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Epidemiological Trends in Inflammatory Bowel Disease in Korea: Age-Related Shifts and Urban-Rural Disparities in a Nationwide Study, 2004–2015

Joonki Lee[1*], Daye Park[2*], Jihye Park[2], Soo Jung Park[2], Jae Hee Cheon[2], Tae Il Kim[2], Jae Jun Park[2], and Aesun Shin[1]

[1]Department of Preventive Medicine, Seoul National University College of Medicine, Seoul;
[2]Department of Internal Medicine, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea.

Purpose: The incidence of inflammatory bowel disease (IBD) is rapidly increasing in newly industrialized Asian countries. However, nationwide epidemiological shifts, especially age-specific trends and urbanization effects, remain unclear in Korea. This study aimed to define recent secular trends in IBD incidence by age and residential area using the Korean National Health Insurance database.

Materials and Methods: We conducted a nationwide, population-based study using claims data from the National Health Insurance Service from 2004 to 2015. IBD cases were defined by a combination of diagnostic codes for Crohn's disease (CD) or ulcerative colitis (UC) and relevant prescription records. Age-standardized incidence rates (ASRs) were calculated, and joinpoint regression was used to estimate annual percent changes (APCs). Standardized incidence ratios (SIRs) compared incidence between metropolitan and non-metropolitan areas.

Results: A total of 15241 CD and 39028 UC patients were identified. ASRs for both CD and UC steadily increased during the study period, with APCs of 6.8% [95% confidence interval (CI): 5.8–7.8] for CD and 3.2% (95% CI: 2.6–3.8) for UC. CD incidence was highest among adolescents aged 15–19 years. For UC, the peak age of onset shifted from 55–69 years in 2004 to 20–39 years by 2015. The most dramatic rise in UC incidence occurred in the 10–19 age group. Metropolitan areas had higher incidence rates than non-metropolitan areas for both diseases.

Conclusion: The epidemiology of IBD in Korea is rapidly evolving, with increasing incidence, younger onset, and an urban–rural divide. Targeted strategies for adolescents and urban populations are needed.

Key Words: Inflammatory bowel disease, Crohn's disease, ulcerative colitis, epidemiology, incidence

INTRODUCTION

Inflammatory bowel disease (IBD), comprising Crohn's disease (CD) and ulcerative colitis (UC), is a chronic inflammatory disorder of the gastrointestinal tract traditionally considered a disease of Western populations.[1,2] However, in recent decades, the epidemiology of IBD has dramatically shifted, evolving from regional emergence to a globally compounding prevalence.[3,4] Since the early 2000s, newly industrialized nations in Asia and South America have experienced rapidly increasing IBD incidence rates, signifying a significant global public health issue.[5,6] Notably, East Asian countries, including Republic of Korea (hereafter referred to as Korea), have observed a particularly rapid increase in IBD cases, suggesting a complex interplay between genetic predispositions and chang-

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Co-corresponding authors: Jae Jun Park, MD, PhD, Department of Internal Medicine, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.
E-mail: JAEJPARK@yuhs.ac and
Aesun Shin, MD, PhD, Department of Preventive Medicine, Seoul National University College of Medicine, 103 Daehak-ro, Jongno-gu, Seoul 03080, Korea.
E-mail: shinaesun@snu.ac.kr

*Joonki Lee and Daye Park contributed equally to this work.
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ing environmental factors in the disease's pathogenesis.[7,8]

Two distinct global epidemiological trends are particularly noteworthy. First, pediatric and adolescent-onset IBD incidence is consistently rising worldwide.[9,10] Early onset of IBD poses greater lifelong disease burdens and substantial socioeconomic consequences, underscoring the importance of understanding underlying etiological factors.[11] Second, several studies have reported significantly higher IBD incidence rates in urban compared to rural areas, suggesting that urbanization-related environmental exposures—such as changes in hygiene practices, diet, and pollution—may play pivotal roles in disease development.[2,12]

Within this global context, understanding the specific epidemiological patterns of IBD in Korea is essential. Korea's rapid economic growth and urbanization in recent decades present a unique context that could distinctly influence IBD trends. Although previous Korean studies have described a general rise in IBD incidence,[10,13] systematic nationwide analyses examining detailed age-specific patterns—particularly in pediatric and adolescent populations—and comparisons based on urbanization levels remain limited.

Therefore, this study aimed to analyze nationwide IBD incidence trends from 2004 to 2015 using comprehensive population-based data from the Korean National Health Insurance Service (NHIS). Specifically, we investigated age-specific incidence rates and compared IBD incidence between metropolitan and non-metropolitan areas. Clarifying these evolving epidemiological characteristics is crucial to inform targeted public health interventions and effective healthcare resource allocation strategies.

MATERIALS AND METHODS

Data source and study population

This nationwide, population-based study utilized claims data from the Korean NHIS database. The NHIS is a mandatory public insurance system covering over 97% of the Korean population, providing comprehensive information on demographics, diagnoses, procedures, and prescriptions. We extracted all claims data for patients who utilized medical services between January 1, 2002, and December 31, 2015. This study was approved by the Institutional Review Board of Yonsei University Gangnam Severance Hospital (IRB No. 3-2016-0250), and the requirement for informed consent was waived as the analysis used fully anonymized and de-identified data.

Case identification and definition

We identified incident cases of IBD diagnosed between January 1, 2004, and December 31, 2015. To ensure that only new (incident) cases were included, a 2-year washout period (from January 1, 2002, to December 31, 2003) was implemented. Any patient with a recorded diagnosis of IBD during this washout period was considered a prevalent case and was excluded from the analysis.

An operational case definition was established to improve diagnostic accuracy. A patient was defined as an incident case of IBD if they had a main diagnostic code for CD [International Classification of Diseases, 10th Revision (ICD-10) code K50] or UC (ICD-10 code K51) and were simultaneously prescribed relevant IBD medications (Supplementary Table 1, only online). The medication criteria were defined as follows:

1) At least one prescription for an immunosuppressant (azathioprine, 6-mercaptopurine, or methotrexate) or a biologic agent (anti-tumor necrosis factor, such as infliximab or adalimumab).

OR

2) A prescription for 5-aminosalicylic acid for a duration of more than 30 days.

This operational definition, which combines diagnostic codes and medication prescriptions, has been previously applied in nationwide Korean IBD cohort studies and is widely accepted in administrative database research.[14]

Patients with invalid or incomplete data were also excluded from the final analysis.

Study variables

For analysis, patients were stratified by sex and age, with age categorized into 5-year intervals (e.g., 0–4, 5–9, ..., 85+ years). To evaluate the influence of urbanization, patients' residential addresses at the time of diagnosis were classified into two groups based on Korea's administrative divisions: "metropolitan" (covering Seoul and the six other major metropolitan cities: Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan) and "non-metropolitan" (all other provinces and cities).

Statistical analysis

Crude annual incidence rates for CD and UC were calculated by dividing the number of new cases identified each year by the total number of beneficiaries registered in the NHIS for that year (Table 1). To enable comparisons across different time periods and demographic structures, age-standardized incidence rates (ASRs) were calculated using the direct standardization method with the WHO 2000–2025 standard population.[15]

Temporal trends in ASRs were analyzed using joinpoint regression analysis (Joinpoint Regression Program, Version 4.6.0.0; National Cancer Institute, USA). This statistical method identifies significant changes in trends over time and calculates the annual percent change (APC) with 95% confidence intervals (CIs) for each identified linear segment. A trend was considered statistically significant if the 95% CI of the APC did not include zero.

To compare incidence between regions, the standardized incidence ratio (SIR) was calculated, with the non-metropolitan area serving as the reference population. The SIR was computed by dividing the observed number of IBD cases in the

Table 1. Temporal Trends of Incident Inflammatory Bowel Disease Cases in Korea between 2004 and 2015

Year	Total number of beneficiaries registered in NHIS	Crohn's disease			Ulcerative colitis		
		Number of incident cases	Age-standardized incidence rate per 100000*	Mean age (SD)	Number of incident cases	Age-standardized incidence rate per 100000*	Mean age (SD)
2004	49229191	895	1.80	31.3±14.6	2551	4.63	42.3±15.3
2005	49477152	920	1.86	31.4±14.9	2805	5.05	42.6±15.7
2006	49600147	1087	2.23	31.2±15.2	2878	5.13	43.0±15.8
2007	50040822	1058	2.16	31.2±14.9	3033	5.30	43.3±15.8
2008	50356084	1148	2.34	31.0±15.4	3011	5.24	42.9±15.7
2009	50629193	1306	2.73	29.4±15.0	3244	5.60	42.8±15.9
2010	50934378	1186	2.48	29.7±15.4	3151	5.43	43.1±16.4
2011	51261549	1368	2.88	29.2±15.1	3403	5.86	42.5±16.6
2012	51557689	1521	3.28	28.4±14.9	3414	5.83	42.8±16.4
2013	51775806	1523	3.33	28.3±15.4	3667	6.30	42.5±16.9
2014	52064081	1657	3.63	29.4±16.1	3892	6.66	42.5±16.9
2015	52349509	1572	3.51	28.8±15.9	3979	6.78	42.4±16.5
Overall		15241	2.69	29.7±15.3	39028	5.65	42.7±16.2

NHIS, National Health Insurance Service; SD, standard deviation.
*Age-standardized incidence rates were calculated using the WHO 2000–2025 standard population.

metropolitan population by the expected number of cases. The expected number was determined by applying the age- and sex-specific incidence rates of the non-metropolitan population to the metropolitan population structure. All statistical analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Sensitivity analysis

To validate our operational case definition, a sensitivity analysis was performed using data from Korea's national Rare Intractable Disease (RID) registration program. The RID program, established in 2009, grants financial support to patients with specific conditions, including IBD, and requires clinical, endoscopic, and histopathologic evidence for registration. We calculated the incidence of IBD using only RID-registered patients from 2010 to 2015 (to exclude prevalent cases registered earlier) and compared these trends with the results from our primary case definition.

RESULTS

Patient characteristics and overall incidence trends

From 2004 to 2015, a total of 15241 incident cases of CD and 39028 incident cases of UC were identified. The overall ASR during the study period was 2.69 per 100000 population for CD and 5.65 per 100000 population for UC.

The incidence of both diseases showed a consistent and significant increase over the 12-year study period (Table 1). The ASR for CD increased from 1.80 per 100000 in 2004 to 3.51 per 100000 in 2015, with an APC of 6.8% (95% CI, 5.8% to 7.8%). For UC, the ASR rose from 4.63 per 100000 in 2004 to 6.78 per 100000 in 2015, corresponding to an APC of 3.2% (95% CI, 2.6% to 3.8%). Throughout the study period, the mean age at diagnosis for CD showed a decreasing trend, whereas it remained relatively constant for UC.

Age-specific incidence trends

CD

The highest incidence of CD was consistently observed in adolescents and young adults, with the peak age of diagnosis occurring in the 15–19 age group throughout the entire study period (Fig. 1). Joinpoint regression analysis revealed that the most significant increases in CD incidence occurred in younger age groups (Table 2). Specifically, the steepest rise was observed in patients aged 10–19 years (APC: 13.5%; 95% CI, 11.6% to 15.4%), followed by those aged 20–29 years (APC: 5.6%; 95% CI, 4.3% to 7.0%) and 0-9 years (APC: 11.3%; 95% CI, 1.5% to 22.1%). In contrast, no significant change was found in older age groups.

When stratified by sex, the age distribution patterns for CD showed notable differences between males and females. Males demonstrated a very sharp and high incidence peak specifically in the 15–19 age group (Supplementary Fig. 1, only online). In contrast, females showed a comparatively lower and broader peak that spanned adolescence and young adulthood (i.e., 15–24 years) (Supplementary Fig. 2, only online). A clear male predominance was observed, particularly in the 15–19 age group, where the incidence rate in males was substantially higher than in females. In older age groups, the rates remained low and were generally comparable between sexes.

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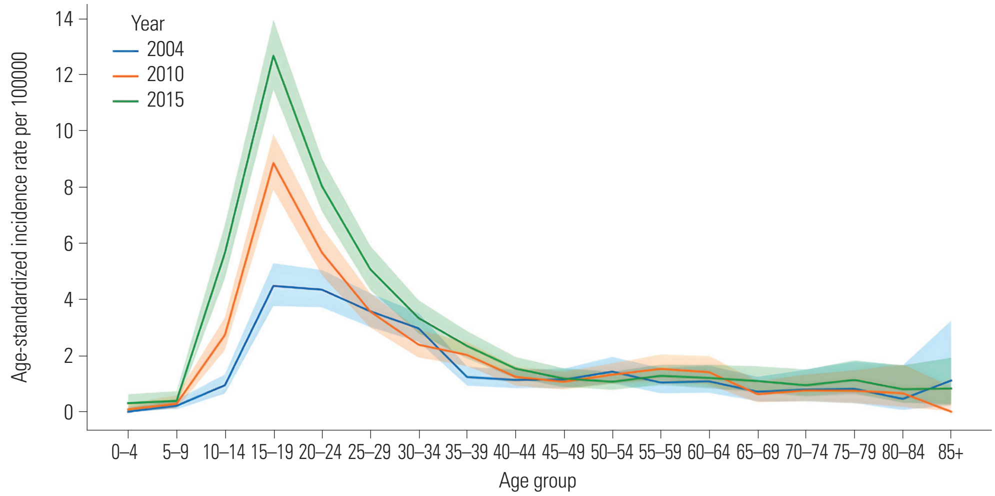

Fig. 1. Age-specific incidence rate of CD in 2004, 2010, and 2015. The figure illustrates the incidence of CD per 100000 population across different age groups for three selected years. It highlights a consistent peak in incidence among adolescents and young adults (15–19 years) throughout the study period. Shaded areas indicate 95% confidence intervals. CD, Crohn's disease.

Table 2. Annual Changes of Age-Specific Incidence Rates of Inflammatory Bowel Disease between 2004 and 2015

Age (years)	Crohn's disease			Ulcerative colitis		
	Incidence rate per 100000		APC (95% CI)	Incidence rate per 100000		APC (95% CI)
	2004	2015		2004	2015	
0–9	0.12	0.34	11.30 (1.50–22.10)	0.10	0.15	4.70 (-2.10–12.00)
10–19	2.62	9.64	13.50 (11.60–15.40)	1.64	5.02	10.10 (8.10–12.10)
20–29	3.96	6.61	5.60 (4.30–7.00)	5.74	10.68	6.30 (5.10–7.50)
30–39	2.11	2.83	2.80 (1.00–4.50)	7.03	9.94	2.80 (2.10–3.60)
40–49	1.13	1.36	1.20 (-1.00–3.50)	6.60	8.42	1.00 (-0.40–2.40)
50–59	1.25	1.17	-0.40 (-2.30–1.60)	7.71	8.81	0.70 (0.20–1.20)
60–69	0.91	1.15	0.80 (-1.50–3.10)	7.84	8.29	0.10 (-0.80–1.00)
70–79	0.80	1.02	4.00 (0.60–7.60)	5.63	6.42	1.00 (-0.30–2.30)
80+	0.70	0.81	0.10 (-9.30–10.50)	1.97	2.43	0.70 (-4.20–5.80)

APC, annual percent change; CI, confidence interval.

UC

The age distribution of UC incidence underwent a notable shift during the study period. In 2004, the peak incidence was seen in the older population (60–69 years), whereas by 2015, the highest rates were observed in the younger age groups (20–39 years), indicating a leftward shift in age at onset (Fig. 2). This visual trend was supported by joinpoint regression analysis, which showed the most pronounced increase in incidence was in the 10–19 age group (APC: 10.1%; 95% CI, 8.1% to 12.1%), followed by the 20–29 age group (APC: 6.3%; 95% CI, 5.1% to 7.5%) (Table 2).

Sex-stratified analyses for UC showed that both males and females exhibited a similar temporal trend, with the peak age of onset shifting from older age groups toward young adulthood over time (Supplementary Figs. 3 and 4, only online). By 2015, the highest incidence for both sexes was observed in individuals in their 20s and 30s. Notably, males had consistently higher incidence rates than females in this young adult age group. In older age groups (≥55 years), the incidence rates became more comparable between the sexes.

Regional differences in incidence

The incidence of IBD was consistently higher in metropolitan areas compared to non-metropolitan areas for both diseases throughout the study period (Fig. 3). For CD, the SIR for metropolitan areas was 1.16 (95% CI, 1.13 to 1.18) compared to non-metropolitan areas. For UC, the SIR was 1.07 (95% CI, 1.05 to 1.08) (Table 3). Both regions experienced a significant increase in the incidence of CD and UC over time, with similar APCs observed in both metropolitan and non-metropolitan areas.

Sensitivity analysis

The trends observed in the sensitivity analysis, using data from the RID registry from 2010 to 2015, were consistent with the primary findings. The analysis confirmed that the incidence of both CD and UC increased, with the most significant rise occurring in younger age groups; the peak age of onset patterns were similar to our main analysis (Supplementary Figs. 5 and 6, only online). Furthermore, the higher incidence in metropolitan areas compared to non-metropolitan areas was also replicated (Supplementary Fig. 7, only online).

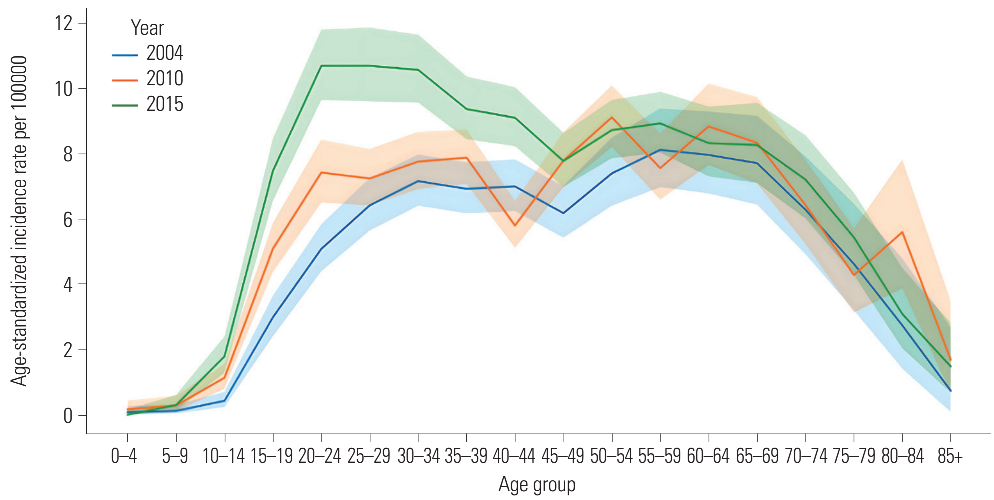

Fig. 2. Age-specific incidence rate of UC in 2004, 2010, and 2015. This graph demonstrates the shift in the age-specific incidence of ulcerative colitis over the study period. It shows that the peak incidence, which was in older age groups (e.g., 60–69 years) in the early 2000s, moved to younger age groups (20–39 years) by 2015. Shaded areas indicate 95% confidence intervals. UC, ulcerative colitis.

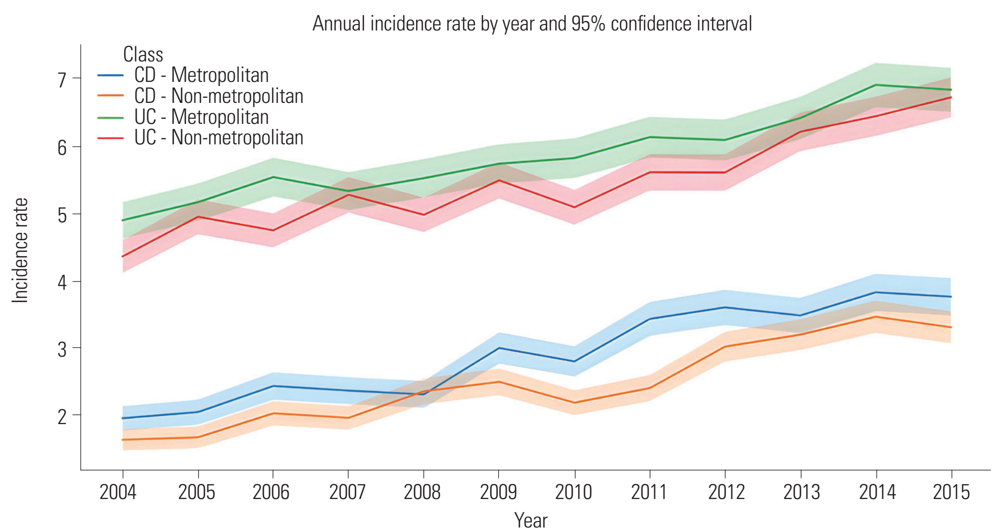

Fig. 3. Temporal trend of the age-standardized incidence rate of inflammatory bowel disease in metropolitan and non-metropolitan areas. This figure compares the annual ASRs of IBD (CD and UC analyzed separately) between metropolitan and non-metropolitan regions from 2004 to 2015, showing a sustained higher incidence in urban areas. Shaded areas indicate 95% confidence intervals. CD, Crohn's disease; UC, ulcerative colitis; ASR, age-standardized incidence rate; IBD, inflammatory bowel disease.

Table 3. Overall Age-Standardized Incidence Rates of Inflammatory Bowel Disease by Region between 2004 and 2015

	Region	Population	N	Age-standardized incidence rate per 100000 in 2004	Age-standardized incidence rate per 100000 in 2015	APC (95% CI)	SIR (95% CI)
Crohn's disease	Metropolitan	350321753	7716	1.96	3.76	6.7 (5.3–8.1)	1.16 (1.13–1.18)
	Non-metropolitan	409153910	7525	1.64	3.31	7.1 (5.5–8.6)	1.00 (Reference)
Ulcerative colitis	Metropolitan	350321753	18868	4.90	6.84	2.9 (2.5–3.4)	1.07 (1.05–1.08)
	Non-metropolitan	409153910	20160	4.36	6.72	3.4 (2.5–4.3)	1.00 (Reference)

APC, annual percent change; CI, confidence interval; N, number of incident cases; SIR, standardized incidence ratio.
Age-standardized incidence rates were calculated using the WHO 2000–2025 standard population. SIR was calculated using non-metropolitan areas as the reference group.

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DISCUSSION

This nationwide, population-based study provides a comprehensive overview of the evolving epidemiology of IBD in Korea from 2004 to 2015. Our principal findings indicate a sustained and substantial increase in the incidence of both CD and UC. More importantly, this study highlights two prominent epidemiological shifts: a remarkable increase in incidence among adolescents and young adults and a persistent, higher incidence in metropolitan areas compared to non-metropolitan regions. These findings confirm that Korea is in a key phase of its IBD evolution, aligning with the "acceleration phase" described in the global IBD evolution model, characterized by rapidly rising incidence amidst relatively low prevalence. This underscores the need to better understand underlying drivers and prepare for the increasing healthcare burden.

A notable finding of our study was the significant surge in IBD incidence among adolescents and young adults. Specifically, CD incidence peaked in the 15–19 age group, with the steepest increases for both diseases occurring among individuals aged 10–19. These trends are consistent with global observations, particularly in newly industrialized Asian and Latin American countries undergoing rapid socioeconomic and lifestyle transformations.[5] This suggests that early-life environmental exposures play a crucial role in IBD pathogenesis, possibly related to changes in diet, increased antibiotic usage, altered microbial exposures, and improved sanitation as proposed by the hygiene hypothesis.[16-18]

Importantly, the incidence of IBD in children under 10 years old remained relatively stable. Internationally, this trend is similarly observed, where pediatric-onset IBD predominantly affects adolescents rather than very young children. The EPIMAD registry in France, for instance, reported negligible changes in IBD incidence among children younger than 6 years old from 1988 to 2011, whereas the incidence more than doubled among older children and adolescents.[19] This divergence by age suggests distinct pathophysiological mechanisms or environmental exposures between early childhood and adolescence. Very early-onset IBD cases are often strongly genetic, whereas adolescent-onset cases appear predominantly influenced by cumulative environmental factors encountered during later childhood.[20]

We observed a striking shift in the peak age of UC onset, decreasing from individuals in their 60s in 2004 to those in their 20s and 30s by 2015. Such a rapid shift within a single decade distinguishes the Korean epidemiologic profile from Western countries, where UC incidence among older adults remains stable or has increased.[21] This swift transition suggests recent environmental pressures acting upon genetically predisposed younger populations. Although specific factors remain unclear, the shift necessitates urgent investigation into lifestyle, dietary, and environmental factors disproportionately affecting younger Koreans.

Another important observation from our study is the persistent urban-rural disparity in IBD incidence, consistently showing higher rates in metropolitan areas for both CD and UC. This aligns with global reports from North America, Europe, and the Asia-Pacific, where urban living is consistently linked to higher IBD risk.[22,23] Urban environments often entail greater exposure to air pollution, diets high in processed foods and low in fiber, psychological stress, and reduced early microbial diversity, factors known to influence IBD development.[17,24] The persistence of this urban-rural gap highlights the significance of targeted public health interventions addressing urban-specific environmental risk factors.

Interestingly, while the absolute incidence of IBD remains higher in metropolitan areas, our analysis revealed a slightly steeper APC in non-metropolitan regions for UC. This trend suggests that environmental and lifestyle risk factors traditionally concentrated in urban settings may be spreading more widely nationwide. If this trajectory continues, the urban–rural gap in IBD incidence may narrow or even reverse in the near future, reflecting a broader shift in nationwide risk profiles.

Clinically and from a public health perspective, these findings are critical. The rising incidence among adolescents and young adults implies a substantial long-term healthcare burden. Early-onset disease is often associated with a more extensive disease course, as demonstrated by more frequent disease extension in both CD and UC, and a greater cumulative impact on quality of life, education, career development, and mental health.[16,20,25] This demands development of specialized pediatric-to-adult transition care systems and long-term, personalized management strategies. The clear urban-rural disparity further underscores the need for public health measures specifically tailored toward mitigating modifiable urban environmental risk factors.

The consistent global increase in young-onset IBD, particularly prominent in rapidly industrializing Asian countries, closely aligns with the trends observed in Korea. A multi-center Korean study confirmed significant rises in pediatric-onset IBD over recent decades, especially among adolescents, underscoring the urgency of early intervention and research into age-specific preventive strategies.[26] These age-specific epidemiological patterns likely reflect a complex interplay between genetic susceptibility and cumulative environmental exposures encountered during later childhood and adolescence. Longitudinal studies are therefore essential to elucidate the timing and nature of these exposures and their mechanistic roles in disease development.

Comparative data from other rapidly industrializing nations provide important context for interpreting Korea's epidemiological transition. Recent systematic reviews and population-based studies have documented similarly steep increases in IBD incidence among adolescents and young adults in countries such as China, India, and Brazil.[5] These nations share many environmental and lifestyle factors with Korea—such as urbanization, dietary westernization, and improved hygiene—suggesting common upstream drivers of disease. In contrast, North America and Western Europe, where IBD incidence has long plateaued at high levels, have shown relatively stable or only modestly increasing trends in recent decades.[22,23] This divergence reinforces the hypothesis that Korea and its regional counterparts are in an earlier phase of the IBD epidemic curve, driven by recent and rapid environmental transformation. Collectively, these international comparisons support the notion that Korea's age-specific trends are not isolated phenomena but part of a broader, globally recognizable pattern among newly industrialized countries. This study has several strengths. Its nationwide design ensures generalizability and minimizes selection bias, while a 12-year longitudinal dataset allowed robust trend analysis. Additionally, our medication-based operational definition validated using the RID registry supports the internal validity of our findings.

However, limitations must be acknowledged. First, administrative claims data may introduce misclassification bias, potentially underestimating true incidence by missing mild cases not requiring IBD-specific treatments. Second, the NHIS database lacks detailed individual-level risk factors like smoking, diet, physical activity, or socioeconomic status, limiting causality assessment. Third, our 2-year washout period, while standard in administrative database research, may not have been sufficient to exclude all prevalent cases, potentially leading to a slight overestimation of incidence. Fourth, increased diagnostic awareness, improved access to advanced endoscopic technologies, and greater availability of specialized healthcare facilities over the study period may have contributed to detection bias. In particular, the observed urban-rural disparity could have been influenced by such bias, as residents in metropolitan areas generally have better access to specialized gastroenterology services and diagnostic tools, potentially resulting in higher case ascertainment compared to non-metropolitan regions. Nevertheless, the magnitude of the observed shifts—especially the marked change in the peak age of UC onset—is unlikely to be fully explained by enhanced detection alone, particularly in a country like Korea, where the healthcare system is well-established and highly accessible. Additionally, the study period was limited to 2004–2015 because the NHIS dataset available at the time of acquisition and approval only included data up to 2015. While more recent data have since become accessible, we chose this time frame to ensure consistency and to avoid potential heterogeneity associated with later database changes or policy revisions—such as the 2019 update to the RID registration criteria.

In conclusion, the epidemiology of IBD in Korea is undergoing rapid transformation, marked by increasing incidence, younger-onset disease, and urban-rural disparities. Our findings emphasize the need for proactive healthcare policy development and resource allocation to address the growing burden of IBD. Future research should prioritize identifying specific early-life urban environmental triggers, laying the groundwork for preventive strategies aimed particularly at Korea's younger populations.

AUTHOR CONTRIBUTIONS

Conceptualization: Jae Jun Park and Aesun Shin. Data Curation: Joonki Lee, Daye Park, Jae Jun Park, and Aesun Shin. Formal analysis: Joonki Lee and Daye Park. Funding acquisition: Jae Jun Park and Aesun Shin. Investigation: Joonki Lee, Daye Park, Jihye Park, Soo Jung Park, Jae Hee Cheon, and Tae Il Kim. Methodology: Joonki Lee, Daye Park, Jae Jun Park, and Aesun Shin. Project administration: Jae Jun Park and Aesun Shin. Resources: Joonki Lee. Software: Joonki Lee. Supervision: Jae Jun Park and Aesun Shin. Validation: all authors. Visualization: Joonki Lee and Daye Park. Writing—original draft: Joonki Lee and Daye Park. Writing—review & editing: Jae Jun Park and Aesun Shin. Approval of final manuscript: all authors.

ORCID iDs

Joonki Lee	https://orcid.org/0000-0002-5643-3062
Daye Park	https://orcid.org/0009-0007-1062-641X
Jihye Park	https://orcid.org/0000-0002-5836-8735
Soo Jung Park	https://orcid.org/0000-0003-0699-6809
Jae Hee Cheon	https://orcid.org/0000-0002-2282-8904
Tae Il Kim	https://orcid.org/0000-0003-4807-890X
Jae Jun Park	https://orcid.org/0000-0001-9974-1658
Aesun Shin	https://orcid.org/0000-0002-6426-1969

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