ORIGINAL ARTICLE



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

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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.

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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 agestandardized 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 disabilityrelated 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 499

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

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111.501 140.88 $219,299$ $265,451$ $268,755$ 362.965 333.0617 333.866 365.019 289 34.7 41.8 46.0 49.5 50.6 58.3 5.29 57.3 $29,500$ $29,840$ 36.253 $39,802$ $38,408$ $68,937$ 33.412 56.311 55.009 3195 3919 5916 7325 7480 15.465 9095 14.461 $16,178$ 10.8 13.11 16.3 18.4 19.5 22.4 27.2 25.7 29.4 66.933 66.612 80.709 86.044 80.233 14.1062 74.361 16.178 12.014 14.108 21.271 25.017 24.566 43.469 28.057 38.229 42.566 17.9 21.2 26.4 29.1 30.5 33.65 37.5 33.0 37.5 24.447 94.920 120.116	Eligible	385,844	405,858	525,085	577,075	543,099	717,773	567,142	630,876	636,546	641,440
289 34.7 41.8 46.0 49.5 50.6 58.3 52.9 57.3 29,500 29,840 36.253 39,802 38,408 68,937 33,412 56,311 55,009 3195 3919 5916 7325 7480 15,465 9095 14,461 16,178 3195 3919 5916 7325 7480 15,465 9095 14,461 16,178 3195 3919 5916 7325 7480 15,465 9095 14,461 16,178 66,993 66,612 80,709 86,044 80,233 141,062 74,800 115,873 113,418 12,014 14,108 21,271 25,017 24,506 43,469 28,057 33,0 37,5 17,9 21,2 26,4 29,1 36,509 37,5 33,0 37,5 17,9 21,2 25,017 24,506 43,469 28,057 33,0 37,5 25,506 28,445 <td>Screened</td> <td>111,591</td> <td>140,888</td> <td>219,299</td> <td>265,451</td> <td>268,755</td> <td>362,965</td> <td>330,617</td> <td>333,866</td> <td>365,019</td> <td>374,192</td>	Screened	111,591	140,888	219,299	265,451	268,755	362,965	330,617	333,866	365,019	374,192
29,500 $29,840$ $36,253$ $39,802$ $38,408$ $68,937$ $33,412$ $56,311$ $55,009$ 3195 3919 5916 7325 7480 $15,465$ 9095 $14,461$ $16,178$ 10.8 13.1 16.3 18.4 19.5 22.4 27.2 25.7 29.4 $66,993$ $66,612$ $80,709$ $86,044$ $80,233$ $141,062$ $74,800$ $115,873$ $113,418$ $12,014$ $14,108$ $21,271$ $25,017$ $24,506$ $43,469$ $28,057$ $38,229$ $42,566$ $17,9$ $21,12$ $26,4$ $29,1$ $30,5$ $30,8$ $37,5$ $33,0$ $37,5$ $94,477$ $94,920$ $120,116$ $128,062$ $119,078$ $18,4,595$ $115,904$ $158,297$ $158,574$ $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ $24,9$ $29,53$ $33,481$ $52,315$ $64,754$ $51,84,24$ $139,643$ $159,220$ $75,120$ $23,509$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,220$ $75,120$ $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ $23,509$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,220$ $75,120$ $25,335$ $33,481$ $52,315$ $65,39$ $20,796$ $78,572$ $79,960$	Crude rate	28.9	34.7	41.8	46.0	49.5	50.6	58.3	52.9	57.3	58.3
e $29,500$ $29,840$ $36,253$ $39,802$ $38,408$ $68,937$ $33,412$ $56,311$ $55,009$ ed 3195 3919 5916 7325 7480 $15,465$ 9095 $14,461$ $16,178$ nate 10.8 13.1 16.3 18.4 19.5 22.4 27.2 55.77 29.4 e $66,993$ $66,612$ $80,709$ $86,044$ $80,233$ $141,062$ $74,861$ $16,178$ e $66,993$ $66,612$ $80,709$ $86,044$ $80,233$ $141,062$ $74,860$ $113,418$ ed $12,014$ $14,108$ $21,271$ $25,017$ $24,595$ $33,229$ $42,566$ nute 17.9 21.2 $26,4$ $29,1$ $30,5$ 30.8 $37,5$ $33,20$ $37,5$ ed $23,506$ $28,077$ $30,7$ $41,66$ $41,06$ $45,566$ $42,566$ ed $23,569$	Grade 1 (most severe)										
ed 3195 3919 5916 7325 7480 $15,465$ 9095 $14,461$ $16,178$ rate 10.8 13.1 16.3 18.4 19.5 22.4 27.2 25.7 29.4 e $66,993$ $66,612$ 80.709 $86,044$ 80.233 $141,062$ $74,800$ $115,873$ $113,418$ e $66,993$ $66,612$ 80.709 $86,044$ $80,233$ $141,062$ $74,800$ $115,873$ $113,418$ ed 17.9 21.2 26.4 $29,11$ 30.5 30.8 37.5 33.229 $42,566$ rate 17.9 21.2 26.4 $29,11$ 30.5 30.8 37.5 33.0 37.5 e $94,447$ $94,920$ $120,116$ $128,062$ $119,078$ $184,595$ $115,904$ $158,297$ $158,574$ e $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $57,866$ $68,500$ $75,120$ e $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $57,866$ $47,44$ $57,866$ e $93,269$ $99,376$ $128,472$ $143,423$ $138,424$ $139,643$ $159,529$ $159,200$ e $93,369$ $32,318$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ rate $21,7$ $33,7$ $47,4$ $19,7$ $43,3$ $47,4$ $53,200$ e $93,286$ $90,286$ $139,643$ $159,529$ $159,2200$ <td>Eligible</td> <td>29,500</td> <td>29,840</td> <td>36,253</td> <td>39,802</td> <td>38,408</td> <td>68,937</td> <td>33,412</td> <td>56,311</td> <td>55,009</td> <td>55,674</td>	Eligible	29,500	29,840	36,253	39,802	38,408	68,937	33,412	56,311	55,009	55,674
rate 10.8 13.1 16.3 18.4 19.5 22.4 27.2 25.7 29.4 e 66.993 66.612 80.709 86.044 80.233 $141,062$ $74,800$ $115,873$ $113,418$ ed 12.014 $14,108$ $21,271$ $25,017$ $24,506$ $43,469$ $28,057$ $38,229$ $42,566$ nue 17.9 21.2 26.4 29.1 30.5 30.8 37.5 33.20 $42,566$ e $94,447$ $94,920$ $120,116$ $128,062$ $119,078$ $184,595$ $115,904$ $158,297$ $158,574$ e $94,447$ $94,920$ $120,116$ $128,062$ $138,148$ $184,595$ $115,904$ $158,529$ 47.4 e $94,920$ $120,116$ $128,062$ $41,6$ $41,0$ $49,9$ 47.4 47.4 e $93,269$ $99,376$ $128,472$ $141,6$ $41,0$ 49.9	Screened	3195	3919	5916	7325	7480	15,465	9095	14,461	16,178	16,162
e $66,993$ $66,612$ $80,709$ $86,044$ $80,233$ $141,062$ $74,800$ $115,873$ $113,418$ ed $12,014$ $14,108$ $21,271$ $25,017$ $24,506$ $43,469$ $28,057$ $38,229$ $42,566$ rate 17.9 21.2 26.4 29.1 30.5 30.8 37.5 33.0 37.5 e $94,447$ $94,920$ $120,116$ $128,062$ $119,078$ $184,595$ $115,904$ $158,297$ $158,574$ ed $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ ed $23,506$ $29,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ ed $23,506$ $29,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ ed $23,509$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,529$ $159,200$ ed $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ ed 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 ed 27.7 33.7 40.7 47.9 56.3 50.1 53.8 24.7 $132,662$ $25,113$ $20,722$ $20,722$ $20,722$ $20,723$ e $133,444$ $142,637$ $195,226$ 2	Crude rate	10.8	13.1	16.3	18.4	19.5	22.4	27.2	25.7	29.4	29.0
e $66,93$ $66,612$ $80,709$ $86,044$ $80,233$ $141,062$ $74,800$ $115,873$ $113,418$ ed $12,014$ $14,108$ $21,271$ $25,017$ $24,506$ $43,469$ $28,057$ $38,229$ $42,566$ nate 17.9 21.2 26.4 $29,1$ 30.5 30.8 37.5 33.29 $42,566$ ed $24,447$ $94,920$ $120,116$ $128,062$ $119,078$ $184,595$ $115,904$ $158,297$ $158,574$ ed $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ rate 24.9 $29,5$ 35.7 39.7 41.6 41.0 49.9 43.3 47.4 ed $23,506$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,529$ $159,200$ ed $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ ed 27.7 33.7 40.7 48.3 47.9 56.3 50.1 53.8 e $133,444$ $142,637$ $186,289$ $208,401$ $195,256$ $255,113$ $201,723$ $221,526$ $222,133$ inte 27.7 33.7 47.9 55.113 $201,723$ $221,526$ $222,133$	Grade 2										
ed $12,014$ $14,108$ $21,271$ $25,017$ $24,506$ $43,469$ $28,057$ $38,229$ $42,566$ rate 17.9 21.2 26.4 29.1 30.5 30.8 37.5 33.0 37.5 le $94,447$ $94,920$ $120,116$ $128,062$ $119,078$ $184,595$ $115,904$ $158,297$ $158,574$ le $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ rate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 le $93,269$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,529$ $159,200$ ed $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ ed 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 late 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 late $13,444$ $142,637$ $186,289$ $208,401$ $195,256$ $255,113$ $221,723$ $221,526$ $221,133$	Eligible	66,993	66,612	80,709	86,044	80,233	141,062	74,800	115,873	113,418	114,208
rate17.9 21.2 26.4 29.1 30.5 30.8 37.5 33.0 37.5 le $94,447$ $94,920$ $120,116$ $128,062$ $119,078$ $184,595$ $115,904$ $158,297$ $158,574$ led $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ led $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ nate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 le $93,269$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,529$ $159,200$ le $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ nate 27.7 33.7 40.7 48.3 47.9 56.3 50.1 53.8 le $133,444$ $142,637$ $186,289$ $208,401$ $195,256$ $255,113$ $201,723$ $221,526$ $222,133$	Screened	12,014	14,108	21,271	25,017	24,506	43,469	28,057	38,229	42,566	42,730
(e) 94,447 94,920 120,116 128,062 119,078 184,595 115,904 158,297 158,574 (ed) 23,506 28,047 42,921 50,900 49,587 75,654 57,866 68,500 75,120 rate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 (e) 93,269 99,376 128,472 143,423 138,148 188,424 139,643 159,529 159,200 (e) 25,835 33,481 52,315 64,754 66,793 90,286 78,572 79,960 85,669 rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 (e) 133,444 142,637 186,289 208,401 195,256 251,13 201,723 201,723 221,526 223,133	Crude rate	17.9	21.2	26.4	29.1	30.5	30.8	37.5	33.0	37.5	37.4
(a) 94,477 94,920 120,116 128,062 119,078 184,595 115,904 158,577 158,574 ed 23,506 28,047 42,921 50,900 49,587 75,654 57,866 68,500 75,120 rate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 rate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 iate 23,269 99,376 128,472 143,423 138,148 188,424 139,643 159,529 159,200 ed 25,835 33,481 52,315 64,754 66,793 90,286 78,572 79,960 85,669 rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 ister 27.7 33,744 142,637 186,289 208,401 195,256 255,113 201,723 221,526 223,133 </td <td>Grade 3</td> <td></td>	Grade 3										
ed $23,506$ $28,047$ $42,921$ $50,900$ $49,587$ $75,654$ $57,866$ $68,500$ $75,120$ rate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 (e) $93,269$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,529$ $159,200$ (e) $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 (e) $13,444$ $142,637$ $186,289$ $208,401$ $195,256$ $255,113$ $201,723$ $221,526$ $222,133$	Eligible	94,447	94,920	120,116	128,062	119,078	184,595	115,904	158,297	158,574	159,916
rate 24.9 29.5 35.7 39.7 41.6 41.0 49.9 43.3 47.4 le $93,269$ $99,376$ $128,472$ $143,423$ $138,148$ $188,424$ $139,643$ $159,529$ $159,200$ led $25,835$ $33,481$ $52,315$ $64,754$ $66,793$ $90,286$ $78,572$ $79,960$ $85,669$ rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 le $133,444$ $142,637$ $186,289$ $208,401$ $195,256$ $255,113$ $201,723$ $221,526$ $222,133$	Screened	23,506	28,047	42,921	50,900	49,587	75,654	57,866	68,500	75,120	75,724
(e) 93,269 99,376 128,472 143,423 138,148 188,424 139,643 159,529 159,200 red 25,835 33,481 52,315 64,754 66,793 90,286 78,572 79,960 85,669 rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 ie 133,444 142,637 186,289 208,401 195,256 255,113 201,723 221,526 222,133	Crude rate	24.9	29.5	35.7	39.7	41.6	41.0	49.9	43.3	47.4	47.4
e 93,269 99,376 128,472 143,423 138,424 139,643 159,529 159,200 ed 25,835 33,481 52,315 64,754 66,793 90,286 78,572 79,960 85,669 rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 e 133,444 142,637 186,289 208,401 195,256 255,113 201,723 221,526 222,133	Grade 4										
ed 25,835 33,481 52,315 64,754 66,793 90,286 78,572 79,960 85,669 rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 e 133,444 142,637 186,289 208,401 195,256 255,113 201,723 221,526 222,133	Eligible	93,269	99,376	128,472	143,423	138,148	188,424	139,643	159,529	159,200	157,409
rate 27.7 33.7 40.7 45.1 48.3 47.9 56.3 50.1 53.8 e 133,444 142,637 186,289 208,401 195,256 255,113 201,723 221,526 222,133	Screened	25,835	33,481	52,315	64,754	66,793	90,286	78,572	79,960	85,669	85,408
e 133,444 142,637 186,289 208,401 195,256 255,113 201,723 221,526 222,133	Crude rate	27.7	33.7	40.7	45.1	48.3	47.9	56.3	50.1	53.8	54.3
133,440 142,637 186,289 208,401 195,256 255,113 201,723 221,526 222,133	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 Number of eligible and screened subjects based on the presence, severity, and type of disability over a 10-year period

Year Year <t< th=""><th>Table 1 (continued)</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>	Table 1 (continued)										
2006 2007 2008 2004 2017 2014 2013 2014 <th< th=""><th></th><th>Year</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>		Year									
99.31 80.326 78,63 96,85 91,364 129,341 117,442 117,342 127,394 vevel 159,131 (6.3,845 210,324 225,521 209,695 274,236 235,716 249,821 235,213 vevel 159,131 (6.3,845 210,324 225,521 209,695 274,236 235,716 249,821 235,213 vevel 333,92 355,082 46,10 105,842 206,851 470,446 656,672 480,56 244,991 vevel 333,922 355,082 46,13 301,412 453,33 314,264 353,37 vevel 333,922 355,082 470,446 656,672 480,36 343,37 344,991 vevel 333,92 355,01 374,41 303 353,33 344,254 353,33 344,354 vevel 64,811 64,821 303,357 344,341 343,37 344,364 353,37 vevel 64,811 64,83 33,33 344,33 <		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
205 353 4.22 4.65 4.90 5.07 5.30 5.74 werd) 19,11 163,845 210,344 225,251 299,695 274,256 299,21 255,213 46,415 57,081 88,321 10,842 10,458 141,338 13,4603 13,5518 151,956 99,92 135,151 10,2602 233,341 20,441 64,67 24,66 54,57 29,52 54,493 54,56 59,53 99,92 135,151 10,2602 233,341 27,616 65,677 480,686 54,370 34,491 54,0 59,5 54,450	Screened	39,351	50,326	78,663	96,855	97,364	129,341	117,442	117,388	127,394	129,979
wttp j< j< </td <td>Crude rate</td> <td>29.5</td> <td>35.3</td> <td>42.2</td> <td>46.5</td> <td>49.9</td> <td>50.7</td> <td>58.2</td> <td>53.0</td> <td>57.4</td> <td>58.3</td>	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)										
46,405 57,081 88,321 103,842 04,405 57,081 88,321 103,842 104,305 134,605 136,518 131,956 355 29,2 34,8 42.0 46,11 49.9 52.3 840,667 54,66 59,5 544,003 59,5 99,492 123,519 192,650 588,51 470,446 65,667 840,667 54,837 344,75 99,492 123,519 122,534 223,344 53,6697 38,437 34,475 54,063 57,73 28,11 33,88 41,2 35,76 38,412 75,513 80,953 104,066 103,871 9 64,811 65,889 82,166 87,561 80,953 14,455 76,60 54,475 46,9 50,9 9 61,760 66,420 85,76 95,43 40,40 54,03 53,06 103,871 9 61,760 64,81 45,3 53,0 40,42 54,475 47,650 53,494 50,9 <td>Eligible</td> <td>159,131</td> <td>163,845</td> <td>210,324</td> <td>225,251</td> <td>209,695</td> <td>274,236</td> <td>225,776</td> <td>249,821</td> <td>255,213</td> <td>261,242</td>	Eligible	159,131	163,845	210,324	225,251	209,695	274,236	225,776	249,821	255,213	261,242
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Screened	46,405	57,081	88,321	103,842	104,598	143,338	134,603	136,518	151,956	158,805
W 333.952 365.082 467.830 508.551 470.446 626.672 480.686 543.872 544.991 99.492 123.519 192.620 222.384 222.615 316.697 28.63 283.370 314.264 28.1 33.8 41.2 45.7 99.4 50.5 58.8 53.0 57.7 28.1 53.8 82.166 87.561 80.922 113.252 84.837 99.623 99.817 18.092 22.049 32.624 38.142 37.581 53.014 46.952 49.4 53.0 53.63 7 01.706 66.420 85.766 95.432 90.706 124.096 99.87 99.4 54.0 7 01.706 66.420 85.766 95.432 90.706 124.096 99.87 94.4 54.0 7 01.706 24.98 53.04 46.9 57.3 49.4 54.0 53.863 7 17.206 2195 47.5 44.75 <td>Crude rate</td> <td>29.2</td> <td>34.8</td> <td>42.0</td> <td>46.1</td> <td>49.9</td> <td>52.3</td> <td>59.6</td> <td>54.6</td> <td>59.5</td> <td>60.8</td>	Crude rate	29.2	34.8	42.0	46.1	49.9	52.3	59.6	54.6	59.5	60.8
33.952 365.082 467.800 506.551 470.446 6.56.672 480.686 54.872 544.901 9.442 13.3 11.2 12.5.130 125.610 232.344 233.616 243.85 53.0 57.7 28.1 33.8 11.2 45.7 49.4 50.5 58.8 53.0 57.7 28.1 64.811 65.889 82.166 87.361 30.922 113.222 84.837 99.623 59.81 18.000 232.09 82.166 87.361 37.351 51.4 46.9 55.3 49.20 57.7 27.9 33.0 39.1 43.4 46.8 55.3 49.4 54.0 57.6 27.9 33.0 39.1 42.1 44.8 45.9 54.4 54.0 57.3 27.9 33.0 39.1 42.1 44.8 55.3 49.4 54.0 57.7 27.9 33.0 39.1 42.1 44.8 57.4 46.6	By disability type										
52 $365,082$ $47,830$ $508,551$ $470,446$ $626,672$ $480,686$ $543,872$ $544,901$ 2 $123,519$ $192,620$ $223,384$ $232,615$ $316,697$ $228,554$ $288,8730$ $314,264$ 2 $123,519$ $192,620$ $223,384$ $232,615$ $316,697$ $288,8730$ $314,264$ 2 $220,99$ $32,624$ $38,142$ $37,581$ $53,014$ 46952 $49,4$ $54,0$ 2 $220,99$ $32,624$ $38,142$ $37,581$ $53,014$ 46952 $49,4$ $54,0$ 3 $32,524$ $40,4$ 46.8 $55,3$ $49,4$ $54,0$ $53,63$ 9 $66,420$ $85,462$ $95,432$ $90,706$ $124,064$ $54,0$ $50,9$ $33,0$ $41,37$ $46,79$ $46,8952$ $49,47$ $54,0$ $50,9$ $33,0$ $31,17$ $42,19$ $46,952$ $49,47$ $54,0$ $52,9$	Physical disability										
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Eligible	353,952	365,082	467,830	508,551	470,446	626,672	480,686	543,872	544,991	544,281
33.8 41.2 45.7 49.4 50.5 58.8 53.0 57.7 1 65.89 82.166 87,561 80.952 113.252 84.837 99.623 99.83 2 32.049 32.624 38.142 37.581 80.952 113.252 84.837 99.623 99.83 3 33.5 32.643 87.46 95.432 90.706 124.096 90.879 104.086 103.871 9 6.6420 85.766 95.432 90.706 124.096 90.879 104.086 103.871 9 6.0420 85.766 95.432 90.706 124.096 90.879 104.086 103.871 9 6.0420 85.766 95.432 90.706 124.096 90.879 104.086 103.871 33.0 21.94 45.3 53.67 43.39 52.4 46.6 50.9 33.0 124.01 155.2 184.8 885.4 46.9 60.7 61.4	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										
2 2.049 3.264 38.142 $3.7.81$ 53.014 46.922 49.200 53.863 33.5 39.7 43.6 46.4 46.8 55.3 49.4 54.0 33.5 39.7 43.6 95.432 90.706 124.096 98.796 103.871 0 21.951 33.508 40.223 40.642 54.475 47.630 48.534 50.9 33.0 39.1 42.1 44.8 6854 4609 6067 6104 3567 4337 4679 488 8534 4609 6067 6104 909 1240 1552 1848 6854 4609 6067 6104 909 1240 1558 2396 1974 2381 2527 1130 1639 2213 2158 2366 2916 2114 555 2866 31.77 2213	Eligible	64,811	65,889	82,166	87,561	80,952	113,252	84,837	99,623	99,817	101,619
33.5 39.7 43.6 46.4 46.8 55.3 49.4 540 90 66.420 85.766 95.432 90.706 124.096 90.879 104.086 103.871 00 21.951 33.508 40.223 40.642 54.475 47.630 48.534 52.876 33.0 39.1 42.1 44.8 6854 4609 6067 6104 33.0 124.00 1552 1588 2396 1974 2381 527 909 1240 1552 1588 2396 1974 2381 5257 255 286 33.2 5581 6959 7771 7651 2381 2381 2377 389 1130 1639 2213 2185 9395 3210 923 11.840 1130 1639 2213 2865 3201 923 30.418 <t< td=""><td>Screened</td><td>18,092</td><td>22,049</td><td>32,624</td><td>38,142</td><td>37,581</td><td>53,014</td><td>46,952</td><td>49,200</td><td>53,863</td><td>55,569</td></t<>	Screened	18,092	22,049	32,624	38,142	37,581	53,014	46,952	49,200	53,863	55,569
9 66,420 85,766 95,432 90,706 124,096 90,879 104,086 103,871 0 21,951 33,508 40,223 40,642 54,475 47,530 48,534 52,876 33.0 39.1 42.1 44.8 439 52,475 47,630 48,534 5,399 3567 4337 4679 44.8 6854 4609 6067 6104 909 1240 1552 1588 2396 1974 2381 2527 909 1240 1552 1588 2396 1974 2381 2527 909 1240 1552 1588 2396 1974 2381 2527 9130 1130 16959 7771 7651 29,658 8880 29,180 30,418 1130 1639 21135 2185 9395 317 36,0 30,418 1130 1639 21,957 21,658 8880 29,180 3	Crude rate	27.9	33.5	39.7	43.6	46.4	46.8	55.3	49.4	54.0	54.7
9 $66,420$ $85,766$ $95,432$ $90,706$ $124,096$ $90,879$ $104,086$ $103,871$ 33.0 39.1 42.1 44.8 $54,475$ $47,630$ $48,534$ $52,876$ 50.9 33.0 39.1 42.1 44.8 $53,475$ $47,630$ $48,534$ $52,876$ 50.9 3567 4337 4679 44.8 6854 4609 6067 6104 3567 4337 4679 4488 6854 4609 6067 6104 3567 4337 4679 4488 6854 4609 6067 6104 909 1240 1552 1588 2396 1974 2381 2277 2558 2866 31.7 350 22.186 31.7 360 30.418 1130 1639 2213 2185 2955 32.11 32.11 $32.11,30$ $11,218$	Hearing disability										
0 $21,951$ $33,508$ $40,223$ $40,642$ $54,475$ $47,630$ $48,534$ $52,876$ 33.0 39.1 42.1 44.8 43.9 52.4 46.6 50.9 3567 4337 4679 44.8 6854 4609 6067 6104 909 1240 1552 1588 2396 1974 2381 2527 909 1240 1552 1588 2396 1974 2381 2527 909 1240 1552 1588 2396 1974 2381 2527 909 1240 1552 35.4 350 42.8 392 41.4 1130 1639 2213 2185 9395 3201 9823 11.840 1130 1639 2213 2185 9395 3217 38.9 2022 23.6 21.7602 91.22 31.217	Eligible	61,769	66,420	85,766	95,432	90,706	124,096	90,879	104,086	103,871	103, 131
330 39.1 42.1 44.8 43.9 52.4 46.6 50.9 3567 4337 4679 4488 6854 4609 6067 6104 909 1240 1552 1588 2396 1974 2381 2527 25.5 28.6 33.2 35.4 35.0 42.8 39.2 41.4 130 1639 7771 7651 29,658 8880 29,180 30,418 5581 6959 7771 7651 29,658 8880 29,180 30,418 1130 1639 2213 2185 9395 3201 9823 11,840 202 23.6 31.7 36.0 33.7 38.9 203 58.144 73,072 80,235 79,947 115,967 74,602 93,301 203 58.144 73,072 80,235 79,947 115,967 74,602 91,320 11,218 17,486 21,098 21,976	Screened	17,260	21,951	33,508	40,223	40,642	54,475	47,630	48,534	52,876	52,945
3567 437 4679 488 6854 4609 6067 6104 909 1240 1552 1588 2396 1974 2381 2527 25.5 28.6 33.2 35.4 35.0 42.8 392 41.4 25.5 28.6 33.2 35.4 35.0 42.8 392 41.4 5581 6959 7771 7651 29.658 8880 29.180 30.418 5581 6959 7771 7651 29.658 8880 29.180 30.418 5581 6959 7771 7651 29.658 32.01 9823 11.840 202 23.6 28.5 28.6 31.77 36.0 33.7 38.9 130 1639 221.3 2185 31.217 25.801 30.301 11.218 17.486 21.098 21.976 31.217 25.807 30.01 33.20 12.1 3.3 23.9 <	Crude rate	27.9	33.0	39.1	42.1	44.8	43.9	52.4	46.6	50.9	51.3
3493 3567 4337 4679 4488 6854 4609 6067 6104 705 909 1240 1552 1588 2396 1974 2381 2527 20.2 25.5 28.6 33.2 35.4 35.0 42.8 39.2 41.4 5510 5581 6959 7771 7651 $29,658$ 8880 $29,180$ $30,418$ 5510 5581 6959 7771 7651 $29,658$ 8880 $29,180$ $30,418$ 583 11300 1639 2213 2185 9395 3201 9823 $11,840$ 5633 $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 55533 $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 55533 $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 55533 $58,144$ $73,072$ $20,93$ $21,976$ $31,217$ $25,801$ $28,007$ $30,301$ 55533 $58,144$ $73,072$ $21,976$ $31,217$ $25,801$ $28,007$ $30,301$ 55533 $58,144$ $73,072$ $21,976$ $31,217$ $25,801$ $28,007$ $30,301$ 55533 $58,144$ $73,072$ $21,976$ $31,217$ $25,801$ $28,007$ $30,301$ 550 77 $22,992$ $27,5$ $26,9$ 3	Speech and language d	lisability									
705909124015521588239619742381252720.225.528.633.235.435.042.839.241.45510558169597771765129,658888029,18030,4185510558169597771765129,658888029,18030,4185510558116392213218593953201982311,84016.020.223.628.528.631.736.033.738.91jury55,53358,14473,07280,23579,947115,96774,60293,07291,32055,53358,14473,07280,23579,947115,96774,60293,07291,320887611,21817,48621,09821,97631,21725,80128,00730,30116.019.323.926.327.526.934.630.133.216.019.37221654225665213347126992134712692223.81013722169422566521347126922201331.223.226.934.630.133.21013722 <td>Eligible</td> <td>3493</td> <td>3567</td> <td>4337</td> <td>4679</td> <td>4488</td> <td>6854</td> <td>4609</td> <td>6067</td> <td>6104</td> <td>6584</td>	Eligible	3493	3567	4337	4679	4488	6854	4609	6067	6104	6584
20.2 25.5 28.6 33.2 35.4 35.0 42.8 39.2 41.4 5510 5581 6959 7771 7651 $29,658$ 8880 $29,180$ $30,418$ 833 1130 1639 2213 2185 9395 3201 9823 $11,840$ 160 20.2 23.6 28.5 28.6 31.7 36.0 33.7 38.9 $191y$ $55,533$ $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ $55,533$ $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ $55,533$ $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 8876 $11,218$ $17,486$ $21,098$ $21,976$ $31,217$ $25,801$ $28,007$ $30,301$ 16.0 19.3 23.9 26.3 27.5 26.9 34.6 30.1 33.2 16.0 19.3 7 22 16 54 22 56 65 10 13 7 22 16 9 9 21.36 92 10 13 7 22 16 54 22 56 65 10 $31,217$ $25,801$ $20,17$ $30,301$ $30,301$ 11 3 7 22 16 9 22 56 65 11 3 4 </td <td>Screened</td> <td>705</td> <td>606</td> <td>1240</td> <td>1552</td> <td>1588</td> <td>2396</td> <td>1974</td> <td>2381</td> <td>2527</td> <td>2825</td>	Screened	705	606	1240	1552	1588	2396	1974	2381	2527	2825
55105581 6959 7771 7651 $29,658$ 8880 $29,180$ $30,418$ 8831130163922132185 9395 3201 9823 11,84016.020.223.628.528.6 31.7 36.0 33.7 38.9 11.020.223.628.528.6 31.7 36.0 33.7 38.9 11.173,072 $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 55,53358,14473,072 $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 55,53358,14473,072 $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 887611,21817,48621,09821,976 $31,217$ $25,801$ $28,007$ $30,301$ 16.019.323.926.327.5 26.9 34.6 30.1 33.2 16.01372216 54 22 56 65 2134712 6 9 22 20.07.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Crude rate	20.2	25.5	28.6	33.2	35.4	35.0	42.8	39.2	41.4	42.9
5510 5581 6959 7771 7651 $29,658$ 8880 $29,180$ $30,418$ 883 1130 1639 2213 2185 9395 3201 9823 $11,840$ 160 20.2 23.6 23.5 28.5 28.6 31.7 36.0 33.7 38.9 $1jury$ $55,533$ $58,144$ $73,072$ $80,235$ $79,947$ $115,967$ $74,602$ $93,072$ $91,320$ 8876 $11,218$ $17,486$ $21,098$ $21,976$ $31,217$ $25,801$ $28,007$ $30,301$ 16.0 19.3 23.9 26.3 27.5 26.9 $34,6$ 30.1 33.2 16.0 19.3 23.9 26.3 27.5 26.9 $34,6$ 30.1 33.2 16.0 19.3 23.9 26.3 27.5 26.9 $34,6$ 30.1 33.2 16.0 13 7 22 16 54 22 56 65 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Intellectual disability										
883 1130 1639 2213 2185 9395 3201 9823 11,840 16.0 20.2 23.6 28.5 28.6 31.7 36.0 33.7 38.9 njury 55,533 58,144 73,072 80,235 79,947 115,967 74,602 93,072 91,320 8876 11,218 17,486 21,098 21,976 31,217 25,801 28,007 30,301 16.0 19.3 23.9 26.3 27.5 26.9 34,6 30.1 33.2 16.0 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Eligible	5510	5581	6959	7771	7651	29,658	8880	29,180	30,418	32,241
16.0 20.2 23.6 28.5 28.6 31.7 36.0 33.7 38.9 njury 55,533 58,144 73,072 80,235 79,947 115,967 74,602 93,072 91,320 55,533 58,144 73,072 80,235 79,947 115,967 74,602 93,072 91,320 8876 11,218 17,486 21,098 21,976 31,217 25,801 28,007 30,301 16.0 19.3 23.9 26.3 27.5 26.9 34.6 30.1 33.2 16.0 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Screened	883	1130	1639	2213	2185	9395	3201	9823	11,840	12,202
jury jury 55,533 58,144 73,072 80,235 79,947 115,967 74,602 93,072 91,320 8876 11,218 17,486 21,098 21,976 31,217 25,801 28,007 30,301 16.0 19.3 23.9 26.3 27.5 26.9 34,6 30.1 33.2 10 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Crude rate	16.0	20.2	23.6	28.5	28.6	31.7	36.0	33.7	38.9	37.9
55,533 58,144 73,072 80,235 79,947 115,967 74,602 93,072 91,320 8876 11,218 17,486 21,098 21,976 31,217 25,801 28,007 30,301 16.0 19.3 23.9 26.3 27.5 26.9 34,6 30.1 33,22 10 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Disability due to brain	injury									
8876 11,218 17,486 21,098 21,976 31,217 25,801 28,007 30,301 16.0 19.3 23.9 26.3 27.5 26.9 34.6 30.1 30.3 16.0 19.3 23.9 26.3 27.5 26.9 34.6 30.1 33.2 10 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Eligible	55,533	58,144	73,072	80,235	79,947	115,967	74,602	93,072	91,320	92,179
16.0 19.3 23.9 26.3 27.5 26.9 34.6 30.1 33.2 10 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Screened	8876	11,218	17,486	21,098	21,976	31,217	25,801	28,007	30,301	30,808
10 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Crude rate	16.0	19.3	23.9	26.3	27.5	26.9	34.6	30.1	33.2	33.4
10 13 7 22 16 54 22 56 65 2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Disability due to autisr	ц									
2 1 3 4 7 12 6 9 22 20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Eligible	10	13	7	22	16	54	22	56	65	81
20.0 7.7 42.9 18.2 43.8 22.2 27.3 16.1 33.8	Screened	2	1	б	4	7	12	9	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

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2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		2010 10,491 3286 31.3 3286 31.3 3286 21.1 4578 1795 39.2 39.2 39.2 39.2 38.8	2011 14,787 14,787 34.5 34.5 5748 21.9 21.9 2019 40.1 7273 7273	2012 10,918 4.313 39.5 18,289 5361 29.3 3059 1533 50.1 4488	2013 38,981 13,524 34.7 25,057 6619 26.4	2014 39,492 15,713 39.8 26,385	2015 41,254 15,657
6208 8567 9949 10,491 1342 2366 3108 3286 21.6 27.6 31.2 31.3 21.6 27.6 31.2 31.3 10,916 13,957 15,919 16,735 11.84 2148 2929 3529 10.8 15.4 18.4 21.1 11.84 2148 2929 3529 11.84 2144 1795 3.2 11.33 1740 2144 1795 26.7 33.0 38.2 39.2 1133 1740 2144 1795 26.7 33.0 38.2 39.2 1133 1740 2144 1795 26.7 33.0 38.2 39.2 1090 16666 1936 1663 25.3 31.5 564 648 21.1 23.9 38.8 2715 22.7 43.5 564 648		10,491 3286 31.3 16,735 3529 3529 21.1 21.1 21.1 23.2 39.2 5063 38.8	42,803 14,787 34.5 26,202 5748 5748 21.9 2019 40.1 7273 7273	10,918 4313 39.5 18,289 5361 29.3 50.1 4488	38,981 13,524 34.7 25,057 6619 26.4	39,492 15,713 39.8 26,385	41,254 15,657
5 6208 8567 9949 $10,491$ 0 1342 2366 3108 3286 74 21.6 27.6 31.2 31.3 74 $10,916$ $13,957$ $15,919$ $16,735$ 1184 2148 2929 3529 1184 2148 2929 3529 1184 2148 2929 3529 1184 2148 2929 3529 1184 2148 2929 3529 1133 1740 2144 1795 1133 1740 2144 1795 1133 1740 2144 1795 1133 1740 2144 1795 1090 1666 1936 963 1133 1740 2144 1795 1090 1666 1936 963 1133 1740 2144 1795 1090 1666 1936 963 1090 1666 1936 963 1090 1666 1936 2715 121 2233 31.5 34.9 38.8 121 229 275 302 121 229 275 302 121 229 275 302 121 229 275 302 121 229 275 302 121 229 275 302 121 248 5026 4906 106 1163 1447 4147 <		10,491 3286 31.3 16,735 3529 3529 21.1 4578 1795 39.2 39.2 5063 1963	42,803 14,787 34.5 26,202 5748 21.9 2019 40.1 7273 7273	10,918 4313 39.5 18,289 5361 29.3 3059 1533 50.1 4488	38,981 13,524 34.7 25,057 6619 26.4	39,492 15,713 39.8 26,385	41,254 15,657
		3286 31.3 16,735 3529 21.1 21.1 4578 1795 39.2 39.2 5063 38.8	14.787 34.5 26,202 5748 21.9 2019 40.1 7273 7273	4313 39.5 18,289 5361 29.3 3059 1533 50.1 4488	13,524 34.7 25,057 6619 26.4	15,713 39.8 26,385	15,657
1 21.6 27.6 31.2 31.3 74 10.916 13.957 15.919 16.735 1184 2148 2929 3529 10.8 15.4 18.4 21.1 as 12.42 5275 5610 4578 1133 1740 2144 1795 1133 1740 2144 1795 1133 1740 2144 1795 1133 1740 2144 1795 1090 1666 1936 963 1090 1666 1936 1963 1090 1666 1936 1963 25.3 31.5 34.9 38.8 25.3 31.5 34.9 38.8 1090 1666 1936 1963 121 2338 2549 2715 261 2533 275 302 13.7 18.4 22.1 23.9 rement 432 600 644 631 rement 223 423 423 32.2 28.0 38.2 42.7 47.9 28.13 4686 5026 4906 5 3813 4686 5026 4906 5 201 24.8 28.8 302 601 1647 1447 1481 766 1163 1447 1481 766 1163 1447 1481 766 1163 1447 1481		31.3 16,735 3529 21.1 4578 1795 39.2 5063 1963 38.8	34.5 26,202 5748 21.9 5040 2019 40.1 7273 7273	39.5 18,289 5361 29.3 3059 1533 50.1 4488	34.7 25,057 6619 26.4	39.8 26,385	
74 10,916 13,957 15,919 16,735 1184 2148 2929 3529 10,8 15,4 18,4 21,1 ns 10,8 15,4 18,4 21,1 ns 22,57 5610 4578 31,1 11 4242 5275 5610 4578 1133 1740 21,44 1795 39,2 coblems 33,0 38,2 39,2 39,2 t 4314 5284 5551 5063 1963 t 1090 1666 1936 1963 38,8 t 25.3 31,5 34,9 38,8 38,8 t 1651 2358 2549 56,4 64 t 1651 2358 2549 2715 23,9 terment 43,4 18,4 22,1 23,9 24,9 24,9 terment 28,0 600 644 631 23,9 30,2 terment 28,0 38,2 42,7 47,9		16,735 3529 21.1 4578 1795 39.2 5063 1963 38.8	26,202 5748 21.9 5040 2019 40.1 7273 7273	18,289 5361 29.3 3059 1533 50.1 4488	25,057 6619 26.4	26,385	38.0
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3655 3813 4686 5026 4906 584 766 1163 1447 1481 16.0 20.1 24.8 28.8 30.2							
584 766 1163 1447 1481 16.0 20.1 24.8 28.8 30.2		4906	6367	4863	5512	5628	5751
16.0 20.1 24.8 28.8 30.2		1481	1943	1887	1967	2192	2326
		30.2	30.5	38.8	35.7	38.9	40.5
Epilepsy disability							
Eligible 902 958 1299 1484 1493 3523		1493	3523	1414	2643	2638	2651
Screened 242 322 540 674 730 1589		730	1589	817	1293	1424	1463
Crude rate 26.8 33.6 41.6 45.4 48.9 45.1	-	48.9	45.1	57.8	48.9	54.0	55.2

Table 1 (continued)

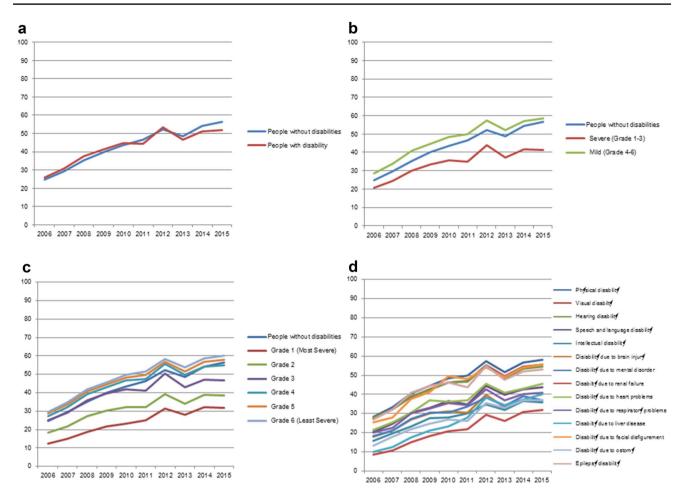


Fig. 1 Gastric cancer screening rate according to the presence, severity, and type of disability from 2006 to 2015

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 21.4 to 45.4%, change: +20.2%) 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

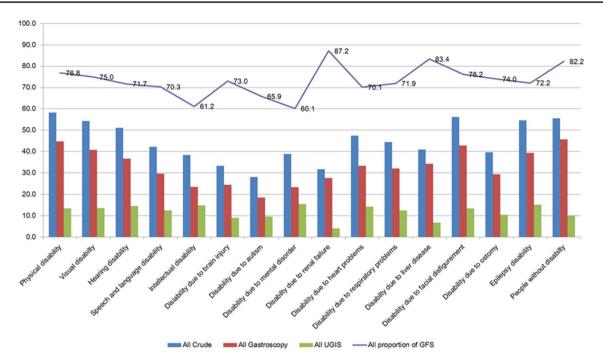


Fig. 2 Gastric cancer screening rate and modality by the type of disability in 2014–2015

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 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,

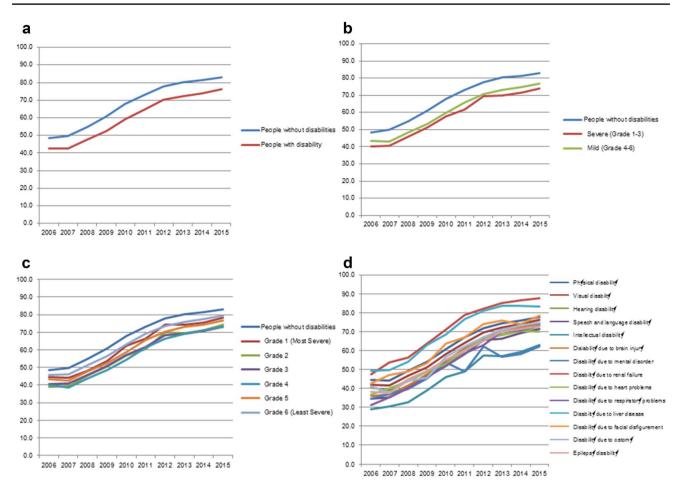


Fig. 3 Trend in gastric cancer screening modality by the type of disability

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.

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Compliance with ethical standards

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

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