Gastric Cancer (2020) 23:497–509
https://doi.org/10.1007/s10120-019-01017-8

ORIGINAL ARTICLE

Disparities in gastric cancer screening among people with disabilities: a national registry-linkage study in South Korea

YoungJee Kim[1] · Dong Wook Shin[1,2] · Hyoung Woo Kim[3] · Jin Hyung Jung[4] · Kyungdo Han[4] · In Young Cho[1] · So Young Kim[5,6,7] · Kui Son Choi[8] · Jong Heon Park[9] · Jong Hyock Park[5,7] · Ichiro Kawachi[7]

Received: 25 July 2019 / Accepted: 15 October 2019 / Published online: 1 November 2019

Abstract

Background and aim Using the national disability registration linked to the cancer screening database in Korea, we examined (1) trends in the gastric cancer screening rate among people with disabilities over time, and (2) whether gastric cancer screening participation and modalities differed according to presence, severity, and type of disability.

Methods We examined gastric cancer screening participation rates among individuals with registered disability, from 2006 to 2015.

Results The age- and sex-adjusted rate for gastric cancer screening in people with disabilities increased from 25.9% in 2006 to 51.9% in 2015 (change: + 26.0%). During the same period, screening rates among people without disability improved from 24.7 to 56.5% (change: + 31.8%). Disability was associated with a screening rate [adjusted odds ratio (aOR) 0.89, 95% confidence interval (CI), 0.88–0.89]. Screening rates were markedly lower among people with severe disabilities (aOR 0.58, 95% CI 0.57–0.58) and people with autism (aOR 0.36, 95% CI 0.25–0.52), renal failure (aOR 0.39, 95% CI 0.38–0.39), brain injury (aOR 0.41, 95% CI 0.40–0.41), ostomy problems (aOR 0.53, 95% CI 0.51–0.55), intellectual disabilities (aOR 0.54, 95% CI 0.53–0.54), or mental disorders (aOR 0.55, 95% CI 0.54–0.56). The use of gastroscopy as the initial screening modality in people with disabilities was lower than in people without a disability.

Conclusions In spite of the availability of national gastric cancer screening program, we found significant disparities in gastric cancer screening participation, especially among people with severe disabilities and those with renal failure or brain-related/mental disabilities.

Keywords Gastric cancer · Screening · Gastroscopy · Disability

Abbreviations

NCSP National Cancer Screening Program
NHID National Health Information Database
NHIS National Health Insurance Service
UGIS Upper gastrointestinal series

Dong Wook Shin and Jong Hyock Park have contributed equally to this work.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10120-019-01017-8) contains supplementary material, which is available to authorized users.

✉ Dong Wook Shin
dwshin.md@gmail.com

✉ Jong Hyock Park
jonghyock@gmail.com; jhpark@hsph.harvard.edu

Extended author information available on the last page of the article

Introduction

Despite improvements in early detection and treatment, the incidence and mortality rates from gastric cancer remain high both worldwide and in Korea. Gastric cancer is the third leading cause of death from cancer worldwide, with 951,600 new cases and 723,100 deaths in 2012 [1]. The burden of disease from gastric cancer is highest in the east Asian region, particularly in Korea, Japan, and China, with about three quarters of all new cases worldwide occurring in Asian countries [1, 2]. In Korea, gastric cancer remains the most commonest cancer in males; 19,545 new cases were detected in men in 2015. Furthermore, gastric cancer is the fourth most common cancer in women, with 9662 new cases detected in women in 2015 [3].

Gastric cancer screening enables the detection of early stage cancer, contributing to dramatic decreases in mortality from the disease in Korea [4]. Due to the lack of

symptoms or signs in the early stage of gastric cancer, it is easy to miss the window for early treatment without regular screening [4]. In Korea, the government started the National Cancer Screening Program (NCSP) in 1999 to provide Korean people aged 40 or older with gastroscopy or upper gastrointestinal series (UGIS) every other year for free, including a biopsy if required [5]. A previous study of the effectiveness of gastric cancer screening in Korea showed that ever-screened subjects had a 21% reduction in mortality from gastric cancer, and as the number of screenings increased, the reduction in the mortality rate from gastric cancer became greater [4]. Partly as a result of the national gastric cancer screening program, the age-standardized gastric cancer mortality rate decreased from 23.8 to 8.9 per 100,000 persons from 1999 to 2015 [3]. Cost-effectiveness of gastric cancer screening in Korea is also well established.[6] Although there are some potential risks of endoscopic screening, including infection (hepatitis B) or bleeding, with good skills and quality management, risk of serious adverse effects (e.g. bleeding requiring admission, anaphylactic shock, or death) is extremely low [7].

In spite of these achievements, inequalities persist in the uptake of cancer screening, particularly with regard to socioeconomic position [8, 9]. Another overlooked dimension of disparity is disability status [10]. People with disabilities are diverse, and their ability to request and receive preventive care depends on the specific type and severity of their disability [11]. For example, some disabilities impede gastric cancer screening participation and would, thus, influence the gastric cancer screening modality (i.e., gastroscopy vs. UGIS). The diverse obstacles associated with different disabilities have important implications for the creation of tailored interventions to improve gastric cancer screening participation.

However, few data are currently available on disparities in gastric cancer screening with regard to disabilities. One previous study analyzed data from the 2005 Korean National Health and Nutrition Examination and found that disability-related factors were not significantly associated with gastric cancer screening participation [9]. However, that study used self-reported disability status, defined as limitations in general activity, walking problems, visual problems, or hearing problems, and did not consider severity information. That is, the study was not based on an objective clinical assessment of disability status and, therefore, could not examine the heterogeneity of gastric cancer screening rates among people with diverse types and severities of disability. Furthermore, it was a cross-sectional study performed in 2005. Data describing trends in gastric cancer screening among people with disabilities are still lacking. To our knowledge, no study has yet used a large-scale administrative data to address that research gap.

In Korea, universal health coverage is offered to all people, and the gastric cancer screening program is offered by the NCSP at minimal or no cost [12]. In addition, through the national disability registration system, the types and severities of disabilities are classified and registered based on medical examinations and specific criteria, providing a unique opportunity to test how specific types and severities of disabilities affect gastric cancer screening participation.

In this study, we used linked administrative data to investigate 1) how gastric cancer screening participation and its modalities differ according to the presence, type, and severity of disability; and 2) temporal trends in the gastric cancer screening rate among people with disabilities.

Methods

Study setting and data sources

Korean National Health Insurance Service (NHIS)

The NHIS is the only government insurer, offering universal health insurance that covers approximately 97% of the Korean population. The government covers the medical fees of people with the lowest incomes, and their qualification status and reimbursement are also settled by the NHIS. Therefore, the NHIS has comprehensive information about the age, sex, residential area, and income level of Koreans. In Korea, health insurance coverage is determined only by income level, not according to pre-existing health risk or disability status.

National Gastric Cancer Screening Program in Korea

The NCSP was initiated in 1999 as part of the 10-year National Cancer Control Plan [13]. Currently, the NCSP covers stomach, liver, colorectal, breast, and cervical cancer screenings for all people as indicated by age (Supplementary Table 1). Since 1999, free gastric cancer screening by gastroscopy or UGIS has been provided every other year to all Korean people aged 40 and older [4]. If gastric cancer is suspected by UGIS, gastroscopy can be offered as the next step, and biopsy is also provided at no charge [5].

All people eligible for the gastric cancer screening program receive an invitation containing information about gastric screening methods and the locations of nearby NCSP providers [14]. The Korean NHIS maintains complete information about both the eligibility for national gastric cancer screenings in a given year and the actual participation.

Disability registration system in Korea

In 1988, Korean government established a national registration system for disabilities that is categorized by type and severity for the purpose of determining welfare benefits. If an individual wishes to be registered as disabled, they must submit appropriate and validated documentation to a local National Pension Service office. The paperwork includes valid results of a disability diagnosis from a specialist physician in the relevant field in accordance with government guidelines for the specific disability. The national disability registration system recognizes 15 types of disability and 6 levels of severity (Supplementary Table 2). The level of severity for each disability is determined by the specialist physician according to pre-defined criteria by the Ministry of Health and Welfare guidelines, based on the degree of functional losses and clinical impairment. Severity is graded into six levels: from grade 1 (most severe) to 6 (least severe) [15–18]. As an example, for visual impairment, patients who have visual acuity < 0.02 in the better eye are classified as grade 1 (>85% of functional loss), and subjects who have visual acuity < 0.2 (better side) or loss of visual field > 50% in both eyes are classified as grade 5 (35–44% of functional loss) (Supplementary Table 3). For brain injuries, people who cannot perform ambulation and activities of daily living (ADL) due to quadriplegia or hemiplegia and totally need help from others are classified as grade 1. Those who need partial help in ambulation and ADL are classified as grade 3, and those who can perform ambulation and ADL perfectly by themselves but take a long time are classified as grade 6. In renal failure, people who had a kidney transplantation are classified as grade 5, and those who received hemodialysis or peritoneal dialysis for more than 3 months are classified as grade 2.

Data source and study subjects

The data used in this study were from the National Health Information Database (NHID) for 2006 to 2015. The NHID is public database containing healthcare utilization, health screening, sociodemographic, and mortality data for the whole population of South Korea. It, thus, provides an excellent platform for epidemiological and health policy studies. We described the details of the database profile elsewhere [19, 20]. Because the NCSP made some changes in its coverage and copayments during its early implementation phase (2001–2005), we have limited our analyses of gastric screening variables to 2006–2015 for consistency.

Statistical analyses

We derived age- and sex-standardized participation rates with 95% confidence intervals for each year during the study period according to the presence, type, and severity of a disability.

The 2010 Census of the Korean population was used for the age and sex standardization. We also assessed the percentage of screening participants in each year who underwent endoscopy and UGIS.

To examine factors associated with participation in gastric cancer screening, we carried out a series of multivariate logistic regressions using variables for disability (presence, severity, and type), and other sociodemographic variables (age, sex, income level, and place of residence). In Model 1, we compared the screening rate of people with disabilities with that of people without disabilities. In Model 2, the severity of disability was categorized into mild vs. severe, and the screening rates for each category were compared with rates among people with no disability. In Model 3, the odds ratio of screening according to disability grade was compared with those with no disability. In Model 4, the odds ratio of screening for people with different types of disabilities was compared with that of people with no disability.

We performed all analyses using SAS 9.3 software (Cary, NC, USA), and $p < 0.05$ was considered statistically significant. This study was reviewed by the Institutional Review Board of Chungbuk National University (CBNU-201708-BM-501-01).

Results

Study participants

The number of people invited to undergo gastric cancer screening increased from 10 million in 2006 to 12 million in 2015. Among these, the proportion of people who had a registered disability increased from 5.75% in 2006 to 8.06% in 2015 (Table 1).

Trends in gastric cancer screening rates according to disability status

The number of eligible and screened people in the national gastric cancer screening program and the crude and age- and sex-adjusted participation rates according to time are given in Table 1 and Supplementary Table 4. Trends in the participation rate in the national gastric cancer screening program from 2006 to 2015 are shown in Fig. 1. The age- and sex-adjusted screening rates for gastric cancer among people with disabilities increased from 25.9% in 2006 to 51.9% in 2015 (absolute change: + 26.0%). Over the same period, the screening rate among people without disabilities increased from 24.7 to 56.5% (absolute change: + 31.8%).

In terms of disability severity, people with mild disabilities showed a higher increase in screening rate (from 28.9

Table 1 Number of eligible and screened subjects based on the presence, severity, and type of disability over a 10-year period

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
People without a disability										
Eligible	9,460,989	8,769,098	10,571,592	10,587,321	9,823,194	11,540,934	10,185,264	10,523,157	10,766,760	11,079,434
Screened	2,261,839	2,526,762	3,657,088	4,200,937	4,212,228	5,362,530	5,336,035	5,131,692	5,869,009	6,281,290
Crude rate	23.9	28.8	34.6	39.7	42.9	46.5	52.4	48.8	54.5	56.7
People with a disability										
Eligible	576,784	597,230	762,163	830,983	780,818	1,112,367	791,258	961,357	963,547	971,238
Screened	150,306	186,962	289,407	348,693	350,328	497,553	425,635	455,056	498,883	508,808
Crude rate	26.1	31.3	38.0	42.0	44.9	44.7	53.8	47.3	51.8	52.4
By disability grade										
Severe (grades 1–3)										
Eligible	190,940	191,372	237,078	253,908	237,719	394,594	224,116	330,481	327,001	329,798
Screened	38,715	46,074	70,108	83,242	81,573	134,588	95,018	121,190	133,864	134,616
Crude rate	20.3	24.1	29.6	32.8	34.3	34.1	42.4	36.7	40.9	40.8
Mild (grades 4–6)										
Eligible	385,844	405,858	525,085	577,075	543,099	717,773	567,142	630,876	636,546	641,440
Screened	111,591	140,888	219,299	265,451	268,755	362,965	330,617	333,866	365,019	374,192
Crude rate	28.9	34.7	41.8	46.0	49.5	50.6	58.3	52.9	57.3	58.3
Grade 1 (most severe)										
Eligible	29,500	29,840	36,253	39,802	38,408	68,937	33,412	56,311	55,009	55,674
Screened	3195	3919	5916	7325	7480	15,465	9095	14,461	16,178	16,162
Crude rate	10.8	13.1	16.3	18.4	19.5	22.4	27.2	25.7	29.4	29.0
Grade 2										
Eligible	66,993	66,612	80,709	86,044	80,233	141,062	74,800	115,873	113,418	114,208
Screened	12,014	14,108	21,271	25,017	24,506	43,469	28,057	38,229	42,566	42,730
Crude rate	17.9	21.2	26.4	29.1	30.5	30.8	37.5	33.0	37.5	37.4
Grade 3										
Eligible	94,447	94,920	120,116	128,062	119,078	184,595	115,904	158,297	158,574	159,916
Screened	23,506	28,047	42,921	50,900	49,587	75,654	57,866	68,500	75,120	75,724
Crude rate	24.9	29.5	35.7	39.7	41.6	41.0	49.9	43.3	47.4	47.4
Grade 4										
Eligible	93,269	99,376	128,472	143,423	138,148	188,424	139,643	159,529	159,200	157,409
Screened	25,835	33,481	52,315	64,754	66,793	90,286	78,572	79,960	85,669	85,408
Crude rate	27.7	33.7	40.7	45.1	48.3	47.9	56.3	50.1	53.8	54.3
Grade 5										
Eligible	133,444	142,637	186,289	208,401	195,256	255,113	201,723	221,526	222,133	222,789

Table 1 (continued)

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Screened	39,351	50,326	78,663	96,855	97,364	129,341	117,442	117,388	127,394	129,979
Crude rate	29.5	35.3	42.2	46.5	49.9	50.7	58.2	53.0	57.4	58.3
Grade 6 (least severe)										
Eligible	159,131	163,845	210,324	225,251	209,695	274,236	225,776	249,821	255,213	261,242
Screened	46,405	57,081	88,321	103,842	104,598	143,338	134,603	136,518	151,956	158,805
Crude rate	29.2	34.8	42.0	46.1	49.9	52.3	59.6	54.6	59.5	60.8
By disability type										
Physical disability										
Eligible	353,952	365,082	467,830	508,551	470,446	626,672	480,686	543,872	544,991	544,281
Screened	99,492	123,519	192,620	232,384	232,615	316,697	282,654	288,370	314,264	319,872
Crude rate	28.1	33.8	41.2	45.7	49.4	50.5	58.8	53.0	57.7	58.8
Visual disability										
Eligible	64,811	65,889	82,166	87,561	80,952	113,252	84,837	99,623	99,817	101,619
Screened	18,092	22,049	32,624	38,142	37,581	53,014	46,952	49,200	53,863	55,569
Crude rate	27.9	33.5	39.7	43.6	46.4	46.8	55.3	49.4	54.0	54.7
Hearing disability										
Eligible	61,769	66,420	85,766	95,432	90,706	124,096	90,879	104,086	103,871	103,131
Screened	17,260	21,951	33,508	40,223	40,642	54,475	47,630	48,534	52,876	52,945
Crude rate	27.9	33.0	39.1	42.1	44.8	43.9	52.4	46.6	50.9	51.3
Speech and language disability										
Eligible	3493	3567	4337	4679	4488	6854	4609	6067	6104	6584
Screened	705	909	1240	1552	1588	2396	1974	2381	2527	2825
Crude rate	20.2	25.5	28.6	33.2	35.4	35.0	42.8	39.2	41.4	42.9
Intellectual disability										
Eligible	5510	5581	6959	7771	7651	29,658	8880	29,180	30,418	32,241
Screened	883	1130	1639	2213	2185	9395	3201	9823	11,840	12,202
Crude rate	16.0	20.2	23.6	28.5	28.6	31.7	36.0	33.7	38.9	37.9
Disability due to brain injury										
Eligible	55,533	58,144	73,072	80,235	79,947	115,967	74,602	93,072	91,320	92,179
Screened	8876	11,218	17,486	21,098	21,976	31,217	25,801	28,007	30,301	30,808
Crude rate	16.0	19.3	23.9	26.3	27.5	26.9	34.6	30.1	33.2	33.4
Disability due to autism										
Eligible	10	13	7	22	16	54	22	56	65	81
Screened	2	1	3	4	7	12	6	9	22	19
Crude rate	20.0	7.7	42.9	18.2	43.8	22.2	27.3	16.1	33.8	23.5

Table 1 (continued)

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Disability due to mental disorder										
Eligible	5795	6208	8567	9949	10,491	42,803	10,918	38,981	39,492	41,254
Screened	1070	1342	2366	3108	3286	14,787	4313	13,524	15,713	15,657
Crude rate	18.5	21.6	27.6	31.2	31.3	34.5	39.5	34.7	39.8	38.0
Disability due to renal failure										
Eligible	10,974	10,916	13,957	15,919	16,735	26,202	18,289	25,057	26,385	28,516
Screened	941	1184	2148	2929	3529	5748	5361	6619	8245	9157
Crude rate	8.6	10.8	15.4	18.4	21.1	21.9	29.3	26.4	31.2	32.1
Disability due to heart problems										
Eligible	4161	4242	5275	5610	4578	5040	3059	3180	2958	2826
Screened	966	1133	1740	2144	1795	2019	1533	1372	1387	1357
Crude rate	23.2	26.7	33.0	38.2	39.2	40.1	50.1	43.1	46.9	48.0
Disability due to respiratory problems										
Eligible	4054	4314	5284	5551	5063	7273	4488	5615	5284	5200
Screened	913	1090	1666	1936	1963	2760	2059	2295	2302	2360
Crude rate	22.5	25.3	31.5	34.9	38.8	37.9	45.9	40.9	43.6	45.4
Disability due to liver disease										
Eligible	1744	1651	2358	2549	2715	3628	3040	3501	3675	3966
Screened	174	227	435	564	648	1018	1079	1194	1431	1701
Crude rate	10.0	13.7	18.4	22.1	23.9	28.1	35.5	34.1	38.9	42.9
Disability due to facial disfigurement										
Eligible	421	432	600	644	631	978	672	912	901	958
Screened	106	121	229	275	302	483	368	468	496	547
Crude rate	25.2	28.0	38.2	42.7	47.9	49.4	54.8	51.3	55.1	57.1
Disability due to ostomy										
Eligible	3655	3813	4686	5026	4906	6367	4863	5512	5628	5751
Screened	584	766	1163	1447	1481	1943	1887	1967	2192	2326
Crude rate	16.0	20.1	24.8	28.8	30.2	30.5	38.8	35.7	38.9	40.5
Epilepsy disability										
Eligible	902	958	1299	1484	1493	3523	1414	2643	2638	2651
Screened	242	322	540	674	730	1589	817	1293	1424	1463
Crude rate	26.8	33.6	41.6	45.4	48.9	45.1	57.8	48.9	54.0	55.2

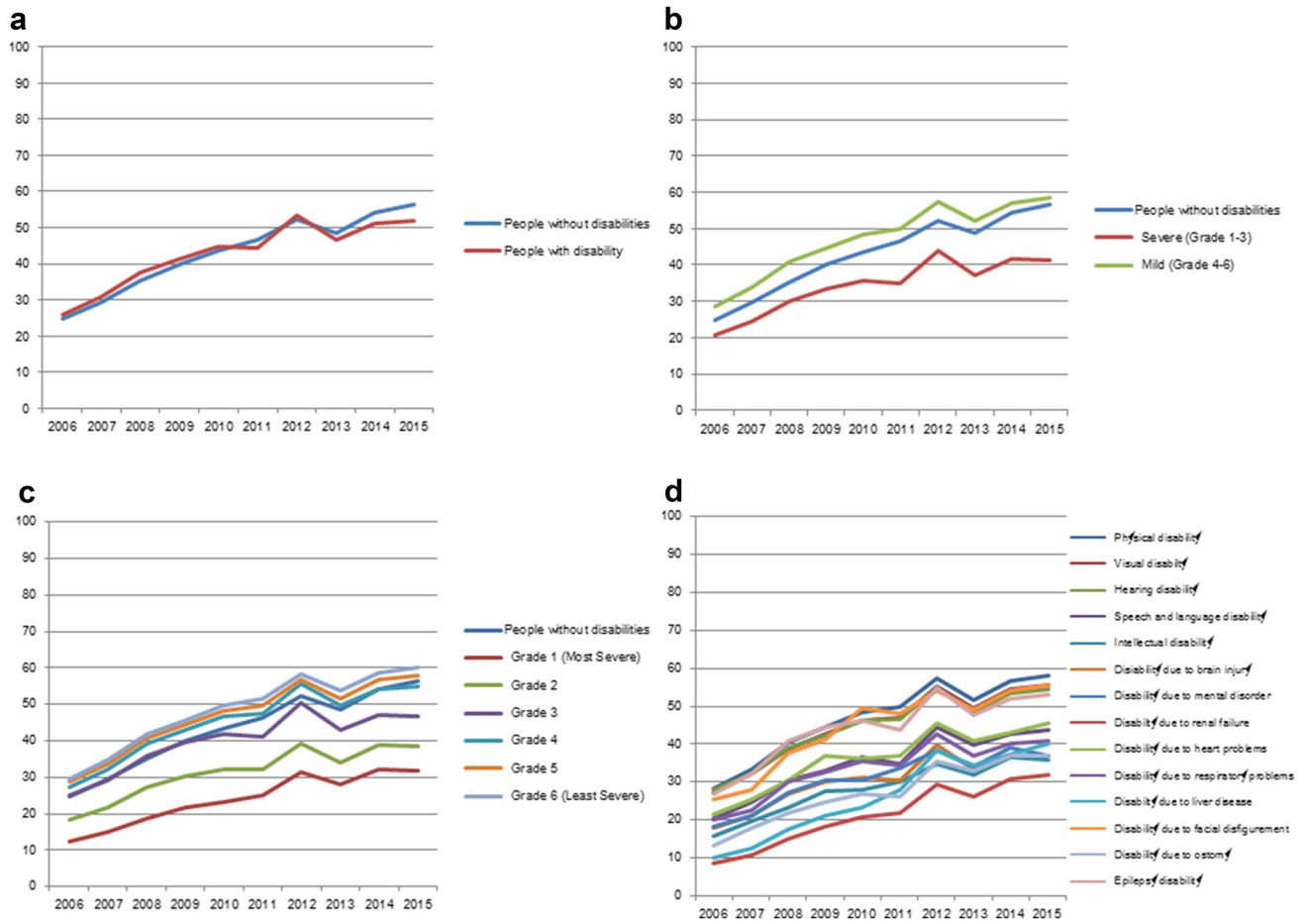

Fig. 1 Gastric cancer screening rate according to the presence, severity, and type of disability from 2006 to 2015

to 58.3%, absolute change: + 29.4%), whereas people with severe disabilities exhibited a more modest increase (from 20.3 to 40.8, absolute change: + 20.5%). Overall, that trend was linear: people with grade 1 (most severe) disabilities showed the lowest increase in screening rate (from 10.8 to 29.0%, absolute change: + 18.2%), while people with grade 6 (least severe) disabilities showed the highest increase (from 29.2 to 60.8%, absolute change: + 31.6%).

Among the disability types, both the highest screening rates and largest increases were observed among people with physical disabilities (from 28.2 to 58.1%, change: + 29.9%), facial disfigurements (from 25.4 to 55.5%, change: + 30.1%), visual disabilities (from 27.2 to 55.6%, change: + 28.4%), and hearing disabilities (from 27.8 to 54.5%, change: + 26.7%). Disabilities related to internal organ problems also showed relatively large increases, as shown in liver diseases (from 9.9 to 40.1%, change: + 30.2%) and heart problems (from 21.4 to 45.4%, change: + 24.1%). The lowest screening rate and the smallest increase in screening were observed in people with disabilities caused by autism. However, the total number of people in that group was too small, and hence, we excluded those data. Otherwise, the lowest screening rates and smallest increases were seen in people with renal failure (from 8.6 to 31.9%, change: + 23.3%), disabilities caused by brain injuries (from 17.8 to 37.0%, change: + 19.2%), intellectual disabilities (from 15.8 to 35.7%, change: + 19.9%), and disabilities caused by mental disorders (18.1 to 37.1%, change: + 19.0%) (Supplementary Table 4).

Factors associated with gastric screening

Adjusted gastric cancer screening rates for 2014–2015 are displayed by disability type and grade in Fig. 2. The patterns varied with the type of disability: overall, people with physical, facial disfigurement, epilepsy, visual, or hearing disabilities showed higher screening rates than those with disabilities related to the brain/mental disorders (autism, brain injury, intellectual disability, or mental disorder), renal failure, or ostomy.

After adjustment for age, income level, place of residence, and calendar year, the presence of a disability was associated with a slightly lower gastric cancer screening

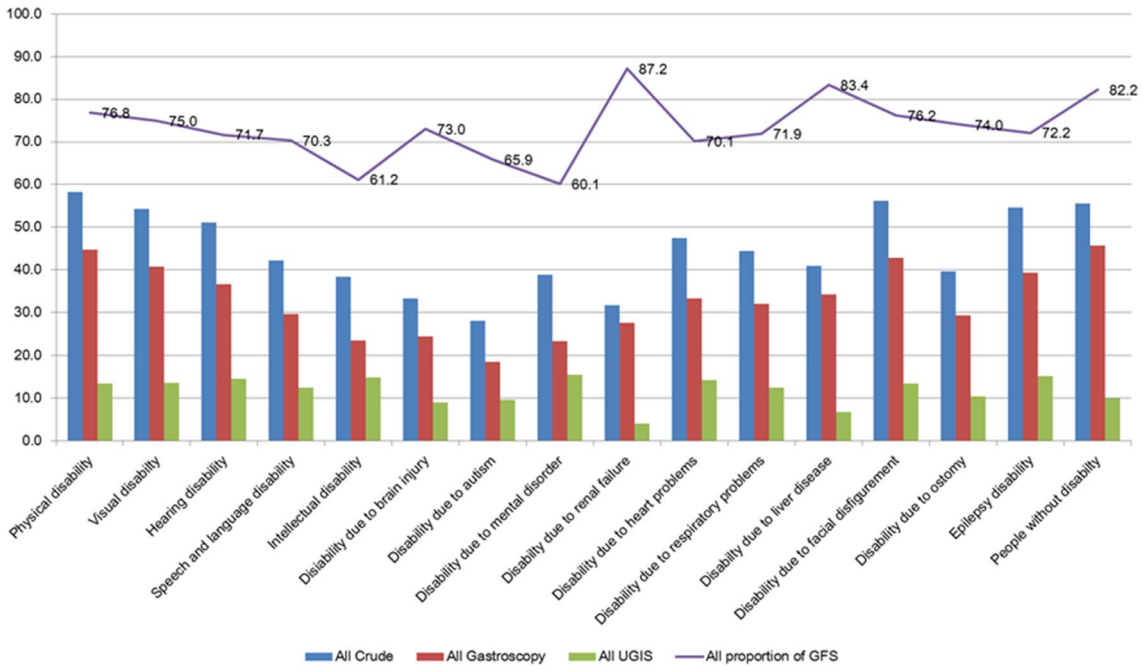

Fig. 2 Gastric cancer screening rate and modality by the type of disability in 2014–2015

rate [adjusted OR (aOR) 0.89, 95% confidence interval (CI), 0.88–0.89]. People with severe disabilities showed a markedly lower screening rate than people without disabilities (aOR 0.58, 95% CI 0.57–0.58); on the contrary, people with mild disabilities had higher screening rates than those without disabilities (aOR 1.11, 95% CI 1.10–1.11). As the severity of disability increased, the odds of having gastric cancer screening decreased gradually, and as the severity of disability decreased, the odds of having gastric cancer screening increased gradually (Table 2). Compared with people without a disability, people with grade 4, 3, 2, 1 disabilities had 0.93 (0.92, 0.94), 0.75 (0.74, 0.75), 0.50 (0.49, 0.50), and 0.34 (0.34, 0.35) times lower participation rates in gastric cancer screening, respectively. Compared with people without a disability, people with grade 5 or 6 disabilities had 1.09 (1.09, 1.10) and 1.24 (1.24, 1.25) times higher participation rates in gastric cancer screening, respectively.

By disability type, people with autism (aOR 0.36, 95% CI 0.25–0.52), renal failure (aOR 0.39, 95% CI 0.38–0.39), brain injuries (aOR 0.41, 95% CI 0.40–0.41), ostomy problems (aOR 0.53, 95% CI 0.51–0.55), intellectual disabilities (aOR 0.54, 95% CI 0.53–0.54), or mental disorders (aOR 0.55, 95% CI 0.54–0.56) showed substantially lower probabilities of having received gastric cancer screening than people without a disability. On the other hand, people with physical disabilities (aOR 1.13, 95% CI 1.12–1.13), facial disfigurement (aOR 1.05, 95% CI 0.96–1.15), or epilepsy disabilities (aOR 1.03, 95% CI 0.97–1.09) had higher screening rates than people without disabilities (Table 2).

Trends in the use of gastroscopy as the initial screening modality according to disability

The trends in the number and proportion people who received gastroscopy as the initial screening modality from 2006 to 2015 are shown in Fig. 3 and Supplementary Table 5. The use of gastroscopy as the initial screening modality for gastric cancer among people with disabilities increased from 42.7% in 2006 to 76.1% in 2015 (change: + 33.4%); the same rate among those without disabilities increased from 48.4 to 83.0% (change: + 34.6%).

Based on disability severity, the use of gastroscopy as the initial screening modality for gastric cancer among people with mild disabilities increased from 43.6% in 2006 to 76.9% in 2015 (change: + 33.3%); the same rate among those with severe disabilities increased from 40.4 to 74.0% (change: + 33.6%). The magnitude of increase in the use of gastroscopy as the initial screening modality was also similar among various disability types.

Discussion

To the best of our knowledge, this study is the first to show disparities in gastric screening rates among people with various severities and types of disabilities. The strengths of our study include the use of a large, representative sample and accurate measurements of disability status and screening practices.

Table 2 Factors associated with gastric cancer screening in year 2014–2015

	OR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Age, per 10 years	1.02 (1.02,1.02)	1.02 (1.02,1.02)	1.02 (1.02,1.02)	1.02 (1.02,1.02)
Male sex (vs. female)	0.77 (0.76,0.77)	0.77 (0.77,0.77)	0.77 (0.76,0.77)	0.77 (0.76,0.77)
Income level				
Rank 16–20 (highest)	1.04 (1.04,1.04)	1.03 (1.03,1.03)	1.03 (1.03,1.03)	1.03 (1.03,1.04)
Rank 11–15	1.19 (1.19,1.20)	1.18 (1.18,1.18)	1.18 (1.18,1.18)	1.18 (1.18,1.19)
Rank 6–10	1.27 (1.27,1.28)	1.26 (1.26,1.26)	1.26 (1.26,1.26)	1.26 (1.26,1.27)
Rank 1–5 and medical aid (lowest)	Ref	Ref	Ref	Ref
Place of residence				
Metropolitan	0.86 (0.86,0.86)	0.86 (0.86,0.86)	0.86 (0.86,0.86)	0.86 (0.86,0.87)
City	0.90 (0.90,0.91)	0.90 (0.90,0.91)	0.90 (0.90,0.91)	0.90 (0.90,0.91)
Rural	Ref	Ref	Ref	Ref
Calendar year (2015 vs. 2014)	1.09 (1.09,1.09)	1.09 (1.09,1.09)	1.09 (1.09,1.09)	1.09 (1.09,1.09)
Disability				
Yes (vs. no)	0.89 (0.88,0.89)			
Severe (vs. no)		0.58 (0.57,0.58)		
Mild (vs. no)		1.11 (1.10,1.11)		
Grade 1 (vs. no)			0.34 (0.34,0.35)	
Grade 2 (vs. no)			0.50 (0.49,0.50)	
Grade 3 (vs. no)			0.75 (0.74,0.75)	
Grade 4 (vs. no)			0.93 (0.92,0.94)	
Grade 5 (vs. no)			1.09 (1.09,1.10)	
Grade 6 (vs. no)			1.24 (1.24,1.25)	
By disability type				
Physical disability (vs. no)				1.13 (1.12,1.13)
Visual disability				0.97 (0.96,0.98)
Hearing disability				0.83 (0.83,0.84)
Speech and language disability				0.62 (0.60,0.64)
Intellectual disability				0.54 (0.53,0.54)
Disability due to brain injury				0.41 (0.40,0.41)
Disability due to autism				0.36 (0.25,0.52)
Disability due to mental disorder				0.55 (0.54,0.56)
Disability due to renal failure				0.39 (0.38,0.39)
Disability due to heart problems				0.75 (0.71,0.79)
Disability due to respiratory problems				0.69 (0.66,0.71)
Disability due to liver disease				0.60 (0.57,0.63)
Disability due to facial disfigurement				1.05 (0.96,1.15)
Disability due to ostomies				0.53 (0.51,0.55)
Epilepsy disability				1.03 (0.97,1.09)

Our results indicate the presence of significant disparities in gastric cancer screening participation among people with disabilities in a setting with minimal financial barriers. We have also shown that the pattern of disparities differs significantly by the severity and type of disability. Although gastric cancer screening rates in people with disabilities increased steadily during the study period, the screening rate in people without disabilities increased more rapidly during the same period, enlarging the disparity between the two groups over time. Furthermore, the choice of initial screening modality also differs significantly by the severity and type of disability, and the proportion of people with disabilities who received gastroscopy as the initial modality is increasing, although it was consistently lower than in people without disabilities.

Previous studies suggested several barriers that could account for the disparity. People with disabilities might not receive preventive screenings (e.g., Pap tests,

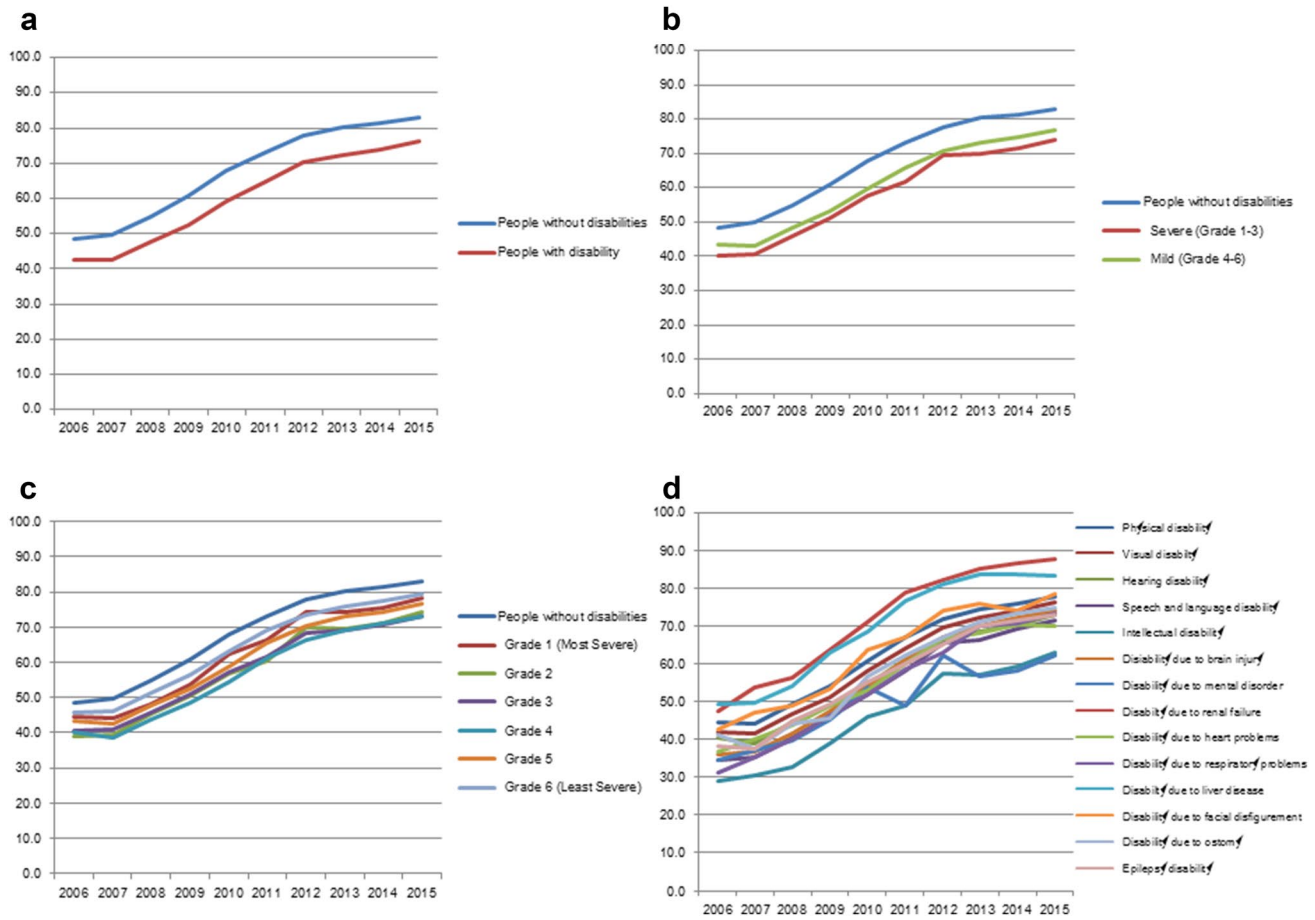

Fig. 3 Trend in gastric cancer screening modality by the type of disability

mammography, dental checks, cancer screenings) because of the unavailability of transportation, provider limitations (poor knowledge and negative attitudes among physicians), or patient limitations (limited access to health information or poor communication with their physicians) [21–24]. We found that having a severe disability correlated with lower screening rates for gastric cancer. Thus, people with disabilities, especially those with severe disabilities, are unlikely to take full advantage of the national free cancer screening service without an improvement in the physical, social, and attitudinal barriers to their participation [25].

On the other hand, we found that people with mild disabilities are more likely to receive gastric cancer screening than those without disabilities [23]. Some previous studies have also reported this phenomenon [26, 27], which probably occurs, because people with mild disabilities have more promoting factors (high health awareness and increased contact with health providers) than restricting factors (mobility or communication barriers) [23]. However, people with mild disabilities show a lower rate of choosing gastroscopy as the initial modality than those without disabilities, perhaps because they have more intention to do the test itself, but have some uncertain fear of the gastroscopy procedure.

People with different types of disabilities experience different cancer screening barriers: physical barriers impair access to facilities or diagnostic equipment [28, 29]; visual and hearing disabilities can limit access to screening information and communication with physicians [30, 31]; and brain-related/mental disabilities can result in limited knowledge about cancer screening [22, 24].

In our study, people with renal failure were the least likely to participate in the gastric screening program and also showed a smaller increase in the screening rate across the 10 year period. Given that people with such disabilities do not usually have mobility or communication barriers, their reasons for avoiding gastric cancer screening could be related to a lack of time (e.g., hemodialysis 3 times a week), they thought that they are already terminally ill, depression, or a fear of further medical interventions.

In another example, people with brain-related/mental disabilities (autism, brain injury, intellectual disabilities, and mental disorders) showed lower rates of gastric cancer screening and smaller increases over the 10 year period than

people without disabilities. These groups are characterized by cognitive and communication impairments. They might have poor communication with their healthcare providers; limited family, social, and community resources; or difficulty in understanding the importance and procedures of cancer screening [24]. Discrimination by healthcare providers against this population could also be a barrier [32]. A Japanese study revealed extremely low gastric cancer screening rates in schizophrenic patients, and suggested psychiatric outpatient clinics could be ideal places for individual interventions, as these people might not understand cancer screening and recall their prior participation.[33]

Participation in gastric cancer screening increased steadily during the study period irrespective of the type or severity of disability. However, the overall uptake remains low (56.7%) even among people with disability, and the disparity gap between people with and without disabilities also increased. This result contradicts previous studies, which suggested that the NCSP was succeeding in encouraging cancer screening equity among groups with different age and income status in Korea [34]. We have shown that different types and severities of disability affect participation in the gastric cancer screening program, and that the most disabled people are not properly benefiting from the current NCSP. It is important to develop healthcare policies to decrease this disparity in gastric cancer screening rates. For example, the NCSP could target specific information to people with disabilities (braille for visual disabilities and audiotapes for hearing disabilities), offer transportation support, allocate additional time for visits with disabled people, address negative and defensive attitudes among healthcare providers, and encourage parent/guardian recognition and participation in gastric cancer screening [23, 35]. People who have disabilities that do not negatively affect their life expectancy need to receive gastric cancer screening at rates comparable to those without disabilities.

People with disabilities generally had lower gastroscopy rates than people without disabilities, especially when the disability was severe, and the proportion of gastroscopy differed by disability type. UGIS is generally not recommended, because numerous studies have shown that gastroscopy offers a better accuracy than UGIS in detecting cancer [8, 36]. However, we could not determine the proportion of people with disabilities who could safely be screened by gastroscopy instead of UGIS. For example, people with mental disorders or intellectual disabilities show the lowest rates of gastroscopy as an initial modality. They might have avoided gastroscopy from fear or concerns about discomfort, because they might have difficulty in understanding the gastroscopy procedure. In other cases, the healthcare provider might have preferred UGIS over gastroscopy because of its simplicity and the difficulty in getting certain patients to cooperate with the gastroscopic exam. Further studies are required to assess the appropriateness of the modality selected for gastric cancer screening of people with disabilities.

Our study has some limitations. First, we could not account for several variables that can affect gastric cancer screening participation, such as the educational level, knowledge about preventive healthcare services, guardian factors, employment, and whether a disability is congenital. Further studies are needed to discover other factors that influence participation in gastric cancer screening. Second, our study did not have information about why people with disabilities did not get gastric cancer screening. Further studies that gather qualitative data through interviews or surveys are necessary to determine those reasons and establish healthcare policies. Third, people can have multiple disabilities simultaneously, but we could not take that into consideration because of the complexity of the analysis. Fourth, because of the specifics of the current Korean healthcare system, which might not reflect worldwide trends, our findings could have limited generalizability. Population-based gastric cancer screening is rarely performed except for Korea and Japan [37]. Nonetheless, our findings can suggest and broaden the understanding needed to develop preventive healthcare services that will function equally.

In summary, in spite of the accessibility of the NCSP, significant disparities exist in gastric cancer screening participation, especially among people with severe disabilities and people with renal failure and brain-related or mental disabilities (autism, brain injury, intellectual disabilities, and mental disorders). Although participation in gastric cancer screening increased steadily in people with disabilities during the study period, regardless of the type and severity of disability, the disparity between people with and without disabilities also widened. Our findings demonstrate the need to identify the specific barriers to gastric cancer screening in this vulnerable population and develop healthcare policies and interventions to remove them.

Author contributions Study concept and design: DWS, YK, SYK, and JHP. Acquisition of data: JHP, KH, JHP, and SYK. Analysis and interpretation of data: JHJ, KH, DWS, YK, HWK, SYK, KSC, JHP, JHP, and IK. Drafting of the manuscript: YK and DWS. Statistical analysis: JHJ and KH. Obtained funding: JHP. Administrative, technical or material support: JHP, JHP, and SYK.

Funding This work was supported by the R&D grant (no. 2016007) on rehabilitation by Korea National Rehabilitation Center Research Institute, Ministry of Health & Welfare, and the National Research Foundation of Korea (NRF) grant funded by the Ministry of Education (no. 2016R1D1A3B03931142) and by the Korea government (MSIT) (nos. 2019R1H1A2080180, 2019R1A2C1087507).

Compliance with ethical standards

Conflict of interest No author has potential conflict of interest, including financial interests or relationships.

References

1. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. CA Cancer J Clin. 2015;65:87–108.
2. Shen L, Shan YS, Hu HM, Price TJ, Sirohi B, Yeh KH, et al. Management of gastric cancer in Asia: resource-stratified guidelines. Lancet Oncol. 2013;14:e535–e547547.
3. Jung KW, Won YJ, Kong HJ, Lee ES. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2015. Cancer Res Treat. 2018;50:303–16.
4. Jun JK, Choi KS, Lee HY, Suh M, Park B, Song SH, et al. Effectiveness of the Korean National Cancer screening program in reducing gastric cancer mortality. Gastroenterology. 2017;152(1319–28):e7.
5. Lee KS, Oh DK, Han MA, Lee HY, Jun JK, Choi KS, et al. Gastric cancer screening in Korea: report on the national cancer screening program in 2008. Cancer Res Treat. 2011;43:83–8.
6. Cho E, Kang MH, Choi KS, Suh M, Jun JK, Park EC. Cost-effectiveness outcomes of the national gastric cancer screening program in South Korea. Asian Pac J Cancer Prev. 2013;14:2533–40.
7. Hamashima C. Benefits and harms of endoscopic screening for gastric cancer. World J Gastroenterol. 2016;22:6385–92.
8. Lee S, Jun JK, Suh M, Park B, Noh DK, Jung KW, et al. Gastric cancer screening uptake trends in Korea: results for the National Cancer Screening Program from 2002 to 2011: a prospective cross-sectional study. Medicine (Baltimore). 2015;94:e533.
9. Kwon YM, Lim HT, Lee K, Cho BL, Park MS, Son KY, et al. Factors associated with use of gastric cancer screening services in Korea. World J Gastroenterol. 2009;15:3653–9.
10. Krahn GL, Walker DK, Correa-De-Araujo R. Persons with disabilities as an unrecognized health disparity population. Am J Public Health. 2015;105(Suppl 2):S198–206.
11. Horner-Johnson W, Dobbertin K, Lee JC, Andresen EM. Disparities in health care access and receipt of preventive services by disability type: analysis of the medical expenditure panel survey. Health Serv Res. 2014;49:1980–99.
12. Jung HM, Lee JS, Lairson DR, Kim Y. The effect of national cancer screening on disparity reduction in cancer stage at diagnosis by income level. PLoS ONE. 2015;10:e0136036.
13. Yoo KY. Cancer control activities in the Republic of Korea. Jpn J Clin Oncol. 2008;38:327–33.
14. Suh M, Song S, Cho HN, Park B, Jun JK, Choi E, et al. Trends in participation rates for the National Cancer Screening Program in Korea, 2002–2012. Cancer Res Treat. 2017;49:798–806.
15. Shin DW, Lee JW, Jung JH, Han K, Kim SY, Choi KS, et al. Disparities in cervical cancer screening among women with disabilities: a national database study in South Korea. J Clin Oncol. 2018;36:2778–866.
16. Shin DW, Cho JH, Noh JM, Han H, Han K, Park SH, et al. Disparities in the diagnosis and treatment of lung cancer among people with disabilities. J Thorac Oncol. 2019;14:163–75.
17. Shin DW, Chang D, Jung JH, Han K, Kim SY, Choi KS, et al. Disparities in the participation rate of colorectal cancer screening by fecal occult blood test among people with disabilities: a national database study in South Korea. Cancer Res Treat. 2019. https://doi.org/10.4143/crt.2018.660.
18. Korea Ministry of Health and Welfare. Rules for disability registration [in Korean]. Korea Ministry of Government Legislation. 2019 [cited 2019 Sept 24]. https://www.law.go.kr/%EB%B2%95%EB%A0%B9/%EC%9E%A5%EC%95%A0%EC%9D%B8%EB%B3%B5%EC%A7%80%EB%B2%95%EC%8B%9C%ED%96%89%EA%B7%9C%EC%B9%99
19. Cheol Seong S, Kim YY, Khang YH, Heon Park J, Kang HJ, Lee H, et al. Data resource profile: the national health information database of the national health insurance service in South Korea. Int J Epidemiol. 2017;46:799–800.
20. Lee J, Lee JS, Park SH, Shin SA, Kim K. Cohort profile: the national health insurance service-national sample cohort (NHIS-NSC), South Korea. Int J Epidemiol. 2017;46:e15.
21. Lawthers AG, Pransky GS, Peterson LE, Himmelstein JH. Rethinking quality in the context of persons with disability. Int J Qual Health Care. 2003;15:287–99.
22. Reichard A, Stolzle H, Fox MH. Health disparities among adults with physical disabilities or cognitive limitations compared to individuals with no disabilities in the United States. Disabil Health J. 2011;4:59–67.
23. Park JH, Lee JS, Lee JY, Gwack J, Park JH, Kim YI, et al. Disparities between persons with and without disabilities in their participation rates in mass screening. Eur J Public Health. 2009;19:85–90.
24. Fujiwara M, Inagaki M, Nakaya N, Fujimori M, Higuchi Y, Hayashibara C, et al. Cancer screening participation in schizophrenic outpatients and the influence of their functional disability on the screening rate: a cross-sectional study in Japan. Psychiatry Clin Neurosci. 2017;71:813–25.
25. World Health Organization; World Bank. World report on disability. Geneva: World Health Organization; 2011.
26. Diab ME, Johnston MV. Relationships between level of disability and receipt of preventive health services. Arch Phys Med Rehabil. 2004;85:749–57.
27. Chan L, Doctor JN, MacLehose RF, Lawson H, Rosenblatt RA, Baldwin LM, et al. Do Medicare patients with disabilities receive preventive services? A population-based study. Arch Phys Med Rehabil. 1999;80:642–6.
28. Ramjan L, Cotton A, Algoso M, Peters K. Barriers to breast and cervical cancer screening for women with physical disability: a review. Women Health. 2016;56:141–56.
29. Iezzoni LI, Kilbridge K, Park ER. Physical access barriers to care for diagnosis and treatment of breast cancer among women with mobility impairments. Oncol Nurs Forum. 2010;37:711–7.
30. O'Day BL, Killeen M, Iezzoni LI. Improving health care experiences of persons who are blind or have low vision: suggestions from focus groups. Am J Med Qual. 2004;19:193–200.
31. Iezzoni LI, O'Day BL, Killeen M, Harker H. Communicating about health care: observations from persons who are deaf or hard of hearing. Ann Intern Med. 2004;140:356–62.
32. Iezzoni LI, Kurtz SG, Rao SR. Trends in pap testing over time for women with and without chronic disability. Am J Prev Med. 2016;50:210–9.
33. Inagaki M, Fujiwara M, Nakaya N, Fujimori M, Higuchi Y, Hayashibara C, et al. Low cancer screening rates among japanese people with schizophrenia: a cross-sectional study. Tohoku J Exp Med. 2018;244:209–18.
34. Suh M, Choi KS, Park B, Lee YY, Jun JK, Lee DH, et al. Trends in cancer screening rates among Korean men and women: results of the Korean National Cancer Screening Survey, 2004–2013. Cancer Res Treat. 2016;48:1–10.

35. Iezzoni LI, Davis RB, Soukup J, O'Day B. Quality dimensions that most concern people with physical and sensory disabilities. Arch Intern Med. 2003;163:2085–92.
36. Lee HY, Park EC, Jun JK, Choi KS, Hahm MI. Comparing upper gastrointestinal X-ray and endoscopy for gastric cancer diagnosis in Korea. World J Gastroenterol. 2010;16:245–50.
37. Hamashima C. Update version of the Japanese Guidelines for Gastric Cancer Screening. Jpn J Clin Oncol. 2018;48:673–83.

Affiliations

YoungJee Kim[1] · Dong Wook Shin[1,2] · Hyoung Woo Kim[3] · Jin Hyung Jung[4] · Kyungdo Han[4] · In Young Cho[1] · So Young Kim[5,6,7] · Kui Son Choi[8] · Jong Heon Park[9] · Jong Hyock Park[5,7] · Ichiro Kawachi[7]

1 Department of Family Medicine/Supportive Care Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-Ro, Gangnam-gu, Seoul 06351, South Korea

2 Department of Digital Health, SAIHST, Sungkyunkwan University, Seoul, Korea

3 Department of Internal Medicine, Chungbuk National University Hospital, Chungbuk National University, Cheongju, Korea

4 Department of Medical Statistics, The Catholic University of Korea, Seoul, Korea

5 College of Medicine/Graduate School of Health Science Business Convergence, Chungbuk National University, Cheongju 28644, Korea

6 Chungbuk National University Hospital, Chungbuk National University, Cheongju, Korea

7 Harvard T.H. Chan School of Public Health, Harvard University, Cambridge, MA, USA

8 Department of Cancer Control and Population Health, Graduate School of Cancer Science and Policy, National Cancer Center, Goyang, Korea

9 Big Data Steering Department, National Health Insurance Service, Wonju, Korea