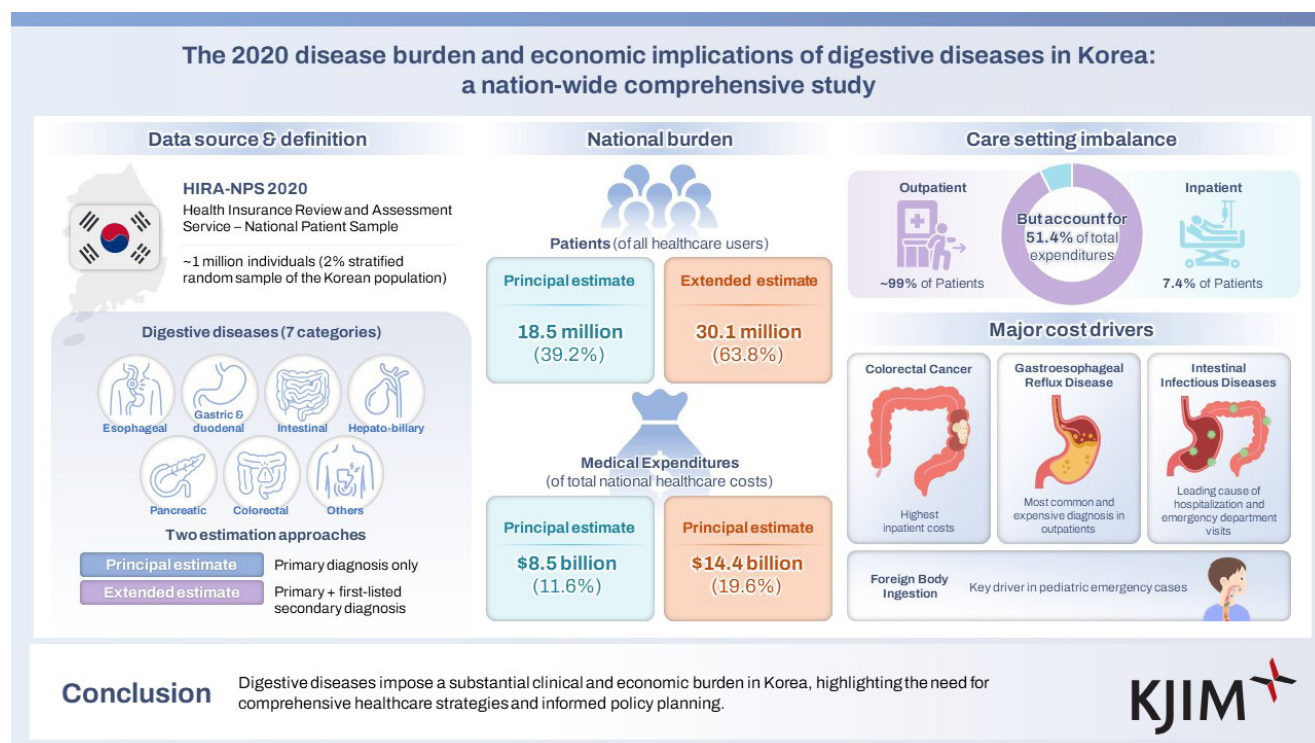




The 2020 disease burden and economic implications of digestive diseases in Korea: a nation-wide comprehensive study

Eui Sun Jeong¹, Hye-Kyung Jung¹, Younhee Kim², and Hyung Seok Lim¹

¹Department of Internal Medicine, College of Medicine, Ewha Womans University, Seoul; ²Department of Social and Preventive Medicine, College of Medicine, Inha University, Incheon, Korea



Background/Aims: Digestive diseases are highly prevalent and contribute substantially to healthcare utilization and costs. However, national-level data on digestive diseases burden in Korea are limited. This study aimed to estimate the healthcare burden of digestive diseases in Korea via a national database analysis.

Methods: We analyzed the 2020 National Patient Sample data from the Health Insurance Review and Assessment Service, covering the entire Korean population. Digestive diseases were grouped into seven categories. Medical utilization and expenditures were assessed using two criteria: the principal estimate (primary diagnosis only) and the extended estimate (primary plus first-listed secondary diagnosis).

Results: Approximately 18.5 million individuals (39.2% of all patients) received care for digestive diseases, according to the principal estimate, and 30.1 million (63.8%) received care, according to the extended estimate. Corresponding medical ex-

penditures were \$8.5 billion (11.6% of total national healthcare costs) based on the principal estimate and \$14.4 billion (19.6%) based on the extended estimate. Although only 7.4% of patients were hospitalized, they accounted for 51.4% of the total expenditure for digestive diseases. Colorectal cancer incurred the highest inpatient costs. Gastroesophageal reflux disease was the most common and expensive diagnosis in outpatients. Intestinal infectious diseases were the leading causes of hospitalization and emergency department visits; foreign body ingestion was a key driver in pediatric emergency cases.

Conclusions: Digestive diseases impose significant clinical and economic burdens in Korea. Their frequent occurrence as primary and comorbid diseases highlights the need for comprehensive healthcare strategies and informed policy planning.

Keywords: Digestive system diseases; Health services; Health expenditures; Cost of illness; Republic of Korea

INTRODUCTION

Digestive diseases are highly prevalent and contribute substantially to the global disease burden through extensive healthcare utilization [1,2]. In the United States, gastrointestinal (GI) health care expenditures totaled \$119.6 billion in 2018, with over 36.8 million ambulatory visits for GI symptoms and more than 3.8 million hospitalizations for principal GI diagnosis [1]. An Italian study reported that gastroenterology was under-resourced as a hospital specialty, with digestive diseases accounting for 10% of all hospital discharges [3].

Statistics that quantify the burden of digestive diseases are crucial for public health research, decision-making, priority-setting, and resource allocation. Studies on the epidemiology of digestive diseases are essential for these purposes and frequently referenced. However, research on the epidemiology and burden of digestive system diseases in Korea remains limited [4,5].

Furthermore, to assess disease burden and healthcare performance, data on the quantitative measurement of health status and creation of a systematically organized classification system encompassing all major disease entities are required. In 2000, the National Health Insurance Service (NHIS) was established to integrate all health insurance forms into a unified national system. By 2006, 96.3% of the South Korean population had been enrolled in the NHIS under government-mandated universal health coverage. This system enables estimation of disease prevalence based on healthcare utilization patterns and systematic calculation of digestive diseases-associated costs.

Therefore, this study aimed to systemically assess healthcare utilization patterns and costs for all categories of digestive diseases in 2020 using the NHIS sample data.

METHODS

Data

This retrospective study used the 2020 Health Insurance Review and Assessment Service-National Patient Sample (HIRA-NPS-2020) data. The HIRA-NPS-2020 includes approximately 1 million individuals, representing a stratified random sample (2%) of the Korean patient population, categorized into 18 age groups and two sex groups.

The HIRA operates as an independent entity separate from the NHIS, healthcare providers, and other stakeholders. Its main functions include reviewing claims for reimbursement and evaluating the quality of healthcare services in South Korea [6]. The HIRA manages claims data generated during reimbursement and evaluates the quality of healthcare services under the National Health Insurance (NHI) and Medical Aids programs in South Korea.

The NHI claims data include disease diagnoses, treatments, procedures, surgical histories, and prescription information. The HIRA-NPS-2020 comprises five datasets: 1) a general information file containing medical expenses, 2) a healthcare services file including inpatient prescriptions, 3) a diagnoses file, 4) an outpatient prescriptions file, and 5) a provider information file. Further details regarding the HIRA-NPS have been outlined in previous studies [6,7].

The Institutional Review Board of Ewha Womans University Medical Center approved this study, and informed consent was waived because of the use of de-identified data (EUMC 2023-07-024).

Definition of the digestive diseases

Patients with digestive diseases were identified from the HIRA-NPS data using the International Classification of Diseases, 10th Revision (ICD-10). The ICD-10 codes for diges-

tive diseases are listed in Supplementary Table 1. Digestive diseases were categorized into seven groups: malignant neoplasm, in situ neoplasm of the digestive tract and benign neoplasm of uncertain behavior, upper GI tract disease, lower GI tract disease, liver disease, pancreaticobiliary disease, and GI symptoms. Each group comprised 190 distinct conditions.

Because digestive diseases often occur as primary conditions and common comorbidities of other disorders, we assessed their burden using two criteria. The principal estimate included only cases in which digestive diseases were the primary diagnosis. However, because digestive diseases often present as significant comorbidities, a strict primary diagnosis-based estimate may substantially underestimate the true burden. Conversely, including all secondary diagnoses in the claims data can lead to extreme overestimation due to reimbursement-driven coding practices. Therefore, we defined an extended estimate that includes cases in which digestive diseases are either the primary diagnosis or the first-listed secondary diagnosis. This dual approach was designed to capture clinically significant comorbidities, while preserving diagnostic validity and minimizing overestimation caused by minor or reimbursement-focused coding.

Analysis

The disease burden of digestive diseases in 2020 was estimated based on the number of patients and healthcare costs for each specific condition. Weights from the HIRA-NPS-2020 were applied, and duplicate patient counts were removed to compute the overall burden. Patients were categorized according to sex, age, healthcare provider type, and service type (inpatient or outpatient).

This study focused exclusively on direct medical expenses to assess the burden of digestive diseases. The costs included hospitalizations, outpatient visits, emergency room visits, diagnostic tests, and outpatient prescriptions. We excluded out-of-pocket expenses for noncovered items, pharmacy dispensing fees (billed separately by pharmacies), and oriental medical service expenses. Additionally, dental services related to digestive diseases were included.

The definitions of terms used in this study were as follows:

1) Number of patients: the actual number of patients who received medical treatment within 1 year categorized by disease and health care facility types.

2) Visit (hospitalization) days: the number of days that patients actually visited or were hospitalized at healthcare

facilities.

3) Medical expenses: the total cost incurred for health-care insurance per claim, excluding non-covered expenses. This included the combined amount covered by the insurer (NHIS) and the patient's out-of-pocket expenses for covered items. However, pharmacy dispensing costs, which were separately billed by pharmacies, were not included. For the extended estimate, the total medical expense of the claim was assigned if digestive disease was the primary or first-listed secondary diagnosis. This is because line-item separation for shared costs (e.g., hospitalization fees) is not feasible in the claims database. All medical expenditures originally calculated in South Korean Won (KRW) were converted to United States Dollars (USD), applying the 2020 average exchange rate of 1,180 KRW per 1 USD.

Use of emergency medical services for the treatment of digestive diseases was estimated based on the number of patients. Because patients were often transferred to outpatient or inpatient care through the emergency department, emergency services were not separately costed but included in the outpatient or inpatient expenses.

Major diagnostic tests and procedures were identified and estimated based on codes from the Health Insurance Fee Schedule. Readmission was defined as subsequent hospitalization within 30 days for the same diagnostic category. Readmission rates were calculated by determining whether patients admitted to hospital between January and November 2020 were readmitted within 30 days of their initial discharge. This method was used because the HIRA-NPS provides annual healthcare utilization data (Supplementary Table 2).

RESULTS

Estimation of total medical utilization

In 2020, a total of 47.2 million individuals utilized medical services at least once (Table 1). Among them, 18.5 million (39.2%) received healthcare services for digestive diseases based on the principal estimate and 30.1 million (63.8%) based on the extended estimates. According to Statistics Korea, the national population in 2020 was 50,133,493. Of this population, 60.1% (30.1 million) and 36.9% (18.5 million) received medical services for digestive diseases according to the extended and principal estimates, respectively.

In 2020, total medical expenses amounted to \$73.5 bil-

Table 1. Summary of digestive system diseases-related hospital utilization in Korea in 2020

Variable	Total		Digestive diseases, the principal estimate			Digestive diseases, the extended estimate		
	Patients (n) ^{a)}	Medical expenses ^{b)}	Patients (n) ^{c)}	Proportion (%) ^{d)}	Medical expenses ^{b)}	Patients (n) ^{c)}	Proportion (%) ^{d)}	Medical expenses ^{b)}
Total utilization	47,244,193	73,486,377	18,500,000	39.2	8,532,553	30,144,955	63.8	14,384,020
In hospitalization	6,620,449	27,869,089	1,359,868	20.5	4,382,321	2,097,951	31.7	6,516,057
Ambulatory care visit	47,031,729	45,617,288	18,311,305	39.0	4,115,553	29,882,661	63.6	7,818,285
Age (yr)								
< 15	5,921,434	3,691,929	1,808,847	30.6	213,643	2,865,816	48.4	386,937
15–39	14,395,827	10,013,611	4,977,566	34.6	1,123,502	8,698,952	60.4	2,050,244
40–65	18,961,228	27,905,009	7,921,528	41.8	3,979,966	12,826,852	67.7	6,641,560
≥ 65	7,965,704	31,875,828	3,792,059	47.6	3,215,442	5,753,335	72.2	5,305,280
Sex								
Male	23,118,404	34,009,748	8,572,850	37.1	4,908,781	14,157,023	61.2	7,804,842
Female	24,125,789	39,476,629	9,927,151	41.2	3,623,773	15,987,932	66.3	6,579,178

The cost is presented in US \$1,000. Converted at the 2020 exchange rate of KRW 1,180 per US \$1.

^{a)}The number of patients utilizing medical services one or more times (excluding cases where only pharmacy services were utilized).

^{b)}The sum of the National Health Insurance coverage costs, patient's co-payment including dental care (excluding non-insured patient co-payments and oriental medicine), and outpatient prescription drug costs excluding pharmacy fees.

^{c)}These values are aggregated based on the primary diagnosis or the primary diagnosis and first-listed secondary diagnosis, applying weighted values.

^{d)}These values represent the proportion of patients with digestive diseases among all patients who visited a healthcare provider.

^{e)}These values represent the percentage of total healthcare expenses attributable to digestive diseases; the principal estimate of digestive diseases, including primary diagnosis; the extended estimate of digestive diseases, including primary and first-listed secondary diagnosis.

lion. Of this, \$8.5 billion (11.6%) was attributed to digestive disease per the principal estimate and \$14.4 billion (19.6%) per the extended estimate.

In pediatric patients (aged < 15 yr), digestive diseases accounted for 48.4% of all cases and 10.5% of pediatric healthcare expenditures, according to the extended estimate. Among individuals aged 40–65 years, 67.7% had digestive diseases, accounting for 23.8% of total healthcare costs. In those aged ≥ 65 years, the prevalence increased to 72.2%, with the corresponding costs comprising 16.6% of total expenses. Although the prevalence of digestive diseases increased with age, the 40–65 years age group showed the highest proportion of digestive disease-related expenditures.

Among the total number of healthcare users for digestive diseases as per the extended estimates, males accounted for 14.2 million individuals, comprising 61.2% of the overall male healthcare users, which was lower than the 66.3% observed in females. However, regarding healthcare costs, males accounted for 23.0%, whereas females accounted for 16.7%. Although 13.0% more females received care for digestive diseases, male patients accounted for 18.6% higher total expenditures.

As shown in Figure 1, the largest proportion of medical expenditures was attributed to malignant neoplasms, followed by lower and upper GI diseases, liver disease, and pancreaticobiliary disease.

Among the most common GI diseases, gastroesophageal reflux disease (GERD) was the most prevalent, followed by gastritis/duodenitis. Malignant neoplasms of the colon had

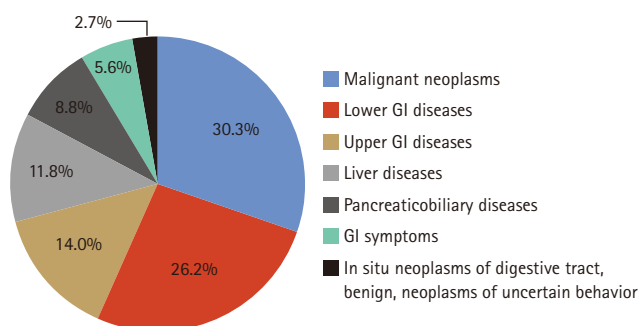


Figure 1. Distribution of medical expenditures for digestive diseases by diagnostic category based on the principal estimates in 2020. Malignant neoplasms accounted for 30.3% of the total costs, followed by lower gastrointestinal (GI) diseases (26.2%), upper GI diseases (14.0%), liver diseases (11.8%), pancreaticobiliary diseases (8.8%), benign and in situ neoplasms (2.7%), and other GI symptoms (5.6%).

the highest overall and per-capita healthcare costs (Supplementary Table 2).

Medical utilization in hospitalized patients with digestive diseases

Based on the principal estimate, 1.4 million patients with digestive diseases were hospitalized (7.4%), incurring \$4.4 billion in healthcare costs (51.4% of total digestive disease expenditures). According to the extended estimate, 2.1 million patients (7.0%) were hospitalized, with associated healthcare costs of \$6.5 billion (45.3%) (Table 1). This indicated that 35.2% of hospitalizations and 32.7% of inpatient costs were related to digestive diseases present as comorbidities rather than primary diagnoses.

Based on the principal estimate, intestinal infectious diseases were the most common cause of hospitalization ($n = 272,843$), ranking fifth in total cost at \$292.0 million (Table 2). Other frequent causes included hemorrhoids, cholelithiasis/cholecystitis, anorectal disorders, abdominal pain, and appendicitis. Malignant neoplasms of the colon accounted for the highest cost among hospitalized patients at \$536.1 million. This was followed by cholelithiasis/cholecystitis and malignant neoplasms of the stomach, liver, and intestinal infections, all of which contributed significantly to the overall costs. According to the extended estimate, gastritis/duodenitis was the most common diagnosis, followed by intestinal infectious disease, GERD, hemorrhoids, abdominal pain, and nausea/vomiting. Consistent with the principal estimate, malignant neoplasms of the colon accounted for the highest healthcare expenditure, followed by cholelithiasis/cholecystitis, intestinal infectious diseases, gastritis/duodenitis, gastric cancer, and GERD. Fatty liver ranked 10th in frequency and 7th in cost, suggesting a significant disease burden.

The highest 30-day readmission rate was observed in patients with pancreatic cancer (48.3%), followed by those with anal cancer (41.7%) and those with esophageal cancer (35.6%). The top 10 conditions with the highest readmission rates were malignancies; congenital intestinal malformation ranked 11th (Supplementary Table 3). The 30-day readmission rate for *Clostridioides difficile* colitis was 8.2%.

Outpatient medical services

According to the principal estimate, 18.3 million outpatient visits were due to digestive diseases (99.0% of total digestive disease utilization), accounting for 48.3% of total

Table 2. Hospitalization for digestive diseases in South Korea in 2020

Rank	Digestive diseases (the primary estimate)				Digestive diseases (the extended estimate)			
	Diagnosis	Patients (n)	Hospital days	Medical expenses	Diagnosis	Patients (n)	Hospital days	Medical expenses
1	Intestinal infectious disease	272,843	1,525,255	292,034	Gastritis/duodenitis	399,642	2,071,500	464,047
2	Hemorrhoid	162,697	434,392	167,313	Intestinal infectious disease	350,491	2,363,178	468,676
3	Cholelithiasis/cholecystitis ^{a)}	105,947	1,115,364	498,530	GERD ^{e)}	219,395	1,327,868	403,255
4	Anorectal disorders ^{b)}	81,348	221,445	89,824	Hemorrhoid	175,447	507,840	185,976
5	Abdominal pain	76,448	161,746	38,383	Abdominal pain	169,396	557,937	139,043
6	Appendicitis	73,149	386,842	233,944	Nausea and vomiting	154,497	562,587	157,830
7	Benign neoplasm of the colon ^{c)}	63,199	175,846	68,592	Cholelithiasis/cholecystitis	127,147	1,683,994	624,428
8	Malignant neoplasm of the colon	47,499	1,876,345	536,126	Anorectal disorders ^{b)}	99,748	308,593	116,490
9	Malignant neoplasm of the stomach	40,599	1,359,410	350,852	Peptic ulcer disease	91,248	778,227	245,590
10	Abdominal wall and inguinal hernia	38,149	140,546	79,186	Fatty liver and other liver diseases ^{d)}	89,048	909,478	245,181
11	Gastritis/duodenitis	34,749	116,147	21,946	Constipation	81,398	1,992,405	235,365
12	Malignant neoplasm of the liver	32,949	865,973	340,280	Appendicitis	79,748	471,189	259,142
13	Ileus and intestinal obstruction	28,449	322,290	78,176	Benign neoplasm of colon ^{c)}	71,698	243,444	86,738
14	Peptic ulcer disease	27,199	246,592	87,070	Malignant neoplasm of colon	55,498	2,446,827	725,917
15	Fatty liver and other liver diseases ^{d)}	26,849	270,993	71,080	Malignant neoplasm of biliary tract	52,348	1,638,048	595,293
16	GERD ^{e)}	25,299	122,547	25,285	Malignant neoplasm of stomach	45,999	1,635,450	422,733
17	Diverticular disease of the intestine	23,250	160,146	44,551	Ileus and intestinal obstruction	44,349	579,431	148,829
18	Benign neoplasm of the stomach, duodenum ^{f)}	23,249	99,097	42,047	Abdominal wall and inguinal hernia	41,199	175,245	93,653
19	Alcoholic liver disease	19,100	480,285	103,111	Functional dyspepsia	41,099	287,644	46,943
20	Acute pancreatitis	19,050	223,895	57,778	Chronic hepatitis	35,799	435,690	145,777

The cost is presented in US \$1,000.

GERD, gastroesophageal reflux disease.

^{a)}Includes cholangitis.

^{b)}Includes fissure, fistula, abscess, and other anorectal disorders.

^{c)}Includes colon polyps.

^{d)}Includes fatty liver, non-alcoholic steatohepatitis, non-alcoholic fatty liver disease, hepatic cysts, and liver abscess.

^{e)}Includes reflux esophagitis and heartburn.

^{f)}Includes polyps of the stomach and duodenum; the principal estimate, digestive diseases including the primary diagnosis; the extended estimate, digestive diseases including the primary and first-listed secondary diagnoses.

Table 3. Outpatient visits for digestive diseases in South Korea in 2020

Rank	Digestive diseases (the primary estimate)				Digestive diseases (the extended estimate)			
	Diagnosis	Patients (n)	Visit days	Medical expenses	Diagnosis	Patients (n)	Visit days	Medical expenses
1	GERD ^{a)}	4,860,997	10,913,752	508,817	Gastritis/duodenitis	19,782,438	61,659,441	2,508,024
2	Gastritis/duodenitis	4,708,449	8,611,451	314,411	GERD ^{a)}	9,962,238	25,409,514	1,481,014
3	Intestinal infectious disease	3,911,561	6,169,904	191,585	Intestinal infectious disease	5,137,079	9,628,304	323,044
4	Abdominal pain	2,027,360	3,081,486	243,245	Functional dyspepsia	4,646,699	10,153,165	384,539
5	Irritable bowel syndrome	1,450,418	2,395,594	126,456	Abdominal pain	3,454,180	5,636,132	436,013
6	Peptic ulcer disease	1,272,322	2,526,641	132,440	Peptic ulcer disease	2,824,487	6,424,545	384,930
7	Fatty liver and other liver diseases ^{b)}	1,174,676	2,084,508	162,704	Irritable bowel syndrome	2,694,291	5,044,530	287,602
8	Non-infective intestinal disease	1,090,376	1,588,713	45,192	Fatty liver and other liver diseases ^{b)}	2,540,648	5,044,345	458,539
9	Benign neoplasm of colon ^{c)}	1,055,578	1,476,068	374,644	Nausea and vomiting	1,712,361	2,641,588	140,560
10	Constipation	677,680	1,379,205	43,832	Non-infective intestinal disease	1,603,314	2,639,486	82,508
11	Functional dyspepsia	658,485	1,071,673	35,759	Constipation	1,392,511	3,378,946	179,494
12	Chronic hepatitis	623,138	2,208,356	389,005	Benign neoplasm of the colon ^{c)}	1,335,022	1,981,557	490,826
13	Hemorrhoid	616,838	1,517,020	65,334	Chronic hepatitis	930,431	3,495,978	627,578
14	Nausea and vomiting	452,289	610,135	18,685	Hemorrhoids	777,984	1,881,712	92,975
15	Anorectal disorders ^{d)}	294,494	745,084	35,184	Functional diarrhea	439,839	727,030	27,343
16	Cholelithiasis/cholecystitis ^{e)}	260,644	628,084	54,501	Anorectal disorders ^{d)}	439,691	1,097,127	62,991
17	Malignant neoplasm of the stomach	166,445	1,030,071	180,719	Cholelithiasis/cholecystitis ^{e)}	394,840	1,014,925	102,155
18	Benign neoplasm of the stomach, duodenum ^{f)}	157,146	348,991	31,333	Benign neoplasm of the stomach, duodenum ^{f)}	212,845	472,638	48,082
19	Foreign body in the gastrointestinal tract	156,847	186,446	9,082	Other GB diseases ^{g)}	212,696	378,442	41,842
20	Malignant neoplasm of colon	151,396	1,193,167	232,333	Alcoholic liver disease	197,096	636,687	68,766

The cost is presented in US \$1,000.

GERD, gastroesophageal reflux disease; GB, gallbladder.

^{a)}Includes reflux esophagitis and heartburn.

^{b)}Includes fatty liver, non-alcoholic steatohepatitis, non-alcoholic fatty liver disease, hepatic cysts, and liver abscess.

^{c)}Includes colon polyps.

^{d)}Includes fissure, fistula, abscess, and anorectal disorders.

^{e)}Includes cholangitis.

^{f)}Includes polyps of the stomach and duodenum.

^{g)}Includes polyps and adenomyomatosis of the GB; the principal estimate, digestive diseases including the primary diagnosis; the extended estimate, digestive diseases including the primary and first-listed secondary diagnoses.

expenditure (\$4.1 billion) (Table 1). Based on the extended estimate, outpatient visits similarly accounted for 99.1% of total cases, with associated expenditures totaling \$7.8 billion, representing 54.4% of total expenditures.

GERD was the most frequent outpatient diagnosis, based on the principal estimate, followed by gastritis/duodenitis, intestinal infections, abdominal pain, irritable bowel syndrome, peptic ulcers, and fatty liver (Table 3). Gastritis/duodenitis ranked first under the extended estimate, with a similar distribution for other conditions. Gastritis/duodenitis commonly appeared as a comorbidity, with the extended estimate showing 4.2 times more patients than the principal estimate. Healthcare costs were 8.0 times higher with

the extended estimate, with gastritis/duodenitis as the most prevalent comorbidity. Among the top 20 outpatient conditions (the principal estimate), GERD was the most expensive, with costs totaling \$508.8 million. Other conditions with associated high costs included chronic hepatitis, benign neoplasms of colon, gastritis/duodenitis, and abdominal pain.

Emergency room medical services

Emergency department visits for digestive diseases were assessed based on primary diagnoses and major symptoms. Intestinal infections were the most common causes of emergency visits ($n = 399,292$), followed by abdominal pain, gastritis/duodenitis, cholelithiasis/cholecystitis, nausea/

Table 4. Emergency room utilization for digestive diseases in South Korea in 2020

Rank	Diagnosis	Total patients (n) ^{a)}	Patients (n) ^{b)}	Proportion (%) ^{c)}
1	Intestinal infectious disease	4,055,908	399,292	9.8
2	Abdominal pain	2,082,258	224,445	10.8
3	Gastritis/duodenitis	4,728,749	91,848	1.9
4	Cholelithiasis/cholecystitis ^{d)}	285,193	52,398	18.4
5	Nausea and vomiting	460,039	41,699	9.1
6	Constipation	685,479	34,349	5.0
7	Ileus and intestinal obstruction	74,648	31,799	42.6
8	Foreign body in the gastrointestinal tract ^{e)}	159,297	29,299	18.4
9	Noninfective intestinal disease	1,100,626	27,249	2.5
10	Appendicitis	102,398	23,750	23.2
11	Malignant neoplasm of the colon	157,545	15,799	10.0
12	Peptic ulcer disease	1,284,171	15,700	1.2
13	Acute pancreatitis	41,449	14,400	34.7
14	Diverticular disease of intestine	62,799	13,900	22.1
15	GERD ^{f)}	4,872,947	13,850	0.3
16	Malignant neoplasm of the stomach	170,195	10,650	6.3
17	Alcoholic liver disease	123,698	10,550	8.5
18	Malignant neoplasm of the liver	70,848	9,450	13.3
19	Malignant neoplasm of the biliary tract	28,199	9,350	33.2
20	Malignant neoplasm of the pancreas	23,949	8,500	35.5

The cost is presented in US \$1,000.

GERD, gastroesophageal reflux disease; ER, emergency room.

^{a)}The total number of patients who visited the ER for each digestive disease.

^{b)}Patients visiting the ER were ranked based solely on the primary diagnosis of digestive disease, considering the primary symptom that prompted the visit.

^{c)}The proportion of ER utilization among all patients for each digestive disease.

^{d)}Includes cholangitis.

^{e)}Includes patients with foreign body sensation in the gastrointestinal tract who visited the ER.

^{f)}Includes reflux esophagitis and heartburn.

vomiting, and constipation (Table 4). Ileus/intestinal obstruction had the highest rate of emergency department utilization was 42.6%, followed by pancreatic cancer (35.5%), pancreatitis (34.7%), appendicitis (23.2%), and diverticular disease of intestine (22.1%).

Pediatric medical service utilization

A total of 2.9 million pediatric patients (aged < 15 yr) received care for digestive diseases, representing 48.4% of all pediatric patients in the extended estimate (Table 1). These patients incurred \$386.9 million in healthcare costs, accounting for 10.5% of pediatric healthcare expenditures. Among children aged < 15 years, intestinal infections were the most prevalent, costing \$91.3 million (23.6%), followed

by gastritis/duodenitis, abdominal pain, non-infective intestinal disease, and constipation. Emergency department visits showed similar trends, with intestinal infections, abdominal pain, foreign bodies in GI tract, and constipation being the most common causes (Table 5).

Neoplasm of digestive diseases leading to hospital utilization

According to the extended estimate, 490,636 patients sought care for malignant tumors through outpatient, inpatient, or emergency visits, comprising 1.6% of all patients with digestive diseases. The corresponding medical expenditures totaled \$3.1 billion, representing 21.3% of the total healthcare costs for digestive diseases. Gastric cancer was

Table 5. Medical utilization for pediatric gastrointestinal diseases in South Korea in 2020

Rank	Diagnosis	Patients (n)	Hospital visits (n)	ER utilization (n)	Medical expenses
1	Intestinal infectious disease	1,066,068	2,105,936	61,098	91,255
2	Gastritis/duodenitis	206,445	295,692	3,200	6,549
3	Abdominal pain	164,445	231,743	26,449	10,977
4	Noninfective intestinal disease	148,446	210,994	3,150	4,521
5	Constipation	138,446	247,492	9,850	5,286
6	Nausea and vomiting	132,246	174,445	8,050	5,036
7	Functional dyspepsia	62,548	78,198	450	1,321
8	GERD ^{a)}	56,999	89,148	300	2,690
9	Irritable bowel syndrome	51,899	68,748	500	1,569
10	Foreign body in the gastrointestinal tract	30,549	36,699	11,250	2,395
11	Functional diarrhea	26,449	42,199	100	768
12	Fatty liver and other liver diseases ^{b)}	14,250	29,049	150	2,042
13	Appendicitis	13,950	65,448	3,450	27,782
14	Peptic ulcer disease	12,350	17,900	700	426
15	Anorectal disorders ^{c)}	11,450	23,599	300	1,763
16	Paralytic ileus and intestinal obstruction without hernia	10,500	26,849	4,600	8,827
17	Abdominal wall and inguinal hernia	9,650	27,699	400	10,625
18	Hemorrhoids	5,500	6,800	- ^{d)}	388
19	Acute viral hepatitis	2,150	5,950	200	906
20	Bloating	2,000	3,500	300	164

This data includes the range of 0 to 14 years for each 5-year age group.

The cost is presented in US \$1,000.

ER, emergency room; GERD, gastroesophageal reflux disease.

^{a)}Includes reflux esophagitis and heartburn.

^{b)}Includes non-alcoholic steatohepatitis, non-alcoholic fatty liver disease, hepatic cysts, and liver abscess.

^{c)}Includes fissure, fistula, abscess, and other anorectal disorders.

^{d)}Not estimated due to a low sample number.

the most common malignancy ($n = 170,195$), followed by colorectal, liver, biliary tract, and pancreatic cancers. Colorectal cancer had the highest cost (\$775.1 million), followed by liver and gastric cancers. Pancreatic cancer had the highest per-patient cost of all digestive system malignancies (Table 6).

Healthcare utilization patterns according to types of medical institutions

Healthcare utilization for digestive diseases was assessed according to the type of medical institution, based on claim counts and expenditures (Supplementary Table 4). Under the extended estimate, tertiary hospitals accounted for 7.5 million patients (37.5%) and incurred \$8.4 billion in medical expenses (32.5%). In contrast, primary care clinics recorded a higher number of patients (25.3 million, 33.3%) but a lower total expenditure (\$4.2 billion, 20.5%). Secondary hospitals accounted for 5.0 million patients (34.3%) and

\$1.4 billion in expenses (19.2%). The lowest utilization was observed in care hospitals, with 172,045 patients (22.5%) and \$0.4 billion in expenditures (8.5%).

Utilization of endoscopy and other diagnostic tests for digestive diseases

According to the NHIS-NPS data, 2,447,896 esophagogastroduodenoscopy procedures were performed under the extended estimate (Supplementary Table 5). In addition, 2,493,798 colonoscopies, 70,098 endoscopic retrograde cholangiopancreatography procedures, and 650 balloon-assisted enteroscopies were performed. The NHIS-NPS data included in this study comprised the number of endoscopic procedures performed in hospitals for digestive diseases. In addition, nationwide gastric and colon cancer screenings using endoscopy are conducted in Korea as part of the National Cancer Screening Program for all citizens aged ≥ 40 years. Apart from the procedures identified through insur-

Table 6. Neoplasms of the digestive system leading to hospital utilization in South Korea in 2020

Rank	Diagnosis	Patients (n)	Hospital visits (days)	Medical expenses ^{a)}	Per capita cost ^{b)}
1	Malignant neoplasm of the stomach	170,195	2,406,881	538,412.5	3,163.5
2	Malignant neoplasm of the colon	157,545	3,081,261	775,147.6	4,920.2
3	Malignant neoplasm of the liver	70,848	1,487,806	541,710.0	7,646.1
4	Malignant neoplasm of the biliary tract	28,199	831,273	249,586.2	8,850.9
5	Malignant neoplasm of the pancreas	23,949	997,872	269,746.7	11,263.2
6	Carcinoma in situ of the colon	21,649	83,248	18,707.3	864.1
7	Neoplasm of the colon ^{c)}	13,450	47,999	11,606.4	2,172.6
8	Malignant neoplasm of the esophagus	12,050	337,640	100,224.9	8,317.7
9	Neoplasm of the hepatobiliary ^{c)}	10,400	18,999	3,250.3	312.5
10	Malignant neoplasm of the gallbladder	9,050	240,193	61,106.9	6,752.4
11	Carcinoma in situ of the stomach	6,950	57,597	10,082.6	1,450.8
12	Neoplasm of the stomach ^{c)}	6,050	25,099	6,272.7	1,036.8
13	Malignant neoplasm of the small intestine	3,450	53,948	26,064.9	7,555.2
14	Malignant neoplasm of the anus	2,450	60,148	12,400.3	5,061.5
15	Neoplasm of the small intestine ^{c)}	1,600	21,849	2,724.2	1,702.6
16	Carcinoma in situ of the hepatobiliary	1,250	9,300	1,908.1	1,526.6
17	Malignant neoplasm of other digestive organs	950	6,150	3,758.9	3,956.8
18	Carcinoma in situ of the esophagus	350	2,650	438.3	1,252.3
19	Carcinoma in situ of the anus	100	150	6.7	67.5

^{a)}The cost is presented in US \$1,000.

^{b)}The cost is presented in US \$1.

^{c)}In each organ, these conditions represent neoplasms of uncertain or unknown behavior, which are diagnosed when there is doubt about whether the neoplasm is malignant or benign.

ance claims, 6,277,456 upper endoscopies and 117,626 colonoscopies were performed in 2020 [8]. Although the two datasets were mutually exclusive, the number of procedures performed was substantial; therefore, additional data were included.

A total of 2,848,130 abdominal CT scans; 3,199,431 abdominal ultrasounds; and 220,745 abdominal magnetic resonance imaging scans were performed.

DISCUSSION

Among the population of South Korea in 2020 [9], 30.1 million (63.8%) and 18.5 million (39.2%) individuals received medical care for digestive diseases according to the extended and principal estimates, respectively. Korea's gross domestic product (GDP) in 2020 was \$1,744.4 billion, with a total national healthcare expenditure of \$73.5 billion (4.2% of GDP) [10]. Digestive diseases represented a considerable share of this expenditure, with costs of \$8.5 billion under the principal estimate and \$14.4 billion under the extended estimate, corresponding to 11.6% and 19.6% of total national healthcare spending, respectively. Notably, 41.0% of the expenditure in the extended estimate was associated with comorbidities rather than the primary diagnosis. Among patients with digestive diseases, 99% received outpatient care and only 7.4% were hospitalized. However, hospitalized patients accounted for 51.4% of the total medical expenditure for digestive diseases. No significant difference in healthcare utilization for digestive diseases was observed between sexes, whereas the highest utilization was observed in middle-aged adults aged 40–65 years.

In 2018, the annual expenditure for digestive diseases in the United States was estimated at a minimum of \$119.6 billion, based on data from the Medical Expenditure Panel Survey [11]. This conservative estimate likely underestimates the true economic burden, as it excluded most GI cancers [12]. Although direct comparisons are limited by the complexity of the healthcare system of the United States, 3.9 million hospitalizations in that year were associated with GI-related principal diagnoses.

That same year, the estimated aggregate charges (national bill) and actual costs for GI hospitalizations in the United States exceeded \$200 billion and \$47 billion, respectively [1]. Although cross-national comparisons are limited by methodological differences, South Korea reported 1.4

million hospitalizations due to digestive diseases, which is approximately one-third of the number observed in the United States. However, the associated treatment cost in Korea was only \$4.4 billion, roughly one-tenth of the United States expenditure, highlighting a substantial difference in per-case cost.

Although individuals aged 40–65 years used digestive disease-related healthcare services nearly twice as often as those aged ≥ 65 years, the associated expenditures were comparable. This pattern reflects high per-capita healthcare utilization among middle-aged people and increasing costs for older adults. Notably, South Korea had the highest per-capita healthcare utilization among Organization for Economic Cooperation and Development countries, with an annual average of 16.9 times in 2019 [11]. This trend is expected to intensify as population aging accelerates.

This study utilized the principal and extended estimates derived from national insurance claims data to assess the burden of digestive diseases. Although principal diagnoses provide greater specificity by focusing on the main cause of medical service use, they may substantially underestimate the disease burden. Given the frequent occurrence of digestive diseases as secondary conditions, we included the first-listed secondary diagnosis to reduce potential underestimation while preserving diagnostic relevance. According to the principal estimate, 39 per 100 individuals utilized healthcare services for digestive diseases, which increased to 64 per 100 when comorbidities were included in the extended estimate. As expected, the extended estimate yielded 1.6 times more patients and incurred 1.7 times higher costs, underscoring the substantial impact of digestive diseases beyond their role as primary diagnoses.

According to the principal estimate, intestinal infectious disease was the most common cause of hospitalization ($n = 272,843$). In contrast, based on the extended estimate, gastritis/duodenitis was the most frequently diagnosed condition ($n = 399,642$), with the highest prevalence among all GI diseases. This finding suggests that a substantial number of patients admitted for other conditions had concurrent diagnoses of gastritis/duodenitis. A similar pattern was observed for outpatient care. This trend may be explained by the heterogeneous clinical presentation of gastritis/duodenitis and the variable application of diagnostic criteria across clinical settings. The corresponding diagnostic codes encompass a broad clinical spectrum, ranging from functional dyspepsia to superficial or erosive mucosal changes

identified during endoscopy, which are often classified under the same category. In addition, the prophylactic use of acid-suppressive agents, particularly in patients prescribed non-steroidal anti-inflammatory drugs, antiplatelet agents, or anticoagulants, may have contributed to the frequent occurrence of this diagnosis. This is likely an important factor underlying its high prevalence in the claims data.

We applied the principal estimate to maintain mutually exclusive disease categories for inpatient cost comparison. Malignant neoplasms comprised the majority of the top five inpatient cost drivers, underscoring the substantial economic burden of GI cancers on hospitalized patients. Colorectal cancer accounted for the highest inpatient costs, followed by gastric, hepatic, and biliary cancers. In outpatient settings, high expenditures have been observed for common benign diseases, including GERD, chronic hepatitis, colorectal adenomas, gastritis/duodenitis, and abdominal pain. The diseases with the highest emergency room utilization included ileus/obstruction, acute pancreatitis, pancreatic cancer, and biliary cancer, suggesting that acute abdominal pain was a major driver of emergency department visits. Foreign body ingestion has been identified as a leading cause of emergency room visit among pediatric patients compared to adult patients.

A major strength of this study is its use of a nationally representative dataset. Even in the United States, where the health insurance system is complex and fragmented, efforts have been made to establish and utilize a nationwide health information network [1,12,13]. By contrast, South Korea operates a single-payer NHI system that provides universal population coverage. The claims database used in this study covers approximately 96% of the Korean population, thus ensuring high external validity [14]. Furthermore, it includes data from a wide range of healthcare institutions, including primary, secondary, and tertiary medical facilities, as well as nursing facilities, thereby reflecting real-world service utilization [15,16].

In addition, our findings reflect a significant temporal shift compared with previous national data. A 2011 study by Jung et al. [5] estimated that approximately 20 million Koreans used medical services for digestive diseases. In contrast, our extended estimate for 2020 shows a substantial increase to 30.1 million individuals, accompanied by a corresponding surge in total healthcare expenditures. This upward trajectory over the past decade is likely driven by South Korea's rapidly aging population, leading to an increase in age-re-

lated chronic digestive disorders and an expanding pool of patients diagnosed through the national cancer screening program. This persistent and growing burden highlights the importance of periodically updating national healthcare utilization statistics to effectively guide resource allocation.

However, this study had several limitations. First, the HIRA-NPS dataset was based on a stratified sample, which may limit its generalizability in estimating the nationwide burden of disease in Korea. However, previous studies have demonstrated that analyses using weighted HIRA-NPS data produce estimates of medical utilization and expenditure that closely align with national statistics for common conditions [17]. In particular, the reliability and stability of the estimates improved with high numbers of patients and service claims. Conversely, the representativeness may be limited for rare diseases with low claim frequencies. Second, the dataset includes only insurance-covered services and excludes out-of-pocket expenditures for non-covered care. Therefore, the overall burden of disease and diagnostic test utilization, especially for endoscopic procedures, may have been underestimated. South Korea has a high incidence of gastric cancer and operates a national cancer screening program for individuals aged ≥ 40 years. However, the results of these screenings were managed separately from those of the NHIS database used in this study. Additionally, screening procedures performed through private or employer-sponsored health checkups were excluded, further contributing to an underestimation of the total number of esophago-gastroduodenoscopies, colonoscopies, abdominal ultrasonography, and CT scans performed for screening purposes. Third, the accuracy of disease coding within the ICD-10 system may have affected diagnostic validity. As the HIRA database is based on a fee-for-service insurance structure, diagnosis codes are primarily assigned for reimbursement instead of clinical classification. Previous studies reported a concordance rate of approximately 70% for primary diagnoses, 53.6% for secondary diagnoses, and slightly higher rates for inpatient data (75.9%) and malignant neoplasms (77.3%) [16,18]. Fourth, the study period (2020) coincided with the onset of the COVID-19 pandemic, which profoundly impacted healthcare access and utilization behaviors. Elective procedures (such as screening endoscopies and non-urgent surgeries) and outpatient visits for mild symptoms were likely reduced during this period due to social distancing measures and patients' fear of infection. Consequently, the disease burden and economic costs reported

in this study may be underestimated compared to pre-pandemic years. Nevertheless, despite the potential contraction in medical utilization, digestive diseases still accounted for a significant proportion of the national healthcare burden, highlighting their ongoing clinical and economic significance. Fifth, because the extended estimate only included the record first secondary diagnosis, digestive diseases that were recorded as lower-priority comorbidities beyond this position may not have been captured. This could potentially lead to an underestimation of the true comorbidity-related burden. Therefore, we present both principal and extended estimates to capture the plausible range of disease burden under different case definitions. Sixth, because isolating line-item costs is unfeasible, the extended estimate attributes the entire claim cost to the digestive disease. This may result in an overestimation of the economic burden when non-GI primary conditions are the main cost driver. Nevertheless, our dual-estimate approach mitigates this issue by providing a conservative lower bound alongside the broader healthcare footprint.

Despite these limitations, this study provided a comprehensive and nationally representative assessment of the healthcare burden associated with digestive diseases in Korea. The application of principal and extended estimations allowed for a more accurate reflection of the real-world clinical and economic impacts of digestive diseases at the national level.

In conclusions, digestive diseases are highly prevalent in Korea, accounting for approximately four in 10 healthcare visits, based on the principal diagnoses, and up to six in 10 patients when comorbidities were included. The corresponding healthcare expenditures, \$8.5–14.4 billion, represents a major economic burden on the national healthcare system. Their frequent presentation as both primary and secondary diagnoses significantly increases healthcare utilization and associated costs.

Given the rapidly aging population of Korea, the demand for digestive disease related to digestive diseases is expected to increase. These findings underscore the urgent need for proactive healthcare strategies, targeted resource allocation, and informed policy planning to effectively manage the increasing clinical and economic burden of digestive diseases.

KEY MESSAGE

1. In 2020, digestive diseases affected a large proportion of the Korean population, accounting for a notable share of national healthcare expenditure.
2. Although most patients were treated in outpatient settings, the care of hospitalized patients contributed to a disproportionate share of total costs.
3. Targeted interventions are required to reduce economic burden, especially for high-cost patient groups.

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Correspondence to

Hye-Kyung Jung, M.D., Ph.D.

Department of Internal Medicine, College of Medicine, Ewha Womans University, 1071 Anyangcheon-ro, Yangcheon-gu, Seoul 07985, Korea
Tel: +82-2-2650-5002, Fax: +82-2-2650-5052

E-mail: junghk@ewha.ac.kr

<https://orcid.org/0000-0002-6653-5214>

Correspondence to

Younhee Kim, Ph.D.

Department of Social and Preventive Medicine, College of Medicine, Inha University, 100 Inha-ro, Michuhol-gu, Incheon 22212, Korea
Tel: +82-32-860-9842, Fax: +82-32-885-8302

E-mail: younhee@inha.ac.kr

<https://orcid.org/0000-0001-6782-3050>

Credit authorship contributions

Eui Sun Jeong: methodology, resources, data curation, formal analysis, writing - original draft, visualization; Hye-Kyung Jung: conceptualization, methodology, resources, investigation, writing - review & editing, supervision, funding acquisition; Younhee Kim: conceptualization, methodology, resources, data curation, formal analysis, software, writing - review & editing; Hyung Seok Lim: investigation, data curation, formal analysis

Conflicts of interest

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Supplementary Table 1. ICD-10: digestive diseases

Diseases	ICD-10 codes
Malignant neoplasm	
Malignant neoplasm of the esophagus	C15
Malignant neoplasm of the stomach	C16
Malignant neoplasm of the small intestine	C17
Malignant neoplasm of the colon and rectosigmoid junction	C18, C19
Malignant neoplasm of the rectum	C20
Malignant neoplasm of the anus and anal canal	C21
Malignant neoplasm of the liver and intrahepatic bile ducts	C22
Liver cell carcinoma	C220
Intra-hepatic duct carcinoma	C221
Malignant neoplasm of the gallbladder	C23
Malignant neoplasm of other and unspecified parts of the biliary tract	C24
Extra-duct cancer	C240
Malignant neoplasm of the pancreas	C25
Malignant neoplasm of other and ill-defined organs of the digestive system	C26
In situ neoplasm of the digestive tract, benign, neoplasm of uncertain behavior	
Carcinoma in situ of the esophagus	D001
Carcinoma in situ of stomach	D002
Carcinoma in situ of the lower GI	D010, D011, D012, D013
Colon and rectosigmoid junction	D010 D011
Rectum	D012
Anus and anal canal	D013
Carcinoma in situ of other parts of the GI	D014, D015, D017, D019
Liver, GB, bile duct, ampulla of Vater	D015
Benign neoplasm of the colon and rectum, anus, and anal canal	D12
From cecum to recto-sigmoid colon	D120 D121 D122 D123 D124 D125 D126 D127
Rectum	D128
Anus and anal canal	D129
Benign neoplasm of other and ill-defined parts of the digestive system	D13
Esophagus	D130
Stomach, including adenomatous polyp of the stomach	D131
Duodenum, small intestine	D132 D133
Liver (intrahepatic)	D134
Extra-hepatic bile ducts	D135
Pancreas	D136 D137
Benign neoplasm, IPNM, MCN, SCA	D136
Endocrine, islet cell	D137
Ill-defined sites in the digestive system	D139
Neoplasm of uncertain or unknown behavior of digestive organs	D371, D372, D373, D374, D375, D376, D377, D379
Stomach	D371
Small intestine	D372

Supplementary Table 1. Continued

Diseases	ICD-10 codes
From appendix to colon	D373 D374
Rectum	D375
Liver, GB, bile duct	D376
Upper GI tract	
Esophagitis	K20
Gastroesophageal reflux disease and reflux esophagitis	K21
Other esophageal disease	K22, K23
Achalasia	K220
Diffuse esophageal spasm	K224
Peptic ulcer disease	K25, K26, K27, K28
Gastric ulcer	K25
Duodenal ulcer	K26
Peptic ulcer	K27
Gastrojejunal ulcer (marginal ulcer)	K28
Gastritis, duodenitis, and dyspepsia	K29, K30
Gastritis, duodenitis	K29
Functional dyspepsia	K30
Other diseases of the stomach and duodenum	K31
Polyp of the stomach and duodenum	K317
Helicobacter infection	A048, A498, B980, K295
Lower GI tract	
Appendicitis	K35, K36, K37
Other diseases of the appendix	K38
Abdominal wall and inguinal hernia	K40, K41, K42, K43, K44, K45, K46
Crohn's disease	K50
Ulcerative colitis	K51
Other noninfective enteritis and colitis	K52
Intestinal infectious disease	A00, A01, A02, A03, A04, A05, A06, A07, A08, A09
Clostridium difficile colitis	A047, A480, A414, B968
Vascular disorders of the intestine	K55
Paralytic ileus and intestinal obstruction without hernia	K56
Diverticular disease of the intestine	K57
Irritable bowel syndrome	K58
IBS-diarrhea predominant	K581
IBS-constipation predominant	K582
IBS-mixed	K583
IBS-other	K588
Other functional intestinal disorders	K59
Constipation	K590
Functional diarrhea	K591
Neurogenic bowel	K592

Supplementary Table 1. Continued

Diseases	ICD-10 codes
Megacolon	K593
Anal spasm	K594
Anorectal disorder	K60, K61, K62
Rectal bleeding	K625
Other diseases of the intestine	K63
Colon polyp	K635
Hemorrhoids	K64
Disease of peritoneum	K65, K66, K67
Liver disease	
Alcoholic liver disease	K70
Alcoholic fibrosis and sclerosis and cirrhosis	K702, K703
Alcoholic hepatic failure	K704
Toxic liver disease	K71
Hepatic failure, not elsewhere classified	K72
Chronic hepatitis	K73
Fibrosis and cirrhosis of liver	K74
Other inflammatory liver diseases	K75
Non-alcoholic steatohepatitis	K758
Other diseases of the liver	K76
Fatty liver, non-alcoholic liver disease	K760
Hepatovenooclusive disease	K765
Portal hypertension	K766, K767
Liver cysts	K768
Liver disorders in diseases classified elsewhere	K77
Esophageal varix	I85, I982, I983
Gastric varix	I864
Viral hepatitis	B15-B19
Acute hepatitis A	B15
Acute hepatitis B	B16
Other acute viral hepatitis	B17
Acute hepatitis C	B171
Chronic viral hepatitis	B18
Chronic viral hepatitis B	B180, B181
Chronic viral hepatitis C	B182
Unspecified viral hepatitis	B19
Pancreaticobiliary disease	
Cholelithiasis	K80
Cholecystitis	K81
Other diseases of the GB	K82
GB polyp	K8280
Adenomyomatosis of the GB	K8288

Supplementary Table 1. Continued

Diseases	ICD-10 codes
Other disease of biliary tract	K83
Acute cholangitis, autoimmune cholangitis, primary sclerosing cholangitis	K830
Biliary stricture	K831
Acute pancreatitis	K85
Idiopathic	K850
Biliary, gallstone	K851
Alcohol	K852
Drug	K853
Acute interstitial pancreatitis, autoimmune, hereditary, necrotizing	K858
Other diseases of the pancreas	K86
Alcoholic pancreatitis, acute or chronic	K860
Chronic pancreatitis	K861
Pancreatic cyst	K862
Pseudocyst	K863
Disorders of the pancreas, gallbladder, and biliary tract in diseases classified elsewhere	K87
GI symptoms	
Intestinal malabsorption	K90
Other diseases of the digestive system	K91, K92, K93
Hematemesis	K920
Melena, hematochezia	K921
Gastrointestinal hemorrhage	K922
Symptoms and signs involving the digestive system and abdomen	R10', 'R11', 'R12', 'R13', 'R14', 'R15', 'R16', 'R17', 'R18', 'R19
Abdominal/pelvic pain	R10
Nausea and vomiting	R11
Heartburn	R12
Dysphagia	R13
Flatulence and related conditions, bloating	R14
Fecal incontinence	R15
Ascites	R18
Foreign body in the GI tract	T172, T173, T181, T182, T183, T184, T185, T188, T189
Specific codes for pediatric patients	
Congenital malformations of esophagus	Q39
Other congenital malformations of the upper alimentary tract	Q40
Congenital absence, atresia, and stenosis of the small intestine	Q41
Congenital absence, atresia, and stenosis of the large intestine	Q42
Other congenital malformations of the intestine	Q43
Congenital malformations of the gallbladder, bile ducts, and liver	Q44
Other congenital malformations of the digestive system	Q45

ICD-10, International Classification of Diseases 10th Revision; GI, gastrointestinal; GB, gallbladder; IPNM, intraductal papillary mucinous neoplasm; MCN, mucinous cystic neoplasm; SCA, serous cystadenoma; IBS, irritable bowel syndrome.

Supplementary Table 2. Leading primary diagnosis for digestive diseases in South Korea in 2020

Rank	Diagnosis ^{a)}	ICD-10 code	Total patients (n)	Inpatients (n)	Outpatients (n)	ER patients (n)	Hospital visit days	Medical expenses ^{b)}	Per capita cost ^{c)}
1	GERD ^{d)}	K21, R12	4,872,947	25,299	4,860,997	13,850	11,038,499	534,410.1	109.7
2	Gastritis/duodenitis	K29	4,728,749	34,749	4,708,449	91,848	8,727,598	336,357.1	71.1
3	Intestinal infectious disease	A00–09	4,055,908	272,843	3,911,561	398,142	7,697,459	484,036.2	119.3
4	Abdominal pain	R10	2,082,258	76,448	2,027,360	224,445	3,243,232	281,627.8	135.3
5	Irritable bowel syndrome	K58	1,457,068	10,300	1,450,418	4,850	2,451,092	137,119.3	94.1
6	Peptic ulcer disease	K25–K28	1,284,171	27,199	1,272,322	15,700	2,774,433	220,101.5	171.4
7	Fatty liver and other liver diseases ^{e)}	K75, K76	1,190,876	26,849	1,174,676	10,050	2,356,701	234,179.7	447
8	Non-infective intestinal disease	K52	1,100,626	12,800	1,090,376	27,249	1,651,911	55,950.7	50.8
9	Benign neoplasm of the colon ^{f)}	K635, D120–128	1,094,727	63,199	1,055,578	950	1,652,263	443,292.2	404.9
10	Constipation	K590	685,479	10,400	677,680	34,349	1,413,004	49,589.7	72.3
11	Functional dyspepsia	K30	660,635	2,750	658,485	5,250	1,079,323	37,243.7	56.4
12	Chronic hepatitis	B18, K73	460,141	5,700	458,441	800	1,894,663	373,273.2	811.2
13	Nausea and vomiting	R11	460,039	9,600	452,289	41,699	636,534	24,395.0	53.0
14	Anorectal disorders ^{g)}	K60–62	302,294	81,348	294,494	3,850	967,229	125,168.7	414.1
15	Cholelithiasis/cholecystitis ^{h)}	K80, K81	285,193	105,947	260,644	52,398	1,746,099	553,586.1	3,931.3
16	Malignant neoplasm of the stomach	C16	170,195	40,599	166,445	10,650	2,406,881	538,412.5	3,163.5
17	Benign neoplasm of the stomach, duodenum ⁱ⁾	K317, D131, D132, D133	160,796	23,249	157,146	400	448,439	73,577.9	457.6
18	Malignant neoplasm of the colon	C18–20	157,545	47,499	151,396	15,799	3,081,261	775,147.6	4,920.2
19	Functional diarrhea	K591	140,147	700	139,547	900	207,294	5,376.2	38.4
20	Other GB diseases ^{j)}	K82	134,847	7,600	133,247	700	272,994	46,419.8	344.2
19	Alcoholic liver disease	K70	123,698	19,100	115,598	10,550	841,678	141,842.6	1,146.7
20	Appendicitis	K35–37	102,398	73,149	96,148	23,750	551,788	242,131.5	2,364.6

ICD-10, International Classification of Diseases 10th Revision; ER, emergency room; GERD, gastroesophageal reflux disease; GB, gallbladder.

^{a)}These values were aggregated based on the primary diagnosis, using weighted values.^{b)}The cost is presented in US \$1,000. The sum of the National Health Insurance coverage costs, patient's co-payment including dental care (excluding non-insured patient co-payments and oriental medicine), and outpatient prescription drug costs excluding pharmacy fees.^{c)}The cost is presented in US \$1.^{d)}Includes reflux esophagitis and heartburn.^{e)}Includes fatty liver, non-alcoholic steatohepatitis, non-alcoholic fatty liver disease, hepatic cysts, and liver abscess.^{f)}Includes polyps of the colon.^{g)}Includes fissure, fistula, abscess, and other anorectal disorders.^{h)}Includes cholangitisⁱ⁾Includes polyps of the stomach and duodenum.^{j)}Includes polyps and adenomyomatosis of the GB.

Supplementary Table 3. Ranking of all-cause 30-day readmissions among patients admitted for digestive diseases in Korea in 2020

Rank	Diagnosis	Readmitted (%)
1	Malignant neoplasm of the pancreas	48.3
2	Malignant neoplasm of the anus	41.7
3	Malignant neoplasm of the esophagus	35.6
4	Malignant neoplasm of the gallbladder	34.6
5	Malignant neoplasm of the colon	34.5
6	Malignant neoplasm of the biliary tract	33.0
7	Malignant neoplasm of the small intestine	30.0
8	Malignant neoplasm of the stomach	26.1
9	Chronic viral hepatitis C	21.1
10	Malignant neoplasm of the liver	19.4
11	Alcoholic liver disease	14.3
12	Dysphagia	13.2
13	Ulcerative colitis	11.1
14	Cholecystitis	9.8
15	Biliary stricture	9.3
16	Acute pancreatitis with gallstone	9.1
17	Hepatic failure	8.5
18	Pancreatic pseudocyst	8.3
19	Fatty liver and other liver diseases	8.2
20	<i>Clostridoides difficile</i> colitis	8.2

Table shows the percentage of readmissions within 30 days for the same class. We excluded cases with a total hospitalization estimate of < 10 because they may be overestimated.

Supplementary Table 4. Healthcare utilization patterns according to the type of medical institution

Type of medical institution	Total			Digestive diseases (the primary estimate)			Digestive diseases (the extended estimate)		
	Patients (n) ^{a)}	Medical expenses ^{b)}		Patients (n) ^{a)}	Medical expenses ^{b)}	Proportion (%) ^{c)}	Patients (n) ^{a)}	Medical expenses ^{b)}	Proportion (%) ^{d)}
Tertiary hospital	19,989,590	25,715,134		4,617,444	5,624,853	23.1	7,496,629	8,356,755	32.5
Secondary hospital	14,643,563	7,190,854		2,629,643	725,112	18.0	5,024,193	1,380,239	19.2
Primary care clinic	75,988,189	20,383,936		14,301,843	1,967,737	18.8	25,263,213	4,177,170	20.5
Care hospital	764,111	5,195,300		85,548	201,344	11.2	172,045	441,465	8.5

The cost is presented in US \$1,000.

^{a)}The utilization of healthcare services according to the type of medical institution is not mutually exclusive.

^{b)}The sum of the National Health Insurance coverage costs, patient's co-payment including dental care (excluding non-insured patient co-payments and oriental medicine), and outpatient prescription drug costs excluding pharmacy fees.

^{c)}These values represent the proportion of patients with digestive diseases among all patients who visited healthcare providers.

^{d)}These values represent the percentage of total healthcare expenses attributable to digestive diseases; the principal estimate, digestive diseases including primary diagnosis; the extended estimate, digestive diseases including the primary and first-listed secondary diagnoses.

Supplementary Table 5. Annual utilization of endoscopy and other diagnostic tests for digestive diseases in South Korea in 2020

Type of test	Digestive diseases	
	Patients (n)	Total number of tests
Endoscopic examination		
Esophagogastroduodenoscopy ^{a)}	2,219,902	2,447,896
Colonoscopy, sigmoidoscopy ^{a)}	2,263,854	2,493,798
Diagnostic ERCP	11,150	12,500
Therapeutic ERCP ^{b)}	44,049	57,598
Balloon enteroscopy	650	650
Therapeutic endoscopy ^{c)}	1,352,671	1,383,870
Screening endoscopy ^{d)}		
Esophagogastroduodenoscopy	6,227,456	
Colonoscopy	117,626	
Diagnostic imaging		
Plain X-ray	2,708,782	4,034,644
Contrast study	48,199	56,048
CT	2,059,100	2,848,130
MRI	178,146	220,745
Ultrasonography	2,893,089	3,199,431
Nuclear imaging test	144,796	182,795

ERCP, endoscopic retrograde cholangiopancreatography; CT, computed tomography; MRI, magnetic resonance imaging.

^{a)}Underestimated compared to the actual number due to the exclusion of screening endoscopy.

^{b)}Includes sphincterotomy, biliary and pancreatic duct drainage, endoscopic biliary and pancreatic duct stricture dilatation, and biliary or pancreatic stone removal.

^{c)}Includes polypectomy, endoscopic mucosal resection, endoscopic submucosal dissection, endoscopic bleeding control, and endoscopic dilatation using a stent or balloon.

^{d)}Data for screening endoscopy were obtained from the National Cancer Screening Program and are not included in claims-based estimates from the Health Insurance Review and Assessment-National Patient Sample [8]. For screening procedures, only the number of individuals who underwent the procedure was available; the number of tests performed was not reported.