].

Previous investigations conducted in South Korea have largely centered on reporting yearly levels or monitoring long-term changes in unmet healthcare needs [14, 15]. The present study, however, moves beyond simply describing these patterns by examining how unmet needs differ across regions. In addition, we seek to draw out the policy implications that emerge from these geographic contrasts. By taking this perspective, the study not only broadens existing scholarship but also offers a deeper look at how issues surrounding unmet care vary from one area to another. Through identifying these regional distinctions, our goal is to provide insights that can guide the development of targeted, region-appropriate policy interventions aimed at reducing unmet healthcare needs across the country.

Materials and Methods

Data and study population

Two open public datasets were employed. The first source was the 2022 Korean Community Health Survey (CHS), administered by the Korea Centers for Disease Control and Prevention. Since 2008, the CHS has annually surveyed adults aged 19 years and older to produce regional health estimates and support local public health planning. Approximately 900 participants were sampled from each of 258 public health centers using region-adjusted sampling techniques, achieving a relative standard error of ± 3 %. Professional fieldworkers carried out one-on-one interviews in selected households, collecting information on 17 health-related domains, including lifestyle behaviors and chronic illness profiles [16].

The second dataset consisted of regional medical utilization statistics publicly released by Statistics Korea, which summarize health-insurance coverage, patterns of medical service use, and the distribution of medical resources across cities, counties, and districts.

From the original 231,785 respondents in the 2022 CHS, individuals younger than 19 years (n = 1290) and those with incomplete data (n = 54,117) were removed, producing a final analytic sample of 176,378 adults. Study reporting follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, and the selection process is depicted in **Figure 1**.

The Institutional Review Board of Gachon University Gil Medical Center approved the study protocol (IRB No. GFIRB2024-133). Because all data were anonymized, the requirement for informed consent was waived.

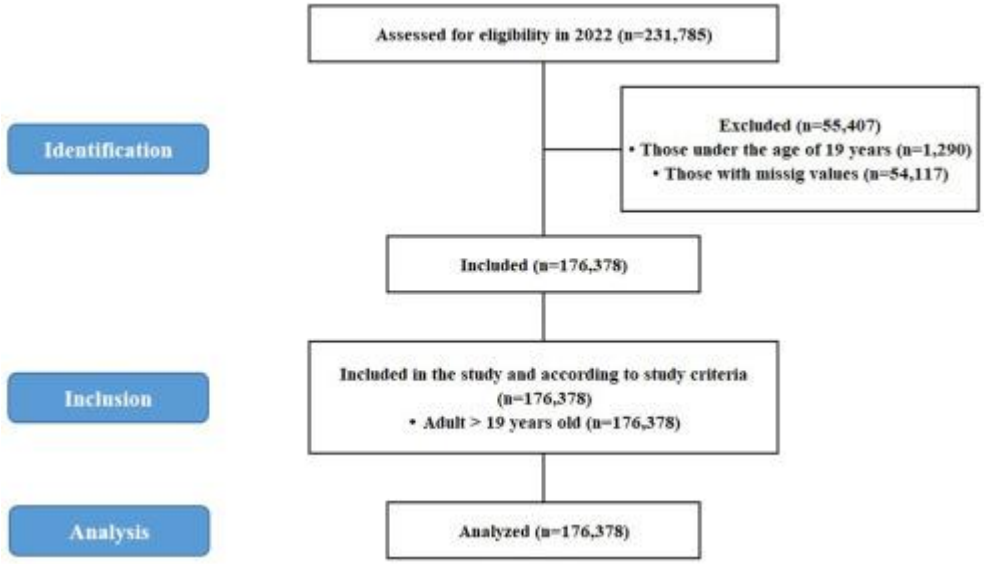

Figure 1. STROBE flow chart.

Measures

The outcome variable was unmet healthcare needs, defined by the CHS as failing to obtain necessary medical care—whether examinations, treatments, or medications—at any time during the previous year. Participants indicated "yes" or "no" to the question: "Have you ever experienced not receiving necessary medical services in the past year?" [17].

The key explanatory measure assessed whether respondents lived in areas with adequate medical resources. Residential locations were sorted into four categories:

1. metropolitan cities with sufficient resources,
2. small cities/rural regions with sufficient resources,
3. metropolitan cities with insufficient resources,
4. small cities/rural regions with insufficient resources.

To classify sufficiency, the number of healthcare facilities, hospital beds, and medical personnel per 10,000 residents was evaluated for each of 244 districts. A district was labeled "sufficient" when two or more of the three indicators exceeded the national median. Under this definition, 115 districts met the sufficiency threshold, while 129 did not. Based on population size, 74 districts were categorized as metropolitan, and 170 as small cities or rural areas.

Covariates included demographic and socioeconomic characteristics, behavioral factors, and health-related variables. These included gender (men, women), age brackets (20–29, 30–39, 40–49, 50–59, 60–69, 70+), marital status (married vs. unmarried/other), educational attainment (low, middle, high), current participation in economic activity (yes/no), and household income grouped into quartiles (Q1–Q4). Behavioral variables captured smoking (yes/no) and alcohol consumption (yes/no).

Health condition indicators included the presence of chronic diseases such as hypertension or diabetes (yes/no), subjective overall health (good vs. bad), and depressive symptoms (yes/no), which were assessed using the Korean version of the Patient Health Questionnaire-9 (PHQ-9). Respondents scoring < 5 points were classified as non-depressive, while those scoring > 5 points were categorized as having depressive symptoms [18].

Statistical analysis

To compare the overall characteristics of the study sample, we first applied a chi-square test, summarizing descriptive data as frequencies (N) and percentages (%). Next, because the dataset involved individuals nested within regional units, we employed a multi-level modeling (MLM) approach to properly account for this hierarchical design. Parameters were estimated using Restricted Maximum Likelihood, which yields more accurate fixed-effect estimates and more reliable variance-component estimates for random effects [19, 20]. A multi-level logistic regression model was then used to evaluate how the availability of medical resources in one's residential area influences the likelihood of experiencing unmet healthcare needs.

To verify whether multi-level modeling was appropriate, we calculated and reported the Intraclass Correlation Coefficient (ICC) [21], which reflects the share of total variance attributable to regional-level differences. The MLM results also included two measures: the between-area variance, representing variability across higher-level units (e.g., regions), and the percentage change in variance, indicating how much of this variability is explained by the model. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Outputs are presented as adjusted odds ratios (aOR), 95 % confidence intervals (CIs), and p-values, with statistical significance defined as $p < 0.05$.

Results and Discussion

Table 1 outlines the population characteristics. Among the 176,378 individuals included, 9224 (5.2 %) reported unmet healthcare needs within the past year. Significant differences were observed across most individual-level variables, except current economic activity and chronic disease status. Unmet needs were more common among participants who were unmarried, had lower education or income, smoked, rated their health poorly, or experienced depressive symptoms. Individuals residing in smaller cities or rural communities with inadequate healthcare resources also showed higher rates of unmet care.

Table 2 summarizes the multi-level findings. The ICC for the null model was 90.3 %, suggesting substantial clustering at the regional level [22]. In Model 3, which included all covariates, people living in small cities or rural regions with adequate medical resources had 1.26 times higher odds of unmet healthcare needs than residents of metropolitan areas with sufficient resources (95 % CI: 1.06–1.49). Those in small cities or rural areas lacking adequate resources had the highest likelihood, with an aOR of 1.32 (95 % CI: 1.13–1.53).

A stratified analysis based on the adequacy of medical resources **(Table 3)** showed that income-based disparities were most pronounced in areas where resources were sufficient. In such areas, individuals in the lowest income group had 1.77 times the unmet healthcare risk compared with the highest income group (95 % CI: 1.58–1.99). **Table 4** provides stratified results by residential area size, revealing a similar trend: the largest income gradient appeared in metropolitan regions, where the lowest income group had an aOR of 1.66 (95 % CI: 1.43–1.93).

Table 1. General characteristics of the study population.

Characteristics	Unmet Healthcare Needs						P-value
	Total		No		Yes		
	N	%	N	%	N	%	
Overall	176,378	100.0	167,154	94.8	9,224	5.2	
Individual-level characteristics							
Sex							<0.0001
Male	79,051	44.8	75,604	95.6	3,447	4.4	
Female	97,327	55.2	91,550	94.1	5,777	5.9	
Age (years)							<0.0001
20–29	16,601	9.4	15,824	95.3	777	4.7	
30–39	18,289	10.4	17,328	94.7	961	5.3	
40–49	25,264	14.3	23,902	94.6	1,362	5.4	
50–59	32,042	18.2	30,208	94.3	1,834	5.7	
60–69	38,660	21.9	36,852	95.3	1,808	4.7	
≥70	45,522	25.8	43,040	94.5	2,482	5.5	
Marital status							<0.0001
Married	114,080	64.7	108,733	95.3	5,347	4.7	
Unmarried / Other	62,298	35.3	58,421	93.8	3,877	6.2	
Education level							<0.0001
Low	37,580	21.3	35,007	93.2	2,573	6.8	

Middle	72,374	41.0	68,736	95.0	3,638	5.0	
High	66,424	37.7	63,411	95.5	3,013	4.5	
Currently employed							<0.0001
Yes	106,004	60.1	100,417	94.7	5,587	5.3	
No	70,374	39.9	66,737	94.8	3,637	5.2	
Household income quartile							<0.0001
Q1 (lowest)	50,047	28.4	46,560	93.0	3,487	7.0	
Q2	46,958	26.6	44,672	95.1	2,286	4.9	
Q3	43,280	24.5	41,336	95.5	1,944	4.5	
Q4 (highest)	36,093	20.5	34,586	95.8	1,507	4.2	
Presence of chronic disease							<0.0001
Yes	64,041	36.3	60,753	94.9	3,288	5.1	
No	112,337	63.7	106,401	94.7	5,936	5.3	
Current smoking							<0.0001
Yes	28,601	16.2	26,805	93.7	1,796	6.3	
No	147,777	83.8	140,349	95.0	7,428	5.0	
High-risk drinking							<0.0001
Yes	140,109	79.4	132,899	94.9	7,210	5.1	
No	36,269	20.6	34,255	94.4	2,014	5.6	
Self-rated health							<0.0001
Good	69,428	39.4	67,190	96.8	2,238	3.2	
Poor	106,950	60.6	99,964	93.5	6,986	6.5	
Depressive symptoms (past 2 weeks)							<0.0001
Yes	30,604	17.4	26,848	87.7	3,756	12.3	
No	145,774	82.6	140,306	96.2	5,468	3.8	
Regional-level characteristic							
Medical resource availability by area type							<0.0001
Sufficient – Metropolitan cities	49,156	27.9	46,998	95.6	2,158	4.4	
Sufficient – Small cities & rural areas	39,370	22.3	37,226	94.6	2,144	5.4	
Insufficient – Metropolitan cities	10,051	5.7	9,626	95.8	425	4.2	
Insufficient – Small cities & rural areas	77,801	44.1	73,304	94.2	4,497	5.8	

Table 2. Adjusted odds ratios of unmet healthcare needs by individual- and regional-level characteristics (multi-level model).

Individual-Level Factors				
Variables	**Null Model**	**Model 1 aOR (95% CI)**	**Model 2 aOR (95% CI)**	**Model 3 aOR (95% CI)**
Gender				
Men	—	1.00	—	1.00
Women	—	1.30 (1.24–1.37)	—	1.30 (1.24–1.37)
Age Group				

20–29	—	1.00	—	1.00
30–39	—	1.10 (0.99–1.21)	—	1.10 (0.99–1.22)
40–49	—	1.12 (1.01–1.23)	—	1.12 (1.01–1.23)
50–59	—	1.15 (1.04–1.27)	—	1.15 (1.04–1.27)
60–69	—	0.82 (0.73–0.91)	—	0.82 (0.73–0.91)
70+	—	0.69 (0.61–0.77)	—	0.69 (0.61–0.77)
Marital Status				
Married	—	1.00	—	—
Unmarried / Other	—	1.09 (1.04–1.15)	—	1.09 (1.04–1.15)
Educational Attainment				
Low	—	1.30 (1.19–1.41)	—	1.29 (1.18–1.40)
Middle	—	1.03 (0.97–1.09)	—	1.02 (0.96–1.09)
High	—	1.00	—	1.00
Employment Status				
Employed	—	1.00	—	1.00
Not employed	—	0.78 (0.74–0.82)	—	0.78 (0.74–0.82)
Household Income Quartile				
Q1 (lowest)	—	1.54 (1.42–1.67)	—	1.54 (1.42–1.67)
Q2	—	1.13 (1.06–1.22)	—	1.13 (1.05–1.22)
Q3	—	1.06 (0.99–1.14)	—	1.06 (0.99–1.14)
Q4 (highest)	—	1.00	—	1.00
Chronic Conditions				
Yes	—	0.83 (0.79–0.87)	—	0.83 (0.79–0.87)
No	—	1.00	—	1.00
Smoking				
Yes	—	1.35 (1.27–1.44)	—	1.35 (1.27–1.44)
No	—	1.00	—	1.00
Alcohol Use				
Yes	—	1.01 (0.96–1.07)	—	1.01 (0.96–1.07)
No	—	1.00	—	1.00
Self-Rated Health				
Good	—	1.00	—	1.00
Poor	—	1.64 (1.56–1.73)	—	1.64 (1.56–1.73)
Depressive Symptoms				
Yes	—	3.09 (2.95–3.24)	—	3.09 (2.95–3.24)
No	—	1.00	—	1.00
Regional-Level Factors				
Variables		**Model 2 aOR (95% CI)**		**Model 3 aOR (95% CI)**
Local Healthcare Resource Availability				
Adequate – Metro areas		1.00		1.00

Adequate – Small cities / Rural		1.29 (1.11–1.54)	1.26 (1.06–1.49)	
Inadequate – Metro areas		0.99 (0.73–1.35)	0.98 (0.73–1.31)	
Inadequate – Small cities / Rural		1.35 (1.16–1.58)	1.32 (1.13–1.53)	
Model Variance & Fit Statistics				
Statistic	**Null Model**	**Model 1**	**Model 2**	**Model 3**
Between-area variance (SE)	0.2491 (0.02664)*	0.2239 (0.02430)*	0.2296 (0.02481)*	0.2076 (0.02274)*
% Change in variance	—	0.10	0.08	0.17
−2 Log Likelihood	70111.11	66182.79	70113.84	66185.33
ICC (%)	90.3	90.2	90.2	90.1

aOR, adjusted odds ratio; CI, confidence interval; SE, standard error. $p < .05$.

Table 3. Stratified analysis based on the adequacy of medical resources in the residential area.

Variables	**Unmet healthcare needs – Medical resources**		**Unmet healthcare needs – Medical resources**	
	Limited areas		**Adequate areas**	
	aOR	95% CI	aOR	95% CI
Sex				
Men	1.00	—	1.00	—
Women	1.28	(1.19–1.37)	1.32	(1.23–1.42)
Age				
20–29	1.00	—	1.00	—
30–39	1.22	(1.03–1.44)	1.03	(0.90–1.17)
40–49	1.23	(1.05–1.44)	1.06	(0.93–1.20)
50–59	1.26	(1.08–1.48)	1.11	(0.97–1.26)
60–69	0.92	(0.78–1.09)	0.77	(0.67–0.89)
70+	0.84	(0.71–1.00)	0.57	(0.48–0.67)
Marital status				
Married	1.00	—	1.00	—
Unmarried / Other	1.11	(1.04–1.19)	1.07	(0.99–1.15)
Education level				
Low	1.32	(1.18–1.49)	1.23	(1.08–1.41)
Medium	1.05	(0.96–1.14)	1.01	(0.93–1.10)
High	1.00	—	1.00	—
Economic activity				
Yes	1.00	—	1.00	—
No	0.85	(0.80–0.91)	0.71	(0.66–0.77)
Household income level				
Q1 (lowest)	1.32	(1.18–1.49)	1.77	(1.58–1.99)
Q2	1.06	(0.95–1.18)	1.19	(1.08–1.32)
Q3	0.96	(0.86–1.07)	1.15	(1.05–1.26)

Q4 (highest)	1.00	—	1.00	—
Chronic diseases				
Yes	0.84	(0.78–0.90)	0.81	(0.75–0.88)
No	1.00	—	1.00	—
Smoking				
Yes	1.31	(1.19–1.43)	1.39	(1.27–1.52)
No	1.00	—	1.00	—
Alcohol use				
Yes	1.05	(0.98–1.13)	0.95	(0.88–1.03)
No	1.00	—	1.00	—
Self-rated health				
Good	1.00	—	1.00	—
Poor	1.70	(1.57–1.83)	1.58	(1.47–1.70)
Depressive symptoms				
Yes	2.85	(2.67–3.04)	3.39	(3.16–3.63)
No	1.00	—	1.00	—

**aOR = adjusted odds ratio; 95% CI = 95% confidence interval

Table 4. Stratified analysis based on the size of the residential area. aOR, adjusted odds ratio; CI, confidence interval.

Variables	**Unmet healthcare needs – Size of residential area**		**Unmet healthcare needs – Size of residential area**	
	Metropolitan cities		**Small cities & rural areas**	
	aOR	95% CI	aOR	95% CI
Sex				
Men	1.00	—	1.00	—
Women	1.29	(1.18–1.42)	1.30	(1.22–1.38)
Age				
20–29	1.00	—	1.00	—
30–39	1.03	(0.88–1.22)	1.14	(1.00–1.29)
40–49	1.10	(0.93–1.29)	1.13	(1.00–1.28)
50–59	1.10	(0.93–1.30)	1.18	(1.05–1.34)
60–69	0.81	(0.67–0.97)	0.83	(0.73–0.95)
70+	0.62	(0.50–0.76)	0.72	(0.63–0.83)
Marital status				
Married	1.00	—	1.00	—
Unmarried / Other	1.06	(0.97–1.17)	1.10	(1.04–1.17)
Education level				
Low	1.16	(0.98–1.37)	1.32	(1.20–1.47)
Middle	1.05	(0.95–1.17)	1.02	(0.94–1.09)
High	1.00	—	1.00	—
Economic activity				

Yes	1.00	—	1.00	—
No	0.68	(0.62–0.75)	0.82	(0.78–0.87)
Household income level				
Q1 (lowest)	1.66	(1.43–1.93)	1.49	(1.35–1.64)
Q2	1.21	(1.06–1.37)	1.10	(1.01–1.20)
Q3	1.03	(0.91–1.17)	1.07	(0.99–1.17)
Q4 (highest)	1.00	—	1.00	—
Chronic diseases				
Yes	0.82	(0.74–0.91)	0.83	(0.78–0.88)
No	1.00	—	1.00	—
Smoking				
Yes	1.35	(1.20–1.51)	1.35	(1.25–1.45)
No	1.00	—	1.00	—
Alcohol consumption				
Yes	0.92	(0.83–1.02)	1.05	(0.98–1.12)
No	1.00	—	1.00	—
Self-rated health				
Good	1.00	—	1.00	—
Poor	1.59	(1.44–1.75)	1.66	(1.56–1.77)
Depressive symptoms				
Yes	3.29	(3.01–3.60)	3.02	(2.85–3.19)
No	1.00	—	1.00	—

This study highlights substantial regional differences in unmet healthcare needs across South Korea, driven in part by uneven medical resource distribution and the combined effects of regional size and socio-economic factors on healthcare accessibility. Using two nationally representative datasets—the Korean Community Health Survey (CHS) and national medical utilization statistics—we analyzed both individual-level and area-level conditions. Our findings indicate that residence in small cities or rural regions, particularly those with limited healthcare infrastructure, is strongly linked to higher levels of unmet healthcare need.

The analysis indicated that healthcare resources are unevenly distributed across South Korea. Differences in unmet healthcare needs were strongly associated with the level of medical resource availability in an individual's place of residence. Notably, residents of small cities and rural regions faced a higher probability of unmet healthcare needs regardless of whether those areas were classified as having "sufficient" resources. However, it is also important to consider that areas with healthier populations may naturally report lower unmet healthcare needs, which could partly shape the observed patterns. For instance, communities with an overall better health status may show fewer unmet needs, potentially masking actual access problems in those regions [23]. In line with this, the scale of the residential area played a substantial role in unmet healthcare needs, much like the degree of resource sufficiency. This further supports the notion that healthcare resources in Korea are concentrated heavily in metropolitan regions. In contrast, people living in small cities and rural communities exhibited higher levels of unmet healthcare needs compared to those in well-resourced metropolitan areas. Additionally, a significant income gradient persisted even in places categorized as having adequate medical resources, suggesting that the greatest income-based disparities in unmet healthcare needs occurred in metropolitan settings or in areas considered sufficiently equipped.

The key outcomes of this study align with previous research focusing on factors linked to unmet medical needs among older women in Korea [24]. Findings from those studies mirrored ours, showing distinct patterns in unmet medical care according to residential location and lower income status [25, 26]. Moreover, earlier investigations into unmet healthcare needs have identified a range of contributing determinants, such as living alone, low

household income, limited education, dependence in daily activities, diagnoses involving hyperactivity, and unfavorable self-rated health [27, 28]. Thus, the present study adds an additional layer to discussions on healthcare equity by revealing how the size of the residential area shapes accessibility to medical services.

Based on our results, healthcare policy in South Korea—and in similar national contexts—must address unmet healthcare needs with more precision. At present, many small cities and rural locations continue to face unequal access due to the concentration of resources elsewhere [29]. Although improvements in rural healthcare have made care more reachable, additional progress remains essential [30]. Policy strategies should therefore emphasize reallocating healthcare resources toward smaller cities and rural communities, which confront structural barriers distinct from those in metropolitan areas [31, 32]. Furthermore, these interventions must directly address socio-economic inequalities that remain deeply embedded in the healthcare system, ensuring equitable access regardless of income level [33].

This study has several limitations. First, our findings rely on self-reported information and utilize data from only a single year. Because self-reported measures reflect individual perceptions, they may not fully capture objective unmet healthcare needs. Second, analyzing data drawn from a single year limits the capacity to examine changes or trends in healthcare access over time. This underscores the need for longitudinal research to assess how unmet needs and resource distribution evolve. Third, although numerous factors were included, the possibility of residual confounding due to unmeasured variables cannot be fully ruled out. Finally, given the unique social and healthcare system characteristics of Korea, caution is needed when generalizing these findings to other national contexts.

Conclusion

The study demonstrates that residence in small cities and rural areas—particularly those with inadequate medical resources—substantially increases the likelihood of unmet healthcare needs. This underscores the severity of regional disparities in healthcare supply within South Korea, highlighting the urgent necessity for public health policies aimed at more equitable resource distribution. Moreover, the results show that even in regions with sufficient medical services, individuals with lower incomes experience higher levels of unmet needs, emphasizing the importance of policies that support populations facing economic barriers to care. Such initiatives are vital for ensuring universal access to healthcare and improving health outcomes for all individuals.

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